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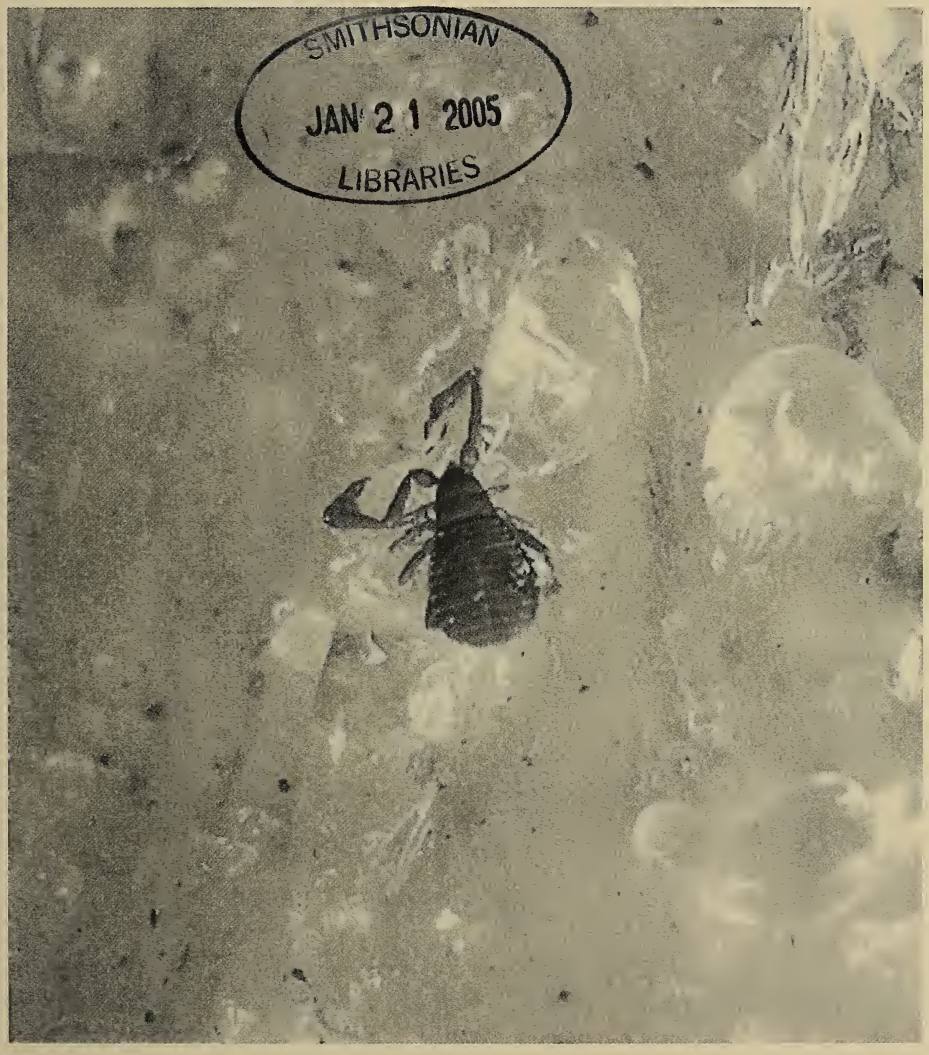

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Cover photo: Pseudoscorpion (Cheliferoidea) trapped in the sap of an Engelmann Spruce (*Picea engelmannii*), Yellowstone National Park. Photo by Jeremy Miller, Washington, D.C.

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A REVIEW OF THE CHINESE NURSERY-WEB SPIDERS (ARANEAE, PISAURIDAE)

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ABSTRACT. The present paper deals with nine genera and 32 species of the family Pisauridae from China, including two new genera, *Dianpisaura* (type species, *Pisaura lizhii* Zhang 2000) and *Qianlingula* (type species, *Qianlingula bilamellata* new species), and 11 new species, *Dolomedes costatus*, *D. raptoroides*, *Eurychoera banna*, *Hygropoda argentata*, *H. campanulata*, *H. menglun*, *H. yunnan*, *Qianlingula bilamellata*, *Q. jiafu*, *Q. turbinata* and *Thalassius paralbocinctus*. The genus *Eurychoera* Thorell 1897 and the species *Perenethis sindica* (Simon 1897) are newly recorded from China. The males of the species *Dianpisaura lizhii* (Zhang 2000) and *Dolomedes mizhoanus* Kishida 1936 are described for the first time. The study indicates that *Thalassius bottrelli* Barrion & Litsinger 1995 and *T. balingkinitanus* Barrion & Litsinger 1995 from the Philippines should be transferred to the genus *Hygropoda*. The species *Dolomedes insurgens* Chamberlin 1924 and *D. pallitarsis* Dönitz & Strand 1906 are shown to be the junior synonyms of *D. saganus* Bösenberg & Strand 1906, and the species *D. strandi* Bonnet 1929 is considered to be a junior synonym of *D. senilis* Simon 1880. Scanning electron microscopy is used to study the spigot morphology of several pisaurids. The SEM results indicate the differences of pisaurid spigots at the generic level, both in shape and numbers. A cladistic analysis of 21 species from China is presented.

Keywords: Araneae, Pisauridae, Asia, taxonomy, new species

The family Pisauridae, commonly called nursery-web spiders, currently contains 51 genera and more than 330 species (Platnick 2002). Members of the family are distributed worldwide and vary in habitus, size and life style. For example, members of the genera *Dolomedes* Latreille 1804 and *Thalassius* Simon 1885 are large species (body length up to 30 mm) hunting on the surface of freshwater ponds or streams, whereas species of the genera *Eurychoera* Thorell 1897 and *Polyboea* Thorell 1895 are much smaller (body length 10 mm or so) and hunt on permanent webs.

Ever since the family Pisauridae was erected by Simon in 1890, many species and genera have been reported. But most of these descriptions lack valuable illustrations of diagnostic characters, such as the female epigynum and the male palpal organ. For example, the result of a recent systematic study indicated that among the 34 specific names applied to nearctic spiders of the genus *Dolomedes*, only seven of them were valid (Carico 1973). Fortunately, some genera from North America and Africa have been revised recently by Carico (1972, 1973, 1976, 1981), Blandin (1975, 1976, 1977) and Sierwald (1987). But most Asian pisaurid species are so poorly known that revisionary work is highly desirable.

As Sierwald (1997) pointed out, the main systematic problem of this family concerns the delineation of the Pisauridae and the definition of subfamilies. Unfortunately, no synapomorphies have been recognized for at least the majority of pisaurid genera that could distinguish them as a single clade. Recent progress in systematic studies has identified 10 genera of this family as a monophyletic clade and placed them in the re-erected South American family Trechaleidae Simon 1890 (Sierwald 1990; Carico 1993).

To date, 10 genera and 33 species have been described from China (Song et al. 1999; Platnick 2002; Zhang & Zhang 2003), including two new genera and 11 new species from this study. The monotypic genus *Archipirata* Simon 1898, from Turkmenistan and China, is not included in this study because of the lack of material.

METHODS

All measurements given are in mm. Palp measurements are shown as: total length (fe-

mur, patella, tibia, tarsus). Leg measurements are shown as: total length (femur, patella and tibia, metatarsus, tarsus). Terms used in this study are as follows: Eye: ALE = anterior lateral eye; AME = anterior median eye; MOA = median ocular area; PLE = posterior lateral eye; PME = posterior median eye. Spinneret and spigot: AC = aciniform gland spigot; ALS = anterior lateral spinneret; CY = cylindrical gland spigot; MAP = major ampullate gland spigot; mAP = minor ampullate gland spigot; N = nubbin; PI = piriform gland spigot; PLS = posterior lateral spinneret; PMS = posterior median spinneret. Female copulatory organ: ab = accessory bulb; al = anterior lobe; bor = basal oblique rumple of lateral lobe; bs = base of spermatheca; ca = carina; cd = copulatory duct; fd = fertilization duct; fo = fossa, small epigynal pit; hs = head of spermatheca; lad = large anterior depression; ll = lateral lobe; mf = median field; mlr = mesal longitudinal ridge of median field; ss = stalk of spermatheca. Male copulatory organ: bac = basal apophysis of cymbium; bpe = basal projection of embolus; bpt = basal protuberance of tegulum; bsa = bulbous section of apical division in *Dianpisaura* and *Pisaura*; c = conductor; da = distal apophysis; dtp = distal tegular projection; e = embolus; ful = fulcrum; gl = guiding lamellae of conductor; ma = median apophysis; mae = membrane accompanied with embolus; sa = saddle in *Dolomedes*; st = subtegulum; t = tegulum; ta = tibial apophysis.

The material used in this study belongs to the following institutions: Museum of Hebei University, Baoding, China (MHU, M. S. Zhu); Institute of Zoology, Academia Sinica, Beijing, China (IZB, L. J. Jia); Guangxi University, Nanning, China (GU, Y. Q. Zhang); Department of Biology, Inner Mongolia Normal University, Huhhot, China (BIMN, G. M. Tang); Faculty of Life Sciences, Hubei University, Wuhan, China (LSHU, F. X. Liu); Department of Biology, Tunghai University, Taichong, Taiwan (BTU, I. M. Tso).

RESULTS

Spinneret morphology.—The female spinneret morphology of 17 species from China was studied using scanning electron microscopy. The photos of 16 species belonging to nine pisaurid genera and one lycosid genus are presented here for further comparison.

ALS with two MAP and many PI (e.g., Figs. 177–179, 183, 184, 207, 208, 215, 216, 221, 222, 251, 252, 257, 258, 263, 264). The nubbin rooted in one reduced MAP in *Eurychoera* (Fig. 202), and the reduced basal part of PI in *Dianpisaura* (Fig. 178) are both unique among the known pisaurid genera. The number of piriform gland spigots varies in different genera.

PMS small and almost triangular, with one or two mAP and some small AC (e.g., Figs. 180, 185, 186, 203, 204, 210, 217, 218, 223, 224, 253, 254, 259, 260, 265, 266). Nubbin present in all examined genera except for *Perenethis* (Fig. 218). CY present only in *Hygropoda* (Figs. 209, 211).

PLS with reduced numbers of AC (e.g., Figs. 181, 187, 205, 219, 225, 255, 261, 267). In *Hygropoda*, six large CY are observed at the outer margin of its distal end (Figs. 212, 213).

PHYLOGENETIC ANALYSIS

Taxa.—The terminal taxa are exemplars embodying the actual character states exhibited by a given species. Twenty-one pisaurid species belonging to nine genera known from China are selected as in-group members: *Dianpisaura lizhii* (Zhang 2000), *Dolomedes mizhoanus* Kishida 1936, *D. nigrimaculatus* Song & Chen 1991, *D. raptor* Bösenberg & Strand 1906, *D. saganus* Bösenberg & Strand 1906, *D. senilis* Simon 1880, *D. stellatus* Kishida 1936, *D. sulfureus* L. Koch 1877, *Eurychoera banna* new species, *Hygropoda higenaga* (Kishida 1936), *Perenethis fascigera* (Bösenberg & Strand 1906), *P. sindica* (Simon 1897), *Pisaura ancora* Paik 1969, *P. bicornis* Zhang & Song 1992, *P. lama* Bösenberg & Strand 1906, *P. mirabilis* (Clerck 1757), *P. sublama* Zhang 2000, *Polyboea zonaformis* (Wang 1993), *Qianlingula bilamellata* new species, *Thalassius paralbocinctus* new species and *T. phipsoni* F.O. Pickard-Cambridge 1898. The other 11 Chinese pisaurid species are excluded in the in-group as we currently lack male specimens.

Judging from the cladogram presented by Griswold (1993), Pisauridae is the sister group of the clade Trechaleidae + Lycosidae. The genera *Trechalea* Thorell 1869 (Trechaleidae) and *Hippasa* Simon 1885 (Lycosidae) serve as outgroups in the cladistic analysis with the exemplars *Trechalea longitarsis* (C.L. Koch

1847) and *Hippasa lycosina* Pocock 1900 respectively.

Characters and character states.—Character scoring is presented in Table 1. The character matrix contains 51 characters: 10 characters derived from the somatic morphology, five from female spinneret spigots, 10 from female copulatory organs, 24 from male copulatory organs, and two from behavior. Characters were scored through direct observation on the specimens in all cases except those of *Trechalea longitarsis* (C.L. Koch 1847) and behavior. The characters of *T. longitarsis* were scored based on the descriptions and illustrations of Sierwald (1990) and Carico (1993). For the behavioral characters assumptions were sometimes made for the exemplars based on published reports regarding their higher taxa.

Character descriptions.—*Somatic characters (Fig. 1):* Character 0: Anterior eye row; 0 = almost straight or slightly recurved, 1 = strongly recurved with ALE and PME in line (e.g., Fig. 170), 2 = procurved (e.g., Figs. 97, 141). Anterior eye row almost straight or slightly recurved is the most common and widely distributed character state in the Pisauridae and its sister group, and thus assumed to be the primitive condition.

Character 1: Size ratio of AME to ALE; 0 = AME larger than ALE, 1 = AME equal to ALE, 2 = AME smaller than ALE. As Sierwald (1997) indicated, AME larger than ALE is the primitive condition.

Character 2: Size ratio of AME to PME; 0 = AME smaller than PME, 1 = AME equal to PME, 2 = AME larger than PME. AME smaller than PME is most common in the Pisauridae and outgroups.

Character 3: MOA; 0 = wider than long, 1 = as long as wide, 2 = longer than wide.

Character 4: Clypeus height; 0 = larger than AME diameter, 1 = smaller than AME diameter. The clypeus height larger than AME diameter is widely distributed in the Pisauridae and outgroups.

Character 5: Number of promarginal teeth on chelicera; 0 = three teeth, 1 = two teeth and several denticles (Fig. 18), 2 = four teeth. Chelicera with three promarginal teeth appears to prevail in the Pisauridae.

Character 6: Number of retromarginal teeth on chelicera; 0 = three teeth, 1 = four teeth, 2 = two teeth. Chelicera with three retromarginal teeth is the most common and widely distributed character state in the Pisauridae and assumed to be the primitive condition by Sierwald (1997) and Griswold (1993).

Character 7: Sternum; 0 = longer than wide, 1 = as long as wide, 2 = wider than long.

Character 8: A pair of distal spines on ventral side of tibia; 0 = present, 1 = absent. Most species of the Pisauridae have a pair of distal spines on the ventral side of tibiae.

Character 9: Tarsus of legs; 0 = normal, 1 = flexible. Flexible tarsi of legs (state 1) are exhibited in *Hygropoda* and *Trechalea*.

Female spinneret spigots: Character 10: Number of piriform gland spigot in ALS; 0 = more than 70, 1 = less than 60.

Character 11: Base of piriform gland spigot in ALS; 0 = normal (e.g., Figs. 190, 208, 216, 222, 252, 264, 270), 1 = reduced (Fig. 178). Differing from other species of the Pisauridae, the bases of piriform gland spigots in ALS are reduced in *Dianpisaura lizhii* (Zhang 2000) and *D. songi* (Zhang 2000).

Character 12: Number of minor ampullate gland spigot in PMS; 0 = two (e.g., Figs. 180, 186, 210, 218, 224, 260, 266, 272), 1 = one (Figs. 204, 236, 254). Judging from the available data, posterior median spinneret with two minor ampullate gland spigots is most common in the Pisauridae.

Character 13: Cylindrical gland spigot in PMS; 0 = absent (e.g., Figs. 180, 185, 203, 217, 223, 253, 259, 265, 271), 1 = present (Figs. 209, 211).

Character 14: Cylindrical gland spigot in PLS; 0 = absent (e.g., Figs. 181, 187, 205, 219, 225, 255, 261, 267, 273), 1 = present (Figs. 212, 213). Judging from available data, the cylindrical gland spigots in PMS and PLS are absent in almost all species of Pisauridae except *Hygropoda higenaga* (Kishida 1936).

Female copulatory organ: Character 15: Anterior depression of epigynum; 0 = absent (e.g., Figs. 19, 66, 80, 151, 165), 1 = small and fossa-shaped (e.g., Figs. 99, 136, 144), 2 = large (Fig. 3). The anterior depression of epigynum is absent in most species of the Pisauridae and related groups, e.g., *Hippasa*, *Uliodon* and *Trechalea* (see Yin et al. 1997: 19, fig. 6d; Griswold 1993: 19, fig. 18; Carico 1993: 226, figs. 13, 37, 43, 47, 51, 55, 59, 63, 67, 71, 73), and thus this character state is assumed to be the primitive condition.

Table 1.—Character scoring. Non-applicable character states indicated by "—". Unknown character states indicated by "?".

	T. longitarsis	*H. lycosina*	*D. lizhii*
Somatic characters			
0) AER straight or slightly recurved; strongly recurved; procurved	0	0	0
1) AME > ALE; AME = ALE; AME < ALE	0	0	2
2) AME < PME; AME = PME; AME > PME	0	0	0
3) Width of MOA/length: >1; =1; <1	0	0	2
4) Clypeus height/AME: >1; <1	0	0	0
5) Promarginal teeth #: 3; 2; 4	0	0	0
6) Retromarginal teeth #: 3; 4; 2	1	0	0
7) Sternum length/width: >1; =1; <1	0	0	0
8) Distal ventral spines on tibia: present; absent	?	0	0
9) Leg tarsus: normal; flexible	1	0	0
Female spinneret spigots			
10) PI in ALS #: >70; <60	?	0	0
11) PI base in ALS: normal; reduced	?	0	1
12) mAP in PMS #: 2; 1	?	0	0
13) CY in PMS: absent; present	?	0	0
14) CY in PLS: absent; present	?	0	0
Female copulatory organ			
15) Anterior depression: absent; small; large	0	0	2
16) Intromittent orifice: anterior; median or posterior	0	0	0
17) Margins of *ll*: parallel; arched; diverging; forming curves	0	0	2
18) Posterior margin of *mf* to genital groove: near; far from	0	0	0
19) *cd*: normal; wide and flat	0	0	1
20) *cd*: sclerotized; slightly sclerotized; membranous and saccate	0	0	0
21) *cd* loops: 0 or 0.5; 2; 3	0	0	1
22) Spermatheca chambers: 3; 2; 1	0	0	0
23) Spermatheca: inflated; not inflated	0	0	0
24) *ab*: absent; present	0	0	0
Male palp			
25) Patella/tibia: <1; >1	?	0	0
26) Palpal tibia/half of cymbium: >1; <1	0	0	0
27) *ta*: distinct; reduced	0	1	0
28) *ta* situation: distal; median	0	—	0
29) *ta* shape: finger-like; branched; rectangular; lamellar	3	—	0
30) Tip of *ta* to base of conductor: not reached; reached or surpassed	0	—	0
31) *bac*: absent; present	0	0	0
32) *bac* shape: humped; hooked	—	—	—
33) *st* situation: under; behind	1	1	0
34) *bpt*: absent; present	0	0	0
35) *dtp*: present; absent	1	1	0
36) *bsa*: absent; present	0	0	1
37) *ma*: present; reduced	0	0	0
38) *ma*: separate; continuous; membranous	0	0	0
39) *da*: present; reduced	0	0	0
40) *da*: separate; continuous; membranous	0	0	0
41) *sa*: absent; present	0	0	0
42) *ful*: absent; present	0	0	0
43) *c*: distinct; small or reduced	1	1	0
44) *c*: translucent or opaque; strongly sclerotized; membranous	?	0	1
45) *gl*: absent; present	0	0	0
46) *e*: long; medium; short	1	1	0
47) *bpe*: absent; present	0	0	0
48) *e* curve: counterclockwise; clockwise	0	0	0
Behavior			
49) Web construction: yes; no	1	0	0
50) Egg sac on spinnerets: no; yes	1	1	?

Table 1.—Extended.

D. mizhoanus	*D. nigrimaculatus*	*D. raptor*	*D. saganus*	*D. senilis*	*D. stellatus*	*D. sulfureus*	*E. banna*
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	1
1	0	0	0	0	0	0	0
1	1	1	1	1	1	1	0
2	0	2	2	1	1	2	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
?	0	0	?	?	?	0	0
?	0	0	?	?	?	0	0
?	0	0	?	?	?	0	1
?	0	0	?	?	?	0	0
?	0	0	?	?	?	0	0
0	0	0	0	0	0	0	0
1	1	1	1	1	1	1	0
1	1	0	1	1	1	1	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
2	2	2	2	2	2	2	0
1	1	1	1	1	1	1	0
1	1	1	1	1	1	1	0
0	0	0	0	0	0	0	1
0	0	1	0	0	0	0	1
0	0	0	0	0	0	0	0
0	0	0	0	1	0	1	1
2	1	2	1	1	1	1	0
0	0	0	0	0	0	0	0
1	1	1	1	1	1	1	0
1	0	0	1	1	0	1	—
1	1	1	1	1	1	1	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	—
1	1	1	1	1	1	1	0
—	—	—	—	—	—	—	1
1	1	1	1	1	1	1	0
1	1	1	1	1	1	1	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	0
1	2	1	2	1	1	1	0
0	0	0	0	0	0	0	0
1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	0
0	0	0	0	0	0	0	0

Table 1.—Extended.

	H. higenaga	*P. fascigera*	*P. sindica*
Somatic characters			
0) AER straight or slightly recurved; strongly recurved; procurved	0	2	2
1) AME>ALE; AME=ALE; AME<ALE	0	1	1
2) AME<PME; AME=PME; AME>PME	0	0	0
3) Width of MOA/length: >1; =1; <1	0	0	0
4) Clypeus height/AME: >1; <1	0	0	0
5) Promarginal teeth #: 3; 2; 4	0	0	0
6) Retromarginal teeth #: 3; 4; 2	0	2	2
7) Sternum length/width: >1; =1; <1	0	0	0
8) Distal ventral spines on tibia: present; absent	0	0	0
9) Leg tarsus: normal; flexible	1	0	0
Female spinneret spigots			
10) PI in ALS #: >70; <60	0	1	?
11) PI base in ALS: normal; reduced	0	0	?
12) mAP in PMS #: 2; 1	0	0	?
13) CY in PMS: absent; present	1	0	?
14) CY in PLS: absent; present	1	0	?
Female copulatory organ			
15) Anterior depression: absent; small; large	0	1	1
16) Intromittent orifice: anterior; median or posterior	0	0	0
17) Margins of *ll*: parallel; arched; diverging; forming curves	2	2	2
18) Posterior margin of *mf* to genital groove: near; far from	0	1	1
19) *cd*: normal; wide and flat	0	1	1
20) *cd*: sclerotized; slightly sclerotized; membranous and saccate	0	2	2
21) *cd* loops: 0 or 0.5; 2; 3	0	1	1
22) Spermatheca chambers: 3; 2; 1	1	0	0
23) Spermatheca: inflated; not inflated	0	0	0
24) *ab*: absent; present	0	0	0
Male palp			
25) Patella/tibia: <1; >1	1	0	0
26) Palpal tibia/half of cymbium: >1; <1	0	1	1
27) *ta*: distinct; reduced	0	0	0
28) *ta* situation: distal; median	0	0	0
29) *ta* shape: finger-like; branched; rectangular; lamellar	0	0	0
30) Tip of *ta* to base of conductor: not reached; reached or surpassed	0	1	1
31) *bac*: absent; present	0	0	0
32) *bac* shape: humped; hooked	—	—	—
33) *st* situation: under; behind	0	0	0
34) *bpt*: absent; present	0	1	1
35) *dtp*: present; absent	1	0	0
36) *bsa*: absent; present	0	0	0
37) *ma*: present; reduced	0	0	0
38) *ma*: separate; continuous; membranous	0	0	0
39) *da*: present; reduced	0	0	0
40) *da*: separate; continuous; membranous	2	0	0
41) *sa*: absent; present	0	0	0
42) *ful*: absent; present	0	0	0
43) *c*: distinct; small or reduced	0	0	0
44) *c*: translucent or opaque; strongly sclerotized; membranous	2	0	0
45) *gl*: absent; present	0	0	0
46) *e*: long; medium; short	2	0	0
47) *bpe*: absent; present	1	0	0
48) *e* curve: counterclockwise; clockwise	1	0	0
Behavior			
49) Web construction: yes; no	?	1	1
50) Egg sac on spinnerets: no; yes	0	0	0

Table 1.—Extended.

P. ancora	*P. bicornis*	*P. lama*	*P. mirabilis*	*P. sublama*	*P. zonaformis*	*Q. bilamellata*	*T. paralbocinctus*	*T. phipsoni*
0	0	0	0	0	2	1	1	1
2	2	2	2	2	2	0	0	0
0	0	0	0	0	0	1	2	2
0	0	0	0	0	0	2	0	0
0	0	0	0	0	0	0	0	0
0	2	0	0	0	0	0	0	0
0	1	0	0	0	2	0	0	0
2	0	2	1	2	1	1	2	0
0	0	0	0	0	1	0	0	0
0	0	0	0	0	0	0	0	0
1	1	1	1	1	1	0	?	0
0	0	0	0	0	0	0	?	0
0	0	1	0	0	1	0	?	0
0	0	0	0	0	0	0	?	0
0	0	0	0	0	0	0	?	0
1	1	1	1	1	1	0	0	0
0	0	0	0	0	0	0	0	0
3	3	3	3	3	2	0	2	2
0	0	0	1	0	1	0	1	1
0	0	0	0	0	1	0	0	0
0	0	0	0	0	2	0	1	1
2	2	2	2	1	1	0	0	0
0	0	0	0	0	0	0	1	1
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	1	1
1	1	?	1	1	0	1	0	0
1	1	1	1	1	1	1	0	0
0	0	0	0	0	0	0	1	1
0	0	0	0	0	0	0	—	—
0	1	0	0	0	1	3	—	—
1	0	1	0	1	1	0	—	—
0	0	0	0	0	0	0	0	0
—	—	—	—	—	—	—	—	—
0	0	0	0	0	0	0	1	1
0	0	0	0	0	1	0	0	0
0	0	0	0	0	0	1	0	0
1	1	1	1	1	0	0	0	0
0	0	0	0	0	0	0	0	0
2	0	2	0	2	0	1	0	0
0	0	0	0	0	0	0	1	1
0	0	0	0	0	0	1	—	—
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	1	1	1
0	0	0	0	0	0	0	0	0
1	1	1	1	1	0	0	0	0
0	0	0	0	0	1	1	0	0
0	0	0	0	0	0	0	2	2
0	0	0	0	0	0	1	0	0
0	0	0	0	0	0	1	1	1
1	1	1	1	1	0	?	1	1
0	0	0	0	0	0	?	0	0

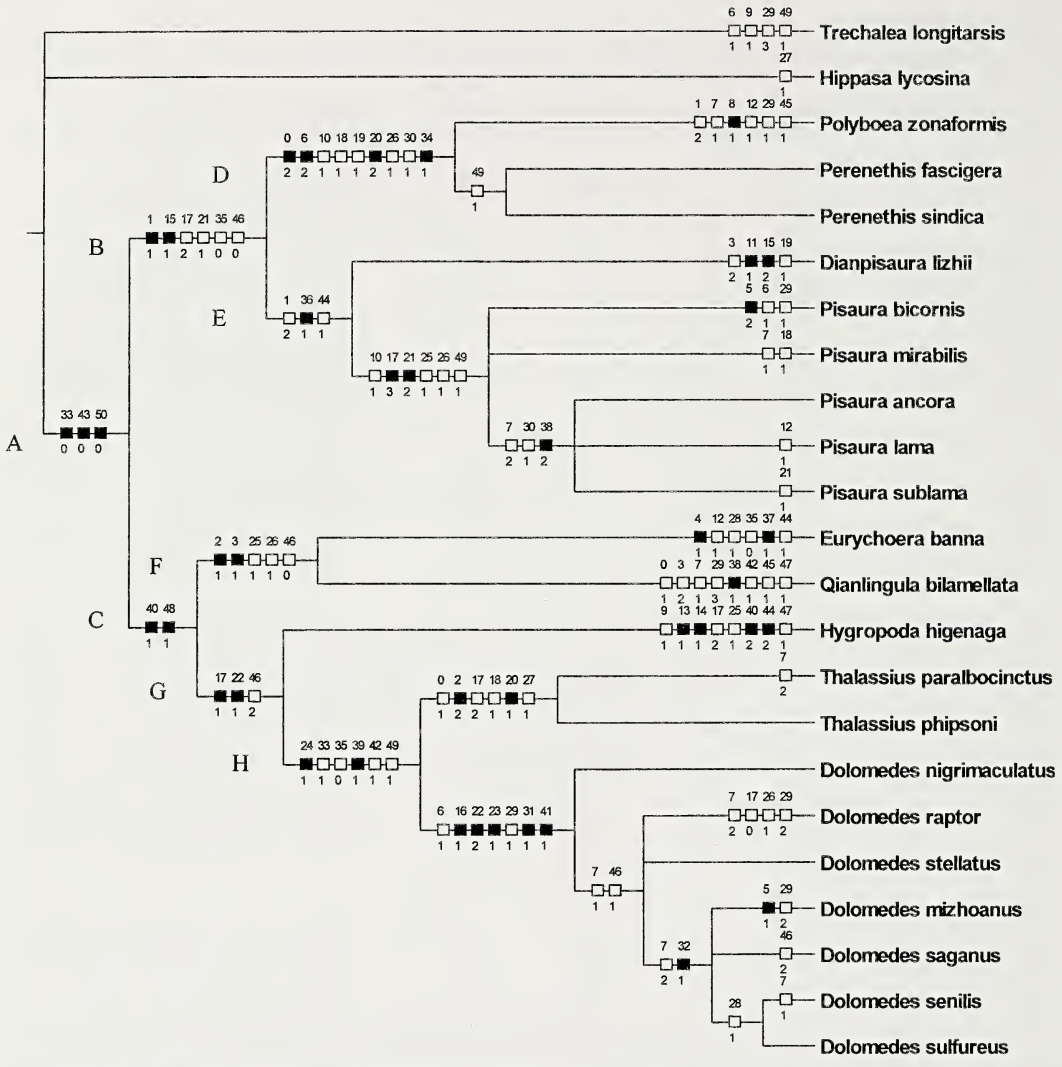


Figure 1.—Preferred Cladogram. DELTRAN character optimization; character mapping: black rectangles = non-homoplastic character state origination, white rectangles = homoplastic character state.

Character 16: Position of intromittent orifice; 0 = at anterior half part of epigynum (e.g., Figs. 67, 115, 152, 166), 1 = at median or posterior half part of epigynum (e.g., Figs. 32, 41, 52). The intromittent orifice located at anterior half part of epigynum is widely distributed in the Pisauridae. Although the intromittent orifices locate near the median part of epigynum in *Hygropoda higenaga*, it is coded as "0" for all other species of *Hygropoda* known from China have intromittent orifice located at anterior half part.

Character 17: Lateral margins of lateral lobes; 0 = parallel (e.g., Figs. 66, 151), 1 = arched (e.g., Figs. 19, 46), 2 = diverging anteriorly (e.g., Figs. 3, 80, 107, 144, 165), 3 = forming curves as in *Pisaura* (e.g., Figs. 113, 120, 130).

Character 18: Posterior margin of median field; 0 = near the genital groove (e.g., Figs. 3, 19, 66, 113, 151), 1 = far from genital groove (e.g., Figs. 99, 130, 165).

Character 19: Copulatory duct; 0 = normal (e.g., Figs. 32, 67, 81, 137, 152, 166), 1 = wide and flat (e.g., Figs. 4, 100, 145).

Character 20: Copulatory duct; 0 = sclerotized (e.g., Figs. 4, 32, 67, 81, 115, 152), 1 = slightly sclerotized (Figs. 166, 172), 2 = membranous and saccate (Figs. 100, 108, 145). The slightly sclerotized copulatory duct

(state 1), membranous and saccate copulatory duct (state 2) are not as common in the Pisauridae as the sclerotized copulatory duct.

Character 21: Number of loops of copulatory duct; 0 = no or half loop (e.g., Figs. 32, 67, 81, 152, 166), 1 = two loops (e.g., Figs. 4, 100, 145), 2 = three or more loops (e.g., Figs. 115, 126, 131). As Sierwald (1997) indicates, the copulatory duct with fewer loops is the primitive condition.

Character 22: Number of spermathecal chambers; 0 = three chambers with base, stalk and head (e.g., Figs. 4, 67, 100, 137, 145, 152), 1 = two chambers with base and head (e.g., Figs. 81, 166), 2 = one chamber (e.g., Fig. 32). Spermatheca with three chambers is most common in the Pisauridae and assumed to be primitive condition. In *Dolomedes*, the spermatheca is slender and long, and is not divided into different chambers.

Character 23: Shape of spermatheca; 0 = inflated and easily distinguished from copulatory duct (e.g., Figs. 4, 67, 81, 100, 137, 145, 152, 166), 1 = not inflated and not easily distinguished from copulatory duct (e.g., Figs. 25, 32) as in *Dolomedes*.

Character 24: Accessory bulb; 0 = absent, 1 = present (e.g., Figs. 32, 166). Accessory bulb of spermatheca is present in *Dolomedes* and *Thalassius*.

Male palp: Character 25: Length of patella and tibia; 0 = patella shorter than tibia, 1 = patella longer than tibia.

Character 26: Palpal tibia; 0 = longer than half of cymbium, 1 = shorter than half of cymbium.

Character 27: Tibial apophysis; 0 = distinct (e.g., Figs. 5, 42, 68, 84, 101, 138, 146, 153), 1 = reduced (Figs. 167, 173). Most species of the Pisauridae have a distinct tibial apophysis on male palp, while in *Thalassius* the tibial apophysis is small or reduced (Sierwald 1987: 51, figs. 1, 2, 54, 55, 58–61, 126, 127). As Griswold (1993) indicated, the palpal tibia with a distinct apophysis is the primitive condition.

Character 28: Position of tibial apophysis; 0 = at distal end of tibia (e.g., Figs. 5, 42, 84, 101, 138, 146, 153), 1 = near median region of tibia (Figs. 48, 60, 68). The distal tibial apophysis is most common in the Pisauridae.

Character 29: Shape of tibial apophysis; 0 = finger-like (e.g., Figs. 5, 68, 84, 101, 138), 1 = with two small branches (e.g., Figs. 42, 146, 147), 2 = almost rectangular in lateral view (Figs. 22, 34), 3 = with two lamellae (Figs. 153–155).

Character 30: Tip of tibial apophysis; 0 = not reaching the base of conductor (e.g., Figs. 5, 42, 84, 123, 153), 1 = reaching or surpassing the base of conductor (e.g., Figs. 102, 110, 117, 139, 147).

Character 31: Basal apophysis of cymbium; 0 = absent, 1 = present (e.g., Fig. 42). A basal cymbial apophysis is present in *Dolomedes*.

Character 32: Shape of basal apophysis of cymbium; 0 = humped (Figs. 26, 33, 53); 1 = hooked (Figs. 21, 42, 48, 60). The well developed and hooked basal apophysis of the cymbium is assumed to be the derived condition.

Character 33: Position of subtegulum; 0 = under the tegulum, not visible or only partly visible in ventral view (e.g., Figs. 5, 83, 101, 138, 146, 153), 1 = behind the tegulum, mostly visible in ventral view (e.g., Figs. 42, 167, 173).

Character 34: Basal protuberance of tegulum; 0 = absent, 1 = present (Figs. 101, 102, 109, 110, 146). Tegulum with basal protuberance is known to be present in some genera of the *Perenethis* genus-group, such as *Perenethis* and *Polyboea* (Sierwald 1997).

Character 35: Distal tegular projection; 0 = present (e.g., Figs. 5, 42, 68, 101, 138, 146, 173), 1 = absent (Figs. 83, 153). Judging from the study of Sierwald (1990), the distal tegular projection is present in many genera of Pisauridae and Griswold (1993) indicated that male palp with a distal tegular apophysis was one of the synapomorphies of the clade (Pisauridae + (Trechaleidae + Lycosidae)). Thus it is assumed to be the primitive condition here.

Character 36: Bulbous section of apical division; 0 = absent, 1 = present (e.g., Figs. 5, 138). Bulbous section of apical division on male palpal organ is present in *Pisaura* and *Dianpisaura*.

Character 37: Median apophysis; 0 = present (e.g., Figs. 5, 42, 83, 101, 138, 146, 153, 173), 1 = reduced (Fig. 68). Sierwald (1990) indicated that the absence of a median apophysis in some pisaurid genera was considered a reduction, and therefore derived.

Character 38: Form of median apophysis; 0 = separate and sclerotized with only basal membrane connected with tegulum (e.g., Figs.

5, 42, 83, 101, 122, 147, 173), 1 = being a continuous projection of tegulum (Fig. 153), 2 = membranous (Figs. 116, 127, 139). The separate and sclerotized median apophysis is most common in the Pisauridae and the outgroups.

Character 39: Distal apophysis; 0 = present (e.g., Figs. 5, 68, 83, 101, 138, 146, 153), 1 = reduced (e.g., Figs. 42, 173).

Character 40: Distal apophysis; 0 = separate and sclerotized with basal membrane connected with tegulum (e.g., Figs. 5, 101, 138, 146), 1 = continuous projection of tegulum (Figs. 68, 153), 2 = membranous (Fig. 83). The membranous distal apophysis is present only in *Hygropoda higenaga*.

Character 41: Saddle; 0 = absent, 1 = present in *Dolomedes* (e.g., Fig. 42).

Character 42: Fulcrum; 0 = absent, 1 = present in *Dolomedes*, *Qianlingula* and *Thalassius* (e.g., Figs. 28, 42, 154, 155, 175).

Character 43: Conductor; 0 = distinct (e.g., Figs. 5, 42, 68, 83, 101, 138, 146, 153, 175), 1 = small or reduced in *Hippasa* and *Trechalea* (see Yin et al. 1997: 19, figs. 6g, h; Sierwald 1990: 33, figs. 31–33, 46).

Character 44: Conductor; 0 = slightly sclerotized, translucent or opaque (e.g., Figs. 42, 101, 146, 153, 175), 1 = strongly sclerotized (e.g., Figs. 5, 68, 140), 2 = membranous (Fig. 83). The strongly sclerotized (state 1) and membranous conductor (state 2) are not as common in the Pisauridae as slightly sclerotized, translucent or opaque one.

Character 45: Two guiding lamellae of conductor; 0 = absent, 1 = present in *Polyboea* and *Qianlingula* (Figs. 148, 155).

Character 46: Embolus; 0 = long and thin (e.g., Figs. 7, 68, 103, 140, 148, 155), 1 = medium (e.g., Figs. 21, 33), 2 = short (e.g., Figs. 28, 83, 175). A long and thin embolus is most common in the Pisauridae and is indicated as the primitive condition by Sierwald (1997).

Character 47: Basal projection of embolus; 0 = absent, 1 = present in *Qianlingula bilamellata* (Fig. 155) and *Hygropoda higenaga* (Figs. 83, 85). Embolus lacks basal projection in most species of Pisauridae.

Character 48: Direction of curve of embolus (left bulb, in ventral view); 0 = counterclockwise (e.g., Figs. 5, 101, 138, 146), 1 = clockwise (e.g., Figs. 42, 68, 83, 173). Judging from the result of cladistic analysis by Griswold (1993), the counterclockwise curving embolus is shared by Pisauridae, Trechaleidae and Lycosidae, and thus it may be the primitive condition.

Behavior: Character 49: Web construction; 0 = adults construct webs for prey capture, 1 = adults hunting without webs.

Character 50: Egg sac carried on spinnerets; 0 = no, 1 = yes, as in lycosids and *Trechalea* (Griswold 1993).

Analysis.—The analysis was carried out using Hennig86 Version 1.5 (Farris 1988) to produce the most-parsimonious trees (MPTs). All resulting trees were forwarded to Winclada (Nixon 1999) to display, reroot and map the characters, and produce rooted trees. All multistate characters were treated unordered (non-additive, implemented with the "ccode-;" command). We obtained 598 MPTs (length = 114, CI = 0.61 and RI = 0.80) by running ie*. These MPTs were subjected to successive character weighting. Characters were reweighted based upon their relative agreement with the cladograms obtained: characters agreeing well with the initial cladograms were given greater weight than those requiring more homoplasy. Three rounds of successive weighting, implemented through the "xsteps w; ie*;" commands produced 12 MPTs (length = 529, CI = 0.82 and RI = 0.93) (character weights are listed in Table 2). Each of the 12 most parsimonious cladograms chosen through successive approximative weighting differed only in the resolution of the five species of the genus *Pisaura* and the seven species of the genus *Dolomedes*. In the strict consensus tree (Fig. 1), some species of the two genera are in an unresolved trichotomy. Optimization of character state changes may differ with the choice of optimization schemes, ACCTRAN or DELTRAN (depicted here in Fig. 1). The discontinuous character state changes are mapped as homoplasy and indicated as white rectangles, non-homoplastic character state changes are indicated as black rectangles). In the following description, only non-homoplastic character state changes supporting a clade under both optimization schemes are discussed unless noted otherwise.

The ingroup (clade A) is defined by the follow synapomorphies of non-homoplastic character state changes: subtegulum under the teg-

Table 2.—Character performance.

Character number	Steps	CI	RI	Weight
0	3	0.66	0.75	5
1	2	1.00	1.00	10
2	2	1.00	1.00	10
3	3	0.66	0.00	0
4	1	1.00	1.00	10
5	2	1.00	1.00	10
6	4	0.50	0.80	4
7	8	0.25	0.45	1
8	1	1.00	1.00	10
9	2	0.50	0.00	0
10	2	0.50	0.83	4
11	1	1.00	1.00	10
12	3	0.33	0.00	0
13	1	1.00	1.00	10
14	1	1.00	1.00	10
15	2	1.00	1.00	10
16	1	1.00	1.00	10
17	5	0.60	0.84	5
18	3	0.33	0.60	2
19	2	0.50	0.66	3
20	2	1.00	1.00	10
21	3	0.66	0.85	5
22	2	1.00	1.00	10
23	1	1.00	1.00	10
24	1	1.00	1.00	10
25	3	0.33	0.66	2
26	4	0.25	0.70	1
27	2	0.50	0.50	2
28	2	0.50	0.50	2
29	7	0.42	0.50	2
30	2	0.50	0.80	4
31	1	1.00	1.00	10
32	1	1.00	1.00	10
33	2	0.50	0.90	4
34	1	1.00	1.00	10
35	3	0.33	0.33	1
36	1	1.00	1.00	10
37	1	1.00	1.00	10
38	2	1.00	1.00	10
39	1	1.00	1.00	10
40	2	1.00	1.00	10
41	1	1.00	1.00	10
42	2	0.50	0.88	4
43	1	1.00	1.00	10
44	3	0.66	0.83	5
45	2	0.50	0.00	0
46	4	0.50	0.80	4
47	2	0.50	0.00	0
48	1	1.00	1.00	10
49	4	0.25	0.00	0
50	1	1.00	1.00	10

ulum (ch 33), palpal organ with distinct conductor (ch 43), egg sac not carried on spinneret (ch 50), and—under ACCTRAN optimization—the male palpal organ with distal tegular projection (ch 35), embolus long and thin (ch 46). All Chinese pisaurid genera (clade A) are grouped into two clades (clade B and clade C). The clade B, containing the genera *Polyboea*, *Perenethis*, *Dianpisaura* and *Pisaura* is supported by four synapomorphies of non-homoplastic character state changes: AME equal to ALE (ch 1), epigynum with small anterior depression (ch 15), and under ACCTRAN optimization, less than 60 piriform gland spigots in ALS (ch 10), wide and flat copulatory duct (ch 19). The other Chinese pisaurid genera (*Eurychoera*, *Qianlingula*, *Hygropoda*, *Thalassius* and *Dolomedes*) are grouped in clade C, which is supported by palpal organ with continuous distal apophysis (ch 40) and clockwise curved embolus (ch 48).

The genera *Polyboea* and *Perenethis* (clade D) form the sister group of clade E. The sister group relationship between *Polyboea* and *Perenethis* is supported by four non-homoplastic character state changes: procurved AER (ch 0), chelicera with two retromarginal teeth (ch 6), membranous and saccate copulatory duct (ch 20), and tegulum with basal protuberance (ch 34). The clade E comprises the genera *Dianpisaura* and *Pisaura*, whose sister group relationship is supported by apical division of palpal organ with a bulbous section (ch 36). The genus *Pisaura* is defined by two apomorphies of non-homoplastic character state changes: lateral margins of lateral lobes of epigynum forming several curves (ch 17), and copulatory duct curved with three or more loops (ch 21, reversal in *Pisaura sublama*).

The genera *Eurychoera* and *Qianlingula* (clade F) form the sister group of clade G. The sister group relationship of *Eurychoera* and *Qianlingula* is supported by AME equal to PME (ch 2), MOA as long as wide (ch 3), and under ACCTRAN optimization, median apophysis being a continuous projection of tegulum (ch 38). The clade G is supported by the non-homoplastic synapomorphies: spermatheca with two chambers (ch 22), and under ACCTRAN optimization, the membranous distal apophysis (ch 40), and—under DELTRAN optimization—the arched lateral

margins of lateral lobes (ch 17). The sister group relationship of *Thalassius* and *Dolomedes* (clade H) is supported by two non-homoplastic synapomorphies: spermatheca with accessory bulb (ch 24) and distal apophysis of palpal organ reduced (ch 39). Non-homoplastic apomorphies for the genus *Thalassius* is AME larger than PME (ch 2) and copulatory duct slightly sclerotized (ch 20). The genus *Dolomedes* is defined by five non-homoplastic apomorphies: intromittent orifice at median or posterior part of epigynum (ch 16), spermatheca not inflated (ch 23) and with only one chamber (ch 22), cymbium with basal apophysis (ch 31) and palpal organ with saddle (ch 41).

Sierwald (1997) presented a phylogenetic analysis of the subfamily Pisaurinae, and the result indicated that this subfamily comprises 19 nominal genera (e.g., the genera *Pisaura*, *Perenethis* and *Polyboea* in clade B), which form a monophyletic group. The genus *Eurychoera*, traditionally placed in the subfamily Pisaurinae (Simon 1898; Roewer 1955), was excluded from this subfamily by Sierwald (1997). This point is supported by the result of present cladistic analysis, which indicates that *Eurychoera*, the sister group of the new genus *Qianlingula*, is not closely related to the other pisaurine genera.

The genera *Dolomedes* and *Hygropoda* were previously placed in the subfamily Thaumasiinae and *Thalassius* was placed in the subfamily Thalassiinae (Simon 1898; Roewer 1955). But this cladogram shows that *Dolomedes* has the closest relationship with *Thalassius* and *Hygropoda* is the sister group of the clade (*Thalassius* + *Dolomedes*). Sierwald (1990) studied the male palpal organ morphology of the representative genera of Pisauridae, and found that the palpal organ of *Thaumasia*, type genus of Thaumasiinae, was closely related to those of *Dolomedes* and *Thalassius*. As Sierwald (1990, 1997) pointed out, the traditional subfamilies Thaumasiinae and Thalassiinae of the Pisauridae as established by Simon do not stand up to phylogenetic scrutiny, and the genera listed in the two subfamilies (Roewer 1955) cannot be grouped into monophyletic clades. Thus, further study is badly needed in order to test the monophyly of the two pisaurid subfamilies.

TAXONOMY

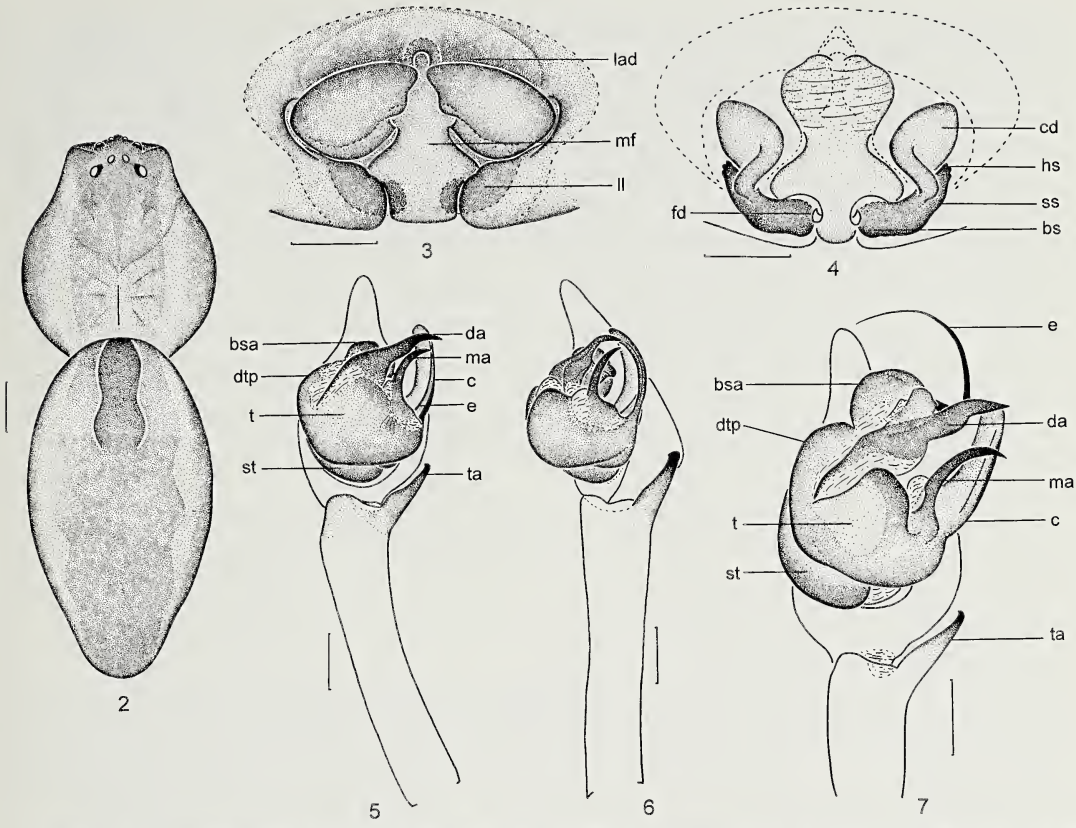
Pisauridae Simon 1890

Pisauridae Simon 1890: 80; Zhu & Shi 1983: 146; Hu 1984: 253; Hu 2001: 217; Song 1987: 204; Chen & Zhang 1991: 221; Barrion & Litsinger 1995: 342; Dippenaar-Schoeman & Jocque 1997: 250; Song et al. 1999: 346; Song et al. 2001: 265.

Type species.—*Pisaura* Simon 1885.

Diagnosis.—The family Pisauridae can be distinguished from both Trechaleidae and Lycosidae by: the nursery web that the female produces surrounded the egg sac, and the egg sac carried underneath the sternum. It differs from Trechaleidae in the median apophysis of the male palp, which is neither large nor distally situated, and lacking a dorsal embolic groove that extends distally into an apical groove and the absence of a "skirt" on the seam of the discoid egg sac (Carico 1993: 230, fig. 6). It can also be distinguished from Lycosidae by the posterior eye row not strongly recurved, and the male palp usually with tibial apophysis.

Description.—Medium-sized to very large, ecribellate and entelegyne spiders. Carapace longer than wide, frequently decorated with light longitudinal bands or dark symmetrical patterns on a brown or gray background. Eight eyes in two (4–4) or three (4–2–2) rows. Clypeus height variable. Chelicera usually stout, with lateral condyle, promargin with 3–4 teeth and retromargin with 2–4 teeth. Labium free, length-width ratio more or less than 1.0. Legs relatively long and spiniferous. Trochanters deeply notched. Tibiae I and II usually with four pairs of ventral spines. Trichobothria present on metatarsi and tarsi. Tarsal organ present on dorsum of tarsi. Tarsi with three dentate claws. Abdomen oval and dark, with longitudinal bands, folium or spots. Six spinnerets; colulus present. Tracheal spiracle located just anterior of colulus. Epigyne always with two integumental folds, forming two lateral lobes and a median field. Copulatory duct sclerotized or membranous. Spermatheca with one, two (head and base) or three (head, stalk and base) chambers. Fertilization duct present. Male palp usually with tibial apophysis, reduced in some species of *Thalassius*. Median



Figures 2–7.—*Dianpisaura lizhii*. 2. Female, dorsal view; 3. Epigynum; 4. Vulva; 5. Left palp of the male, ventral view; 6. Left palp of the male, retrolateral view; 7. Left palp of the male, expanded. Scale lines: 2 = 2 mm; 3–7 = 0.5 mm.

apophysis usually present, reduced in *Eurychoera*. Embolus varies from simple and short to long and curved.

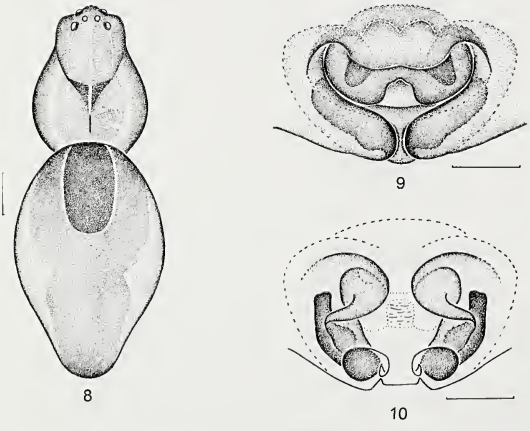
Remarks.—Formerly, the pisaurid genera were grouped into three subfamilies: Pisaurinae, Thaumasiinae and Thalassiinae (Simon 1898; Roewer 1955). The result of a phylogenetic study (Sierwald 1997) indicated that the subfamily Pisaurinae, containing 19 pisaurid genera is a monophyletic clade, and the defining characters for it were presented. Unfortunately, the monophyly of the other two subfamilies is so poorly substantiated that recent catalogs (Platnick 1989, 1993, 1997, 2002) listed pisaurid genera without reference to subfamilies.

KEY TO CHINESE PISAURID GENERA

1. AME smaller or equal to ALE; copulatory duct of female epigynum coiled (Figs. 4, 100, 115, 145); distal apophysis of papal organ larger than median apophysis (Figs. 5, 101, 116, 146) 1
   AME larger than ALE; copulatory duct of female epigynum not distinctly coiled (Figs. 32, 67, 81, 152, 166); distal apophysis of palpal organ absent (Figs. 42, 173), or small (Figs. 68, 83, 153) 5
2. Anterior eye row almost straight or slightly recurved; chelicera with three retromarginal teeth; copulatory duct of female epigynum sclerotized and not saccate (Figs. 4, 137); tegulum of palpal organ lacking basal protuberance (Figs. 5, 138) 3
   Anterior eye row procurved; chelicera with two retromarginal teeth; copulatory duct of

female epigynum membranous and saccate (Figs. 100, 145); tegulum of palpal organ with a basal protuberance (Figs. 101, 146) 4

3. Dorsum of abdomen with a large fuscous patch in anterior part (Fig. 2); epigynum with large anterior depression (Fig. 3); copulatory duct short and thick (Fig. 4); male palpal tibia longer than cymbium, embolus not accompanied by membrane (Figs. 5–7) ..... *Dianpisaura*
Dorsum of abdomen lacking large fuscous patch in anterior part; anterior depression of epigynum small and fossa-shaped (Fig. 136); copulatory duct slender (Fig. 137); male palpal tibia shorter than cymbium, embolus accompanied by membrane (Figs. 138–140) ... *Pisaura*
4. AME equal to ALE; ventral tibia with a pair of distal short spines; carina of epigynum separated (Fig. 99); conductor of palpal organ small (Figs. 101–103) ..... *Perenethis*
AME smaller than ALE; ventral tibia lacking a pair of distal short spines; carina of epigynum entire (Fig. 144); conductor of palpal organ large, with two guiding lamellae (Figs. 146–148) ..... *Polyboea*
5. Chelicera with four retromarginal teeth; intromittent orifice located at the median or posterior part of epigynum; spermatheca long and coiled (Fig. 41); palpal organ with saddle (Fig. 42) ..... *Dolomedes*
Chelicera with three retromarginal teeth; intromittent orifice located at the anterior part of epigynum; spermatheca inflated and short; palpal organ lacking saddle 6
6. Anterior eye row almost straight; clypeus height shorter or slightly longer than AME diameter; palpal organ lacking fulcrum 7
Anterior eye row recurved; clypeus height much longer than AME diameter; palpal organ with fulcrum (Figs. 155, 175) 8
7. Tarsus of leg not flexible; lateral lobe of epigynum with a basal oblique rumple (Fig. 66); conductor of palpal organ sclerotized (Figs. 68–70) ..... *Eurychoera*
Tarsus of leg long and flexible; epigynum otherwise; conductor of palpal organ membranous (Figs. 83–85) ..... *Hygropoda*
8. Median field of epigynum strongly sclerotized (Fig. 151); palpal organ with distal apophysis, embolus slender and flagelliform, conductor large, with two guiding lamellae (Figs. 153–155) ..... *Qianlingula*
Median field of epigynum not sclerotized (Fig. 165); palpal organ lacking distal apophysis, embolus short, conductor small and lacking guiding lamellae (Figs. 173–175) .... *Thalassius*



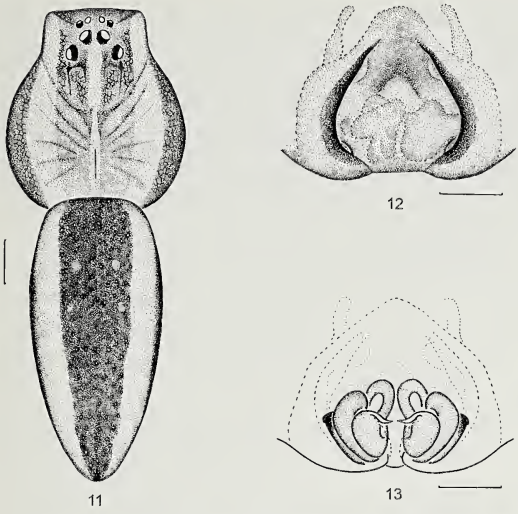
Figures 8–10.—*Dianpisaura songi*. 8. Female, dorsal view; 9. Epigynum; 10. Vulva. Scale lines: 8 = 2 mm; 9, 10 = 0.5 mm.

Dianpisaura new genus

Type species.—*Pisaura lizhii* Zhang 2000.

Diagnosis.—The new genus is closely related to *Pisaura*, but can be distinguished by: the presence of a fuscous patch at the anterior part of dorsum of abdomen; the presence of 6–8 dorsal spines on palpal femur; the reduced base of the PI on the ALS (Fig. 178); the presence of one or two large depressions at the anterior part of epigynum (Figs. 3, 9); the short and wide epigynal copulatory duct (Fig. 4); the long male palpal tibia (longer than cymbium) and the absence of embolic membrane (Figs. 5–7). The adults of the type species *D. lizhii* (Zhang 2000) was found building funnel-webs in the bush rather than hunting in the vegetation.

Description.—Body medium to large. Carapace red brown. Anterior eye row slightly re-



Figures 11–13.—*Dolomedes chinesus*. 11. Female, dorsal view; 12. Epigynum; 13. Vulva. Scale lines: 11 = 2 mm; 12, 13 = 0.5 mm.

curved, posterior row strongly recurved and wider than anterior row. Posterior eyes larger than anterior eyes. Palpal femur with 6–8 dorsal spines. Chelicera stout, with three teeth on both margins. Labium wider than long. Legs long and spinous. Tibiae I and II with four pairs of ventral spines; tibiae III and IV with three pairs of ventral spines. Metatarsus and tarsus with dorsal trichobothria. Tarsus of leg with three claws, unpaired claw with two teeth. Dorsum of abdomen with a fuscous patch at the anterior part. Epigynum strongly sclerotized, with one or two large anterior depressions, lateral lobes anteriorly separated; spermatheca with head, stalk and base, copulatory duct short and wide. Male palpal tibia longer than cymbium, with lateral apophysis; conductor sheet and situated at the base of the tegulum; median apophysis sclerotized, much smaller than distal apophysis, both with basal membrane connecting with the tegulum; distal end of the tegulum extending ahead, forming the distal tegular projection, which connected with the bulbous section of apical division; embolus long and lacking an associated membrane.

Etymology.—"Dian" is an alternative name in Chinese for the Yunnan Province; feminine in gender.

KEY TO CHINESE *DIANPISAURA* SPECIES

1. Female 2
   Male; Palpal tibia longer than cymbium; median apophysis sclerotized and crescent-shaped, embolus not accompanied by membrane (Figs. 5–7) ..... *D. lizhii*
2. Lateral margins of abdominal fuscous patch concaved (Fig. 2); median field of epigynum with a pair of sclerotized plates, posterior margin wide (Fig. 3); base of spermatheca not inflated (Fig. 4) ..... *D. lizhii*
   Lateral margins of abdominal fuscous patch parallel (Fig. 8); median field of epigynum with a transverse sclerotized plate, with a central depression, posterior margin narrow (Fig. 9); base of spermatheca inflated and round (Fig. 10) ..... *D. songi*

Dianpisaura lizhii (Zhang 2000) new combination
Figs. 2–7, 176–181

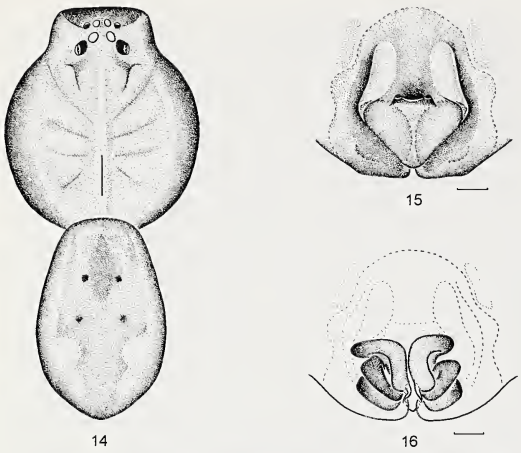
Pisaura lizhii Zhang 2000: 4, figs. 3A–D (female holotype from Yunnan, China, in MHU, examined).

Material examined.—Holotype female, no precise details, Yunnan, China, 6 June 1984, L.Z. Zhang (MHU). CHINA: 4 ♀, Mengla, *Yunnan:* 8 July 1981, J.F. Wang (MHU); 2 ♀, 1 ♂, Mengla, 24 May 2000, D. Q. Li (MHU); 3 ♀, Mengla, 27 July 2000, J. X. Zhang (MHU); 3 ♀, Menglun County, 30 June 2001, C. Zhang, D. Q. Li (MHU).

Diagnosis.—This species is similar to *D. songi* but can be distinguished by concave lateral margins of the fuscous patch on the dorsum of the abdomen (Fig. 2); the presence of a pair of sclerotized plates on median field of epigynum; the wide posterior margin of the median field, and the spermathecal base that is not distinctly inflated (Figs. 3–4).

Female.—Described by Zhang (2000).

Male.—Total length 10.80: cephalothorax 4.50 long, 3.69 wide; abdomen 6.53 long, 3.02 wide. Carapace red brown, covered with dark brown fine hairs, with a wide orange band near each of the lateral margins. Anterior



Figures 14–16.—*Dolomedes costatus*. 14. Female, dorsal view; 15. Epigynum; 16. Vulva. Scale lines: 14 = 2 mm; 15, 16 = 0.5 mm.

eye row slightly recurved, and posterior eye row strongly recurved. Posterior eyes larger than anterior eyes. Chelicera dark red brown, with three teeth on both margins. Labium and endites red brown. Legs dark yellow brown, with hairs and spines. Measurements of palp and legs: palp 8.55 (3.60, 1.17, 2.34, 1.44); leg I 23.63 (7.02, 8.10, 5.85, 2.66), II 22.46 (6.30, 7.74, 5.85, 2.57), III 19.59 (5.49, 7.12, 4.86, 2.12), IV 24.13 (6.57, 7.47, 7.16, 2.93). Leg formula: 4, 1, 2, 3. Dorsum of abdomen gray brown, with a dark brown patch at the center of the anterior part; venter yellow brown. Palpal tibia much longer than cymbium, distal end of tibial apophysis with a small hook; subtegulum partly visible in ventral view; median apophysis sclerotized and crescent-shaped; embolus long and not accompanied by membrane (Figs. 5–7).

Distribution.—China (Yunnan).

Dianpisaura songi (Zhang 2000) new combination
Figs. 8–10

Pisaura songi Zhang 2000: 5, figs. 5A–C (holotype female, 1 female paratype from Menglun, Yunnan, China, in MHU, examined).

Material examined.—Holotype female, Menglun, Yunnan, China, 11 November 1988, D.X. Song (MHU); 1 female paratype, Menglun, Yunnan, China, 15 November 1988, D.X. Song (MHU).

Diagnosis.—Body shape and patches are similar to those of *D. lizhii*, but it differs from the latter by lateral margins of the fuscous patch on the dorsum of the abdomen almost parallel (Fig. 8); sclerotized plate of the median field of the epigynum transverse, with a depression at the center; base of spermatheca inflated and round (Figs. 9–10).

Female.—Described by Zhang (2000).

Male.—Unknown.

Distribution.—China (Yunnan).

Dolomedes Latreille 1804

Dolomedes Latreille 1804: 135; Carico 1973: 448; Hu 1984: 254; Chen & Zhang 1991: 222; Song et al. 2001: 266.

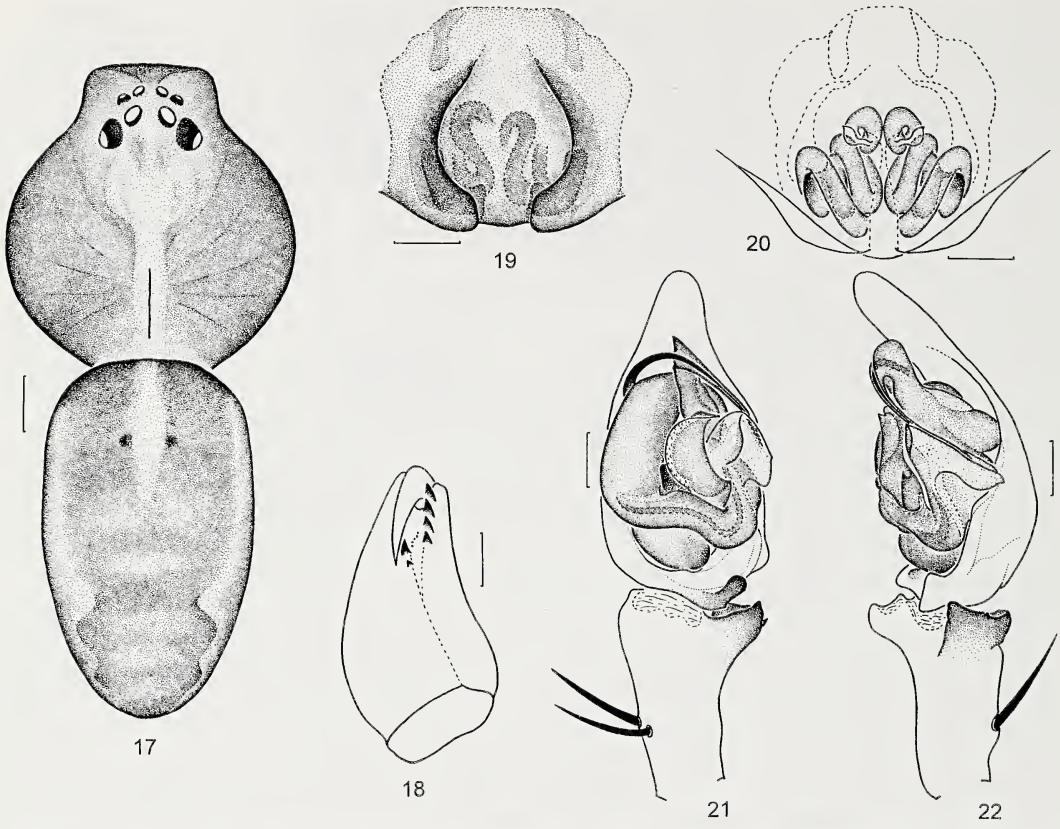
Type species.—*Araneus fimbriatus* Clerck 1757, by subsequent designation of Walckenaer (1805).

Diagnosis.—The genus is closely related to *Bradystichus* Simon 1884 from New Caledonia in eye pattern, cheliceral teeth, shape of the female and male copulatory organs (Platnick & Forster 1993), but can be distinguished from the latter by femora I, II and III with five prolateral and retrolateral spines respectively; spermatheca of the female with a basal accessory bulb (Fig. 32); and base of the median apophysis of the male palpal organ lacking hooked projection (Fig. 42).

Remarks.—This large genus of about 100 species is distributed in Asia (38 species), Africa (24 species), America (13 species), Oceania (13 species), Australia (7 species) and Europe (6 species). Among them, 16 species and one subspecies have been reported from China (Song et al. 1999), of which *D. angustivirgatus* Kishida 1936 has been synonymized with *D. sulfureus* L. Koch 1877 (Yaginuma 1986); *D. cordivulva* Strand 1907 has been considered as a nomen dubium (Platnick 2002); *D. chinesus duoformus* Fox 1936 (Sichuan), *D. plantarius* (Clerck 1757) (Xinjiang), *D. fimbriatus* (Clerck 1757) (Hebei) and *D. fimbriatoides* Bösenberg & Strand 1906 (Hunan, Sichuan) were listed as species inquirendae by Song et al. (1999); *D. insurgens* Chamberlin 1924 and *D. pallitarsis* Dönitz & Strand 1906 (in Bösenberg & Strand 1906) are both synonymized with *D. saganus* Bösenberg & Strand 1906 in this study; *D. horishanus* Kishida 1936 is considered a nomen dubium as the original description did not show its differences from other species in the genus and the type specimens may be lost (Dr. A. Tanikawa, in litt.). The other eight species and an additional two new species are reported here.

KEY TO CHINESE *DOLOMEDES* SPECIES

1. Female 2
   Male 11
2. Lateral margins of lateral lobes of epigynum almost parallel (Figs. 31, 36) 3
   Lateral margins of lateral lobes of epigynum arched (Figs. 12, 46) 4
3. Median field of epigynum longer than wide (Fig. 36); copulatory duct short, spermatheca thick (Fig. 37) ..... *D. raptoroides*
   Median field of epigynum wider than long (Fig. 31); copulatory duct long, spermatheca thin (Fig. 32) ..... *D. raptor*
4. Chelicera with two promarginal teeth and 4–5 denticles (Fig. 18); spermatheca long and strongly coiled (Fig. 20) ..... *D. mizhoanus*
   Chelicera with three promarginal teeth 5
5. Median field of epigynum almost entirely dark in color 6
   Median field of epigynum not entirely dark in color 7
6. Posterior margin of median field truncate (Fig. 12); spermatheca pointing at front and inflated at the tip (Fig. 13) ..... *D. chinesus*
   Posterior margin of median field round (Fig. 58); spermatheca pointing at back and not inflated at the tip (Fig. 59) ..... *D. sulfureus*
7. Posterior part of carapace and anterior part of abdomen both with a pair of large fuscous patches (Fig. 23); posterior margin of median field tongue-shaped (Fig. 24); spermatheca thin and long (Fig. 25) ..... *D. nigrimaculatus*
   Carapace and abdomen lacking large fuscous patch; epigynum otherwise 8
8. Median field of epigynum extruded like an eave at the center (Fig. 15) ..... *D. costatus*
   Median field of epigynum otherwise 9
9. Fuscous region in median field not broadened at anterior part (Fig. 51) ..... *D. stellatus*
   Fuscous region in median field broadened at anterior part 10
10. Median field of epigynum rhomboid, with posterior margin not reaching genital groove (Fig. 46) ..... *D. senilis*
    Median field of epigynum not rhomboid, with posterior margin slightly surpassing genital groove (Figs. 39, 40) ..... *D. saganus*
11. Basal cymbial apophysis of palpal organ not distinct 12
    Basal cymbial apophysis of palpal organ distinct and hook-shaped 14
12. Palpal tibia half of cymbium, tibial apophysis wide, with three branches in lateral view (Figs. 33, 34) ..... *D. raptor*
    Palpal tibia longer than half of cymbium, tibial apophysis narrow, with two branches in lateral view 13
13. Posterior part of carapace and anterior part of abdomen both with a pair of large fuscous patches; palpal tibia longer than cymbium, tip of median apophysis surpassing the top of embolus (Figs. 26, 27) ..... *D. nigrimaculatus*
    Carapace and abdomen lacking large fuscous patch; palpal tibia shorter than cymbium, tip of median apophysis not surpassing the top of embolus (Figs. 53, 54) ..... *D. stellatus*
14. Palpal tibial apophysis not branched, distal tegular projection almost two times as wide as tegulum (Figs. 21, 22) ..... *D. mizhoanus*
    Palpal tibial apophysis branched, distal tegular projection only slightly wider or as wide as tegulum 15
15. Tip of median apophysis not reaching the top of fulcrum, tibial apophysis at the median of palpal tibia (Figs. 48, 49) ..... *D. senilis*
    Tip of median apophysis reaching the top of fulcrum, tibial apophysis at the distal end of palpal tibia 16
16. Base of basal cymbial apophysis attenuated, embolus extended from outside of fulcrum (Figs. 60, 61) ..... *D. sulfureus*
    Base of basal cymbial apophysis not attenuated, embolus extended from dorsal surface of fulcrum (Figs. 42, 43) ..... *D. saganus*



Figures 17–22.—*Dolomedes mizhoanus*. 17. Female, dorsal view; 18. Left chelicera, prolateral view; 19. Epigynum; 20. Vulva; 21. Left palp of the male, ventral view; 22. Left palp of the male, retrolateral view. Scale lines: 17 = 2 mm; 18 = 1 mm; 19–22 = 0.5 mm.

Dolomedes chinesus Chamberlin 1924
Figs. 11–13

Dolomedes chinesus Chamberlin 1924: 26, pl. 6, fig. 42 (holotype female from Suzhou, Jiangsu, China, in National Museum of Natural History, Smithsonian Institution, examined by Song 1988); Yin et al. 1980: 175, figs. 95a–c; Song 1988: 132, figs. 12A–B; Song et al. 1999: 347, figs. 202K–L.

Dolomedes chinsus: Wang 1981: 125, figs. 65A–B (lapsus for *D. chinesus*).

Dolomedes chinensis: Hu 1984: 255, figs. 267.1–3; Guo 1985: 132, figs. 2–68.1–2 (lapsus for *D. chinesus*).

Material examined.—CHINA: *Yunnan*: Limaoba, 29 September 1977, 1 ♀, MHU).

Diagnosis.—This species resembles *D. sulfureus* in the epigynal shape, but it differs from the latter in: posterior margin of the median field of the epigynum truncate (Fig. 12); tip of the spermatheca inflated and pointing at the front (Fig. 13).

Female.—Described by Yin et al. (1980) and Song (1988). Median field of the epigynum swollen at the anterior part, posterior margin wide; tip of the spermatheca inflated.

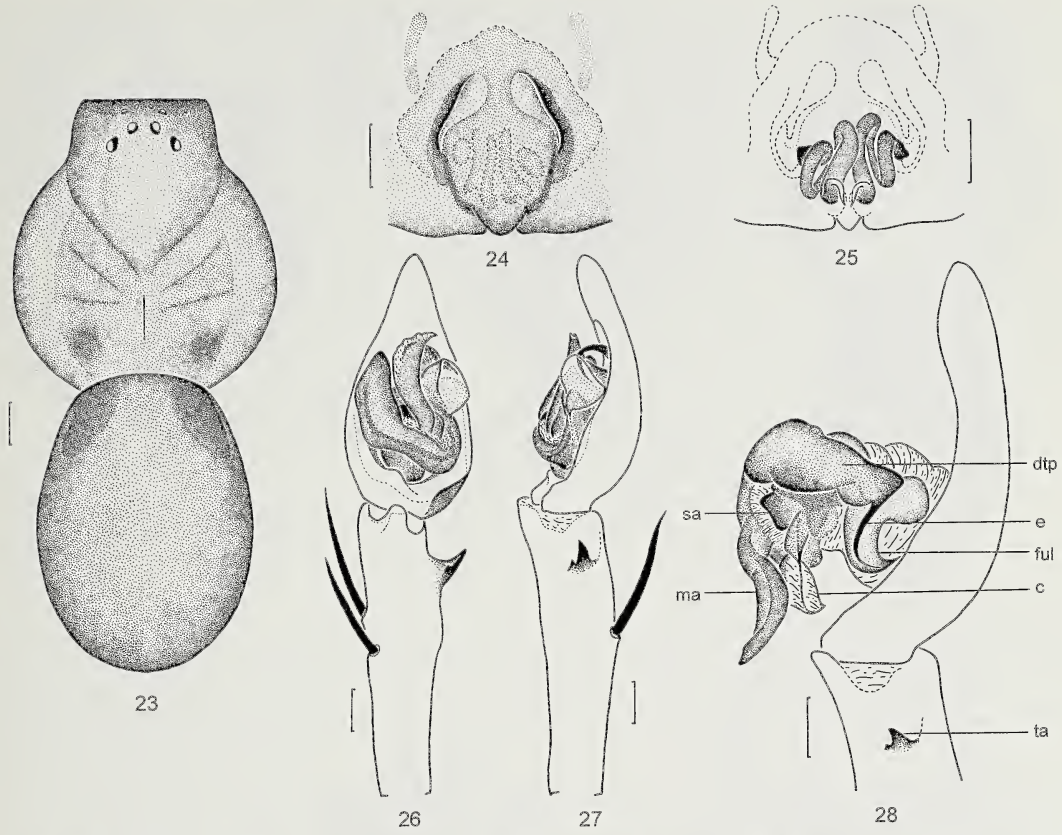
Male.—Unknown.

Distribution.—China (Jiangsu, Hubei, Hunan, Guangdong, Guizhou, Yunnan, Shaanxi).

Dolomedes costatus new species
Figs. 14–16

Material examined.—Holotype female, Chengbu (26°18′N, 110°18′E), Hunan, China, 26 July 1982, J.F. Wang (MHU).

Diagnosis.—The new species resembles *D. stellatus*, but it differs from the latter in: dorsum of the abdomen with an oval dark brown patch (Fig. 14); median field of the epigynum extruded like an eave at the center (Fig. 15);



Figures 23–28.—*Dolomedes nigrimaculatus*. 23. Female, dorsal view; 24. Epigynum; 25. Vulva; 26. Left palp of the male, ventral view; 27. Left palp of the male, retrolateral view; 28. Left palp of the male, expanded. Scale lines: 23 = 2 mm; 24–28 = 0.5 mm.

spermatheca longer than that of the latter (Fig. 16).

Female.—Total length 24.00: cephalothorax 14.00 long, 10.00 wide; abdomen 12.00 long, 8.00 wide. Carapace dark red brown with two narrow yellowish bands laterally and one mesally. Chelicerae dark red. Labium, endites dark red brown and lighter distally. Sternum red brown. Legs red brown dorsally scattered with yellow brown spots. Abdomen light brown, dorsum with a yellowish brown "Π"-shaped streak and an oval dark brown patch at the anterior part, and two pairs of dark brown spots at the center. Chelicerae with three teeth on promargin and four on retromargin. Anterior eye row slightly recurved and posterior eye row recurved. AME–AME: AME–ALE (0.24:0.24), PME–PME:PME–PLE (0.44:0.85); AME:ALE: PME:PLE (0.48: 0.31:0.65:0.63). MOA 1.38 long, front width 1.05, back width 1.63. Measurements of legs: I 49.46 (13.32, 18.90, 10.89, 6.35), II 50.09 (13.68, 18.99, 11.12, 6.30), III 46.04 (12.78, 17.28, 10.80, 5.18), IV 54.54 (13.68, 19.71, 14.40, 6.75). Leg formula: 4, 2, 1, 3. Tibiae I and II with four pairs of ventral spines, III and IV with three pairs respectively. Median field of the epigynum extruded like an eave at the center; spermatheca long and coiled.

Male.—Unknown.

Etymology.—The specific name is from the Latin *costatus*, and refers to the median field of the epigynum extruded like an eave at the center.

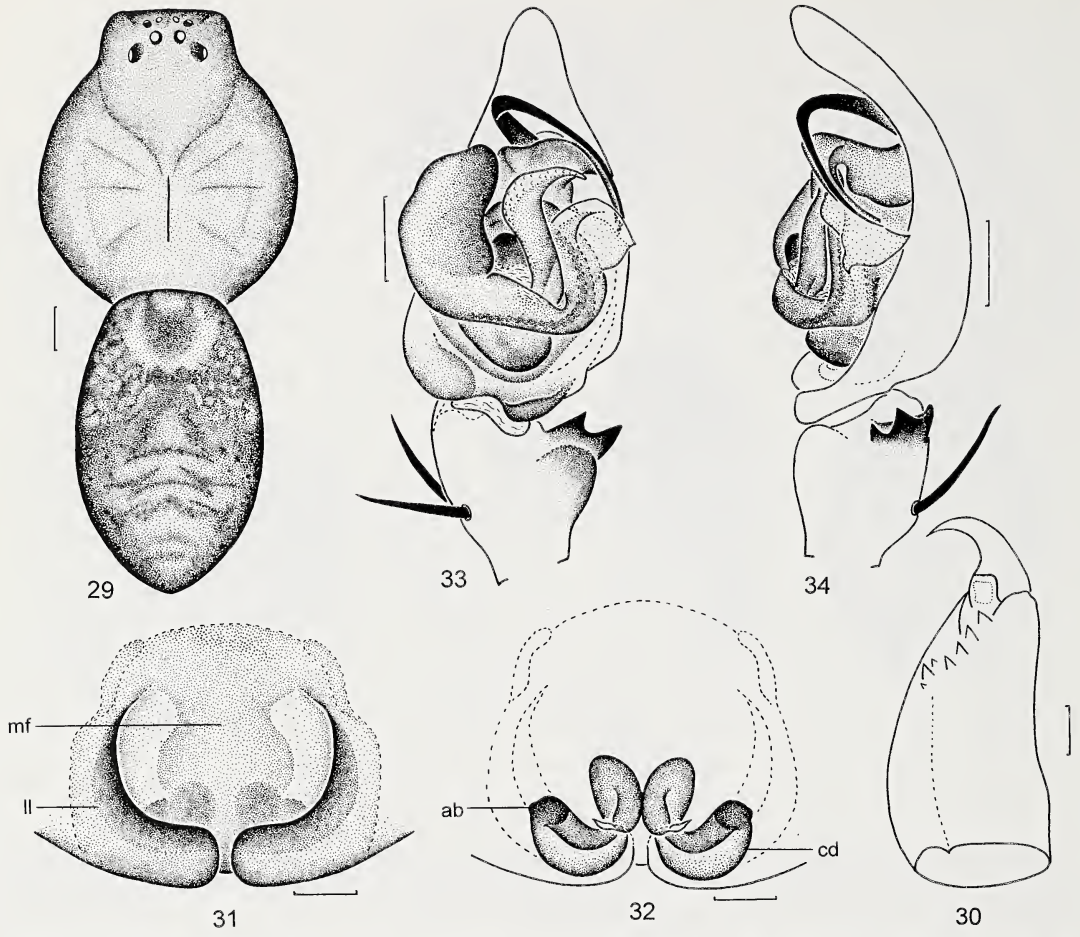
Distribution.—China (Hunan).

Dolomedes mizhoanus Kishida 1936
Figs. 17–22

Dolomedes mizhoanus Kishida 1936: 120, pl. 13, fig. 10 (holotype female from Mizho, Taiwan, presumably lost).

Dolomedes mizuhoanus: Brignoli 1983: 466 (lapsus for *D. mizhoanus*).

Material examined.—CHINA: *Hunan*: 1



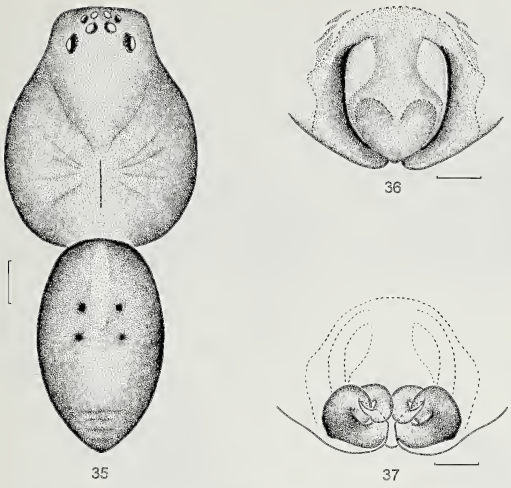
Figures 29–34.—*Dolomedes raptor*. 29. Female, dorsal view; 30. Left chelicera, prolateral view; 31. Epigynum; 32. Vulva; 33. Left palp of the male, ventral view; 34. Left palp of the male, retrolateral view. Scale lines: 29 = 2 mm; 30 = 1 mm; 31–34 = 0.5 mm.

♀, 2 ♂, Chengbu, 26 July 1982, J.F. Wang (MHU); *Yunnan*: 1 ♀, (no details), 6 June 1984, L.Z. Zhang (MHU); *Hainan*: 1 ♀, Wuzhi Mt., Qiongzhong, 27 June 1984, M.Y. Liu (MHU); *Guangxi*: 1 ♀, Shuolong, Daxin, 20 August 2000, F.X. Liu (LSHU); *Taiwan*: 1 ♀, Nanren Mt., Pingdong, 24 September 2000, Z.X. Gu (BTU); 1 ♀, Nanren Mt., Pingdong, 28 April 2001, P.L. Dai (BTU); *Yunnan*: 1 ♀, Menglun, 3 July 2001, C. Zhang (MHU).

Diagnosis.—This species is similar to *D. raptor*, but it differs from the latter in: chelicera with two promarginal teeth and 4–5 denticles (Fig. 18); median field of the epigynum narrow (Fig. 19); spermatheca long and coiled (Fig. 20); tibial apophysis of the male palp not branched in lateral view; fulcrum large, with the top surpassing that of the embolus (Figs. 21, 22).

Female.—Described by Kishida (1936). Chelicera with 2 teeth and 4–5 denticles on promargin. Posterior margin of the median field of the epigynum wide; spermatheca long and coiled.

Male.—Total length 10.40–14.09. One specimen total length 10.40: cephalothorax 5.40 long, 5.20 wide; abdomen 5.67 long, 2.70 wide. Measurements of palp and legs: palp 9.45 (3.78, 1.35, 1.44, 2.88); leg I 37.09 (9.54, 12.15, 10.13, 5.27), II 36.50 (10.22, 11.88, 9.45, 4.95), III 27.91 (7.83, 9.72, 6.98, 3.38), IV 34.84 (9.45, 11.12, 9.23, 5.04). Leg formula: 1, 2, 4, 3. Tibial apophysis of the palp short and wide not branched in lateral



Figures 35–37.—*Dolomedes raptoroides*. 35. Female, dorsal view; 36. Epigynum; 37. Vulva. Scale lines: 35 = 2 mm; 36, 37 = 0.5 mm.

view; fulcrum large, with the top surpassing that of the embolus.

Distribution.—China (Hunan, Guangxi, Hainan, Yunnan, Taiwan).

Dolomedes nigrimaculatus Song & Chen 1991
Figs. 23–28, 182–187

Dolomedes nigrimaculatus Song & Chen 1991: 15, figs. 1–4 (holotype female, allotype male from Tianmu Mt., Zhejiang, China, in MHU, examined); Song et al. 1999: 347, figs. 202M–N, 203F–G.

Dolomedes nigramaculatus: Chen & Zhang 1991: 222, figs. 229.1–4 (lapsus for *D. nigrimaculatus*).

Material examined.—Holotype female, allotype male, Tianmu Mt., Zhejiang, China, 16 July 1981, Z.F. Chen (MHU); CHINA: *Hunan*: 1 ♀, 1 ♂, Zhangjiajie, Dayong, 20 July 1981, J.F. Wang (MHU); 2 ♀, 3 ♂, Nanhua Mt., Fenghuang, 24 July 2001, Z.S. Zhang & J.X. Zhang (MHU); *Hebei*: 1 ♂, Bailuquan, Shijiazhuang, 4 August 1986 (MHU); *Guizhou*: 1 ♂, Fanjing Mt., 3 August 2001, H.X. Wu (MHU).

Diagnosis.—This species can be easily distinguished from others of the genus by the posterior part of the carapace and anterior part of the abdomen with a pair of large dark colored patches (Fig. 23). It is similar to *D. stellatus* in the shape of male palpal organ, but differs from the latter in: posterior margin of the median field of the epigynum tongue-shaped (Fig. 24); spermatheca long (Fig. 25); tibia of the male palp longer than cymbium; top of the median apophysis extended beyond that of embolus (Figs. 26, 27).

Female.—Described by Song & Chen (1991). Posterior margin of the median field of the epigynum tongue-shaped; spermatheca long and coiled with the accessory bulb located at the outer surface.

Male.—Described by Song & Chen (1991). Palpal tibia longer than cymbium, tibial apophysis with two branches; tip of the median apophysis not smooth; basal apophysis of cymbium not distinct.

Distribution.—China (Hebei, Zhejiang, Hunan, Guizhou).

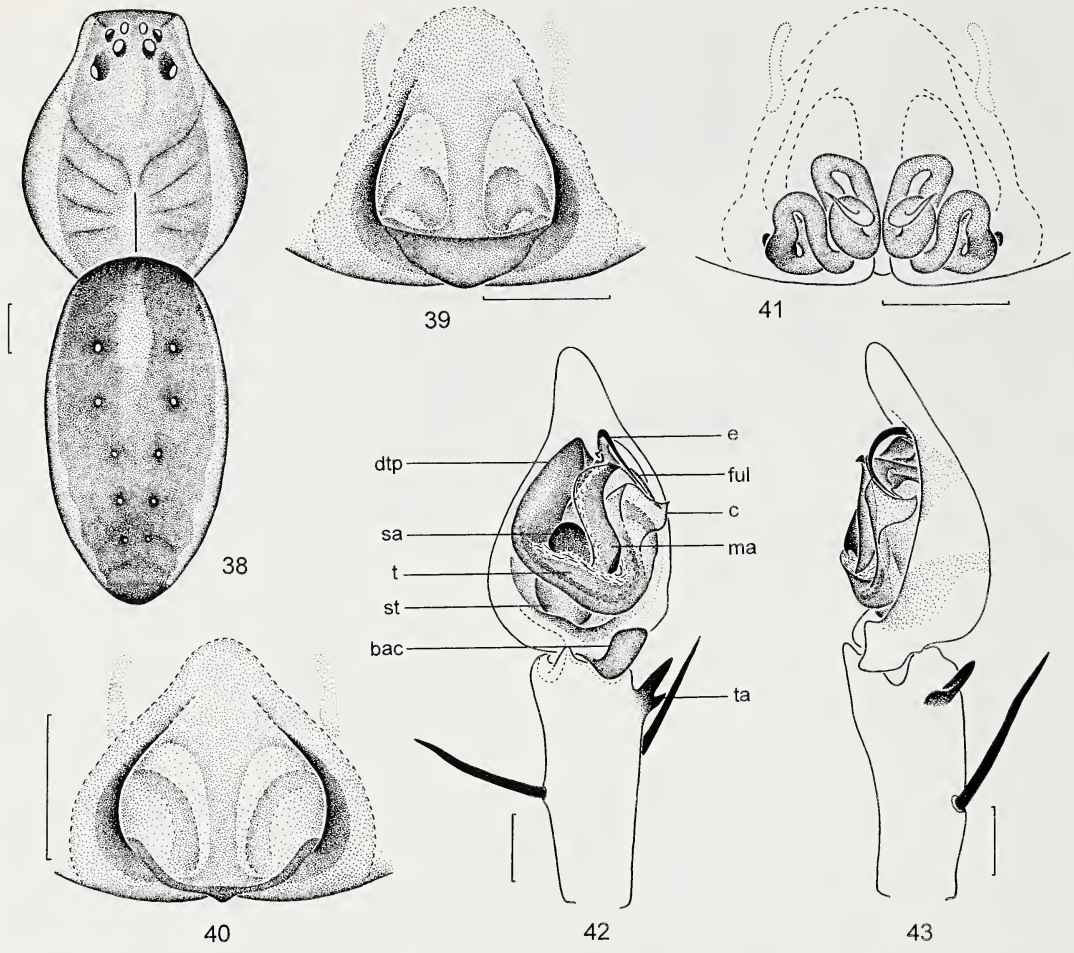
Dolomedes raptor Bösenberg & Strand 1906
Figs. 29–34, 188–193

Dolomedes raptor Bösenberg & Strand 1906: 309, pl. 8, fig. 119, pl. 13, fig. 342 (holotype female from Japan, in Hamburg Museum, not examined); Paik 1969: 42, figs. 7, 46–47; Yaginuma 1986: 172, fig. 95.3; Chikuni 1989: 107, fig. 5; Song et al. 1999: 348.

Material examined.—CHINA: *Shaanxi*: 1 ♀, Baoji, 19 September 1980 (MHU); 2 ♀, 1 ♂, Huayin, 8 May 1981 (MHU); 2 ♂, Louguantai, Zhouzhi, 19 May 1981, M.S. Zhu (MHU); *Zhejiang*: 1 ♀, Tianmu Mt., 16 July 1981, Z.F. Chen (MHU); *Guizhou*: 1 ♀, Maolan National Natural Reserve, Libo, 2 August 1995, H.M. Chen (MHU); 1 ♀, Chishui Natural Reserve, 27 May 2000, H.M. Chen (MHU).

Diagnosis.—This species is similar to *D. mizhoanus* in the shape of body and epigynum, but it differs from the latter in: chelicera with three teeth on promargin (Fig. 30); median field of the epigynum wide (Fig. 31); spermatheca short (Fig. 32); tibial apophysis of the male palp with three branches in lateral view; fulcrum not surpassing the top of the embolus (Figs. 33, 34). It is also similar to *D. yawatai* Ono 2002 (Ono 2002: 55, figs. 12–17), but differs in the shape of the tibial apophysis of male palp (Figs. 33, 34), and spermatheca of the female genitalia shorter than that of the latter (Fig. 32).

Female.—Described by Paik (1969), Yaginuma (1986) and Chikuni (1989). Median field of the epigynum wide, its center dark in color, and with variations in its width; acces-



Figures 38–43.—*Dolomedes saganus*. 38. Female, dorsal view; 39. Epigynum; 40. Epigynum, different individual; 41. Vulva; 42. Left palp of the male, ventral view; 43. Left palp of the male, retrolateral view. Scale lines: 38 = 2 mm; 39–43 = 0.5 mm.

sory bulb located at the outer surface of the spermatheca.

Male.—Described by Yaginuma (1986) and Chikuni (1989). Tibial apophysis of male palp thick, with three branches in lateral view; basal apophysis of cymbium small; embolus flagelliform.

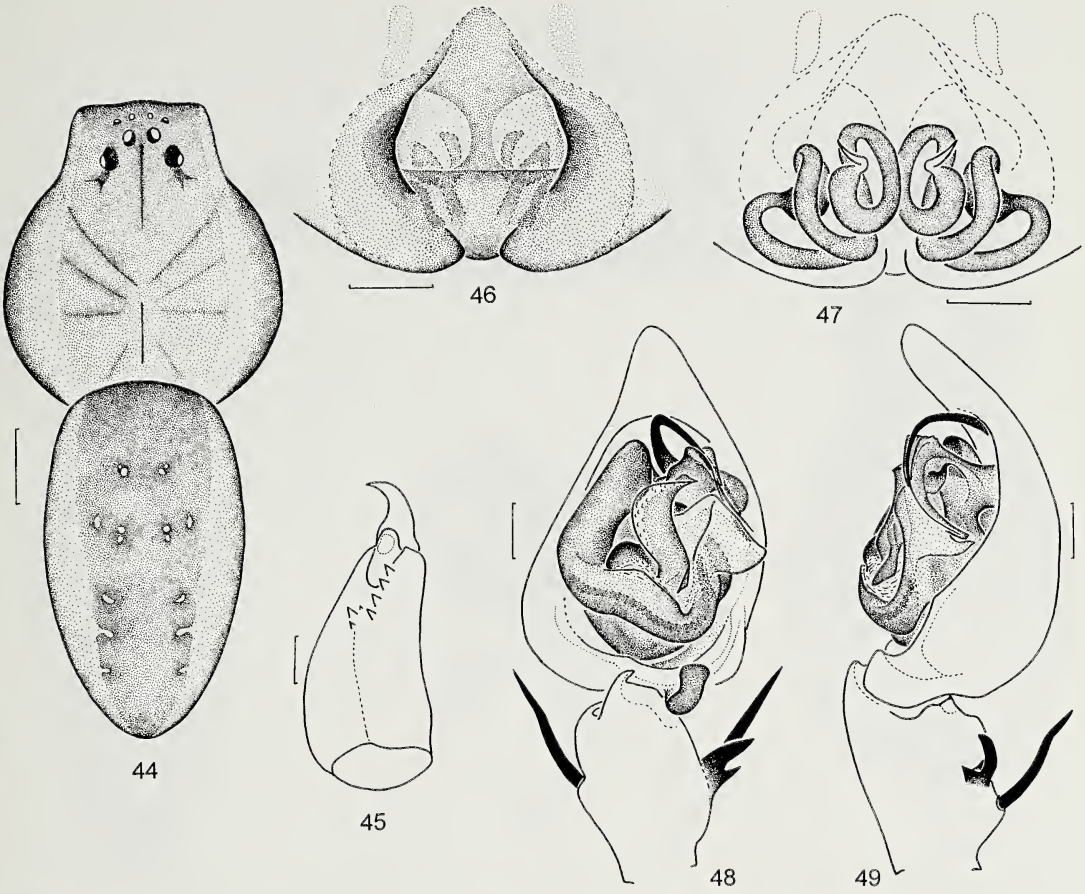
Distribution.—China (Zhejiang, Guizhou, Shaanxi); Japan, Korea, Russia.

Dolomedes raptoroides new species
Figs. 35–37

Material examined.—Holotype female from Menglun (21°55′N, 101°15′E), Yunnan, China, 6 July 2001, C. Zhang (MHU).

Diagnosis.—The new species is similar to *D. raptor*, but it differs from the latter in: median field of the epigynum longer than wide (Fig. 36); copulatory duct short and spermatheca thick (Fig. 37).

Female.—Total length 20.93: cephalothorax 11.93 long, 9.72 wide; abdomen 9.68 long, 5.76 wide. Carapace red brown. Chelicerae dark red brown. Labium and endites red brown. Sternum and dorsal legs reddish brown. Dorsum of abdomen dark brown, with two pairs of black brown spots; venter with a mesal brown band. Chelicerae with three teeth on promargin and four on retromargin. Anterior eye row almost straight and posterior eye row recurved. AME–AME:AME–ALE (0.20: 0.14), PME–PME:PME–PLE (0.37:0.80); AME:ALE:PME:PLE (0.44:0.32:0.56:0.54). MOA 1.28 long, front width 0.99, back width 1.46. Measurements of legs: I 40.47 (11.12, 15.71, 8.78, 4.86), II 41.18 (11.70, 15.62,



Figures 44–49.—*Dolomedes senilis*. 44. Female, dorsal view; 45. Left chelicera, prolateral view; 46. Epigynum; 47. Vulva; 48. Left palp of the male, ventral view; 49. Left palp of the male, retrolateral view. Scale lines: 44 = 2 mm; 45 = 1 mm; 46–49 = 0.5 mm.

9.00, 4.86), III 39.47 (11.57, 14.40, 9.00, 4.50), IV (lost). Tibiae I and II with four pairs of ventral spines, tibia III with three pairs. Median field of the epigynum widest at anterior part, and narrower at posterior margin; copulatory duct and spermatheca thick.

Male.—Unknown.

Etymology.—The specific name refers to its close resemblance to *D. raptor*.

Distribution.—China (Yunnan).

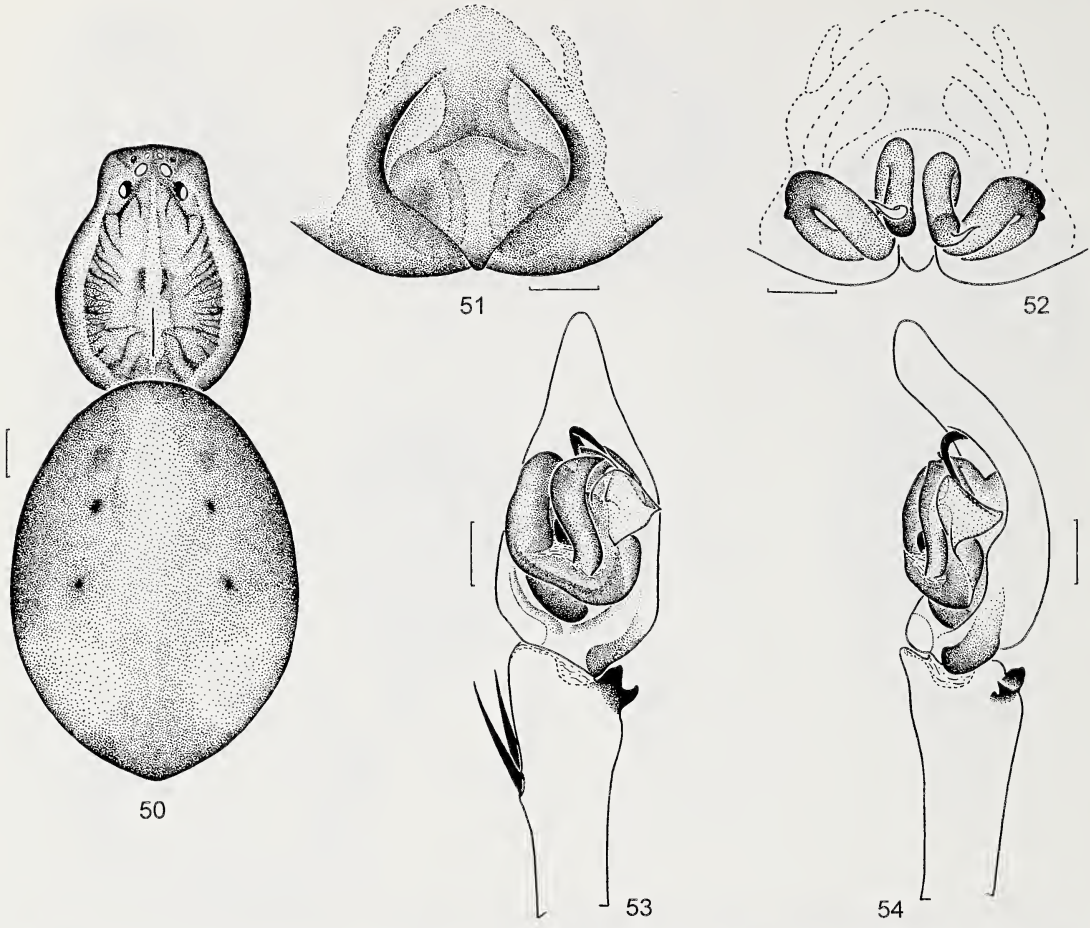
Dolomedes saganus Bösenberg & Strand 1906
Figs. 38–43

Dolomedes saganus Bösenberg & Strand 1906: 312, pl. 8, fig. 115, pl. 13, fig. 328 (holotype female, 1 male paratype from Yamato, Japan, in Hamburg Museum, not examined); Lee 1966: 58, figs. 21c–d; Hu 1984: 258, figs. 270.3–4; Yaginuma 1986: 172, fig. 95.4; Chikuni 1989: 106, fig. 4.

Dolomedes pallitarsis Dönitz & Strand in Bösenberg & Strand 1906: 388, pl. 8, fig. 114 (holotype female from Saga, Japan, depository not mentioned by authors); Hu 1984: 257, fig. 270.1; Yaginuma 1986: 171, fig. 95.2; Song 1987: 205, figs. 163–164; Chikuni 1989: 107, fig. 7; Feng 1990: 158, figs. 133.1–4; Chen & Gao 1990: 134, figs. 167a–b; Chen & Zhang 1991: 223, figs. 230.1–4; Zhao 1993: 304, figs. 139a–c; Song et al. 1999: 347, figs. 13D, 202O-P, 203H-I. NEW SYNONYMY.

Dolomedes insurgens Chamberlin 1924: 25, pl. 6, fig. 41 (male holotype from Suzhou, Jiangsu, China, in National Museum of Natural History, Smithsonian Institution, examined by Song 1988); Yin et al. 1980: 174, figs. 94a–f; Hu 1984: 256, figs. 269.1–6; Song 1988: 132, figs. 11A–B; Chen & Gao 1990: 133, figs. 166a–b; Song et al. 1999: 347, figs. 203D-E. NEW SYNONYMY.

Material examined.—CHINA: *Zhejiang*: 1 ♀, Tianmu Mt., 16 July 1981, Z.F. Chen



Figures 50–54.—*Dolomedes stellatus*. 50. Female, dorsal view; 51. Epigynum; 52. Vulva; 53. Left palp of the male, ventral view; 54. Left palp of the male, retrolateral view. Scale lines: 50 = 2 mm; 51, 52 = 0.5 mm; 53, 54 = 1 mm.

(MHU); *Hubei*: 1 ♀, Yingshan, 27 June 1984 (LSHU); *Guizhou*: 1 ♀, Fanjing Mt., 28 July 2001, J.X. Zhang (MHU). JAPAN: *Kagoshima*: 1 ♀, 1 ♂, Yakushima Island, 17 July 1990, A. Tanikawa (MHU); *Tokyo*: 2 ♀, 1 ♂, Yokozawa, Itsukaichi-shi, 12 July 1992, A. Tanikawa (MHU).

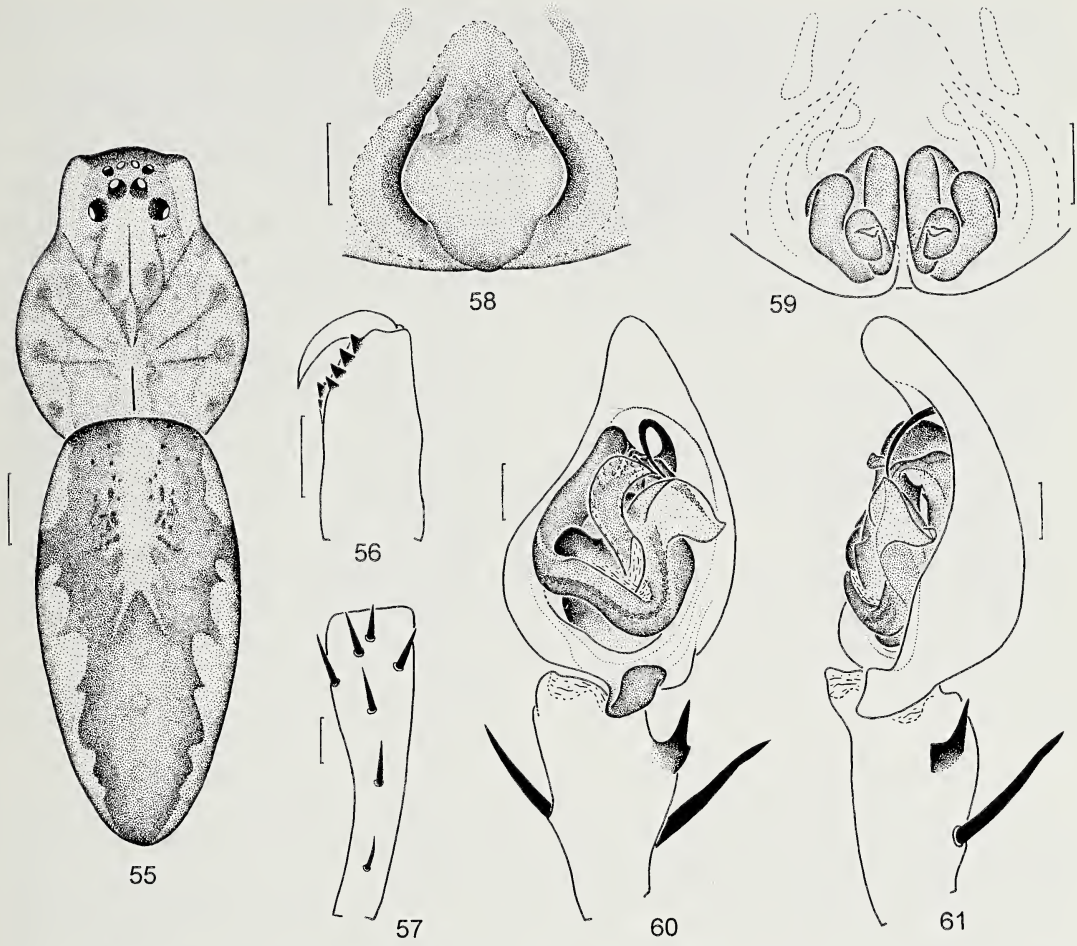
Diagnosis.—This species resembles *D. senilis* in body shape and coloration, but can be distinguished from the latter by the median field of the epigynum not rhomboid in shape, its posterior margin reaching the genital groove (Figs. 39, 40); tibia of the male palp long; fulcrum small, with its top not beyond the median apophysis (Figs. 42, 43).

Female.—See descriptions of Yaginuma (1986) and Chikuni (1989). See also the descriptions of *D. pallitarsis* by Song (1987) and Zhao (1993). Median field of the epigynum with a posterior triangular sclerotized plate, but with variation in its size; spermatheca long and coiled.

Male.—See descriptions of Yaginuma (1986) and Chikuni (1989). See also Song's (1987) and Zhao's (1993) descriptions of *D. pallitarsis*. The male description and illustrations in this study are based on the specimens from Japan. Tibial apophysis of palp with two branches; basal apophysis of cymbium distinct; embolus flagelliform.

Distribution.—China (Jiangsu, Zhejiang, Hubei, Hunan, Guangdong, Sichuan, Guizhou, Taiwan); Japan.

Remarks.—The species *D. insurgens* Chamberlin 1924 was redescribed by Song (1988) based on the male holotype. Judging from the illustrations of its male palpal organ (Song 1988: 132, figs. 11A–B), we found its



Figures 55–61.—*Dolomedes sulfureus*. 55. Female, dorsal view; 56. Left chelicera, retrolateral view; 57. Femur of left female palp, dorsal view; 58. Epigynum; 59. Vulva; 60. Left palp of the male, ventral view; 61. Left palp of the male, retrolateral view. Scale lines: 55, 56 = 2 mm; 57–61 = 0.5 mm.

difference from that of *D. saganus* Bösenberg & Strand 1906 was due to the slightly outward median apophysis which was forced to move by the extended basal membrane. The shape of the female copulatory organ of *D. insurgens* Chamberlin 1924 (Yin et al. 1980: 174, figs. 94a–f) is the same as that of *D. saganus*. Besides, the features of the female and male copulatory organs of *D. pallitarsis* Dönitz and Strand 1906 (Yaginuma 1986; Song 1987; Chikuni 1989) are also in accord with those of *D. saganus*. Therefore the two species are both synonymized with *D. saganus*.

Dolomedes senilis Simon 1880
Figs. 44–49

Dolomedes senilis Simon 1880: 101 (holotype female from Beijing, China, in Muséum Nationale d'Histoire Naturelle, Paris, lost); Song & Zheng 1982: 156, figs. 3–4; Hu 1984: 258, figs. 271.1–3; Guo 1985: 132, figs. 2–69.1–3; Song 1987: 205, fig. 165; Zhang 1987: 166, figs. 140.1–2; Feng 1990: 159, figs. 134.1–4;

Dolomedes senillis: Song et al. 1999: 347, figs. 202Q, 203J; Song et al. 2001: 266, fig. 166 (lapsus for *D. senilis*).

Dolomedes strandi Bonnet 1929: 268, figs. 1–3 (female and male syntypes from Russia, depository not clear); Marusik 1988: 1471, figs. 1.6–7; Renner 1988: 2, figs. 1a, 2–5. NEW SYNONYMY.

Material examined.—CHINA: *Beijing*: 1 ♀, 2 ♂, Badaling, 1 July 1974 (IZB); 2 ♂, Yuanmingyuan, 10 May 1978 (IZB); *Hebei*: 2 ♂, Bailuquan, Shijiazhuang, 7 May 1986 (MHU); 1 ♂, Baishi Mt., Laiyuan, 19 July 1999, F. Zhang (MHU).

Diagnosis.—This species is similar to *D. saganus* in the body shape and coloration, but can be distinguished from the latter by the median field of the epigynum rhomboid, with its posterior margin not reaching the genital groove (Fig. 46); tibia of the male palp short; fulcrum large, with its top beyond the tip of median apophysis (Figs. 48, 49).

Female.—See descriptions of Song & Zheng (1982) and Song (1987). Median field of the epigynum rhomboid; spermatheca long and coiled.

Male.—See descriptions of Song & Zheng (1982) and Song (1987). Tibial apophysis of palp with two branches; basal apophysis of cymbium distinct; embolus flagelliform.

Distribution.—China (Beijing, Hebei, Shaanxi); Russia.

Remarks.—Marusik (1988) and Renner (1988) redescribed the species *D. strandi*. Judging from their descriptions and illustrations of the female and male copulatory organs, we consider it to be conspecific with *D. senilis*.

Dolomedes stellatus Kishida 1936
Figs. 50–54

Dolomedes stellatus Kishida 1936: 121, fig. 1 (holotype female from Honshu, the main island of Japan, presumably lost); Paik 1969: 39, figs. 6, 40–45; Hu 1984: 259, figs. 272.1–2; Song 1987: 207, fig. 166; Chen & Gao 1990: 134, figs. 168a–b; Chen & Zhang 1991: 223, figs. 231.1–2; Song et al. 1999: 347, figs. 203A–B; Song et al. 2001: 267, fig. 167.

Material examined.—CHINA: *Shandong*: 2 ♀, 1 ♂, Kunyu Mt., 26 July 1990, J.L. Hu (MHU).

Diagnosis.—This species is similar to *D. saganus* in the shape of the palpal organ, but it differs from the latter in: posterior part of the median field of the epigynum lacking sclerotized plate (Fig. 51); spermatheca short (Fig. 52); basal apophysis of cymbium of the male palp not hook-shaped; saddle small (Figs. 53, 54).

Female.—See descriptions of Paik (1969) and Song (1987). Median field of the epigynum with a transverse ridge; accessory bulb visible in dorsal view; spermatheca short and thick.

Male.—See descriptions of Paik (1969). Tibial apophysis of the palp branched; saddle small; basal apophysis of cymbium not distinct.

Distribution.—China (Shanxi, Zhejiang, Shandong, Sichuan); Japan, Korea.

Dolomedes sulfureus L. Koch 1877
Figs. 55–61, 194–199

Dolomedes sulfureus L. Koch, 1877: 778 (female juvenile holotype from Japan, in the Museum at Vienna, not examined); Bösenberg & Strand 1906: 311, pl. 13, fig. 330; Paik 1969: 29, figs. 1–3, 8–9, 16, 19–33; Hu 1984: 258, fig. 270.2; Yaginuma 1986: 171, fig. 95.1; Song 1987: 208, fig. 167; Chikuni 1989: 107, fig. 6; Feng 1990: 160, figs. 135.1–5; Chen & Gao 1990: 135, figs. 169a–b; Chen & Zhang 1991: 224, figs. 232.1–2; Song et al. 1993: 874, figs. 42A, B; Zhao 1993: 306, figs. 140a, b; Song et al. 1999: 347, figs. 203C, K.

Caripeta japonica Bösenberg & Strand 1906: 307, pl. 13, fig. 343 (holotype female from Saga, Kompira, Japan, depositary not mentioned by authors). First synonymized by Paik (1969).

Dolomedes oviger Dönitz & Strand in Bösenberg & Strand 1906: 389, pl. 8, fig. 113 (data on types not mentioned by authors). First synonymized by Kishida (1936).

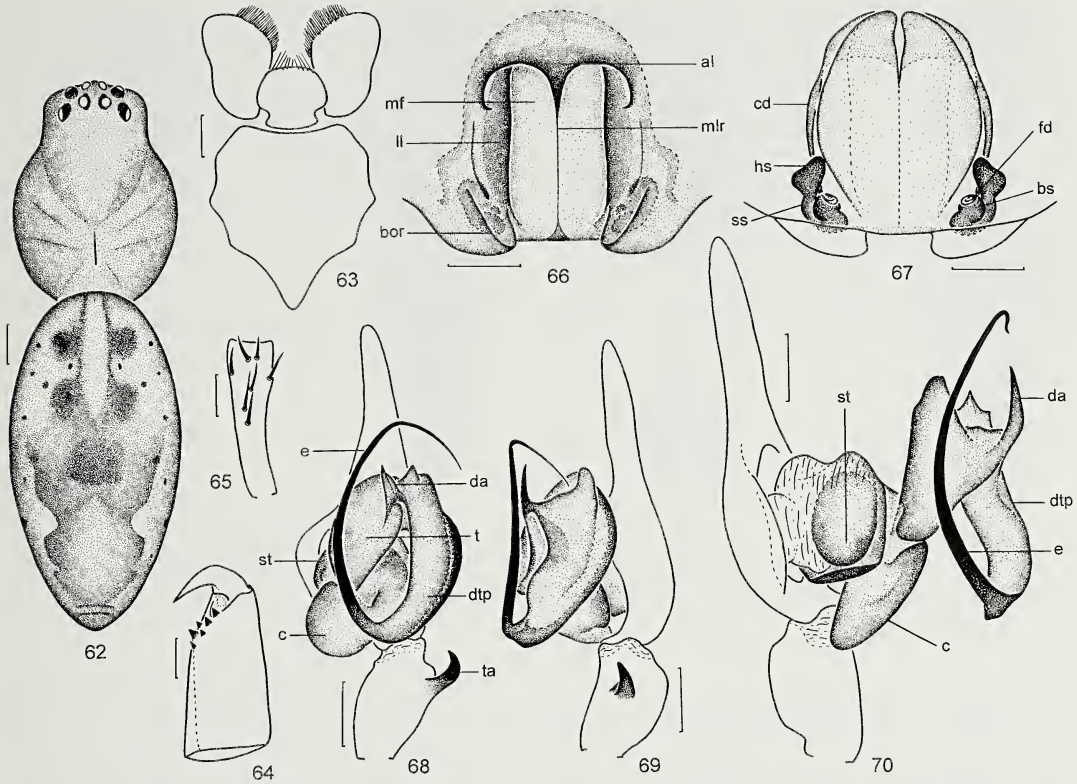
Dolomedes annulatus Kishida 1936: 121, pl. 13, fig. 7 (holotype female from Nagano Prefecture, Japan, presumably lost). First synonymized by Paik (1969).

Dolomedes angustivirgatus Kishida 1936: 123, pl. 13, fig. 3 (male holotype from Japan, presumably lost); Paik 1969: 36, figs. 5, 38–39; Hu 1984: 254, figs. 266.1–2. First synonymized by Yaginuma (1986).

Dolomedes hercules Bösenberg & Strand 1906: 310, pl. 13, fig. 361 (holotype female from Yokohama, Japan, in Stuttgart Museum, not examined); Paik 1969: 33, figs. 4, 10–12, 17, 34–37. First synonymized by Yaginuma (1986).

Dolomedes insurgens: Feng 1990: 157, figs. 132.1–6 (misidentification).

Material examined.—CHINA: *Anhui*: 1 ♀, Huang Mt., 27 October 1974 (MHU); *Sichuan*: 1 ♀, Emei Mt., 30 September 1975 (MHU); *Hubei*: 2 ♀, 2 ♂, Wuhan, 7 November 1977, J.Z. Zhao (LSHU); 1 ♀, Yingshan, 3 July 1984, (LSHU); *Guizhou*: 1 ♀, Meitan, 18 May 1981, F.J. Li (MHU); 3 ♀, 1 ♂, Maolan National Natural Reserve, Libo, 2 August 1995, H.M. Chen (MHU); 1 ♀, 1 ♂, Fanjing Mt., 4 August 2001, D.C. Zhang & Z.S. Zhang (MHU); 1 ♂, Jiangkou, 5 August 2001, J.X. Zhang (MHU); 1 ♀, Weng'ang, Libo, 9 August 2001, J.X. Zhang (MHU); *Zhejiang*: 1 ♀, Tianmu Mt., 16 July 1981, Z.F. Chen



Figures 62–70.—*Eurychoera banna*. 62. Female, dorsal view; 63. Endites, labium and sternum; 64. Left chelicera, retrolateral view; 65. Femur of left female palp, dorsal view; 66. Epigynum; 67. Vulva; 68. Left palp of the male, ventral view; 69. Left palp of the male, retrolateral view; 70. Left palp of the male, expanded. Scale lines: 62 = 1 mm; 63–65 = 0.5 mm; 66, 67 = 0.3 mm; 68–70 = 0.2 mm.

(MHU); *Fujian*: 1 ♀, Wuyi Mt., 10 June 1986, Z.F. Chen (MHU); 1 ♀, 1 ♂, Longqi Mt., Jiangle, 14 August 1991, S.Q. Li (IZB); *Yunnan*: 1 ♀, Lincang, 7 August 1999, X.Z. Gan (MHU); 1 ♂, Gong Mt., 8 July 2001, Z.Z. Yang (MHU); *Taiwan*: 1 ♀, Qilong, 26 July 2000, J.N. Huang (BTU); *Hunan*: 3 ♀, Nanhua Mt., Fenghuang, 24 July 2001, J.X. Zhang & Z.S. Zhang (MHU); 1 ♀, Zhangjiajie, Dayong, 7 August 2001, G.D. Ren (MHU).

Diagnosis.—This species is closely related to *D. chinesus* in the shape of epigynum, but can be distinguished from the latter by the posterior margin of the median field of the epigynum tongue-shaped (Fig. 58); tip of the spermatheca pointing backwards and not distinctly inflated (Fig. 59). It is also similar to *D. saganus* Bösenberg & Strand 1906 in the shape of male palpal organ, but differs from the latter in: anterior part of the median field of the epigynum slightly swollen; spermatheca thick (Fig. 59); basal apophysis of cymbium tapered off to the base; distal end of the median apophysis inflated (Figs. 60, 61).

Female.—See descriptions of Song (1987) and Chikuni (1989). Median field of the epigynum peach-shaped, with its anterior part slightly swollen; spermatheca long and coiled.

Male.—See descriptions of Song (1987) and Chikuni (1989). Tibial apophysis of the palp branched; basal apophysis of cymbium tapered off to the base; embolus long and flagelliform.

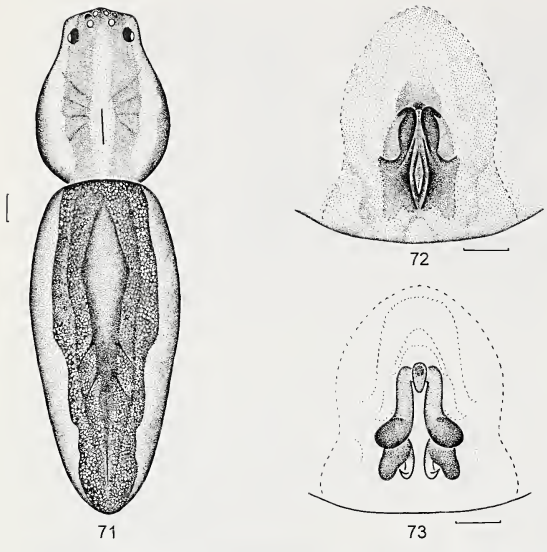
Distribution.—China (Zhejiang, Anhui, Fujian, Hubei, Hunan, Sichuan, Guizhou, Yunnan, Taiwan); Japan, Korea, Russia.

Eurychoera Thorell 1897

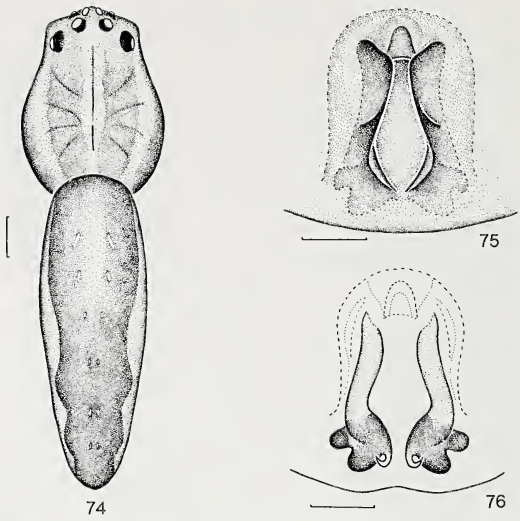
Eurychoera Thorell 1897: 19.

Type species.—*Eurychoera quadrimaculata* Thorell 1897, by monotypy.

Diagnosis.—This genus can be easily distinguished from others of the family by anterior lateral spinneret with a nubbin (Fig. 202);



Figures 71–73.—*Hygropoda argentata*. 71. Female, dorsal view; 72. Epigynum; 73. Vulva. Scale lines: 71 = 1 mm; 72, 73 = 0.2 mm.



Figures 74–76.—*Hygropoda campanulata*. 74. Female, dorsal view; 75. Epigynum; 76. Vulva. Scale lines: 74 = 1 mm; 75, 76 = 0.2 mm.

lateral lobe of the epigynum with a basal oblique rumple (Fig. 66); epigynum with an anterior lobe, which extended backwards and forming a mesal longitudinal ridge (Fig. 66); male palpal organ lacking median apophysis; distal apophysis small and triangular (Figs. 68, 69).

Remarks.—Only the type species has been reported, which is only known from Singapore. We studied specimens of *Eurychoera quadrimaculata* deposited in the Raffles Museum of Singapore, and concluded that the species found in China is new to science.

Eurychoera banna new species
Figs. 62–70, 200–205

Material examined.—Holotype female, Menglun (21°55′N, 101°15′E), Yunnan, China, 30 June 2001, C. Zhang & D.Q. Li (MHU). Paratypes: 4 females, 7 males, same data as holotype (MHU); 1 ♀, 2 ♂, Menglun (21°55′N, 101°15′E) , Yunnan, China, 14 July 2001, C. Zhang & D.Q. Li (MHU).

Diagnosis.—The new species is very similar to *E. quadrimaculata* in body coloration, but can be distinguished from the latter by the lateral margins of lateral lobe of epigynum almost parallel (Fig. 66); head of spermatheca triangular (Fig. 67); palpal tibial apophysis of male not branched at the tip; and the embolus longer than that of the latter (Figs. 68–70).

Female.—Total length 8.64–9.14. Holotype total length 8.64: cephalothorax 3.42 long, 2.88 wide; abdomen 5.67 long, 3.33 wide. Carapace red brown. Palp orange. Chelicerae, labium, endites and sternum red brown. Legs orange. Abdomen yellow brown, dorsum with five dark brown and two white patches. Chelicerae with three teeth on both margins. Both eye rows recurved. AME–AME:AME–ALE (0.14:0.09); PME–PME:PME–PLE (0.23: 0.30); AME:ALE:PME:PLE (0.22:0.20:0.21: 0.23); MOA 0.65 long, front width 0.59, back width 0.65. Measurements of legs: I 17.42 (4.95, 6.21, 4.32, 1.94), II 17.83 (5.09, 6.30, 4.50, 1.94), III 13.68 (4.14, 4.77, 3.33, 1.44), IV 15.13 (4.41, 5.18, 3.92, 1.62). Leg formula: 2, 1, 4, 3. Tibiae I and II with four pairs of ventral spines, III and IV with three pairs. Unpaired tarsal claw with two teeth. Median field of the epigynum quadrate, lateral margins of lateral lobe almost parallel; copulatory duct thin, head of spermatheca almost triangular.

Male.—Total length 4.50–5.04. A male total length 4.50: cephalothorax 2.12 long, 1.71 wide; abdomen 2.70 long, 1.26 wide. Characters as in holotype female. Measurements of palp and legs: palp 2.68 (1.09, 0.34, 0.31, 0.94); leg I 11.12 (2.97, 3.78, 2.88, 1.49), II 11.35 (3.06, 3.92, 2.88, 1.49), III 8.38 (2.43, 2.75, 2.12, 1.08), IV 9.32 (2.61, 3.06, 2.43, 1.22). Tibial apophysis of palp hook-shaped

in ventral view; embolus flagelliform, conductor flat and axe-shaped.

Etymology.—The specific name is a noun in apposition, and refers to the type locality.

Distribution.—China (Yunnan).

Hygropoda Thorell 1894

Hygropoda Thorell 1894: 4; Hu 1984: 260; Yaginuma 1986: 176.

Type species.—*Tegenaria dolomedes* Doleschall 1859, by original designation.

Diagnosis.—This genus can be easily distinguished from others of the family by: posterior lateral and median spinnerets with cylindrical gland spigots (Figs. 209, 211–213); leg I, II and IV with long and flexible tarsi; conductor and distal apophysis membranous (Figs. 83–85).

Remarks.—This genus comprises 17 species distributed in Asia (14 species), Africa (three species) and Australia (one species). Besides the two known species, *H. higenaga* and *H. taeniata* Wang 1993, another four species are considered new to science and reported here.

KEY TO CHINESE *HYGROPODA* SPECIES

1. Female 2
   Male; palpal tibia slightly curved; distal apophysis of palpal organ membranous, embolus needle-shaped (Figs. 83–85) ..... *H. higenaga*
2. Carapace with a dark longitudinal stripe in front of fovea 3
   Carapace lacking dark longitudinal stripe in front of fovea 5
3. Median field of epigynum almost trapeziform; copulatory duct thin, spermatheca with only one chamber (Figs. 87, 88) ..... *H. menglun*
   Epigynum otherwise; copulatory duct thick, spermatheca with two chambers 4
4. Median field of epigynum almost as long as wide, with a mesal longitudinal ridge; head of spermatheca with a small lateral tubercle (Figs. 95, 96) ..... *H. yunnan*
   Median field of epigynum longer than wide, lacking a mesal longitudinal ridge; head of spermatheca lacking a lateral tubercle (Figs. 75, 76) ..... *H. campanulata*
5. Median field of epigynum widest at anterior margin; copulatory duct short (Figs. 80, 81) ..... *H. higenaga*
   Epigynum otherwise; copulatory duct long 6
6. Median field of epigynum rhomboid, margins of lateral lobe swollen at anterior half part; base of spermatheca almost oval (Figs. 72, 73) ..... *H. argentata*
   Epigynum otherwise; base of spermatheca round ..... *H. taeniata*

Hygropoda argentata new species
Figs. 71–73

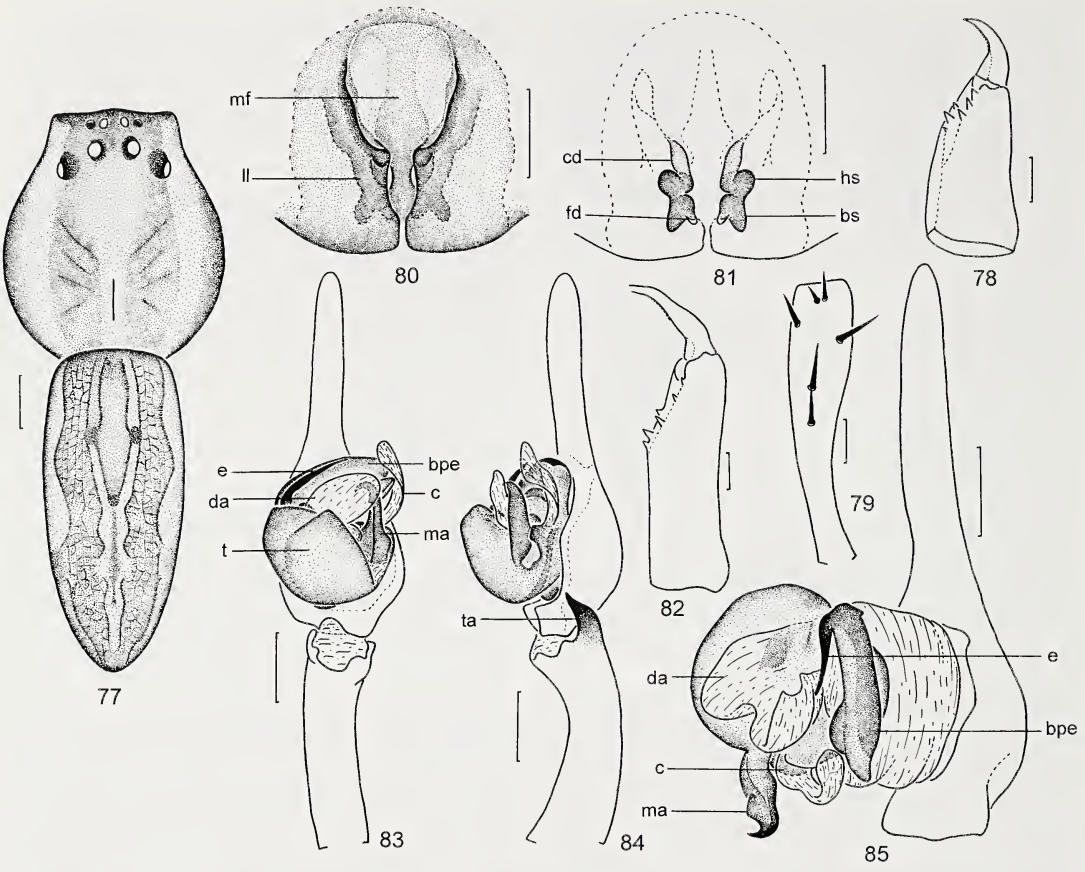
Material examined.—Holotype female from Menglun (21°55′N, 101°15′E), Yunnan, China, 3 July 2001, C. Zhang (MHU).

Diagnosis.—The new species is closely related to *H. campanulata*, but it differs from the latter in: dorsum of abdomen with many silvery spots (Fig. 71); median field of the epigynum narrow and rhomboid (Fig. 72); and copulatory duct short (Fig. 73).

Female.—Total length 12.70: cephalothorax 4.50 long, 3.87 wide; abdomen 9.00 long, 3.92 wide. Carapace brown, with lateral and mesal orange band. Chelicerae, endites and legs orange. Labium gray brown. Sternum yellowish, with marginal grayish patches. Dorsum of abdomen brown, with numerous silvery spots and a rhomboid brown patch at anterior part. Chelicerae with three teeth on both margins. Anterior eye row almost straight, posterior eye row recurved. AME–AME:AME–ALE (0.16:0.07); PME–PME:PME–PLE (0.33:0.46). AME:ALE:PME:PLE (0.20:0.18:0.23:0.26). MOA 0.65 long, front width 0.59, back width 0.83. Measurements of legs: I (lost), II 34.52 (9.36, 10.49, 8.10, 6.57), III 16.08 (5.04, 5.09, 4.10, 1.85), IV 34.07 (10.08, 9.63, 8.87, 5.49). Tibiae I and II with four pairs of ventral spines, III and IV with three pairs. Margins of lateral lobes of epigynum swollen at the anterior part, median field narrow and rhomboid; copulatory duct short, spermatheca with head and base.

Male.—Unknown.

Etymology.—The specific name is from



Figures 77–85.—*Hygropoda higenaga*. 77. Female, dorsal view; 78. Left chelicera of female, retrolateral view; 79. Femur of left female palp, dorsal view; 80. Epigynum; 81. Vulva; 82. Left chelicera of male, retrolateral view; 83. Left palp of the male, ventral view; 84. Left palp of the male, retrolateral view; 85. Left palp of the male, expanded. Scale lines: 77 = 1 mm; 78–85 = 0.5 mm.

the Latin *argentata*, and refers to the dorsum of abdomen with numerous silvery spots.

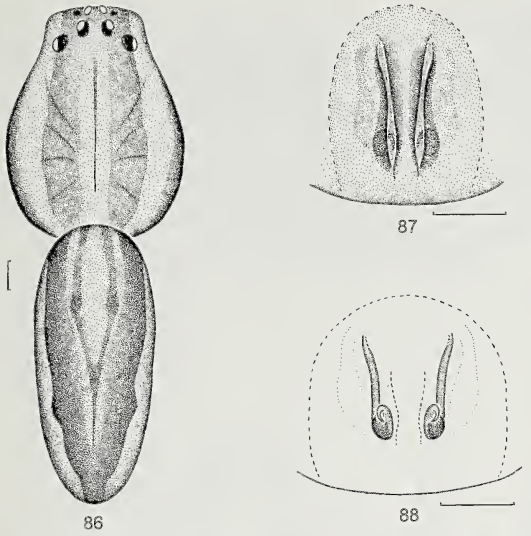
Distribution.—China (Yunnan).

Hygropoda campanulata new species
Figs. 74–76

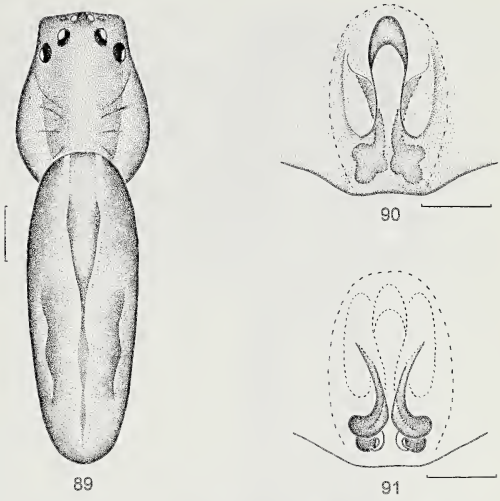
Material examined.—Holotype female from Menglun (21°55′N, 101°15′E), Yunnan, China, 30 June 2001, D.Q. Li (MHU); 1 female paratype from Menglun, Yunnan, China, 3 July 2001, C. Zhang (MHU).

Diagnosis.—The new species is similar to *H. argentata*, but it differs from the latter by dorsum of abdomen with pairs of small spots (Fig. 74); median field of epigynum wide and not rhomboid, with a bell-shaped hood at anterior part (Fig. 75); and copulatory duct long (Fig. 76).

Female.—Total length 7.11–8.82. Holotype total length 8.82: cephalothorax 3.33 long, 2.52 wide; abdomen 5.58 long, 2.03 wide. Carapace yellow brown, with lateral and mesal yellow bands. Chelicerae yellow. Endites, labium and legs yellow brown. Sternum yellowish, with marginal grayish patches. Dorsum of abdomen dark brown, with a rhomboid yellow brown patch at anterior part and pairs of small spots. Chelicerae with three teeth on both margins. Anterior eye row almost straight, posterior eye row recurved. AME–AME:AME–ALE (0.08:0.05); PME–PME:PME–PLE (0.33:0.36). AME:ALE:PME:PLE (0.17:0.13:0.23:0.23). MOA 0.56 long, front width 0.40, back width 0.75. Measurements of legs: I 25.75 (6.21, 7.97, 6.44, 5.13), II 19.72 (5.22, 6.17, 4.82, 3.51), III 10.54 (3.24, 3.06, 2.66, 1.58), IV 19.86 (5.72, 5.49, 5.27, 3.38). Leg formula: 1, 4, 2, 3. Tibiae I and II with 4 pairs of ventral spines, III and IV with 3 pairs. Median field of epigynum with a bell-



Figures 86–88.—*Hygropoda menglun*. 86. Female, dorsal view; 87. Epigynum; 88. Vulva. Scale lines: 86 = 1 mm; 87, 88 = 0.1 mm.



Figures 89–91.—*Hygropoda taeniata*. 89. Female, dorsal view; 90. Epigynum; 91. Vulva. Scale lines: 89 = 1 mm; 90, 91 = 0.2 mm.

shaped hood; copulatory duct thick, head of spermatheca round.

Male.—Unknown.

Etymology.—The specific name is from the Latin *campanulata*, refers to the epigynum with a bell-shaped hood.

Distribution.—China (Yunnan).

Hygropoda higenaga (Kishida 1936)
Figs. 77–85, 206–213

Dolomedes higenaga Kishida 1936: 119, pl. 13, fig. 8 (male holotype from Okinawajima Island, Japan, presumably lost).

Hygropoda higenaga: Yaginuma 1965: 32, figs. 2.1–7; Yaginuma 1986: 176, fig. 97.2; Hu 1984: 260, figs. 273.1–2; Zhang & Zhang 2003: 15, figs. 1A–G.

Hygropoda hippocrepiforma Wang 1993: 156, figs. 1–4 (holotype female, allotype male from Mengla, Yunnan, China, in MHU, examined); Song et al. 1999: 348, figs. 203O–Q. First synonymized by Zhang & Zhang (2003).

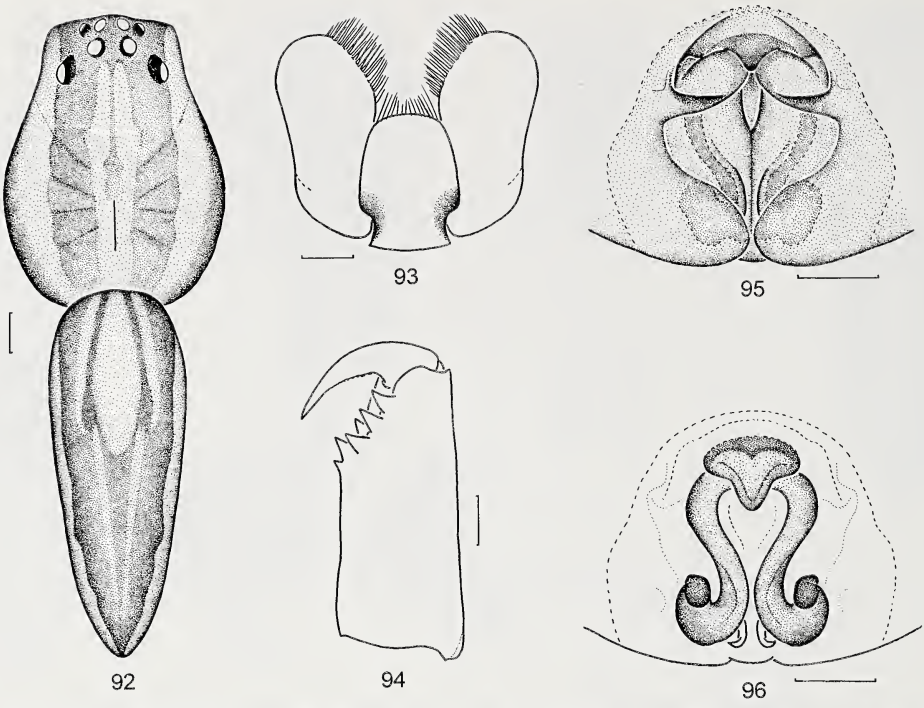
Material examined.—Holotype female, allotype male of *H. hippocrepiforma*, Menglun, Yunnan, China, 8 July 1981, J.F. Wang (MHU). CHINA: *Guangxi*: 1 ♂, Longsheng, 10 September 1981, J.F. Wang (MHU); *Hunan*: 1 ♀, Suining, 7 March 1984, J.F. Wang (MHU); *Taiwan*: 1 ♀, Taipei, 24 July 1997, I.M. Tso (BTU); 1 ♀, Nantou, 24 August 1999, Q.C. Lai (BTU). JAPAN: *Okinawa*: 1 ♂, Shirahama, Iriomotejima Island, 25 August 1988, A. Tanikawa (MHU); 1 ♀, Komi, Iriomotejima Island, 29 July 1995, A. Tanikawa (MHU); 1 ♀, Urauchi, Iriomotejima Island, 28 July 1996, A. Tanikawa (MHU); 1 ♂, Midara, Iriomotejima Island, 5 August 1997, A. Tanikawa (MHU).

Diagnosis.—The species is similar to *H. menglun* in body shape and coloration, but it differs from the latter in: posterior part of the median field of epigynum distinctly narrower than anterior part, intromittent orifice near the center of the lateral margin of the median field (Fig. 80); copulatory duct short and thick; spermatheca with two chambers (Fig. 81).

Female.—See descriptions of Zhang & Zhang (2003). See also the description of *H. hippocrepiforma* by Wang (1993). Posterior part of the median field of epigynum distinctly narrower than anterior part; copulatory duct short, and spermatheca with two chambers.

Male.—See descriptions of Yaginuma (1986), Hu (1984) and Zhang & Zhang (2003). Patella of the palp longer than tibia; tibia slightly curved, with a lateral apophysis not branched; distal apophysis membranous and petal-shaped; tip of the median apophysis hooked, its center with a process.

Distribution.—China (Hunan, Guangxi, Yunnan, Taiwan); Japan.



Figures 92–96.—*Hygropoda yunnan*. 92. Female, dorsal view; 93. Endites and labium; 94. Left chelicera of female, retrolateral view; 95. Epigynum; 96. Vulva. Scale lines: 92 = 1 mm; 93, 94 = 0.5 mm; 95, 96 = 0.3 mm.

Hygropoda menglun new species
Figs. 86–88

Material examined.—Holotype female, 1 female paratype from Menglun (21°55′N, 101°15′E) , Yunnan, China, 6 July 2001, C. Zhang (MHU).

Diagnosis.—The new species resembles *H. higenaga* in body shape and coloration, but it differs from the latter in: median field of the epigynum almost trapeziform (Fig. 87); copulatory duct thin and long, spermatheca with only one chamber (Fig. 88).

Female.—Total length 7.88–11.52. Holotype total length 11.52: cephalothorax 5.40 long, 4.41 wide; abdomen 6.57 long, 2.79 wide. Carapace yellow brown, with lateral and mesal yellow band. Chelicerae, endites and legs yellow. Labium orange. Sternum yellowish. Dorsum of abdomen brown, with both sides dull yellow, and an almost rhomboid dull yellow patch at anterior part. Chelicerae with three teeth on both margins. Anterior eye row almost straight, posterior eye row recurved. AME–AME:AME–ALE (0.14:0.10); PME–PME:PME–PLE (0.36:0.49). AME:ALE:PME:PLE (0.23:0.17:0.26:0.27). MOA 0.60 long, front width 0.60, back width 0.90. Measurements of legs: I 45.64 (10.53, 12.83, 10.85, 11.43), II 32.24 (8.37, 10.50, 7.02, 6.35), III 15.18 (4.82, 5.00, 3.78, 1.58), IV 31.73 (9.18, 9.09, 7.97, 5.49). Leg formula: 1, 2, 4, 3. Tibiae I and II with four pairs of ventral spines, III and IV with three pairs. Epigynum small, median field trapezoid; copulatory duct thin, spermatheca with only one chamber.

Male.—Unknown.

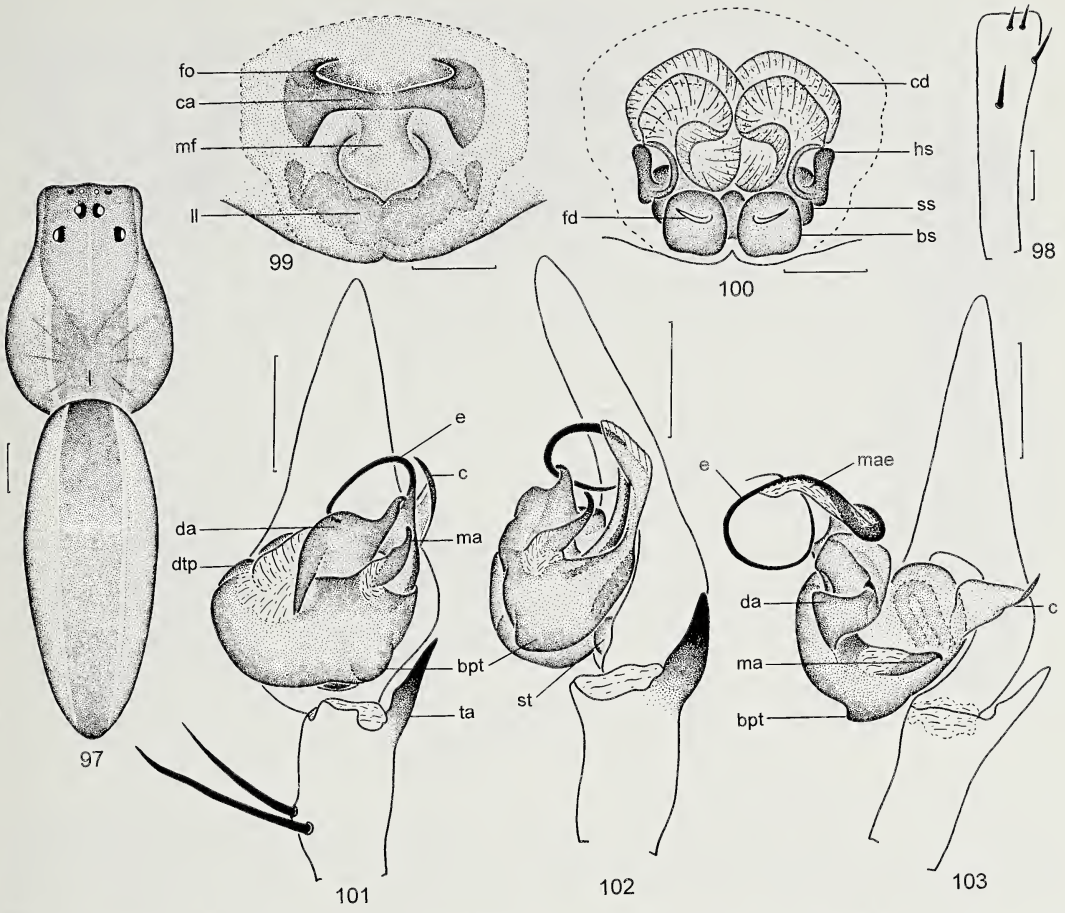
Etymology.—The specific name refers to the type locality, and is a noun in apposition.

Distribution.—China (Yunnan).

Hygropoda taeniata Wang 1993
Figs. 89–91

Hygropoda taeniata Wang 1993: 157, fig. 5 (holotype female from Menglun, Yunnan, China, in MHU, examined); Song et al. 1999: 348, fig. 203L.

Material examined.—Holotype female, Menglun, Yunnan, China, 27 July 1983, K. M. Zou (MHU).



Figures 97–103.—*Perenethis fascigera*. 97. Female, dorsal view; 98. Femur of left female palp, dorsal view; 99. Epigynum; 100. Vulva; 101. Left palp of the male, ventral view; 102. Left palp of the male, retrolateral view; 103. Left palp of the male, expanded. Scale lines: 97 = 1 mm; 98, 101–103 = 0.5 mm; 99, 100 = 0.3 mm.

Diagnosis.—This species is similar to *H. higenaga* in abdominal coloration, but can be easily distinguished from the latter by the shape of the epigynum (Fig. 90).

Female.—See description of Wang (1993). Chelicera with three teeth on promargin. Lateral margins of the median field of the epigynum ripple-like, and the spermatheca with two chambers.

Male.—Unknown.

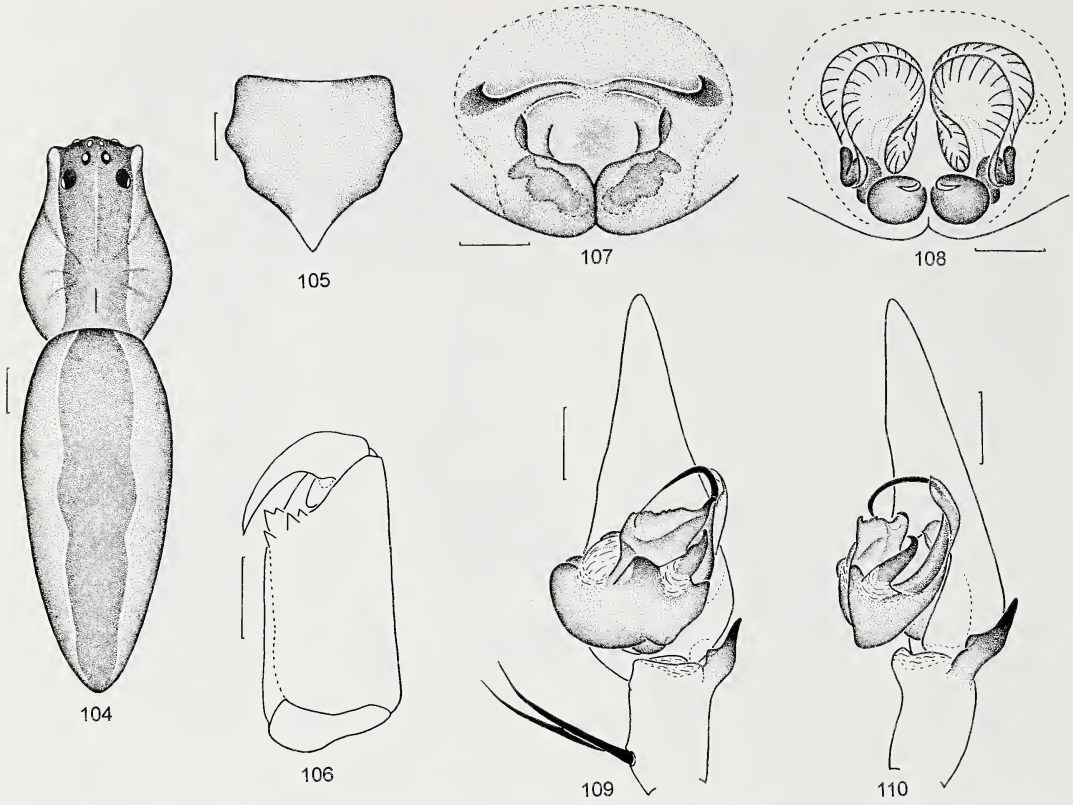
Distribution.—China (Yunnan).

Hygropoda yunnan new species
Figs. 92–96

Material examined.—Holotype female from Mohan, Mengla (21°24′N, 101°30′E), Yunnan, China, 25 July 2000, M.S. Zhu (MHU); 3 female paratypes from Zhenkang (23°54′N, 99°00′E), Yunnan, China, 14 September 2000, F.X. Liu (MHU).

Diagnosis.—The new species is similar to *H. campanulata* in body shape and coloration, but it differs from the latter in: dorsum of the abdomen lacking paired small spots (Fig. 92); median field of the epigynum almost as long as wide, with a longitudinal ridge, anterior lobe triangular (Fig. 95); head of spermatheca with a lateral tubercle (Fig. 96).

Female.—Total length 7.92–11.30. Holotype total length 10.80: cephalothorax 4.95 long, 3.69 wide; abdomen 6.30 long, 2.34 wide. Carapace yellow brown, with lateral and mesal yellow bands. Chelicerae, endites and labium yellow brown. Sternum and legs yel-



Figures 104–110.—*Perenethis sindica*. 104. Female, dorsal view; 105. Sternum; 106. Left chelicera, retrolateral view; 107. Epigynum; 108. Vulva; 109. Left palp of the male, ventral view; 110. Left palp of the male, retrolateral view. Scale lines: 104 = 1 mm; 105, 106, 109, 110 = 0.5 mm; 107, 108 = 0.2 mm.

lowish. Dorsum of abdomen dark brown, with an almost rhomboid brownish patch at anterior part. Chelicerae with three teeth on both margins. Anterior eye row almost straight, posterior eye row recurved. AME–AME: AME–ALE (0.13:0.09); PME–PME:PME–PLE (0.36:0.47). AME:ALE:PME:PLE (0.26: 0.18:0.29:0.29). MOA 0.72 long, front width 0.57, back width 0.82. Measurements of legs: I 37.59 (8.87, 11.03, 8.69, 9.00), II 27.15 (7.34, 8.24, 6.03, 5.54), III 13.73 (4.50, 4.46, 3.33, 1.44), IV 27.46 (8.15, 7.65, 7.02, 4.64). Leg formula: 1, 4, 2, 3. Tibiae I and II with four pairs of ventral spines, III and IV with three pairs. Median field of the epigynum with a longitudinal ridge, anterior lobe triangular; head of spermatheca with a lateral tubercle.

Etymology.—The specific name refers to the type locality, and is a noun in apposition.

Distribution.—China (Yunnan).

Perenethis L. Koch 1878

Perenethis L. Koch 1878: 980; Hu 1984: 260; Chen & Zhang 1991: 225; Barrion & Litsinger 1995: 345; Sierwald 1997: 387.

Type species.—*Perenethis venusta* L. Koch 1878, by original designation.

Diagnosis.—This genus is similar to *Polyboea*, but can be distinguished from the latter by ALE smaller than PME; tibia of leg with a pair of short ventral spines at the distal end; carina of the epigynum forming two lateral branches (Fig. 99); conductor of the male palpal organ small and not provided with two guiding lamellae (Figs. 101–103).

Remarks.—This genus has recorded seven species distributed in Asia (five species), Africa (two species) and Australia (one species). Only one species, *P. fascigera*, has been reported from China. Two species of the genus are reported below, of which *P. sindica* (Simon 1897) is newly recorded from our fauna.

KEY TO CHINESE *PERENETHIS* SPECIES

1. Female 2
   Male 3
2. Carina of epigynum long, surpassing the outer margin of the head of spermatheca (Fig. 107); base of spermatheca oval (Fig. 108) ..... *P. sindica*
   Carina of epigynum short, not surpassing the outer margin of the head of spermatheca (Fig. 99); base of spermatheca almost round (Fig. 100) ..... *P. fascigera*
3. Anterior margin of distal apophysis smooth, conductor with several parallel longitudinal ridges (Fig. 101) ..... *P. fascigera*
   Anterior margin of distal apophysis serrated, conductor lacking longitudinal ridges (Fig. 109) ..... *P. sindica*

Perenethis fascigera (Bösenberg & Strand 1906)
Figs. 97–103, 214–219

Tetragonophthalma fascigera Bösenberg & Strand 1906: 306, pl. 13, fig. 329 (holotype female from Japan, in Naturkunde-Museum Stuttgart, lost).

Perenethis fascigera: Paik 1978: 375, figs. 170.1–4; Yin et al. 1980: 177, figs. 96a–c; Hu 1984: 260, figs. 274.1–3; Song 1987: 209, fig. 168; Chikuni 1989: 106, fig. 3; Chen & Gao 1990: 136, figs. 170a–b; Chen & Zhang 1991: 225, figs. 233.1–2; Song et al. 1999: 348, figs. 203M–N.

Material examined.—CHINA: *Guangxi*: 1 ♀, 2 ♂, Nanning, 18 July 1982, Y. G. Huang (GU); 1 ♀, Liangfengjiang Natural Reserve, Nanning, 7 August 2000, Z. Li (MHU); *Hainan*: 2 ♀, 1 ♂, Jianfengling, 12 December 1989, M. S. Zhu (MHU); *Yunnan*: 1 ♀, Longling, Baoshan, 2 August 1999, M. K. Yang (MHU); *Guizhou*: 1 ♀, Jiangkou, 5 August 2001, J. X. Zhang (MHU).

Diagnosis.—This species is so closely related to *P. venusta* that Sierwald (1997: 390) thought it might be conspecific with the latter. By examining the Chinese specimens of this species and comparing with the description and illustrations of *P. venusta* given by Sierwald (1997: 396, figs. 42–47, 53, 57, 75, 76), we believe that this is a distinct species, which can be distinguished from *P. venusta* by: carina of the epigynum short and not beyond the outer margin of the head of spermatheca (Fig. 99); distal end of conductor of male palpal organ sharp; and distal end of the distal apophysis not pointed backwards (Figs. 101–103).

Female.—See descriptions of Paik (1978), Hu (1984) and Song (1987). Median field of the epigynum almost heart-shaped, copulatory duct membranous and saccate, base of spermatheca almost round.

Male.—See descriptions of Paik (1978), Chikuni (1989) and Chen & Gao (1990). Tibial apophysis of the palp finger-shaped; embolus long and slender; conductor with several parallel longitudinal ridges at the outer surface.

Distribution.—China (Zhejiang, Hunan, Guangxi, Hainan, Sichuan, Guizhou, Yunnan); Japan, Korea.

Perenethis sindica (Simon 1897)
Figs. 104–110

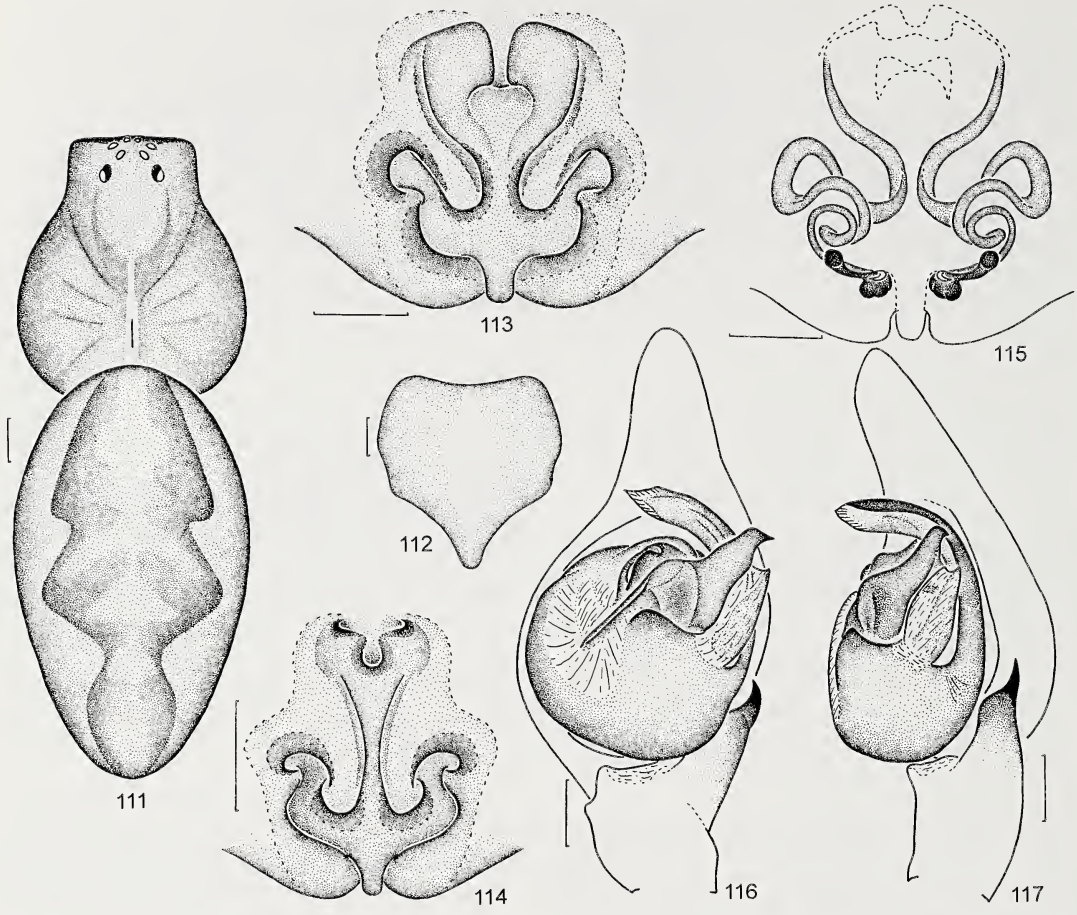
Tetragonophthalma sindica Simon, 1897: 295 (2 female syntypes from Kurrachee, India, in Muséum Nationale d'Histoire Naturelle, Paris, examined by Sierwald 1997).

Perenethis sindica: Sierwald 1997: 395, figs. 36–41, 59–72.

Material examined.—CHINA: *Yunnan*: 1 ♀, Renhe, Yongsheng, 26 July 1999, K.L. Yu (MHU); 1 ♂, Binchuan, 25 July 2002, L.Y. Liu (MHU); *Sichuan*: 1 ♀, Maomao Mt., Huili, 9 August 1999, G.D. Ren (MHU); 2 ♀, Xichang, 18 July 2000, J.X. Zhang (MHU).

Diagnosis.—This species resembles *P. fascigera* in body shape and coloration, but it differs from the latter in: longitudinal patch on the sternum light in color, and not branched laterally (Fig. 105); carina of the epigynum long and surpassing the outer margin of the head of spermatheca, basal part of spermatheca elliptic in shape (Figs. 107, 108); and anterior margin of the distal apophysis serrated (Fig. 109).

Female.—Described by Sierwald (1997). Carina of the epigynum long and surpassing the outer margin of the head of spermatheca, head of spermatheca club-shaped.



Figures 111–117.—*Pisaura ancora*. 111. Female, dorsal view; 112. Sternum; 113. Epigynum; 114. Epigynum, different individual; 115. Vulva; 116. Left palp of the male, ventral view; 117. Left palp of the male, retrolateral view. Scale lines: 111 = 1 mm; 112–117 = 0.5 mm.

Male.—Described by Sierwald (1997). Tibial apophysis of the palp finger-shaped; embolus long and slender; anterior margin of the distal apophysis serrated. Judging from the illustrations and descriptions by Sierwald (1997), features of the male palpal organ are surprisingly variable (figs. 59–72 in Sierwald 1997).

Distribution.—China (Sichuan, Yunnan); India, Sri Lanka, Nepal, Philippines.

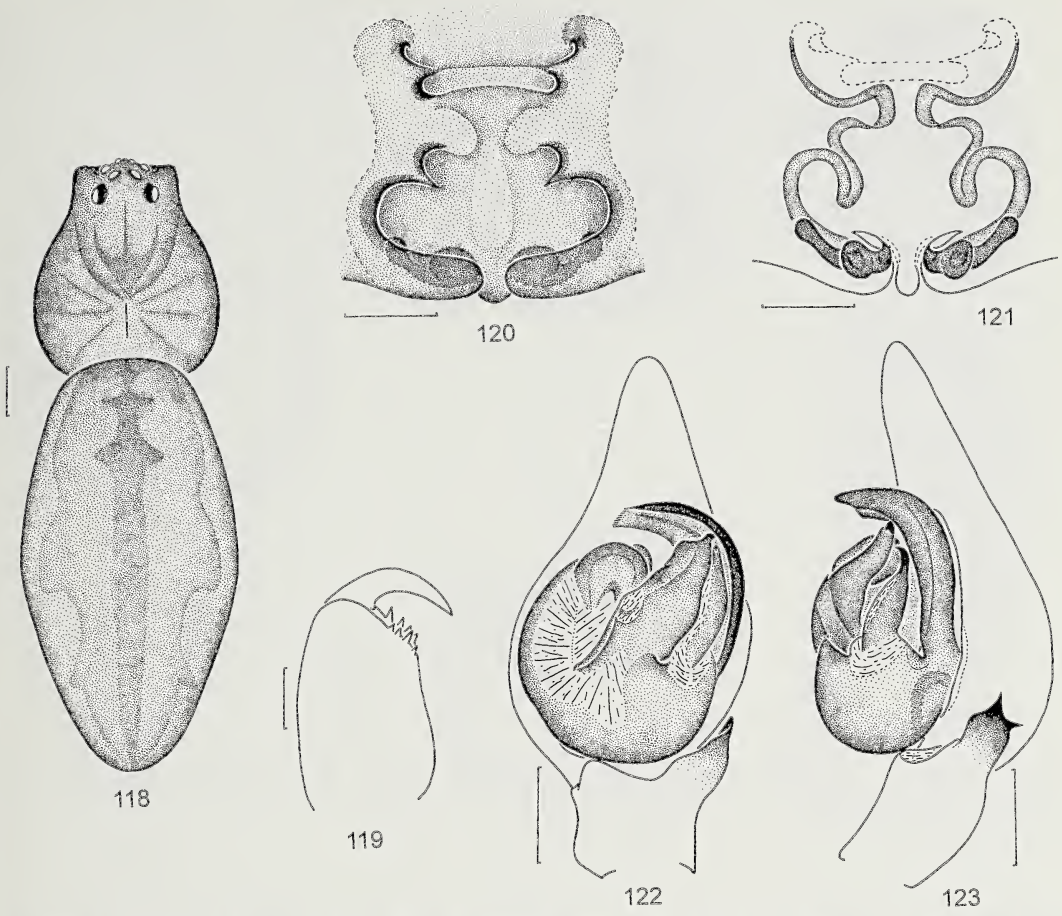
Pisaura Simon 1885

Pisaura Simon 1885b: 345; Chen & Zhang 1991: 226; Barrion & Litsinger 1995: 343; Song et al. 2001: 268; Hu 2001: 217.

Type species.—*Araneus mirabilis* Clerck 1757, by original designation.

Diagnosis.—This genus can be distinguished from the similar genera *Perenethis* and *Polyboea* by: the chelicera with three or four retromarginal teeth; lateral lobes of epigynum forming curves (Figs. 113, 120); copulatory ducts long and slender, not membranous or saccate (Figs. 115, 121); and the basal protuberance of tegulum of the male palpal organ absent (Fig. 140). It also differs from *Dianpisaura* in the epigynum lacking large depressions anteriorly (Fig. 136), copulatory duct long and coiled (Fig. 115); tibia of male palp shorter than cymbium, subtegulum invisible in ventral view, base of embolus accompanied by membrane (Figs. 138–140).

Remarks.—Up to now, 21 species of the genus have been reported worldwide (Platnick 2002; Zhang & Zhang 2003), distributed in

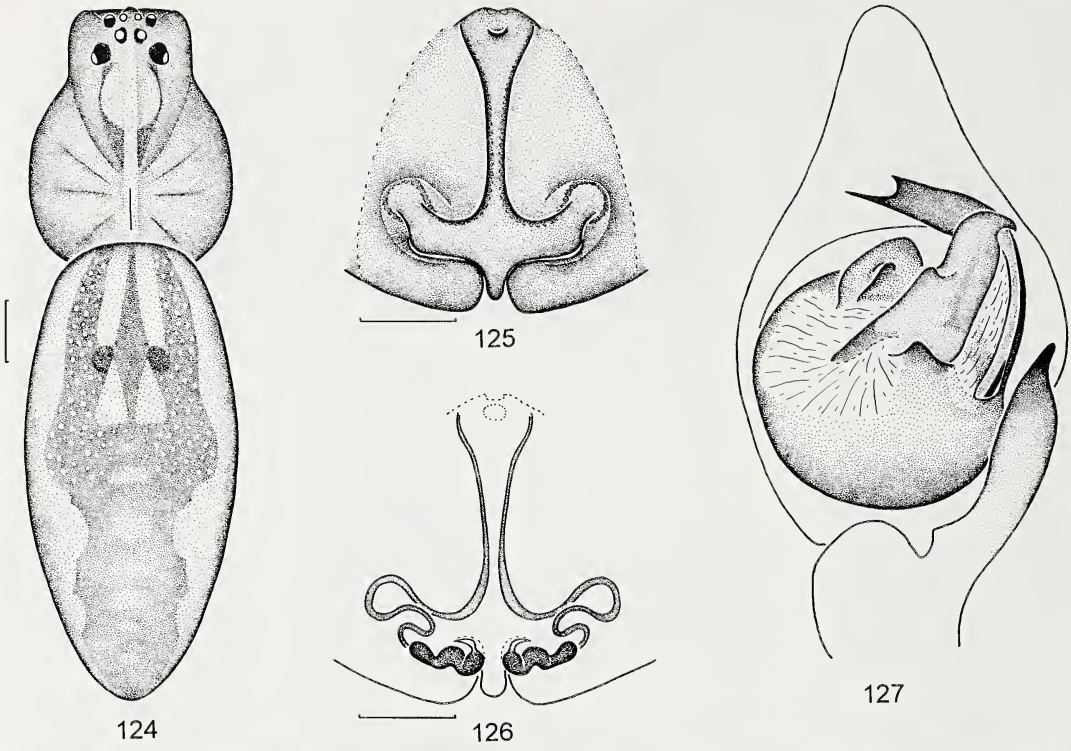


Figures 118–123.—*Pisaura bicornis*. 118. Female, dorsal view; 119. Left chelicera, prolateral view; 120. Epigynum; 121. Vulva; 122. Left palp of the male, ventral view; 123. Left palp of the male, retrolateral view. Scale lines: 118 = 1 mm; 119, 122, 123 = 0.5 mm; 120, 121 = 0.3 mm.

Asia (17 species), Europe (three species) and Latin America (one species). Among them, *P. lizhii* Zhang 2000 and *P. songi* Zhang 2000 are transferred to the new genus *Dianpisaura* in this study. Therefore, six species of this genus are reported from China, of which *P. kishidai* Saito 1936 (CHINA: Hebei) has been considered as a nomen dubium by Song et al. (2001). The other five species are reported here.

KEY TO CHINESE *PISAURA* SPECIES

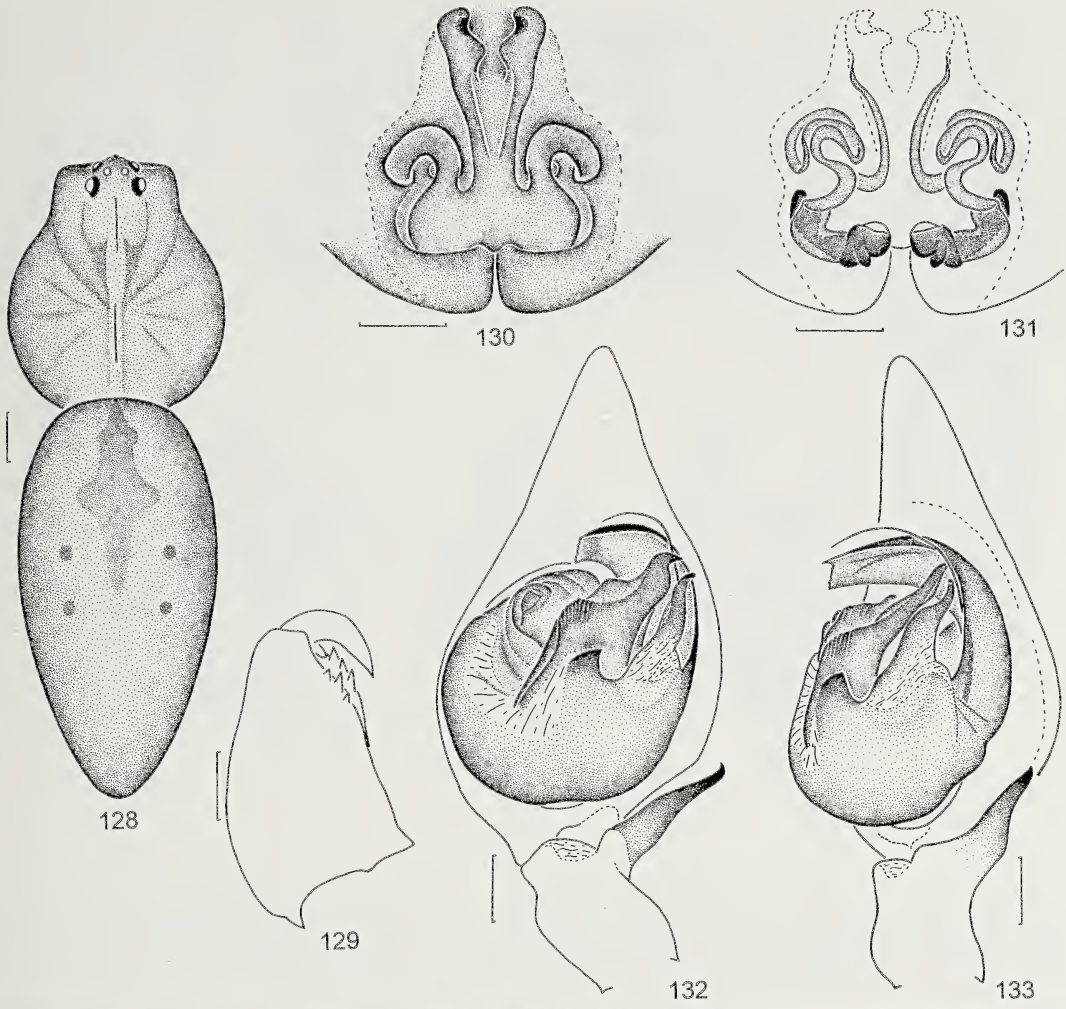
1. Female 2
   Male 6
2. Chelicera with four teeth on both margins (Fig. 119); tibiae of the first and second legs both with five pairs of ventral spines; median field of epigynum lantern-shaped (Fig. 120) .... *P. bicornis*
   Chelicera with three teeth on both margins; tibiae of the first and second legs both with four pairs of ventral spines; epigynum otherwise 3
3. Median field of epigynum almost "⊥"-shaped (Fig. 136); copulatory duct short, with only two curves (Fig. 137) ..... *P. sublama*



Figures 124–127.—*Pisaura lama*. 124. Female, dorsal view; 125. Epigynum; 126. Vulva; 127. Left palp of the male, ventral view (copied from Yaginuma, 1986). Scale lines: 124 = 1 mm; 125, 126 = 0.5 mm.

Median field of epigynum otherwise; copulatory duct long, with more than three curves 4

4. Posterior margin of median field of epigynum far from genital groove (Fig. 130); copulatory duct with six curves and joined with the base of spermatheca at dorsal side (Fig. 131) ... . *P. mirabilis*
   Posterior margin of median field of epigynum near genital groove; copulatory duct with four curves and joined with the base of spermatheca at ventral side 5
5. Copulatory duct thin, base of spermatheca almost as large as head (Fig. 126) ..... *P. lama*
   Copulatory duct thick, base of spermatheca much larger than head (Fig. 115) ..... *P. ancora*
6. Chelicera with four teeth on both margins; tibial apophysis of palp with two branches (Fig. 123) ..... *P. bicornis*
   Chelicera with three teeth on both margins; tibial apophysis of palp not branched 7
7. Tip of palpal tibial apophysis not reaching or only slightly surpassing the base of median apophysis 8
   Tip of palpal tibial apophysis reaching half of median apophysis 9
8. Tip of palpal tibial apophysis hooked and not reaching the base of median apophysis; distal apophysis lacking central depression (Fig. 132) ..... *P. mirabilis*
   Tip of palpal tibial apophysis not hooked and slightly surpassing the base of median apophysis; distal apophysis with a large central depression (Figs. 116, 117) ..... *P. ancora*
9. Tip of palpal tibial apophysis spinous; apical division of distal apophysis inflated and round (Fig. 138) ..... *P. sublama*
   Tip of palpal tibial apophysis finger-shaped; distal apophysis otherwise (Fig. 127) ... *P. lama*

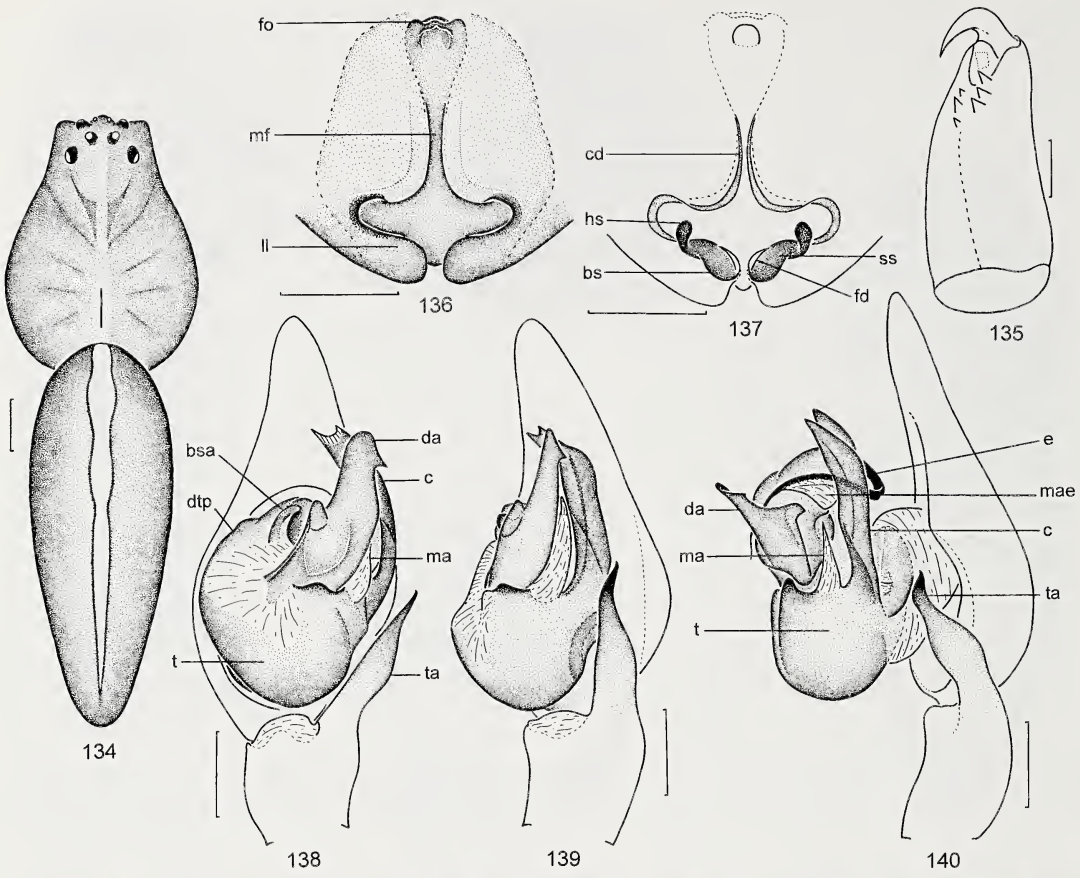


Figures 128–133.—*Pisaura mirabilis*. 128. Female, dorsal view; 129. Left chelicera, prolateral view; 130. Epigynum; 131. Vulva; 132. Left palp of the male, ventral view; 133. Left palp of the male, retrolateral view. Scale lines: 128 = 1 mm; 129–133 = 0.5 mm.

Pisaura ancora Paik 1969
Figs. 111–117, 220–225

Pisaura ancora Paik 1969: 49, figs. 14, 18, 54–64, text-f. 2 (holotype female, female and male paratypes from Korea, in Kyungpook National University, Korea, not examined); Paik 1978: 377, figs. 171.1–10; Song & Zheng 1982: 155, fig. 1; Zhu & Shi 1983: 147, figs. 130a–c; Hu 1984: 261, figs. 275.1–2, 276.1–2 (only ♀, not ♂); Guo 1985: 134, figs. 2–70.1–3; Song 1987: 210, fig. 169; Zhang 1987: 167, figs. 141.1–2; Logunov 1990: 37, figs. 2, 3; Feng 1990: 162, figs. 137.1–3; Chen & Gao 1990: 137, figs. 171a, b; Chen & Zhang 1991: 227, figs. 235.1–2; Song et al. 1999: 348, fig. 204A; Zhang 2000: 2, figs. 1A–E; Hu 2001: 217, figs. 115.1–4 (only ♀, not ♂); Song et al. 2001: 268, fig. 168.

Material examined.—CHINA: *Jilin*: 4 ♀, 2 ♂, Liang Mt., Liuhe, 31 May 1973 (MHU); *Zhejiang*: 1 ♀, Sanmen, 17 May 1978, (MHU); *Shanxi*: 1 ♀, Yuncheng, 16 May 1980, M.S. Zhu (MHU); 2 ♀, Guandi Mt., 4 August 1982, M.S. Zhu (MHU); *Hubei*: 1 ♀, Luojia Mt., Wuhan, 4 July 1980, (LSHU); 1 ♀, Muyuping, Shennongjia, 26 September 2001, M.S. Zhu (MHU); *Shaanxi*: 1 ♂, Taibai Mt., 15 May 1991, M.S. Zhu (MHU); 1 ♂, Feng County, 8 April 1992, M.S. Zhu (MHU); *Beijing*: 3 ♀, (no further details), 25 May 1993 (IZB); *Inner Mongolia*: 2 ♀, Huolin River, Jirem Meng, 30 June 1997, J. Tian (BIMN); *Hebei*: 1 ♂, Wuyuezhai, Shijiazhuang, 21 June 1998, W.L. Lie (MHU); 7 ♀,



Figures 134–140.—*Pisaura sublama*. 134. Female, dorsal view; 135. Left chelicera, prolateral view; 136. Epigynum; 137. Vulva; 138. Left palp of the male, ventral view; 139. Left palp of the male, retrolateral view; 140. Left palp of the male, expanded. Scale lines: 134 = 1 mm; 135–140 = 0.5 mm.

Taihang Mts., June to August 1999, F. Zhang (MHU); *Guizhou*: 2 ♀, Xianheping Natural Reserve, Anlong, 8 June 1999, H.M. Chen (MHU).

Diagnosis.—This species is similar to *P. mirabilis*, but it differs from the latter in: median field of the epigynum anchor-shaped (Figs. 113, 114), copulatory duct thin and joined with the base of spermatheca at the ventral side (Fig. 115); tibial apophysis of male palp thick; and distal apophysis with a large central depression (Figs. 116, 117).

Female.—See descriptions of Paik (1969), Song & Zheng (1982) and Zhang (2000). Median field of the epigynum anchor-shaped, but with variations in the width of its top, copulatory duct long and curved, base of spermatheca much longer than head.

Male.—See descriptions of Paik (1969) and Zhang (2000). Base of tibial apophysis of palp thick, tip pointed; distal apophysis with a large central depression; median apophysis membranous.

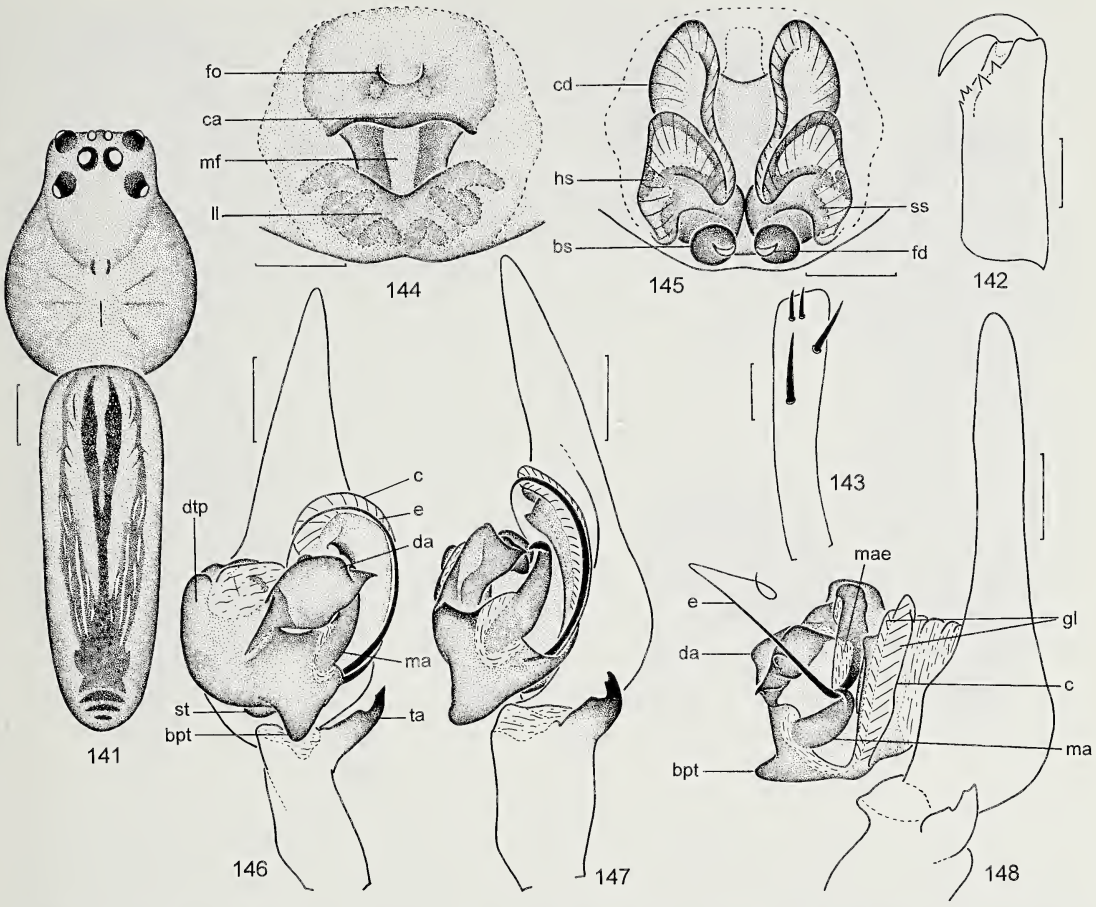
Distribution.—China (Beijing, Hebei, Shanxi, Inner Mongolia, Jilin, Zhejiang, Hubei, Sichuan, Guizhou, Tibet, Shaanxi); Russia, Korea.

Pisaura bicornis Zhang & Song 1992
Figs. 118–123, 226–231

Pisaura bicornis Zhang & Song 1992: 17, figs. 1A–D (holotype female, allotype male from Ningbo, Zhejiang, China, in IZB, examined); Song et al. 1999: 348, figs. 204B, C, I–J; Zhang 2000: 2, figs. 2A–F.

Pisaura lantanus Wang 1993: 158, fig. 11 (holotype female from Chong'an, Fujian, China, in MHU, examined); Song et al. 1999: 348, fig. 204E. First synonymized by Zhang (2000).

Material examined.—Holotype female, al-



Figures 141–148.—*Polyboea zonaformis*. 141. Female, dorsal view; 142. Left chelicera, retrolateral view; 143. Femur of left female palp, dorsal view; 144. Epigynum; 145. Vulva; 146. Left palp of the male, ventral view; 147. Left palp of the male, lateral view; 148. Left palp of the male, expanded. Scale lines: 141 = 1 mm; 142, 143, 146–148 = 0.5 mm; 144, 145 = 0.3 mm.

lotype male of *Pisaura bicornis*, Tiantong Mt., Ningbo, Zhejiang, China, Y.J. Zhang (IZB).

Holotype female of *P. lantanus*, Chong'an, Fujian, China, 13 July 1986, J.F. Wang (MHU).

Diagnosis.—This species can be easily distinguished from others of the genus by chelicera with four promarginal and retromarginal teeth (Fig. 119); tibiae I and II with five pairs of ventral spines; distal end of the tibial apophysis of the male palp with two branches (Fig. 123).

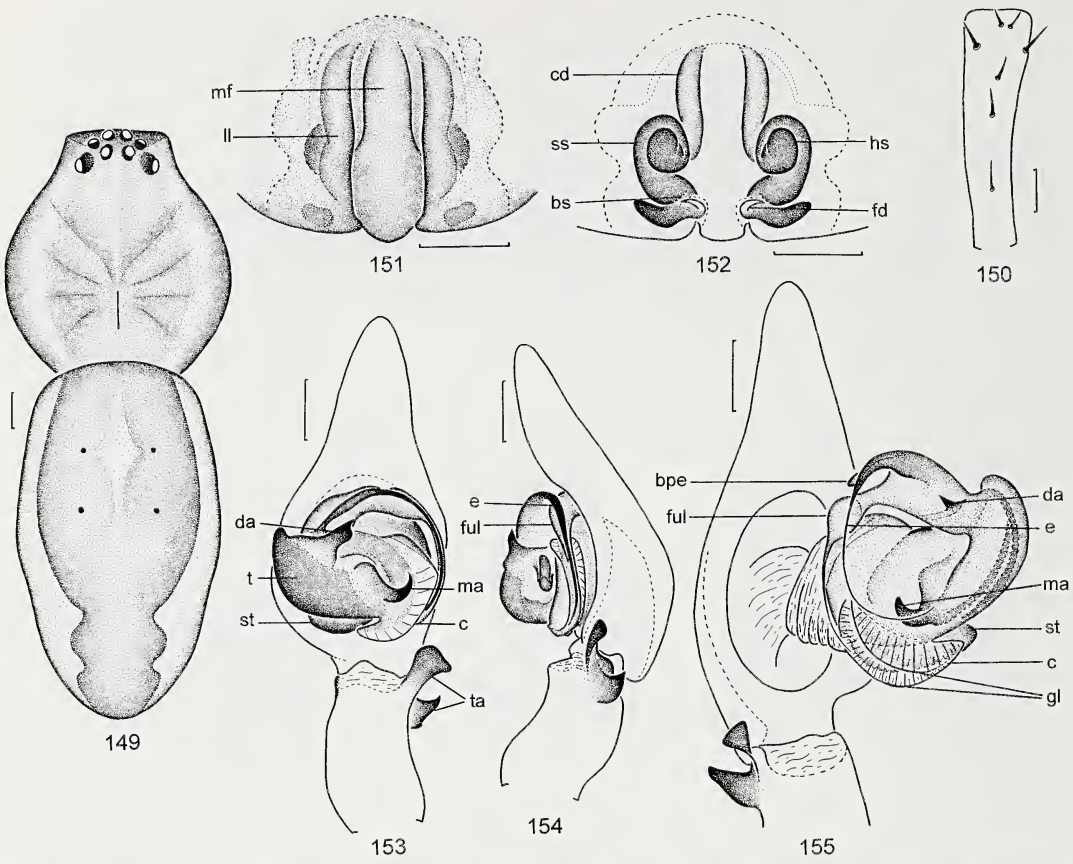
Female.—Described by Zhang & Song (1992) and Zhang (2000). See also description of *P. lantanus* (Wang 1993). Chelicera with four teeth on both margins. Legs with five pairs of ventral spines on tibiae I and II. Median field of the epigynum lantern-shaped, copulatory duct long and curved.

Male.—Described by Zhang & Song (1992) and Zhang (2000). Distal end of the tibial apophysis of palp with two branches; median apophysis strongly sclerotized, with its tip hooked.

Distribution.—China (Zhejiang, Fujian).

Pisaura lama Bösenberg & Strand 1906
Figs. 124–127, 232–237

Pisaura lama Bösenberg & Strand 1906: 306, pl. 13, fig. 430 (holotype female from Yokohama, Japan, in Stuttgart Museum, not examined); Paik 1969: 44, figs. 13, 15, 48–53, text-f. 1; Paik 1978: 379, figs. 172.1–6; Song & Zheng 1982: 156, fig. 2; Hu 1984: 262, fig. 275.3; Guo 1985: 135, figs. 2–71.1–2; Yaginuma 1986: 174, fig. 96; Song 1987: 210, fig. 170; Zhang 1987: 168, figs.



Figures 149–155.—*Qianlingula bilamellata*. 149. Female, dorsal view; 150. Femur of left female palp, dorsal view; 151. Epigynum; 152. Vulva; 153. Left palp of the male, ventral view; 154. Left palp of the male, retrolateral view; 155. Right palp of the male, expanded. Scale lines: 149 = 1 mm; 150–155 = 0.5 mm.

142.1–4; Chikuni 1989: 105, fig. 1; Logunov 1990: 37, figs. 2–3; Feng 1990: 163, figs. 138.1–5; Chen & Gao 1990: 137, fig. 172; Chen & Zhang 1991: 227, fig. 236; Song et al. 1999: 348, figs. 204D, K; Song et al. 2001: 269, fig. 169.

Pisaura clarivittata Dönitz & Strand in Bösenberg & Strand, 1906: 389, pl. 6, fig. 76 (data on types not mentioned by authors). First synonymized by Yaginuma (1974).

Pisaura ancora Hu 1984: 261, figs. 275.1–2, 276.1–2 (male, misidentified).

Material examined.—CHINA: *Jilin*: 2 ♀, Liang Mt., 23 April 1960 (MHU); 1 ♀, Linjiang, 7 June 1973 (MHU).

Diagnosis.—This species is closely related to *P. sublama*, but can be distinguished from the latter by the copulatory duct long, base of spermatheca small (Fig. 126); tip of the tibial apophysis of the male palp finger-shaped; and distal end of the distal apophysis not distinctly inflated (Fig. 127).

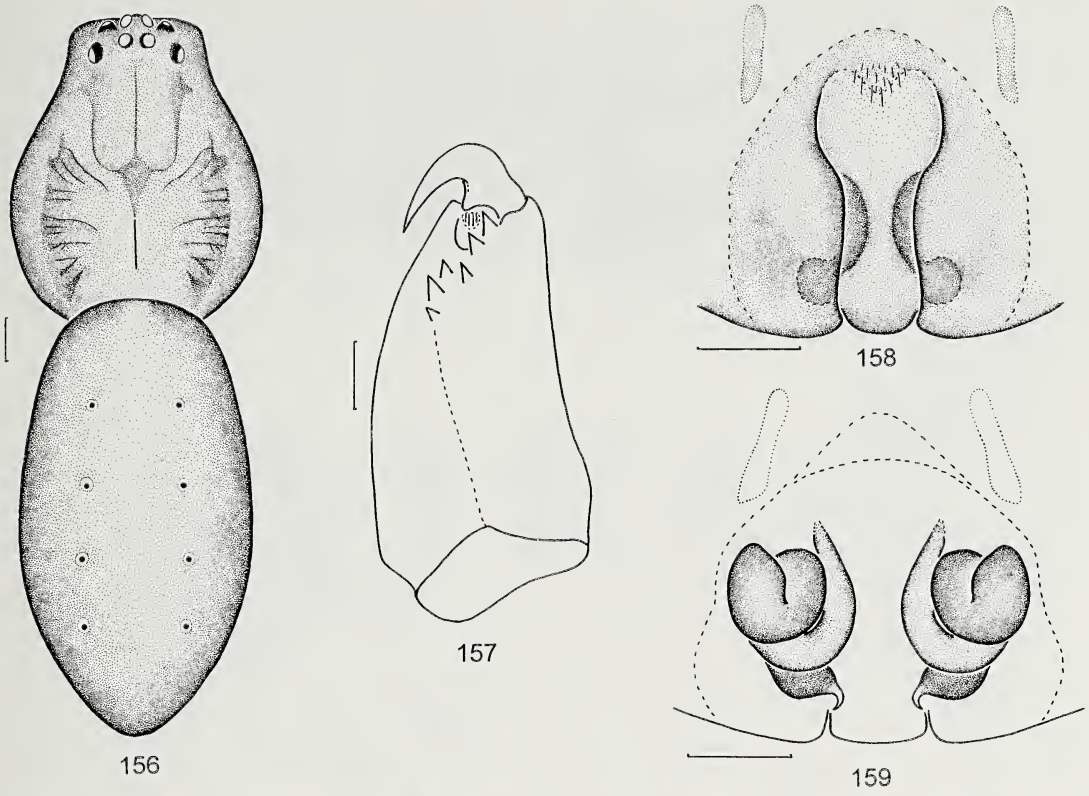
Female.—See descriptions of Paik (1969), Song & Zheng (1982) and Song (1987). Median field of the epigynum almost "+"-shaped, copulatory duct long and thin, base of spermatheca small.

Male.—Described by Paik (1969), Zhang (1987) and Song et al. (2001). The male specimens are not available in this study. Judging from the illustrations by Yaginuma (1986), tibial apophysis of male palp long, with its tip finger-shaped; distal end of the distal apophysis not strongly inflated.

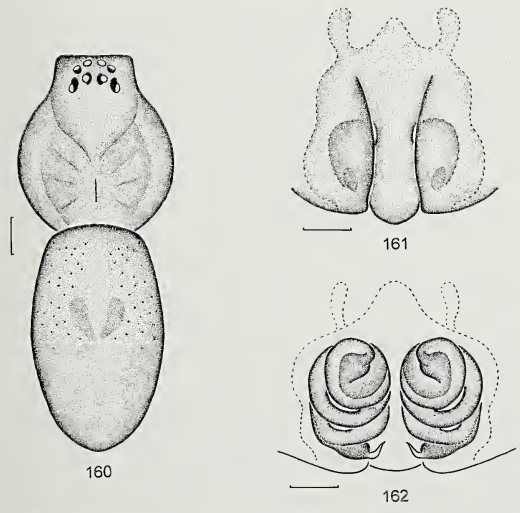
Distribution.—China (Hebei, Jilin, Zhejiang, Hubei, Sichuan, Tibet, Shaanxi); Japan, Korea, Russia.

Pisaura mirabilis (Clerck 1757)
Figs. 128–133, 238–243

Araneus mirabilis Clerck 1757: 108, pl. 5, fig. 10 (female and male syntypes from Sweden, presumably lost).



Figures 156–159.—*Qianlingula jiafu*. 156. Female, dorsal view; 157. Left chelicera, prolateral view; 158. Epigynum; 159. Vulva. Scale lines: 156 = 1 mm; 157 = 0.5 mm; 158, 159 = 0.3 mm.

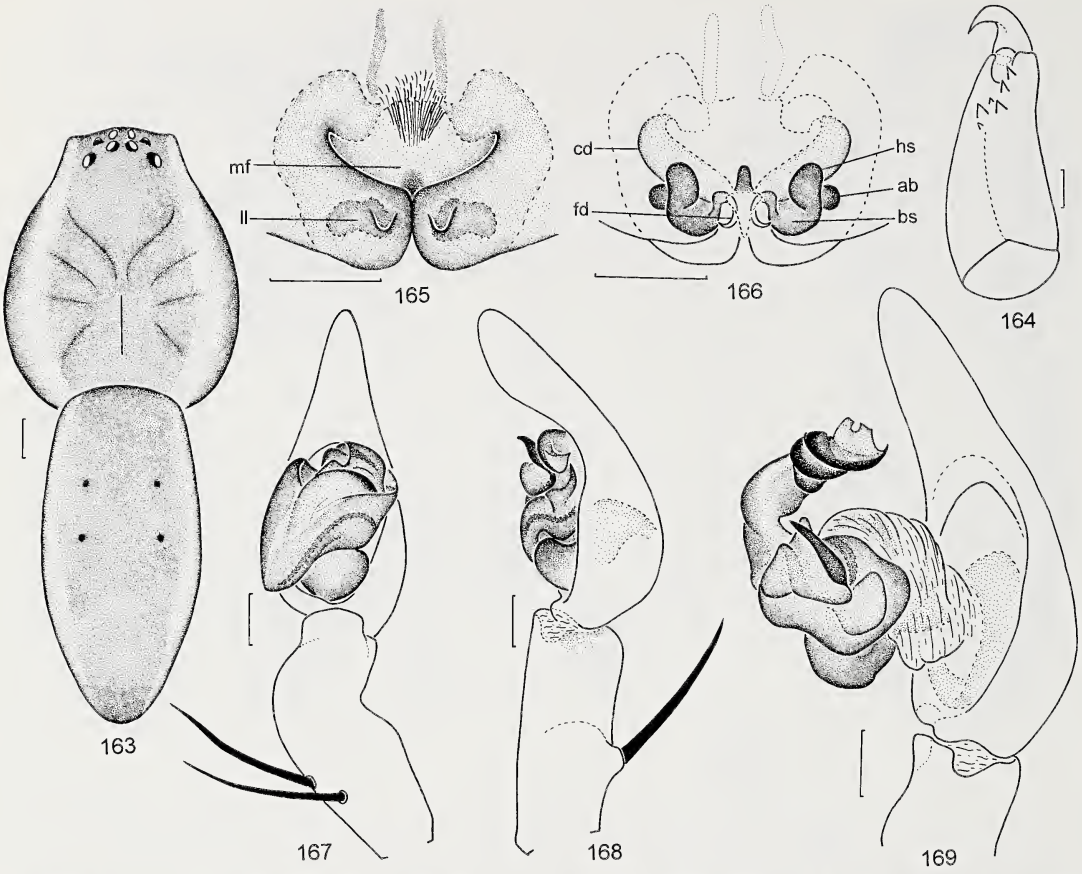


Figures 160–162.—*Qianlingula turbinata*. 160. Female, dorsal view; 161. Epigynum; 162. Vulva. Scale lines: 160 = 2 mm; 161, 162 = 0.5 mm.

Pisaura mirabilis: Simon 1885b: 354; Locket & Millidge 1951: 293, figs. 141, 142A–B; Miller 1971: 171, pl. XXVII, figs. 13–14; Blandin 1976: 919, figs. 1, 7a, 10, 13, 15, 18; Hu 1984: 263, figs. 277.1–2; Song 1987: 211, fig. 171; Hu & Wu 1989: 241, figs. 198.1–2; Sierwald 1990: 31, figs. 7, 30, 45; Logunov 1990: 37, figs. 2–3; Heimer & Nentwig 1991: 350, figs. 9–11; Zhao 1993: 307, fig. 141; Roberts 1995: 237, fig. 19; Levy 1999: 55, figs. 29A–C, 30A–F; Song et al. 1999: 348, figs. 204F, N; Zhang 2000: 4, figs. 4A–F; Hu 2001: 220, figs. 116.1–4.

Material examined.—CHINA: *Xinjiang*: 4 ♀, 3 ♂, Manasi, 2 May 1981, H.Z. Wang (IZB); 2 ♀, Cha County, Ili, 14 June 1981, H.Z. Wang (MHU).

Diagnosis.—The species resembles *P. ancora* in the shape of the epigynum, but it differs from the latter in the copulatory duct thick, and joined with the base of spermatheca at the dorsal side (Fig. 131); tibial apophysis of the male palp thin, with its tip hooked; and the distal apophysis lacking central depression (Figs. 132, 133).



Figures 163–169.—*Thalassius paralbocinctus*. 163. Female, dorsal view; 164. Left chelicera, prolateral view; 165. Epigynum; 166. Vulva; 167. Left palp of the male, ventral view; 168. Left palp of the male, retrolateral view; 169. Left palp of the male, expanded. Scale lines: 163 = 2 mm; 164 = 1 mm; 165–169 = 0.5 mm.

Female.—See descriptions of Song (1987), Zhang (2000) and Hu (2001). Median field of the epigynum with a small depression anteriorly, copulatory duct long and curved, joined with the base of spermatheca at the dorsal side.

Male.—See descriptions of Song (1987), Sierwald (1990), Zhang (2000) and Hu (2001). Tip of the tibial apophysis of palp hooked; distal apophysis with several parallel longitudinal ridges at the center.

Distribution.—China (Tibet, Gansu, Xinjiang); Palearctic.

Pisaura sublama Zhang 2000
Figs. 134–140, 244–249

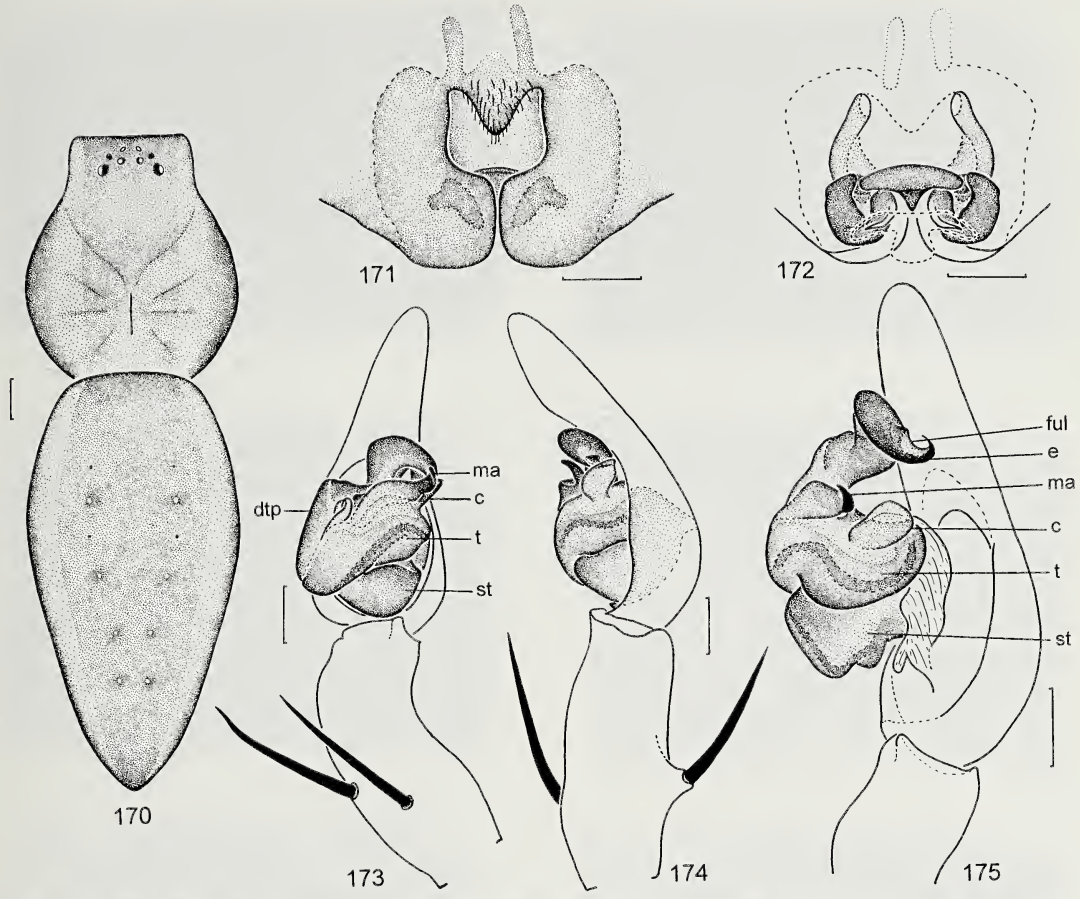
Pisaura sublama Zhang 2000: 5, figs. 6A–E (holotype female, 1 female, 2 male paratypes from Zhouzhi, Shaanxi, China, in MHU, examined).

Material examined.—Holotype female, 1 female, 2 male paratypes, Louguantai, Zhouzhi, Shaanxi, China, 19 May 1981, M. S. Zhu (MHU). CHINA: *Shandong*: 2 ♀, 1 ♂, Lao Mt., Qingdao, 23 June 1987, J.L. Hu (MHU); *Sichuan*: 3 ♀, Xiaomiao Mt., Mao County, 22 July 1999, G.D. Ren (MHU).

Diagnosis.—The species is similar to *P. lama*, but can be distinguished from the latter by the copulatory duct short (Fig. 137); tip of the tibial apophysis of the male palp pointed; and the distal end of the distal apophysis inflated (Figs. 138–140).

Female.—Described by Zhang (2000). Median field of the epigynum with a small depression at the anterior part, posterior part narrow, copulatory duct short and not strongly coiled.

Male.—Described by Zhang (2000). Tip of the tibial apophysis of the palp pointed and



Figures 170–175.—*Thalassius phipsoni*. 170. Female, dorsal view; 171. Epigynum; 172. Vulva; 173. Left palp of the male, ventral view; 174. Left palp of the male, retrolateral view; 175. Left palp of the male, expanded. Scale lines: 170 = 2 mm; 171–175 = 0.5 mm.

spinous; distal end of the distal apophysis inflated and round.

Distribution.—China (Shandong, Sichuan, Shaanxi).

Polyboea Thorell 1895

Polyboea Thorell 1895: 228; Sierwald 1997: 401; Zhang & Zhang 2003: 15.

Type species.—*Polyboea vulpina* Thorell 1895, by monotypy.

Diagnosis.—This genus is closely related to *Perenethis*, but differs from the latter in: anterior and posterior eye rows almost equal in width, ALE larger than AME and PME; tibia of leg lacking a pair of short ventral spines at the distal end; carina of the epigynum entire (Fig. 144); conductor of the male palpal organ with two guiding lamellae (Fig. 148).

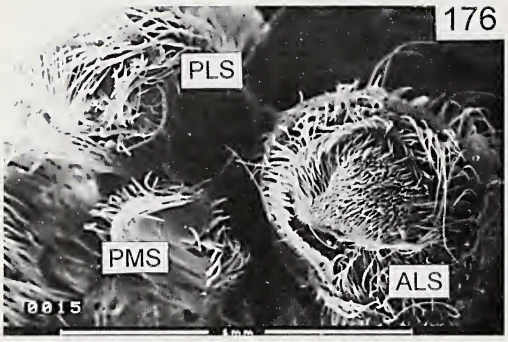
Remarks.—This genus has reported only two species, found in China (one species), Thailand, Malaysia and Singapore (one species).

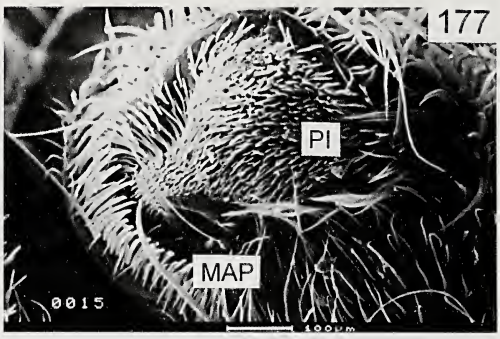
Polyboea zonaformis (Wang 1993)
Figs. 141–148, 250–255

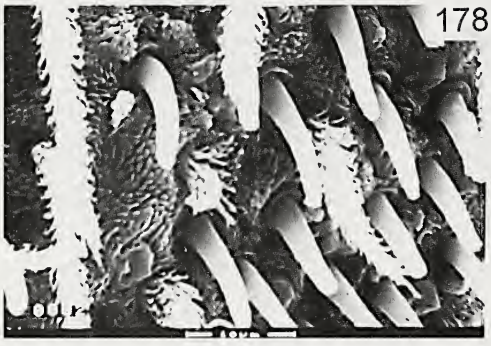
Pisaura zonaformis Wang 1993: 157: figs. 6–10 (holotype female, allotype male from Menglun, Yunnan, China, in MHU, examined); Song et al. 1999: 353, figs. 204G–H, L–M.

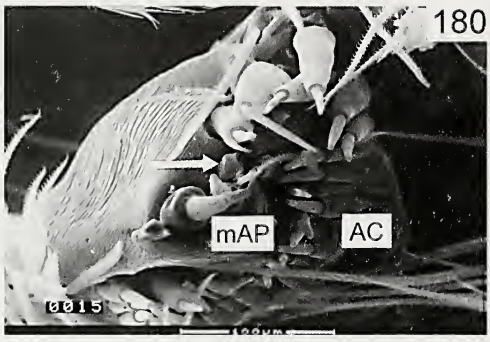
Polyboea zonaformis: Zhang & Zhang 2003: 15, figs. 2A–G.

Material examined.—Holotype female, allotype male, Menglun, Yunnan, China, 30 July 1981, J.F. Wang (MHU). CHINA: *Yunnan:* 2 ♀, 3 ♂, Mengla, 26 July 2000, J.X. Zhang (MHU); 1 ♀, Daluo, Menghai, 31 July 2000, M.S. Zhu (MHU); 1 ♂, Menglun, 6 July 2001, C. Zhang (MHU).







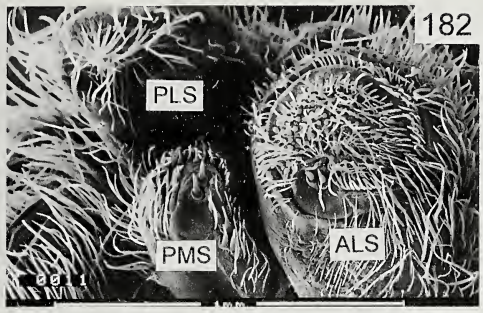


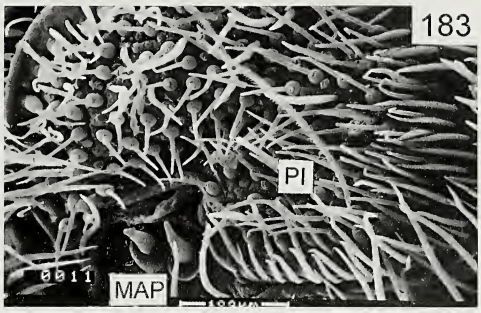
Figures 176–181.—Spinnerets of female *Dianpisaura lizhii*. 176. Right spinneret group, ×80; 177. ALS, ×150; 178. PI in ALS, ×2000; 179. MAP in ALS, ×600; 180. PMS, ×350; 181. PLS, ×200 (white arrow refers to nubbin).

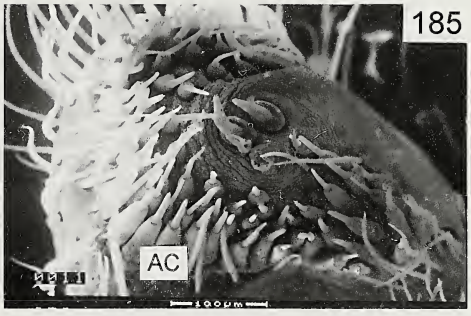
Diagnosis.—This species resembles *P. vulpina* in the shape of male palpal organ (Sierwald 1997: 401, figs. 88–90, 97–101), but it differs from the latter in: anterior depression of the epigynum small, carina not horizontal, but ripple-like (Fig. 144); base of spermatheca small and oval (Fig. 145); base of the tibial apophysis of the male palp thick; distal end of the distal apophysis beak-shaped (Figs. 146–148).

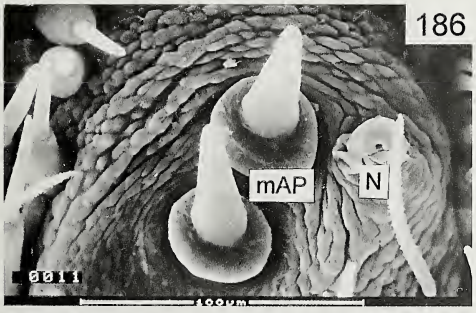
Female.—Described by Wang (1993) and Zhang & Zhang (2003). Epigynum with a small anterior semi-circular depression; copulatory duct wide, membranous and saccate, forming two loops; base of spermatheca oval.

Male.—Described by Wang (1993) and Zhang & Zhang (2003). Base of the tibial apophysis of the palp thick, tip with two small branches; basal protuberance of the tegulum









Figures 182–187.—Spinnerets of female *Dolomedes nigrimaculatus*. 182. Right spinneret group, ×80; 183. ALS, ×250; 184. MAP in ALS, ×600; 185. PMS, ×230; 186. mAP and N in PMS, ×650; 187. PLS, ×230.

large; distal end of the distal apophysis beak-shaped.

Distribution.—China (Yunnan).

Qianlingula new genus

Type species.—*Qianlingula bilamellata* new species.

Diagnosis.—The new genus is related to *Thalassius* in body shape and eye pattern, but can be easily distinguished from the latter by: median field of epigynum strongly sclerotized, posterior margin of lateral lobe far from each other (Fig. 151); male palp with distinct lamellar tibial apophysis; palpal organ with distal apophysis; tip of fulcrum fine; conductor with two guiding lamellae (Figs. 153–155).

Description.—Body medium-sized or large. Carapace yellow brown or dark red brown. Both eye rows recurved, posterior eyes larger than anterior eyes, AME equal to PME. Femur of palp with seven dorsal spines. Chelicera with three teeth on both margins. Labium slightly longer than wide. Unpaired tarsal claw with two teeth. Abdomen oval.

Posterior margins of lateral lobes far from each other, median field strongly sclerotized and tongue-shaped; spermatheca with head, stalk and base, copulatory duct joined with the spermatheca at the stalk. Tibial apophysis of the male palp lamellar; distal apophysis of palpal organ small, embolus accompanied by a fine fulcrum, conductor with two guiding lamellae.

Etymology.—The generic name is from the Latin *lingula*, and refers the median field of the tongue-shaped epigynum; "Qian" in Chinese is an alternative name for Guizhou Province; feminine in gender.

KEY TO CHINESE *QIANLINGULA* SPECIES

1. Female 2
   Male; tibial apophysis of male palp lamellar; median apophysis hook-shaped, embolus slender and flagelliform (Figs. 153–155) ..... *Q. bilamellata*
2. Body large (20.00–24.00); lateral lobes of epigynum separated outwards at anterior part (Fig. 161); stalk of spermatheca long and coiled (Fig. 162) ..... *Q. turbinata*
   Body small (11.88–13.95); lateral lobes of epigynum otherwise; stalk of spermatheca short and not coiled 3
3. Lateral margins of lateral lobe of epigynum almost parallel (Fig. 151); base of spermatheca with a finger-shaped projection (Fig. 152) ..... *Q. bilamellata*
   Lateral margins of lateral lobe of epigynum protruding outwards at anterior part (Fig. 158); base of spermatheca lacking finger-shaped projection (Fig. 159) ..... *Q. jiafu*

Qianlingula bilamellata new species
Figs. 149–155, 256–261

Material examined.—Holotype female, Meitan (27°42′N, 107°24′E), Guizhou, China, 10 May 1981, F. J. Li (MHU). Paratypes: 3 females, 1 male, same data as holotype (MHU); 4 ♀, Yuelu Mt. (28°06′N, 112°54′E), Changsha, Hunan, China, 14 May 1980, J. F. Wang (MHU).

Diagnosis.—The new species can be easily distinguished from the other two species of the genus by lateral margins of lateral lobes of the epigynum parallel, median field quadrate (Fig. 151); base of spermatheca with a finger-shaped projection (Fig. 152).

Female.—Total length 12.60–13.95. Holotype total length 13.95: cephalothorax 5.22 long, 4.50 wide; abdomen 9.00 long, 5.40 wide. Carapace yellow brown, with lateral yellow bands. Chelicerae red brown. Labium, endites and legs yellow brown. Sternum yellow. Dorsum of abdomen gray brown, with a rhomboid yellowish cardiac marking at the center of anterior part. Chelicerae with 3 teeth on both margins. Both eye rows recurved. AME–AME:AME–ALE (0.17:0.09), PME–PME:PME–PLE (0.22:0.39); AME:ALE:PME:PLE (0.27:0.24:0.27:0.29). MOA 0.71 long, front width 0.65, back width 0.68. Measurements of legs: I 27.36 (7.29, 9.90, 7.20, 2.97), II 29.57 (7.88, 10.62, 8.10, 2.97), III 21.47 (6.21, 7.56, 5.54, 2.16), IV 25.97 (7.20, 8.64, 7.52, 2.61). Leg formula: 2, 1, 4, 3. Tibiae I and II with four pairs of ventral spines, III and IV with three pairs. Median field of the epigynum tongue-shaped; base of spermatheca with a finger-shaped projection.

Male.—Total length 11.70: cephalothorax 5.40 long, 5.04 wide; abdomen 6.75 long, 4.05 wide. Characters as in holotype female. Measurements of palp and legs: palp 7.47 (2.70, 1.08, 0.99, 2.70); leg I (7.65, 10.58, lost, lost), II 31.73 (8.46, 11.25, 8.37, 3.65), III 22.65 (6.53, 7.79, 5.94, 2.39), IV 44.79 (7.70, 9.36, 7.65, 3.02). Tibial apophysis of palp lamellar in shape; median apophysis of palpal organ small, embolus slender, conductor with two guiding lamellae (Figs. 153–155).

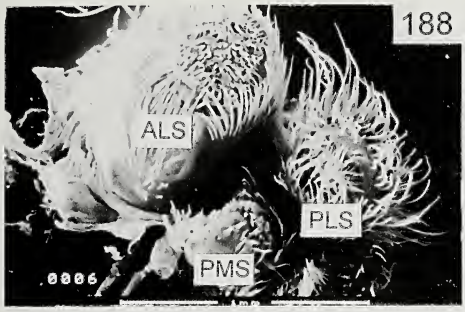
Etymology.—The specific name is from the Latin *lamellata*, and refers to the tibial apophysis of male palp lamellar in shape.

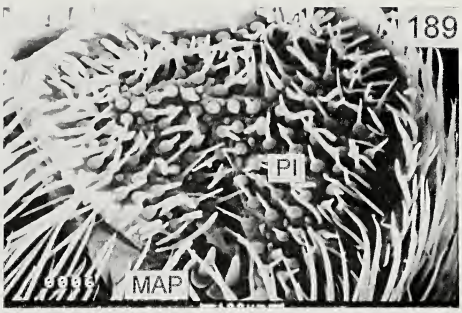
Distribution.—China (Guizhou, Hunan).

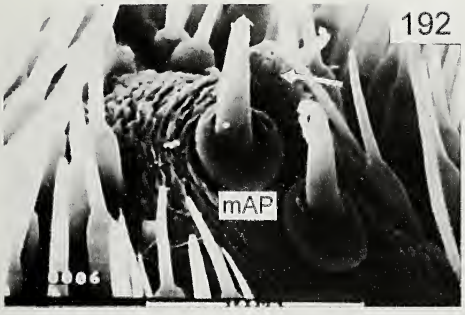
Qianlingula jiafu new species
Figs. 156–159

Material examined.—Holotype female, from Zhangjiajie, Dayong (29°06′N, 110°24′E), Hunan, China, 20 July 1981, J.F. Wang (MHU). Paratypes: 3 females, same data as holotype (MHU).

Diagnosis.—The new species is similar to



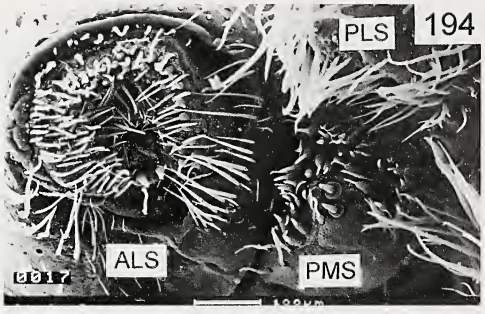


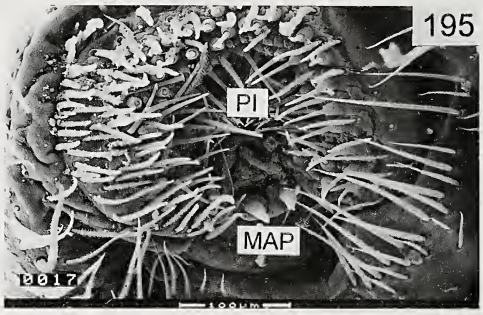


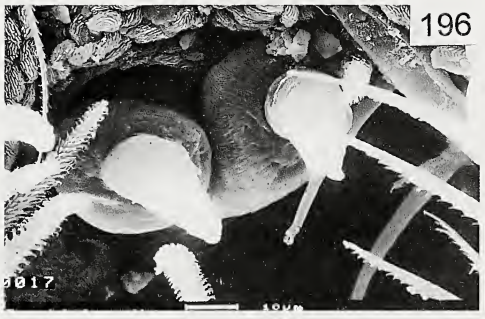
Figures 188–193.—Spinnerets of female *Dolomedes raptor*. 188. Left spinneret group, ×60; 189. ALS, ×200; 190. PI in ALS, ×500; 191. PMS, ×250; 192. mAP and N in PMS, ×650; 193. PLS, ×700 (white arrow refers to nubbin).

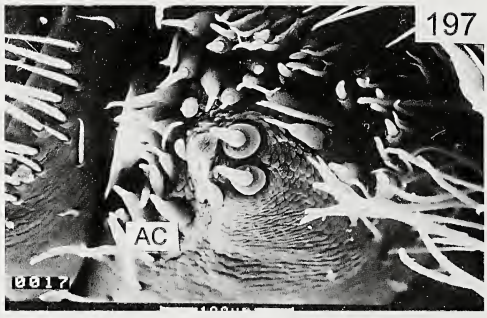
Q. bilamellata in the body shape, but can be distinguished from the latter by the lateral margins of lateral lobes of the epigynum not parallel (Fig. 158), base of spermatheca lacking finger shaped projection (Fig. 159). It differs from *Q. turbinata* in the median field of the epigynum with a depression on each side at the center (Fig. 158), stalk of spermatheca short and not coiled (Fig. 159).

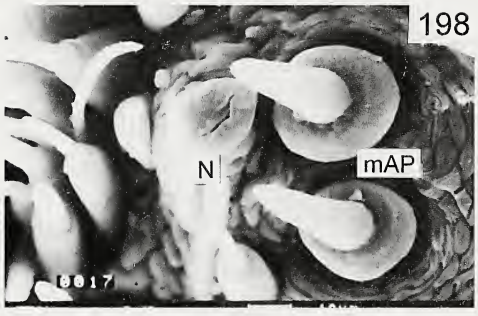
Female.—Total length 11.88–12.50. Holotype total length 11.88: cephalothorax 5.09 long, 4.37 wide; abdomen 7.29 long, 4.05 wide. Carapace dark red brown, with many dark brown streaks. Chelicerae dark red brown. Labium and endites dark red. Sternum gray brown. Legs red brown. Dorsum of abdomen dark brown, with four pairs of red brown dots and a rhomboid brownish patch. Chelicerae with three teeth on both margins. Both eye rows recurved. AME–AME:AME–ALE (0.23:0.13); PME–PME:PME–PLE (0.20:0.35). AME:ALE:PME:PLE (0.23:0.21:

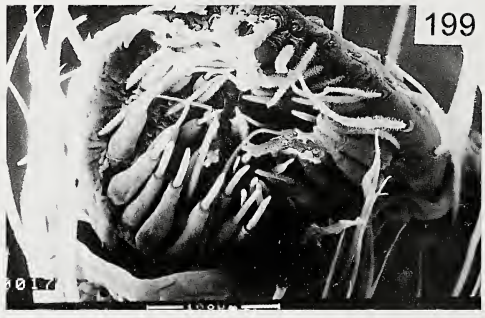












Figures 194–199.—Spinnerets of female *Dolomedes sulfureus*. 194. Left spinneret group, ×150; 195. ALS, ×250; 196. MAP in ALS, ×1200; 197. PMS, ×300; 198. mAP and N in PMS, ×1000; 199. PLS, ×300.

0.23:0.26). MOA 0.70 long, front width 0.62, back width 0.65. Measurements of legs: I 26.33 (6.75, 10.49, 6.84, 2.25), II 26.92 (7.43, 9.81, 7.29, 2.39), III 22.69 (6.03, 8.65, 6.03, 1.98), IV 25.26 (7.07, 8.60, 7.20, 2.39). Leg formula: 2, 1, 4, 3. Tibiae I and II with four pairs of ventral spines, III and IV with three pairs. Median field of the epigynum with a depression on each side at the center, stalk of spermatheca short and not coiled.

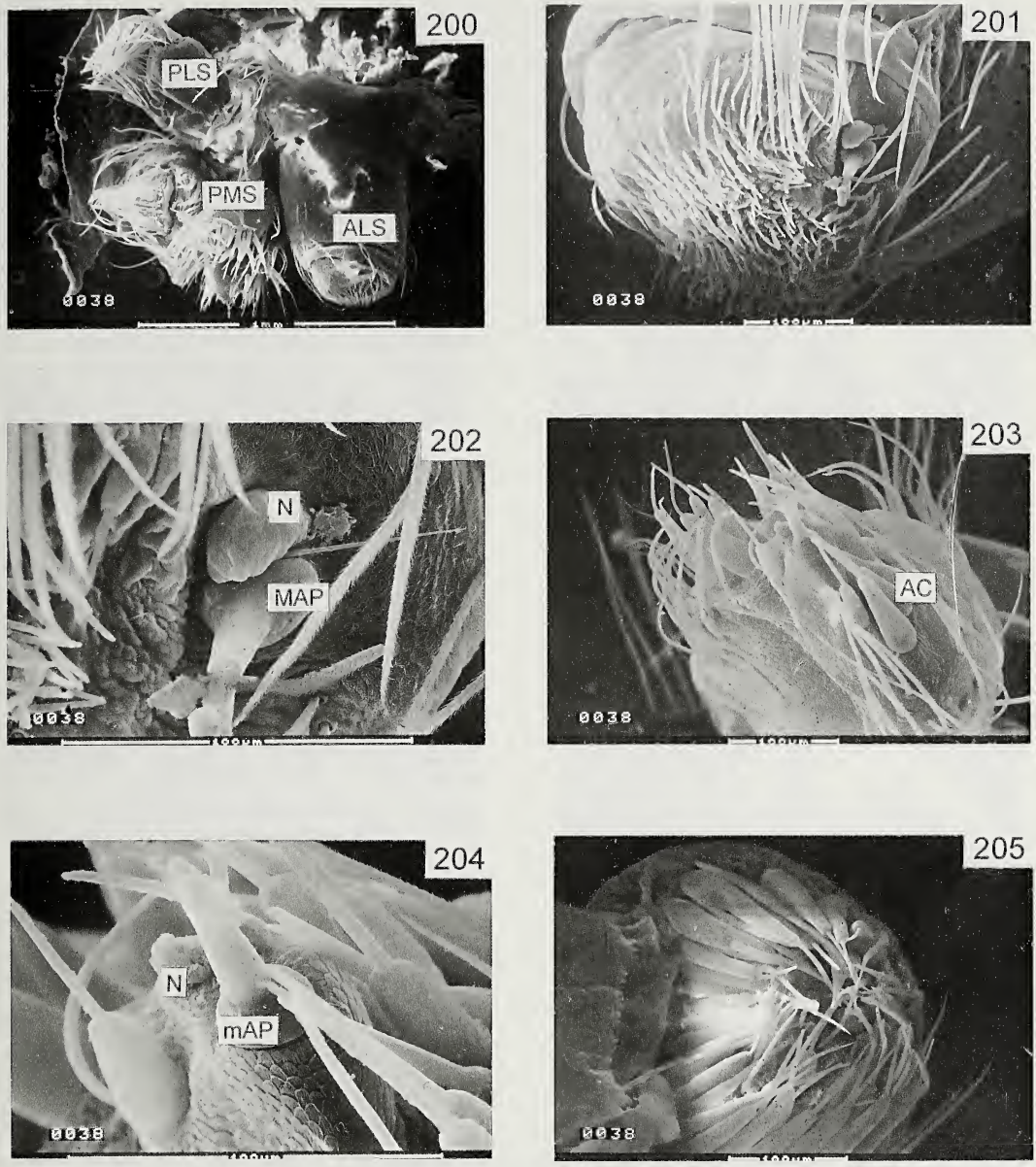
Male.—Unknown.

Etymology.—The specific name is a noun in apposition taken from the first name of the collector.

Distribution.—China (Hunan).

Qianlingula turbinata new species
Figs. 160–162

Material examined.—Holotype female, Chengbu (26°18′N, 110°18′E), Hunan, China, 5 August 1982, J.F. Wang (MHU). Paratypes: CHINA: *Hunan:* 1 ♀, same data as holotype

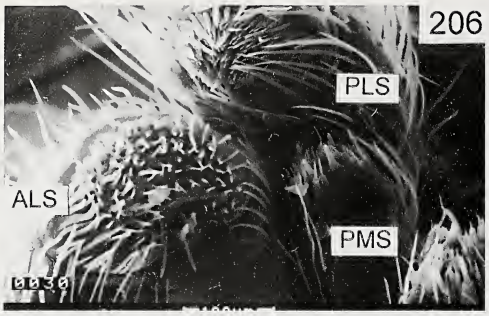


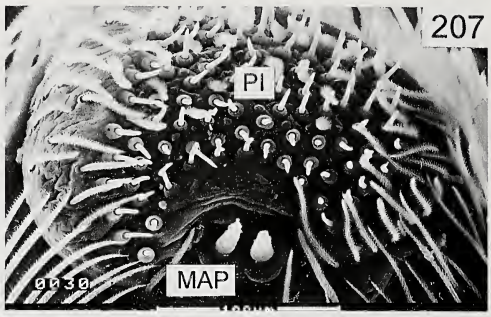
Figures 200–205.—Spinnerets of female *Eurychoera banna*. 200. Right spinneret group, ×60; 201. ALS, ×250; 202. MAP and N in ALS, ×870; 203. PMS, ×250; 204. mAP and N in PMS, ×870; 205. PLS, ×276.

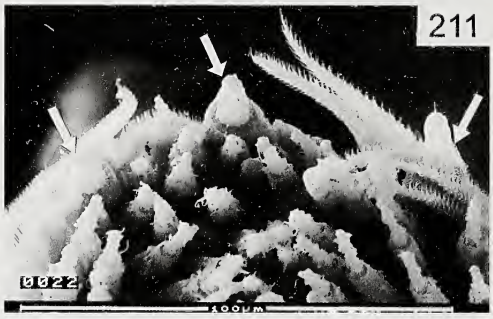
(MHU); 2 ♀, Ling County (26°30′N, 113°42′E), 16 August 1979, J.F. Wang (MHU); 1 ♀, Zhangjiajie, Dayong (29°06′N, 110°24′E), 20 July 1981, J.F. Wang (MHU); *Guizhou:* 2 ♀, Meitan (27°42′N, 107°24′E), 4 May 1981, F.J. Li (MHU); *Hainan:* 1 ♀, Wuzhi Mt. (18°48′N, 109°30′E), Qiongzhong, 27 June 1984, M.Y. Liu (MHU); *Fujian:* 2 ♀, 21 July 1986, J.F. Wang (MHU).

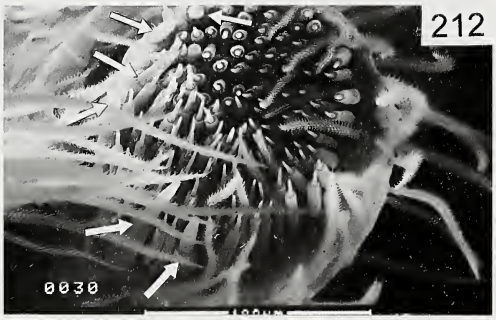
Diagnosis.—Body large (20.00–24.00). The new species resembles *Q. jiafu* in the shape of epigynum, but can be easily distinguished from the latter by lateral lobes of the epigynum separated outwards at anterior part (Fig. 161); base of spermatheca small, stalk of spermatheca long and coiled (Fig. 162).

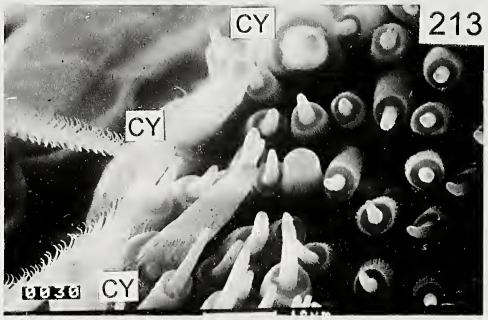
Female.—Total length 20.00–24.00. Holotype total length 24.00: cephalothorax 8.73



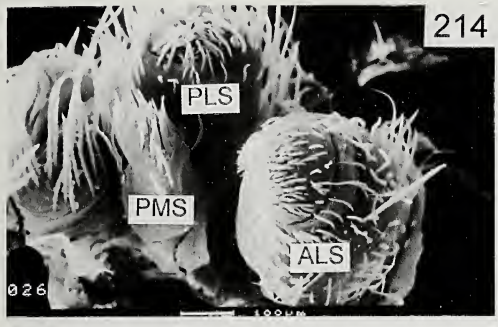


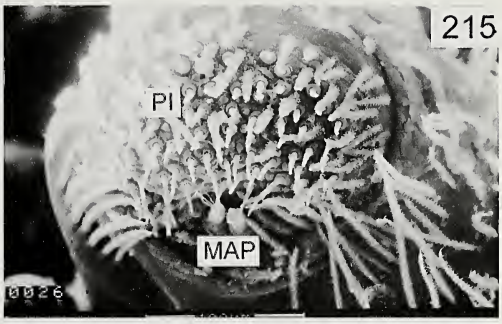


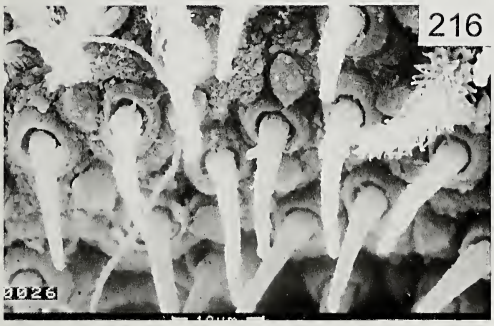


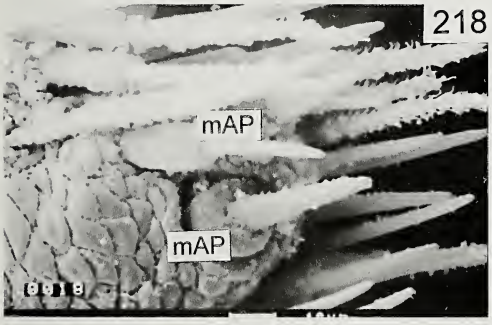


Figures 206–213.—Spinnerets of female *Hygropoda higenaga*. 206. Left spinneret group, ×200; 207. ALS, ×410; 208. PI in ALS, ×2200; 209. PMS, ×750; 210. mAP and N in PMS, ×1200; 211. CY in PMS, ×960; 212. PLS, ×505; 213. CY in PLS, ×1650 (black arrow refers to nubbin, white arrows refer to cylindrical gland spigots).



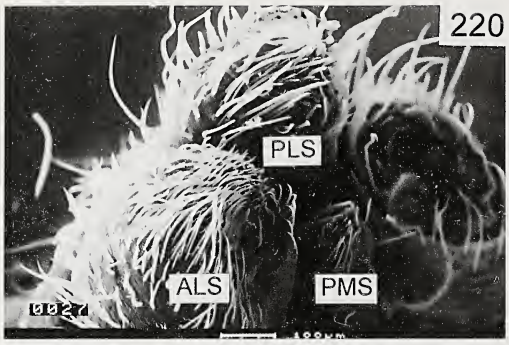


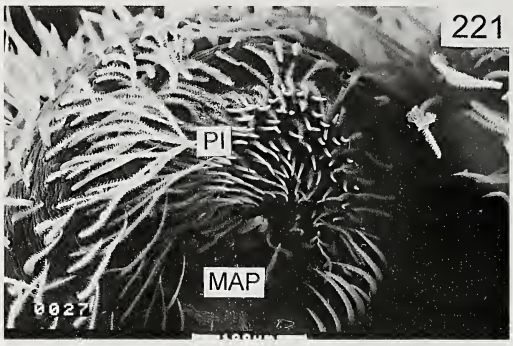


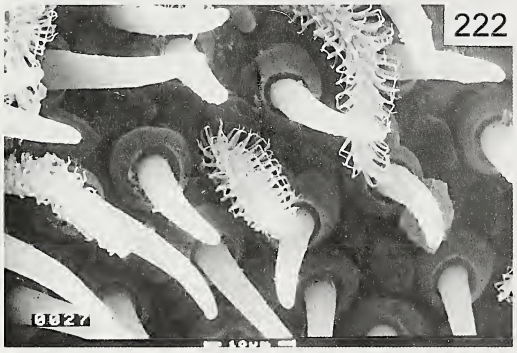


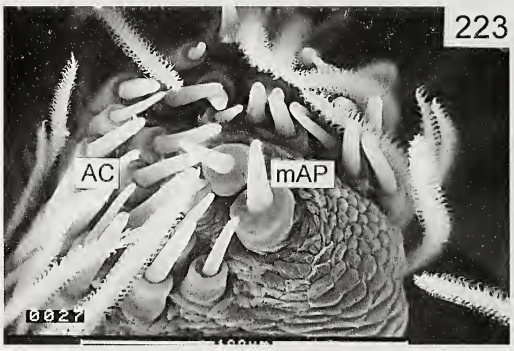
Figures 214–219.—Spinnerets of female *Perenethis fascigera*. 214. Right spinneret group, ×220; 215. ALS, ×400; 216. PI in ALS, ×1500; 217. PMS, ×500; 218. mAP in PMS, ×1000; 219. PLS, ×550.

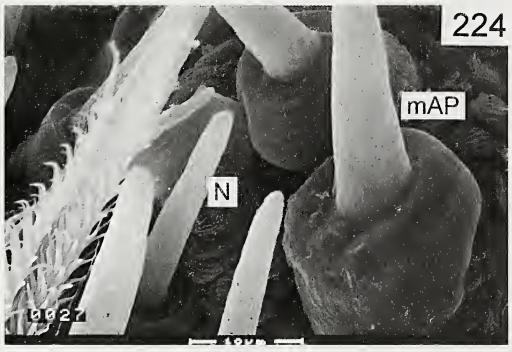
long, 6.98 wide; abdomen 16.00 long, 9.00 wide. Carapace red brown. Chelicerae dark red. Labium and endites dark red brown and lighter distally. Sternum yellow brown. Legs red brown without darker color markings. Abdomen grayish brown scattered with many small black spots at the anterior part. Cardiac mark yellowish brown with one dark brown patch at each side. Chelicerae with three teeth on both margins. Both eye rows recurved. AME–AME:AME–ALE (0.20:0.14); PME–PME:PME–PLE (0.29:0.51). AME:ALE:PME:PLE (0.41:0.37:0.41:0.48). MOA 1.07 long, front width 0.95, back width 1.05. Measurements of legs: I 46.89 (13.14, 17.10, 12.78, 3.87), II 49.96 (13.95, 17.87, 13.95, 4.19), III 43.11 (12.60, 15.12, 11.52, 3.87), IV 48.87 (14.04, 16.38, 14.58, 3.87). Leg formula: 2, 4, 1, 3. Tibiae I and II with four pairs of ventral spines, III and IV with three pairs.











Figures 220–225.—Spinnerets of female *Pisaura ancora*. 220. Left spinneret group, ×125; 221. ALS, ×250; 222. PI in ALS, ×2000; 223. PMS, ×500; 224. mAP and N in PMS, ×2000; 225. PLS, ×400.

Tarsus with scopula ventrally. Median field of epigynum sclerotized and stalk of spermatheca coiled.

Male.—Unknown.

Etymology.—The specific name is from the Latin *turbinata*, and refers to the shape of the curved spermatheca.

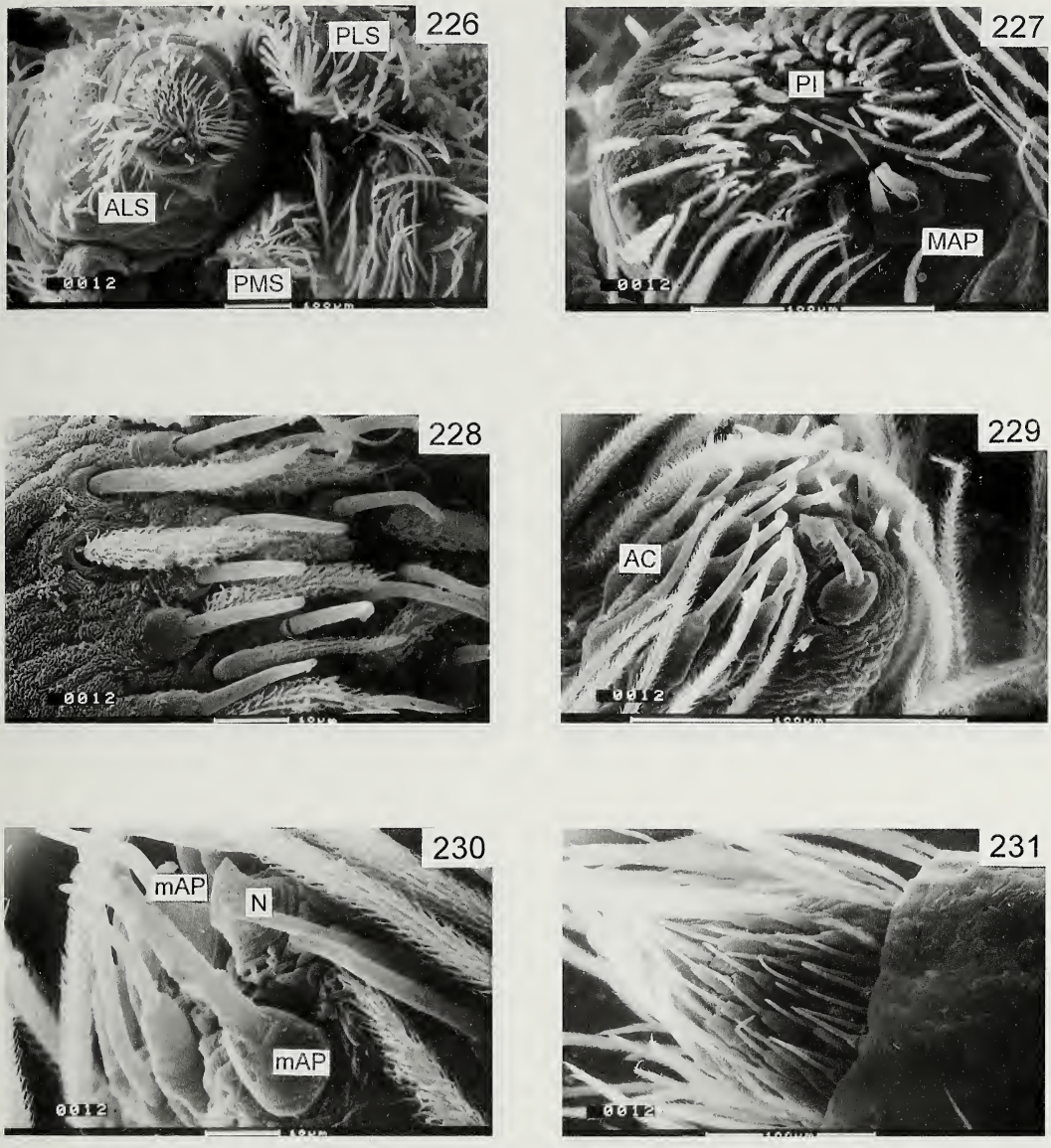
Distribution.—China (Hunan, Guizhou, Hainan, Fujian).

Thalassius Simon 1885

Thalassius Simon 1885a: 13; Sierwald 1983: 203; Hu 1984: 264; Sierwald 1987: 131; Chen & Zhang 1991: 225; Barrion & Litsinger 1995: 350.

Type species.—*Dolomedes albocinctus* Doleschall 1859, by subsequent designation of Simon (1898).

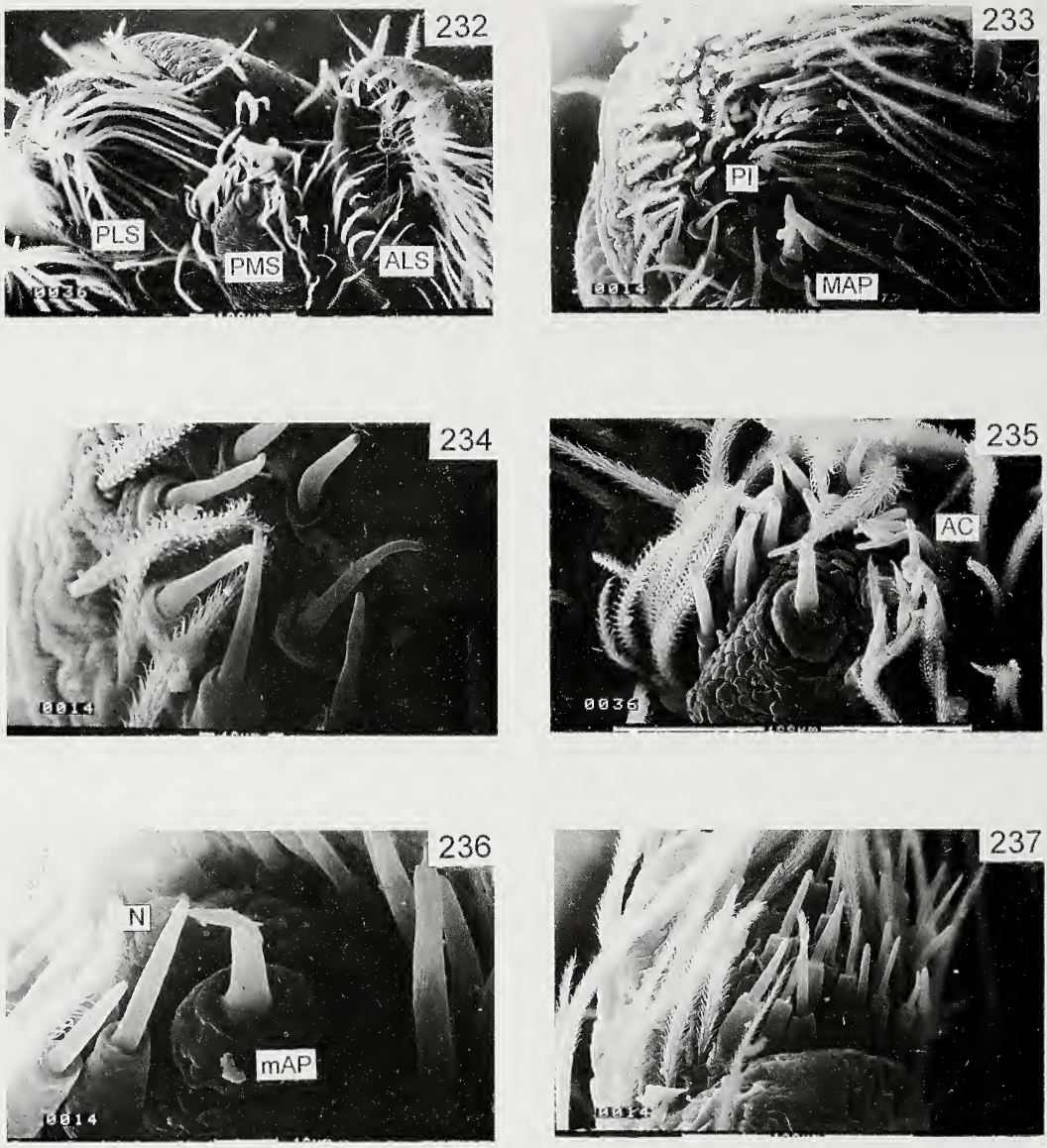
Diagnosis.—This genus is closely related to *Dolomedes* in body shape, median field of



Figures 226–231.—Spinnerets of female *Pisaura bicornis*. 226. Left spinneret group, ×150; 227. ALS, ×550; 228. PI in ALS, ×1800; 229. PMS, ×800; 230. mAP and N in PMS, ×1800; 231. PLS, ×400.

the epigynum not strongly sclerotized, and male palpal organ with fulcrum, but can be distinguished from the latter by the anterior eye row strongly recurved; chelicera with three retromarginal teeth; spermatheca short and thick, not strongly coiled (e.g., Fig. 166); tibial apophysis of male palp small or reduced; and palpal organ lacking saddle (e.g., Figs. 173–175).

This genus comprises 17 species distributed in Africa (eight species), Madagascar (four species), southeast Asia (four species) and Middle East (one species). Among them, *T. bottrelli* Barrion and Litsinger 1995 (Barrion & Litsinger 1995: 350, figs. 207a–d, female) and *T. balingkinitanus* Barrion and Litsinger 1995 (Barrion & Litsinger 1995: 352, figs. 208a–f, male) from Philippines should be transferred to *Hygropoda* [*Hygropoda bottrelli* (Barrion and Litsinger 1995) NEW COMBINATION and *Hygropoda balingkinitanus* Barrion and Litsinger 1995 NEW COMBI-



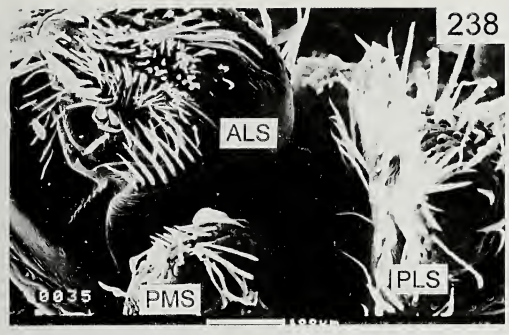
Figures 232–237.—Spinnerets of female *Pisaura lama*. 232. Right spinneret group, ×145; 233. ALS, ×600; 234. PI in ALS, ×2000; 235. PMS, ×850; 236. mAP and N in PMS, ×1500; 237. PLS, ×550.

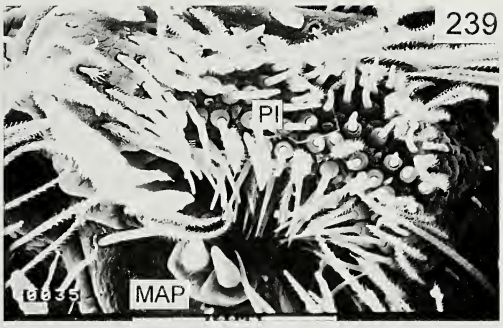
NATION] due to the long and flexible tarsi of the legs and the male palpal patella longer than tibia.

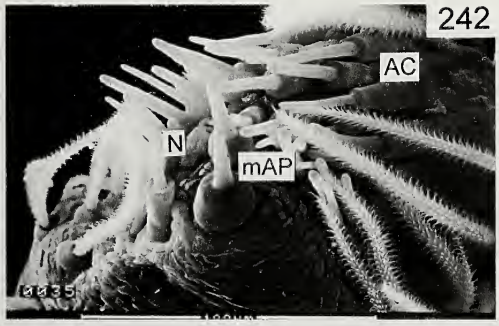
Only one species (*T. phipsoni* F.O.P.-Cambridge 1898) has been previously recorded from our fauna. A new species under the name of *T. paralbocinctus* is added and reported here.

KEY TO CHINESE *THALASSIUS* SPECIES

1. Female 2
   Male 3
2. Lateral margins of lateral lobe of epigynum parallel (Fig. 171); head of spermatheca almost boot-shaped (Fig. 172) ..... *T. phipsoni*







Figures 238–243.—Spinnerets of female *Pisaura mirabilis*. 238. Left spinneret group, ×180; 239. ALS, ×470; 240. PI in ALS, ×1500; 241. MAP in ALS, ×1000; 242. PMS, ×680; 243. PLS, ×500.

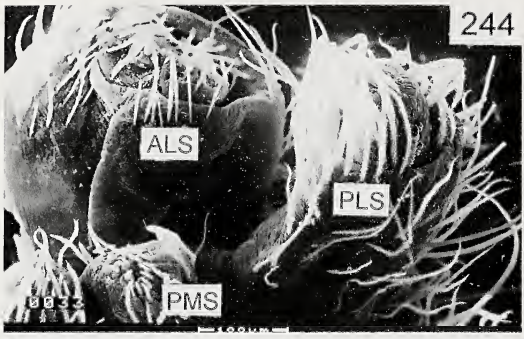
Lateral margins of lateral lobe of epigynum not parallel (Fig. 165); head of spermatheca round (Fig. 166) ..... *T. paralbocinctus*

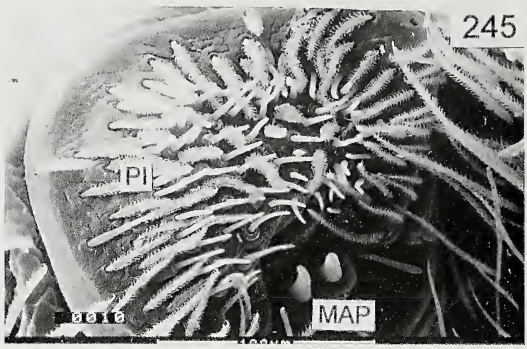
3. Median apophysis of palpal organ small and hooked, embolus sickle-shaped (Figs. 173–175) ..... *T. phipsoni*

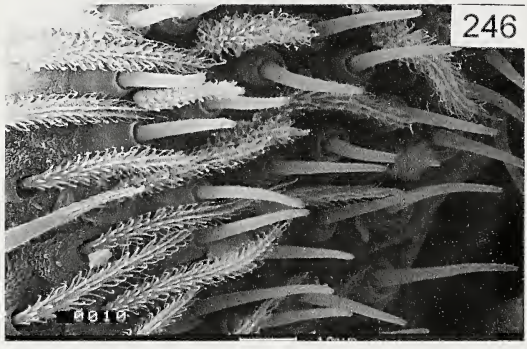
Median apophysis of palpal organ large and wide, embolus coiled spirally (Figs. 167–169) ..... *T. paralbocinctus*

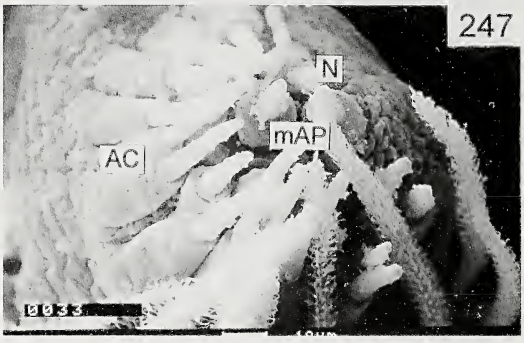
Thalassius paralbocinctus new species
Figs. 163–169

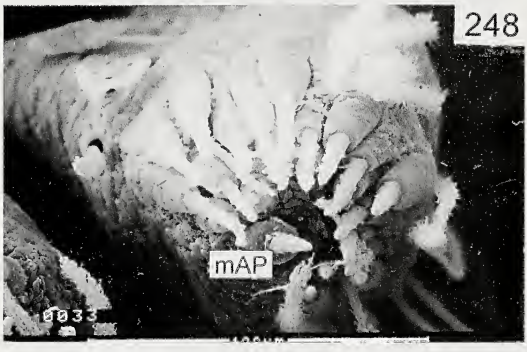
Material examined.—Holotype female, Mengla (21°24′N, 101°30′E), Yunnan, China, 24 July 2000, M.S. Zhu (MHU). Paratypes: CHINA: *Yunnan:* 2 ♀, 2 ♂, Daluo (21°36′N, 100°00′E), Menghai, 31 July 2000, M.S. Zhu and G.M. Tang (MHU); *Guangxi:* 1 ♀, 1 ♂,









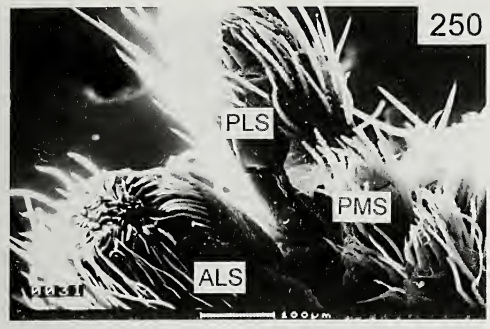


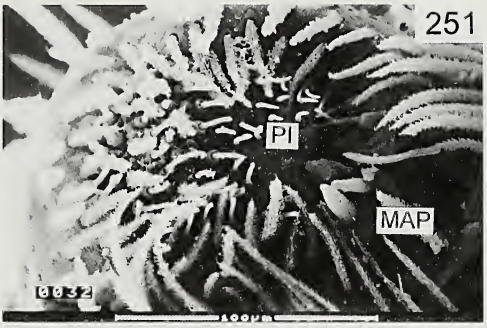
Figures 244–249.—Spinnerets of female *Pisaura sublama*. 244. Left spinneret group, ×200; 245. ALS, ×500; 246. PI in ALS, ×1300; 247. Right PMS, ×1000; 248. Left PMS, ×750; 249. PLS, ×400.

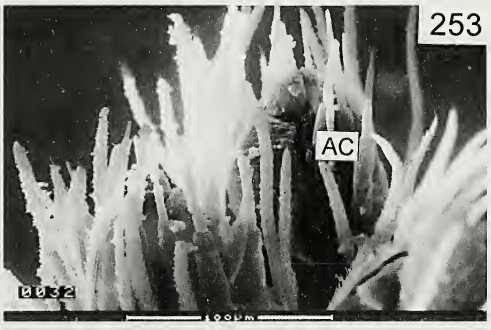
Yingluo (21°30′N, 109°42′E), 26 August 1995 (GU).

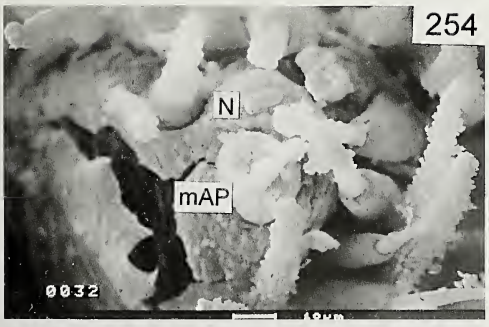
Diagnosis.—The new species is closely related to *T. albocinctus* (Sierwald 1987: 119, figs. 127, 132–140, 143–148), but it differs from the latter by the shorter stalk of spermatheca (Fig. 166); narrower cymbium of male palpal organ, and the embolus mostly hidden by the median apophysis (Fig. 167).

Female.—Total length 22.14–26.00. Holotype total length 22.14: cephalothorax 9.99 long, 8.82 wide; abdomen 12.60 long, 6.03 wide. Carapace red brown, with lateral yellow bands. Chelicerae dark red brown. Labium, endites and dorsal legs red brown. Sternum gray yellow. Dorsum of abdomen dark brown, with lateral yellowish bands. Chelicerae with three teeth on both margins. Both eye rows strongly recurved. AME–AME:AME–ALE (0.31:0.24), PME–PME:PME–PLE (0.34:0.58); AME:ALE:PME:PLE (0.41:0.26:0.37:0.43). MOA 1.04 long, front width 1.07, back







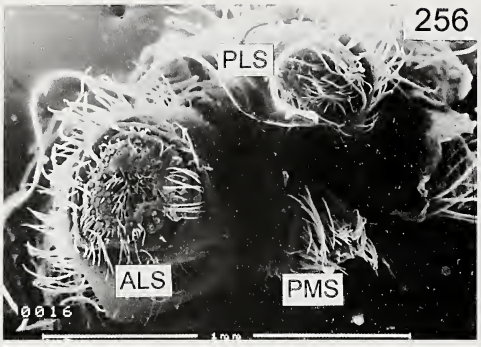


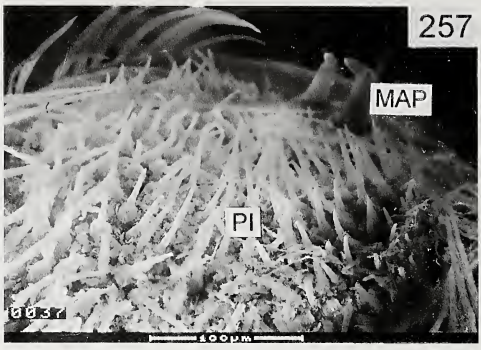
Figures 250–255.—Spinnerets of female *Polyboea zonaformis*. 250. Left spinneret group, ×170; 251. ALS, ×600; 252. PI in ALS, ×3500; 253. PMS, ×470; 254. mAP and N in PMS, ×1000; 255. PLS, ×420.

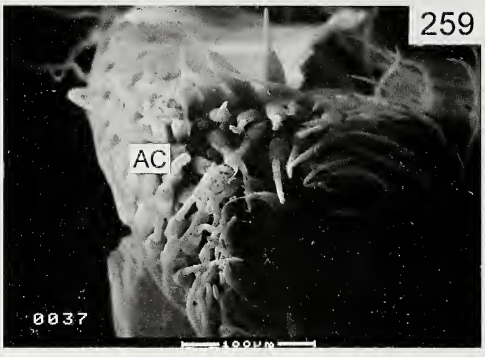
width 1.09. Measurements of legs: I 44.92 (12.42, 17.69, 10.49, 4.32), II 45.28 (12.96, 16.88, 10.80, 4.64), III 40.95 (11.97, 15.12, 10.08, 3.78), IV 48.24 (13.32, 17.55, 12.69, 4.68). Leg formula: 4, 2, 1, 3. Tibiae with four pairs of ventral spines. Median field of the epigynum wide and semi-circular; head of spermatheca round.

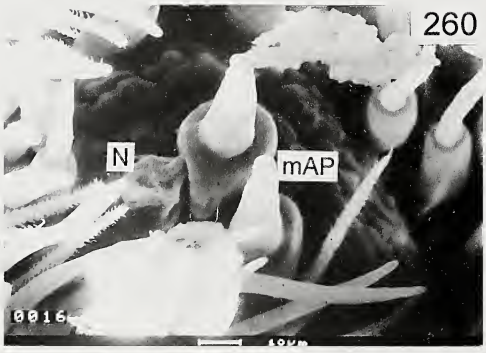
Male.—Total length 16.22–17.91. A male total length 16.22: cephalothorax 6.98 long, 6.12 wide; abdomen 9.91 long, 3.42 wide. Characters as in holotype ♀. Measurements of palp and legs: palp 8.06 (3.15, 1.22, 1.62, 2.07); leg I 37.10 (10.58, 13.55, 8.87, 4.10), II 37.18 (10.26, 13.64, 9.18, 4.10), III 33.35 (9.27, 12.15, 8.46, 3.47), IV 39.47 (10.35, 14.13, 10.49, 4.50). Median apophysis of the male palpal organ wide and large, embolus coiled spirally.

Etymology.—The specific name refers to its close resemblance to *T. albocinctus* (Doleschall 1859).









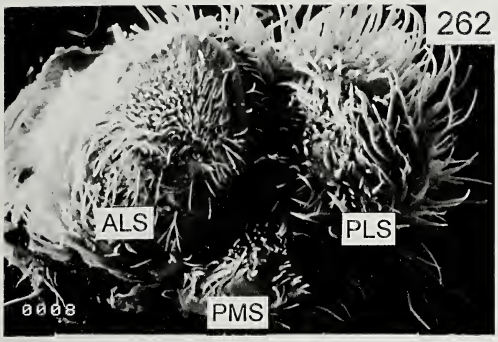
Figures 256–261.—Spinnerets of female *Qianlingula bilamellata*. 256. Left spinneret group, ×85; 257. ALS, ×340; 258. MAP in ALS, ×1000; 259. PMS, ×300; 260. mAP and N in PMS, ×1010; 261. PLS, ×360.

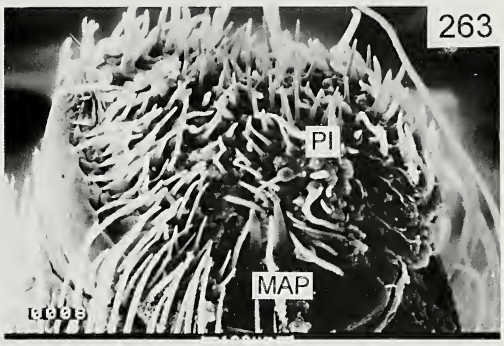
Distribution.—China (Yunnan, Guangxi).

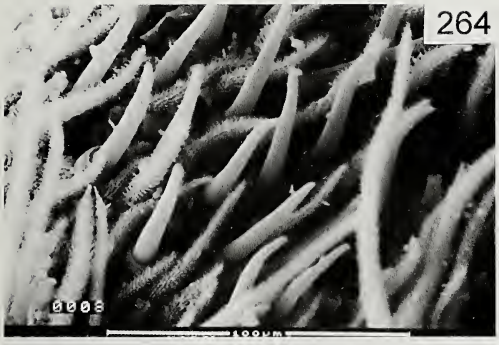
Thalassius phipsoni F. O. P.-Cambridge 1898
Figs. 170–175, 262–267

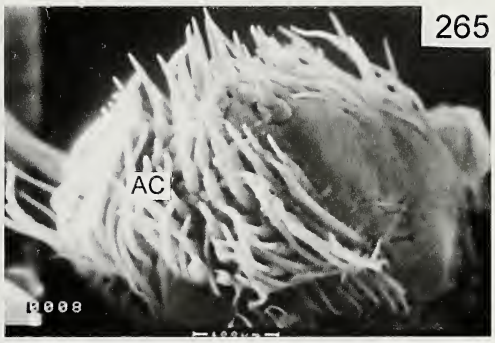
Thalassius phipsoni F. O. P.-Cambridge 1898: 31 (holotype female from India, in the Natural History Museum, London, examined by Sierwald 1987); Lee 1966: 58, figs. 21a–b; Hu 1984: 265, figs. 279.1–2; Sierwald 1987: 116, figs. 126, 128–131, 141–142; Chen & Zhang 1991: 225, figs. 234.1–4; Song et al. 1999: 353, figs. 204O–Q.

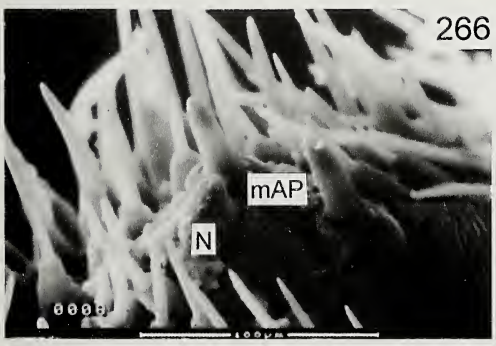
Thalassius affinis Song & Zheng 1982: 157, figs. 5–8 (holotype female, allotype male, 2 females, 1 male paratypes from Sanmen, Zhejiang, China, in IZB, examined); Hu 1984: 264, figs. 278.1–4;









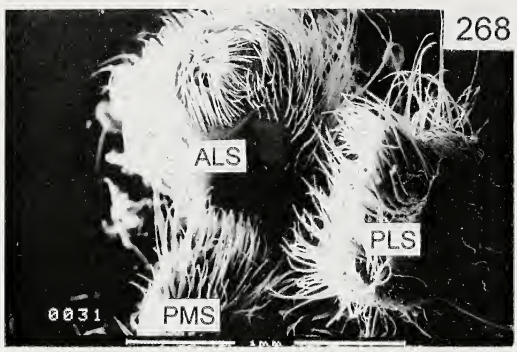


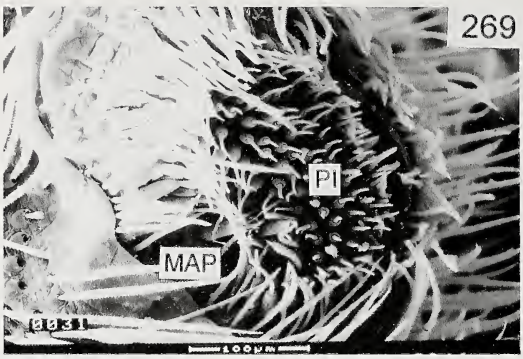
Figures 262–267.—Spinnerets of female *Thalassius phipsoni*. 262. Left spinneret group, ×80; 263. ALS, ×200; 264. PI in ALS, ×600; 265. PMS, ×200; 266. mAP and N in PMS, ×550; 267. PLS, ×200.

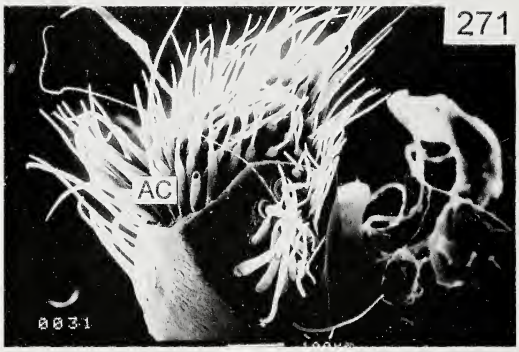
Song 1987: 212, fig. 172; Feng 1990: 161, figs. 136.1–6; Chen & Gao 1990: 138, figs. 173a–b. First synonymized by Sierwald (1987).

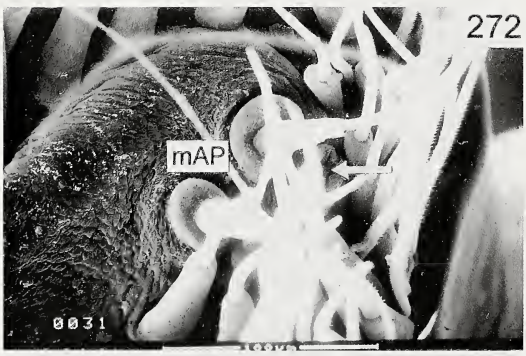
Material examined.—Holotype female, allotype male, 2 female, 1 male paratypes of *T. affinis*: Sanmen, Zhejiang, China, 19 June 1976 (IZB). CHINA: *Guizhou*: 1 ♀, Meitan, 10 September 1979, L.F. Jiang (MHU); 1 ♀, Maolan National Natural Reserve, Libo, 13 August 2000, G.M. Tang (MHU); *Fujian*: 1 ♀, Longqi Mt., Jiangle, 14 August 1991, S.Q. Li (IZB); *Sichuan*: 2 ♀, Panzhihua, 11 August 1999, S.H. Dong & Z. Li (MHU).

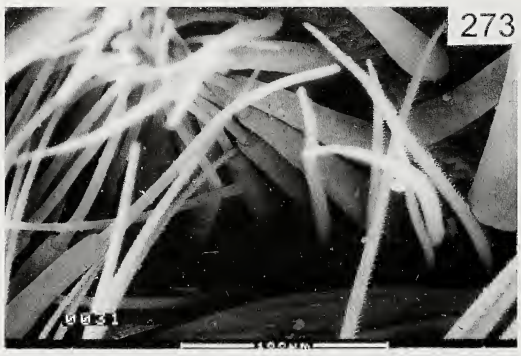
Diagnosis.—The species differs from *T. paralbocinctus* in lateral margins of lateral lobes of the epigynum parallel; median field almost quadrate (Fig. 171); head of spermatheca boot-shaped (Fig. 172); median apophysis small and hook-shaped; embolus sickle-shaped (Figs. 173–175).











Figures 268–273.—Spinnerets of female *Hippasa lycosina*. 268. Left spinneret group, ×60; 269. ALS, ×260; 270. PI in ALS, ×1200; 271. PMS, ×125; 272. mAP and N in PMS, ×470; 273. PLS, ×450 (white arrow refers to nubbin).

Female.—Descriptions of *T. affinis* see Song & Zheng (1982). Lateral lobe of the epigynum kidney-shaped; median field almost quadrate; head of spermatheca boot-shaped.

Male.—Descriptions of *T. affinis* see Song & Zheng (1982). Palpal tibia curved; tibial apophysis reduced; median apophysis small and hooked; conductor foliar in lateral view.

Distribution.—China (Zhejiang, Fujian, Sichuan, Guizhou, Taiwan, Hong Kong); India.

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A REVIEW OF THE SPIDER GENUS *THIODINA* (ARANEAE, SALTICIDAE) IN THE UNITED STATES

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ABSTRACT. The jumping spider genus *Thiodina* in the United States is reviewed here and the common western species, *T. hespera* new species, is formally described for the first time. We present a species key for specimens north of Mexico.

Keywords: Taxonomy, new species, North America

The jumping spider genus *Thiodina* is common throughout much of the southern United States extending south into Argentina. Eighteen species are known (Platnick 2003). Hentz (1846) described two species from the eastern United States, *T. sylvana* and *T. puerpera*, the type specimens of which no longer exist. At least one undescribed species is known from the western United States. The purpose of the current work is to describe this western species, to review the other two described species, and to provide a key to differentiate them.

Wolff (1985) produced a full revision of the North American (including Mexican) species of *Thiodina*. Unfortunately, that work was never published and the western species was referred to only as *Thiodina* new species A. Because this lack of a proper description and name is not likely to change, we felt that it was necessary to rectify this situation.

We have not included the tropical American fauna because the species in Mexico and Central and South America require further study and would need a much broader effort. There are also fewer specimens available and the inter- and intraspecific genitalic differences are not always sufficiently diagnostic to allow for a description of new species without a large number of specimens for comparison. Future study should include the Central and South American species as well, as some of these may range into southern Mexico. Wolff (1985) did study the fauna of Mexico through Central America and found no described species from this area matching the new species we describe here. He did include two undescribed species (*Thiodina* sp. B and sp. C) from Panama, and Oaxaca, respectively, which are not the species in question. Pires de Melo Nogueira (2003) recently revised the species of *Thiodina* from Brazil. Comparison of our species with the illustrations of seven species included in her thesis (including one undescribed) produced no close matches. Four other species were eliminated because three are probable synonyms of other species covered and the other is represented by an immature female type. Two other species (*T. sylvana* and *T. puerpera*) are included in the current work. *Thiodina crucifera* (Cambridge 1901) does not appear to be the same, based on the epigynal illustration. Thus 13 of the 18 described species and three undescribed species have been eliminated from consideration. The remaining 5 species are *T. branicki* (Taczanowski) from northern South America, *T. cockerelli* (Peckham & Peckham) from Hispaniola and Jamaica, *T. inerma* Bryant from Cuba, the type species *T. nicoleti* Roewer from Chile, and *T. peckhami* (Bryant) from Cuba. As none of these were found by Wolff (1985), we are confident that the new species described in the current work has never been described before.

METHODS

In the following descriptions, city/town and county records are provided only for *T. hes-*

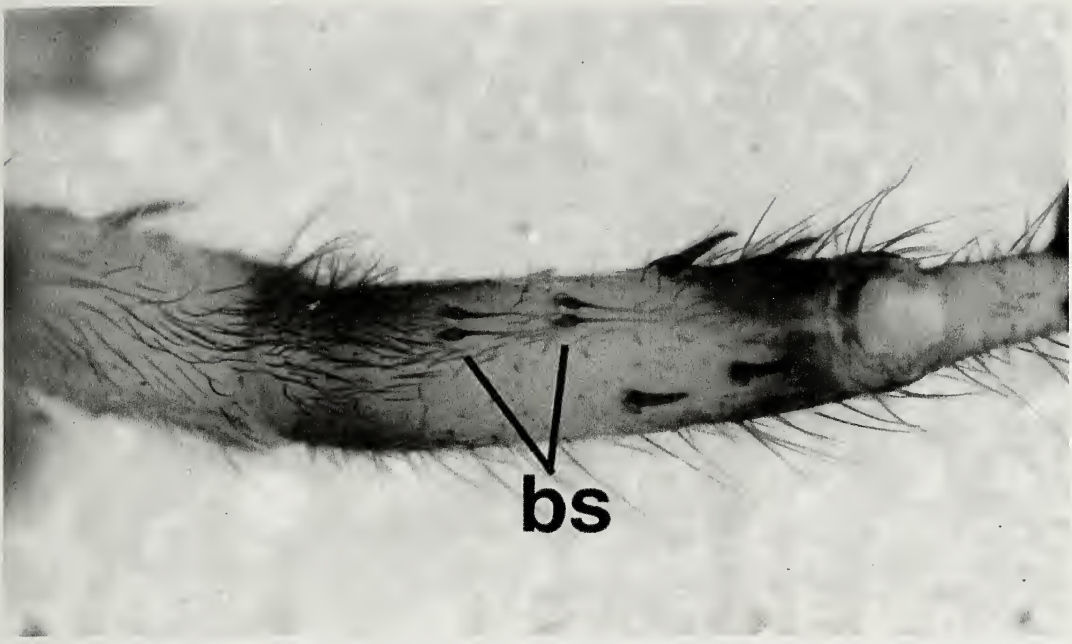


Figure 1.—*Thiodina* sp., left tibia I, ventral view, showing two pairs of bulbous spines (bs). Photograph by R. Vetter.

pera. The other species records for specimens we have examined are listed by counties within the United States. Detailed foreign records for *T. sylvana* and records given by Wolff (1985) are not included. Because *Thiodina* is often found in urban and suburban environments over a wide geographic area, providing more exact locality data seemed superfluous.

The following institutions or collectors loaned material for examination: BCU = Bruce Cutler, University of Kansas; CAS = California Academy of Science, San Francisco; CUAM = Clemson University Arthropod Museum, South Carolina; FAC = Frederick A. Coyle, Western Carolina University, North Carolina; FMNH = Field Museum of Natural History, Chicago; JLK = Jack L. Kaspar, University of Wisconsin-Oshkosh; LAMNH = Los Angeles Museum of Natural History; MCZ = Museum of Comparative Zoology, Harvard University; NMNH = United States National Museum of Natural History; NMSU = New Mexico State University Arthropod Museum; RAB = Richard A. Bradley, Ohio State University-Marion; TRP = Thomas R. Prentice, University of California-Riverside; UCB = University of California-Berkeley, Essig Museum; UCR = University of California-Riverside, Entomology Research Museum; WTAM—West Texas A & M University, Canyon, Texas.

Carapace lengths and widths and total lengths are in millimeters but are listed below without units. Latitude and longitude records for exact localities not recorded by GPS are approximate only and were obtained from the USGS GNIS web site at http://geonames.usgs.gov/pls/gnis/web_query.gnis_web_query_form. No latitude or longitude data were provided for county records for *T. sylvana* and *T. puerpera* as these would be essentially meaningless.

Family Salticidae
Thiodina Simon 1900

Thiodina Simon 1900: 392.
Colonus Cambridge 1901: 246.
Nilakantha Peckham & Peckham 1901: 8–9; Bryant 1950: 202 (nomen nudum; see Platnick 2003).

Type species.—*Thiodina nicoleti* Roewer 1951 (= *Attus elegans* Nicolet 1849, preoccupied by *A. elegans* Hentz 1846) from Chile, female only.

Remarks.—The genus *Thiodina* is distinct among salticid genera found in North America north of Mexico in that members of both sexes, as well as immatures, have two pairs of bulbous spines on the ventral first tibiae (Fig.

Table 1.—Characteristics to distinguish the male *Thiodina* species of the United States. The white scales on the carapace will always appear obvious in fresh specimens and will be unreliable in specimens showing wear. However, in very well-preserved specimens, the scale patterns are diagnostic for species identification. In specimens showing gradation between species for the usually-consistent diagnostic characters, the remaining characteristics will help determine species identification.

	Thiodina sylvana	*Thiodina puerpera*	*Thiodina hespera*
Medial white scales on carapace	small, round, restricted to cephalic region between PLE	longitudinal stripe extending posteriorly along declivity	medium, round, extending anterior of PLE
White scales on lateral carapace, ventral to PLE	3+ stripes	patch	3+ stripes
Two longitudinal rows of dorsolateral abdominal white scales	present	present	absent
Fang retromargin teeth	2–3, if one then bi- or tricuspid	typically 1, rarely 2	typically 1, rarely 2
Ventral RTA	much thicker basally than at midpoint, taper is readily apparent	thin basally, taper is subtle for entire length	much thicker basally than at midpoint, taper is readily apparent
Tip of ventral RTA	slightly to distinctly sinuate	gentle ventrad curve	slightly to distinctly sinuate
Distribution	eastern half of U.S.A.	eastern half of U.S.A.	southwestern U.S.A. to West Coast

1). Their function is unknown. All also have 2–2 distal ventral spines on the first tibiae. In general, all species are similar in external appearance in that males usually have dark carapaces, with either a white blotch or stripe in the center (Fig. 2) and females have tan carapaces with dark blotches around the eyes (Fig. 4). The male palpi of the three North American species are very similar in morphology with variation overlapping among the species, hence, it is much easier to determine species by the females if examining only genitalia. However, there are sufficient non-genitalic characters in males that allow accurate species determination when a suite of features is considered (Table 1). Some of these characteristics are difficult to see if the specimen is rubbed or immersed in fluid. The genus ranges from New York, south to Argentina. It is mainly distributed in South America, based on the fact that 11 of the 18 currently recognized species occur in this area. The last published treatment of this genus in the United States was by Peckham and Peckham (1909).

The palps of male *Thiodina* are very similar. With the variation we noticed among the specimens, we found it useful to employ additional non-genitalic features to confirm species determination. The most diagnostic traits for the males were patches of white scales on the carapace (typically present in fresh and well preserved specimens), which alone were sufficient for species determination (Figs. 2, 3). Scales are best observed by removing the spider from alcohol and allowing it to air-dry for a few minutes at which point they become highly conspicuous. However, the scales are easily rubbed off. As a secondary diagnostic structure, retromarginal tooth number is very consistent within each species but occasional specimens have two teeth on one chelicera and one on the other, obfuscating the determination. Due to the intraspecific variation in tooth number, one should examine several characters in determining males. See Table 1 for a list of traits of male characters.

In a review of the phylogeny of the Salticidae, Maddison & Hedin (2003) placed *Thiodina* among the Amycoida, a group that is largely restricted to the New World.

Excluded species.—The name *Attus inquies* Walckenaer 1837 was resurrected by Chamberlin and Ivie (1944) as a senior synonym of *T. sylvana*. As Richman (1978) pointed out, there is no certain way to assign this name, which was based on Abbot's (1792)

drawings. Thus Walckenaer's (1837) names for species now included in *Thiodina* are all suspect.

Attus irrorata Walckenaer 1837 was similarly resurrected by Chamberlin and Ivie (1944) as a senior synonym of *T. puerpera*. Again, Richman (1978) noted that Abbot's 1792 drawings did not allow a conclusion as to the association of this name with *T. puerpera* or *T. sylvana*.

KEY TO SPECIES IN THE UNITED STATES

Three species are known from the United States, *Thiodina sylvana* (Hentz 1846), *T. puerpera* (Hentz 1846) and *T. hespera* new species. They can be separated by the following key.

1. Retrolateral fang furrow usually with 2 or 3 teeth, or if one tooth, then usually bi- or tricuspid ..... *T. sylvana*
   Retrolateral fang furrow usually with 1 simple tooth, rarely 2 2
2. Males 3
   Females 4
3. In lateral view, basal half of ventral process of RTA does not conspicuously broaden and is only slightly wider than distal half; terminus gently curving ventrad (Fig. 7); carapace with medial longitudinal stripe of white scales (if present- scales easily rubbed off in alcohol specimens) extending posteriorly along declivity toward abdomen (Fig. 2); abdomen with paired longitudinal stripes (Fig. 2) ..... *T. puerpera*
   In lateral view, basal half of ventral process of RTA conspicuously broadens and is much wider than distal half, terminus slightly to distinctly sinuate (Fig 8); carapace with medial marking of white scales (if present) always square or rounded, never extending posteriorly along declivity (Fig. 2); abdomen without paired longitudinal stripes (Fig. 2) ..... *T. hespera*
4. Epigynum with transverse ridge distant from epigastic furrow, typically anterior to spermathecae (Fig. 10) ..... *T. puerpera*
   Epigynum with transverse ridge close to epigastric furrow, posterior to spermathecae (Fig. 11) ..... *T. hespera*

Thiodina sylvana (Hentz 1846)
Figures 2–3, 5–6, 9, 12

Attus sylvanus Hentz 1846: 364, plate 22, fig. 10.
Attus retiarius Hentz 1850: 288, plate10, fig. 11.
Plexippus puerperus (Hentz): Peckham & Peckham 1885: 68, plate 2, fig. 5; 1888: 33, plate1, fig. 23, plate 2, fig. 23, plate 3, fig. 23 (misidentified).
Colonus puerperus (Hentz): Cambridge 1901: 246, plate 21, figs. 11, 12 (misidentified).
Metaphidippus retiarius (Hentz): Cambridge 1901: 272.
Thiodina puerpera (Hentz): Simon 1901: 457 (misidentified).
Thiodina sylvana (Hentz): Peckham & Peckham 1909: 449, plate 35, fig. 9; Oehler, 1980: 12, figs. 128–132; Breene et al. 1993: 64, figs. 41A–C.
Thiodina inquies (Walckenaer): Chamberlin & Ivie 1944: 216, fig. 11; Kraus, 1955: 59, fig. 169.

Type specimens.—No types of Hentz are known to exist.

Material examined.—U.S.A.: *Alabama*: Winston County (BCU); *Florida*: Alachua County (NMSU), Duval County (UCR), Escambia County (CAS), Highlands County (BCU, NMSU, UCB), Monroe County (NMNH), Orange County (NMNH), Osceola County (UCR), St. Lucie County (NMNH), Santa Rosa County (BCU); *Georgia*: Rabun County (NMNH), Ware County (NMNH); *Indiana*: Monroe County (FMNH), Park County (FMNH); *Kansas*: Coffey County (BCU), Douglas County (BCU), Elk County (BCU), Johnson County (BCU), Wyandotte County (BCU); *Kentucky*: Whitley County (UCB); *Mississippi*: Lee County (BCU); *Missouri*: Boone County (BCU); *North Carolina*: Macon County (NMNH), Rutherford County (CUAM), Transylvania County (NMNH); *Oklahoma*: Payne County (CUAM); *Ohio*: Delaware County (RAB), Greene County (RAB), Hocking County (RAB), Preble County (RAB); *South Carolina*: Anderson County (CUAM), Oconee County (CUAM), Pickens County (CUAM); *Tennessee*: Blount County (FAC), Campbell County (UCB); *Texas*: Angeline County (BCU), Aransas County (MCZ), Bexar County (CAS), Cameron County (NMNH), Comal County (MCZ), Dallas County (MCZ), Denton County (MCZ), Fairfax County (UCB), Galveston County (MCZ),

Figure 2.—Males of *Thiodina*. Left to right, *T. sylvana*, *T. puerpera*, *T. hespera*. Note the elongate dorsal stripe of cephalic white scales in *T. puerpera* in comparison to a more circular patch in the other species. Also note the lack of paired longitudinal abdominal stripes of white scales in *T. hespera*. Photograph by R. Vetter

Jasper County (BCU), Liberty County (MCZ), San Patricio County (CAS), West County (UCB); *Virginia*: Essex County (NMNH), Fairfax County (NMNH), Greene County (NMNH); *Washington D.C.* (NMNH).

Diagnosis.—*Thiodina sylvana* can usually be separated from the other *Thiodina* species in the United States in having two or three retromarginal teeth, or if one tooth, then usually bi- or tricuspid. To confirm determination of specimens, the medial white scales on the carapace in male *T. sylvana* consist of a much smaller trapezoidal patch between the PLE than in *T. hespera* and does not have the patch drawn into a longitudinal stripe along the declivity as in *T. puerpera* (Fig. 2). In females, lateral pouches (termed by Wolff 1985), internally located at the lateral margins of the epigynal ridge, are about midway between the epigastric furrow and the anterior copulatory

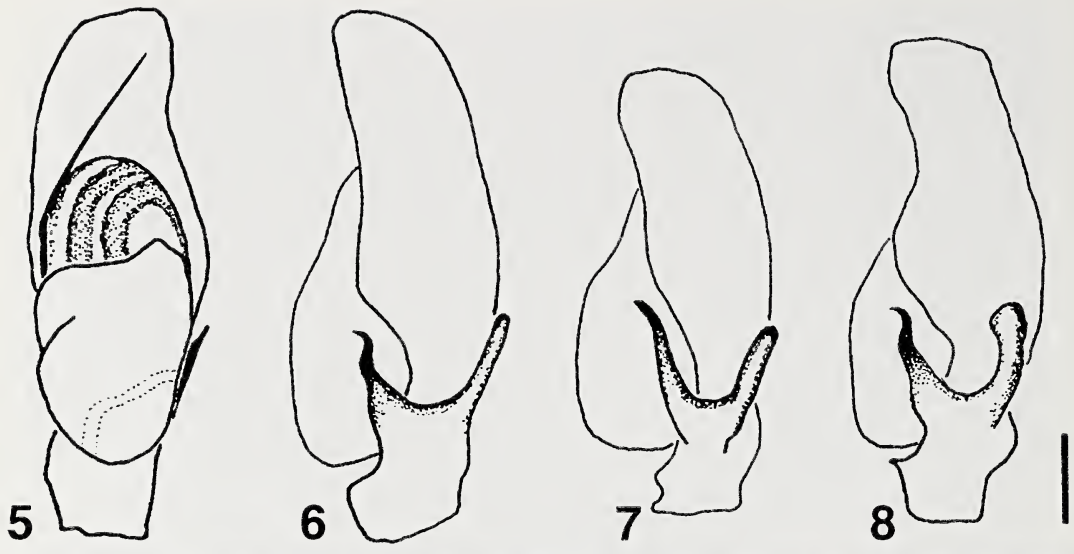
Figure 3.—Males of *Thiodina sylvana* (left) and *T. puerpera*. Note ventral to the PLE, that the white scales consist of 3 stripes in *T. sylvana* and of a solid patch in *T. puerpera*. *T. hespera* also exhibits the striped pattern. Photograph by R. Vetter

Figure 4.—Female *Thiodina hespera*. Photograph by D. Boe.

openings (Fig. 9), whereas in *T. puerpera*, the pouches are much nearer the copulatory openings (Fig. 10) and in *T. hespera*, they are very close to the epigastric furrow (Fig. 11).

Description.—*Male:* Florida (Highlands County, Archbold Biological Station, 27°10′N, 81°21′W, 30 April 1982, D. Richman, deposited in NMSU). Total length 6.5; carapace length 3.0; carapace width 2.3. PME much closer to ALE than PLE. Leg formula 1432. Carapace orange-brown; scattered black setae; white scales present ventral and anterior to PLE forming remains of probably three undulating longitudinal stripes (specimen partly rubbed); similar scales forming central medium-sized trapezoidal white patch and lateral posterior slash-like marks converging in the direction of the medial patch of scales. PLE surrounded by black pigment; remaining eyes not surrounded by pigment. Clypeus dark. Chelicerae orange-brown; crenulated with dark lateral carinae, four promarginal teeth and one bicuspid retromarginal tooth. Endites yellow-brown with prolateral third nearly white. Labium orange-brown. Sternum yellow-brown. Abdomen yellowish-gray-brown with curved lateral stripe of white scales containing several dark spots on inside margins on each side of dorsum. First and second legs mostly orange-brown with dark areas prolateral on femora widening toward venter, and on prolateral patellae and tibiae (not widening toward venter); metatarsi and tarsi unmarked. Third and fourth legs unmarked. Pedipalpi orange-brown with darker bulb.

Female: Texas (Dallas, Dallas County, 32°47′N, 96°48′W, August 1935, collected by O. Sanders, deposited in MCZ). Total length 7.4; carapace length 3.3; carapace width 2.5. PME much closer to ALE than PLE. Leg formula 4312. Carapace yellow with scattered black setae, eyes on dark spots. Clypeus yellowish. Chelicerae yellow, with slightly darker fangs, four promarginal teeth and one bicuspid retromarginal tooth. Endites and labium yellow, with anterior ends slightly lighter. Sternum yellow. Abdomen yellowish, with a split central streak and lateral streaks, area between lateral and central streaks speckled with gray spots. All legs yellow, with first



Figures 5—8.–Left male palps of *Thiodina* species: 5. *T. sylvana*, ventral view; 6. Same, retrolateral view; 7. *T. puerpera*, retrolateral view; 8. *T. hespera*, retrolateral view. Scale = 0.2 mm.

and second legs with slightly darker tarsi and metatarsi. Pedipalpi yellow.

Genitalic variation.—In the male, the ventral edge of the ventral RTA varies from straight to undulating and the terminus varies from slightly to distinctly sinuate. Specimens with a slightly sinuate tip may be confused with *T. puerpera* but should be distinguishable by both the degree of basal broadening of the ventral RTA and retromarginal tooth number. In the female, the transverse epigynal ridge typically bisects the spermathecae, however, in a few specimens the ridge almost touches the epigastric furrow as in *T. hespera* or crosses the spermathecae anteriorly as in many *T. puerpera* specimens. Such specimens are difficult to place except by habitat (*T. puerpera* is usually found on grasses) or distribution (*T. hespera* is not likely to be found very far east of the Texas-New Mexico state line and does not seem to overlap *T. sylvana* in any part of its range).

Distribution.—According to Wolff (1985) *T. sylvana* is known from central Texas north to eastern Kansas, east to New York and Florida, south to Panama. Beatty (2002) lists it from both Illinois and Indiana.

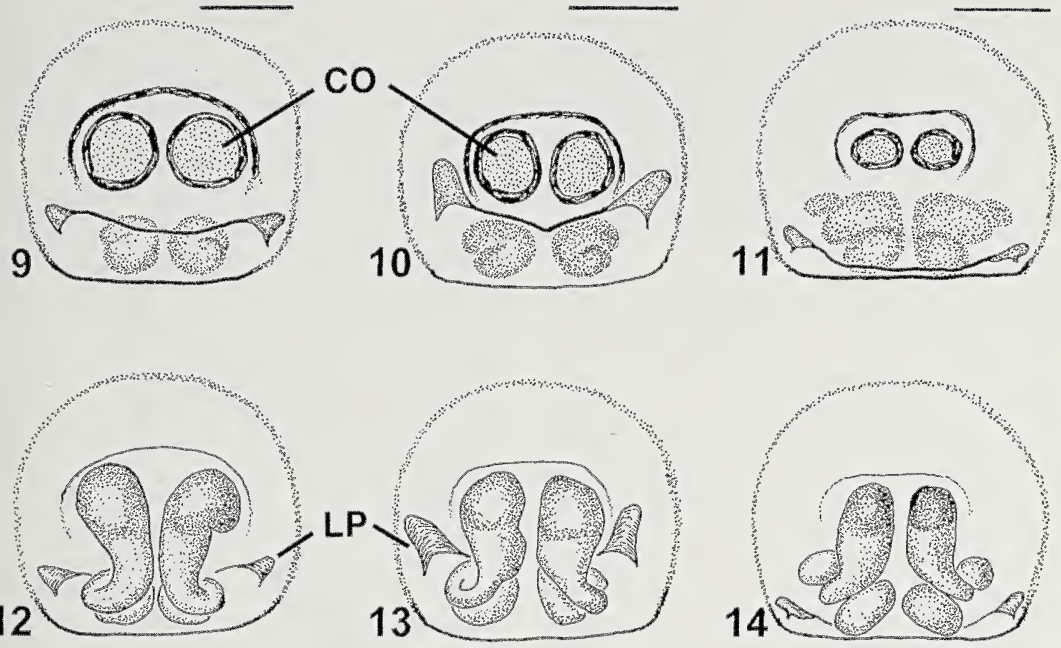
Natural history.—Males have been collected from February through November except for August, females from March through December. One female was collected with 30 eggs in June and another with young (not counted) in July. Usually associated with trees; presumably arboreal. The specific name suggests association with woodland and this generally seems to be the case.

Thiodina puerpera (Hentz 1846)
Figures 2–3, 7, 10, 13

Attus puerperus Hentz 1846: 360, plate 21, fig. 22.
Attus agrestis Peckham & Peckham 1883: 12, plate 1, fig. 9.
Plexippus puerperus (Hentz): Emerton 1902: 51, figs. 137–139.
Thiodina. puerpera (Hentz): Peckham & Peckham 1909: 449, plate 35, fig. 8. Oehler, 1980: 12, figs. 122–127; Breene et al. 1993: 64, figs. 40A–C.
Thiodina irrorata (Walckenaer): Chamberlin & Ivie 1944: 215, fig. 11.

Type specimens.—No types of Hentz are known to exist. The type of *Attus agrestis* is apparently lost, as it appears to not be at the Museum of Comparative Zoology or the Milwaukee Public Museum.

Material examined.—U.S.A.: *Georgia*: Bulloch County (NMNH), Rabun County (NMNH), Ware County (NMNH); *Kansas*: Barber County (BCU), Douglas County (BCU), Ellsworth County (BCU), Greenwood County (NMSU), Harper County (BCU), Johnson County (BCU), Riley County (BCU); *Maryland*: Montgomery County (NMNH); *Missouri*: Ralls County (JLK); *North Carolina*: Craven County (NMNH); *Ohio*: Delaware



Figures 9—14.–Epigyna of *Thiodina* species. Ventral views: 9. *T. sylvana*; 10. *T. puerperal*; 11. *T. hespera*. Dorsal views: 12. *T. sylvana*; 13. *T. puerpera*; 14. *T. hespera*. Scale = 0.2 mm.

County (RAB); *Oklahoma*: Tulsa County (NMSU); *South Carolina*: Greenville County; *Tennessee*: Blount County (FAC); *Texas*: Bexar County (UCB), Brazos County (MCZ), Cameron County (CAS), Comal County (CAS), Denton County (MCZ), Dimmit County (MCZ), Hidalgo County (JLK), Live Oak County (BCU), Potter County (WTAM), Randell County (WTAM), San Patricio County (JLK), West County (UCB).

Diagnosis.—*Thiodina puerpera* typically has one retromarginal tooth which distinguishes it from the often-sympatric *T. sylvana*. *Thiodina puerpera* males have a medial carapace marking usually longitudinally elongated on the declivity, reaching almost to the posterior edge (Fig. 2) and a patch of white scales ventral to the PLE (Fig. 3) whereas the other two species lack medial white scales on the declivity and typically have 3 undulating, longitudinal stripes ventral to the PLE. In worn specimens, diagnosis must be made using genitalic characters. The male of *T. puerpera* has a ventral RTA thin along the entire length with a terminus that curves gently ventrad, never sinuate (Fig. 7) whereas male *T. hespera* and *T. sylvana* have the ventral RTA broad basally, usually with a conspicuously sinuate terminus (Fig. 6, 8). In addition, the slash-like marks on the carapace are more posterior and not so slanted as in *T. sylvana* and first and second legs less dark than in the other two species. The female epigynum is distinct, where the lateral pouches of the transverse epigynal ridge lie anteriad to the spermathecae, resting very close to the copulatory openings (Fig. 10) whereas the pouches are at the midline of the spermathecae in *T. sylvana* (Fig. 9) and just anterior of the epigastric furrow in *T. hespera* (Fig. 11).

Description.—*Male:* Kansas (Fall River, Greenwood County, 37°36′N, 96°01′W, 11 September 1978, collected by W.F. Rapp, deposited in NMSU). Total length 7.2; carapace length 3.0; carapace width 2.4. PME much closer to ALE than PLE. Leg formula 1342. Carapace yellow-brown with scattered black setae; white scales laterad and forming a medial white stripe from just anterior of PLE, posterior to the level of the slash-like white scale patches on the posterior sixth of carapace. Eyes surrounded by black pigment. Carapace with sides bearing solid patch of white scales ventral to PLE. Chelicerae, yellowish-brown, crenulated, with dark lateral carinae, three promarginal teeth and one simple retromarginal tooth. Endites yellow-brown with prolateral third nearly white. Labium and ster-

num yellow-brown. Abdomen yellowish-gray-brown with a curved lateral stripe of white scales on each side of dorsum; these have scattered dark spots, both internally and lateral to the curved white stripes. First and second legs mostly yellow-brown with some dark areas on segments. Third and fourth legs unmarked. Pedipalpi yellow brown, including darker bulb.

Female: Oklahoma (Tulsa, Tulsa County, 36°09′N, 95°59′W, 7 June 1975, collected by J.M. Nelson, deposited in NMSU). Total length 8.4; carapace length 3.2; carapace width 2.6. PME much closer to ALE than PLE. Leg formula 4312. Carapace yellow with scattered black setae and with eyes on dark spots. Clypeus yellowish. Chelicerae yellow, with slightly darker fangs, four promarginal teeth and one simple retromarginal tooth. Endites and labium yellow, with anterior ends very slightly lighter. Sternum yellow. Abdomen yellowish, with scattered black setae and with no markings except vague speckles of gray. All legs yellow; first and second legs with slightly darker tarsi and metatarsi. Pedipalpi yellow.

Genitalic variation.—The genitalia of *T. puerpera* were fairly consistent in structure, much more so than the other two species considered here.

Distribution.—According to Wolff (1985) *T. puerpera* is known from central Texas and southern Oklahoma and eastern Kansas to Pennsylvania and Florida. Beatty (2002) recorded it from Illinois. Records from West Texas A & M University (Canyon, TX) indicate that it is also present in the panhandle of Texas in at least Potter and Randell counties.

Natural history.—Males were collected from February through November: females from February through December except for November. Females with young or egg sac collected in June and October. Usually associated with grassy areas and presumably found primarily on grasses.

Thiodina hespera new species
Figures 2, 4, 8, 11, 14–16

Dendryphantes retiarius (Hentz): Banks 1898: 284. (misidentified)

Thiodina retiarius (Hentz): Banks 1904: 358. (misidentified)

Thiodina n. sp.: Jung & Roth 1974: 33

Type material.—Holotype female, allotype male: U.S.A.: *California:* San Diego County, San Diego, Mission Trails Regional Park, Mission Gorge, 32°48′N, 117°04′W, 26 May 1979, D. Boe (AMNH). Paratypes: 3 males, 1 female, same data (CAS).

Other material examined.—U.S.A.: *Arizona*: Cochise County: Chiricahua Mountains, approx. 31°52′N, 109°12′W (NMSU), Portal (Southwest Research Station) N, 31°52′N, 109°12′W (CAS); Maricopa County: Mesa, 33°52′N, 111°49′W (MCZ); Pima County: Santa Catalina Mountains, Molina Basin, 32°20′N, 110°41′W (BCU); Tucson, 32°13′N, 110°55′W (MCZ); Santa Cruz County: Nogales, 31°20′N, 110°56′W (NMNH); *California*: Alameda County: Oakland Hills, 37°48′N, 122°09′W (UCB); Butte County: Oroville, 39°30′N, 121°33′W (UCB); Palermo, 39°26′N, 121°31′W (UCB); Contra Costa County: Lafayette, 37°53′N, 122°07′W (CAS), Mitchell Canyon Park, 37°55′N, 121°57′W (CAS); Fresno County: Auberry, 37°04′N, 119°29′W (CAS); Fresno 36°45′N, 119°47′W (CAS, UCB); Inyo County: Panamint Mountains, Surprise Canyon, 36°45′N, 117°30′W (UCB); Kern County: Kernville, 35°45′N, 118°25′W (JLK); Maricopa, 35°04′N, 119°28′W (CAS); Kings County: Hanford, 36°19′N, 119°38′W (CAS); Los Angeles County: Agoura Hills, 34°10′N, 118°43′W (LAMNH); 15 mi N. Azusa, 34°18′N, 117°51′W (UCR); Glendale, 34°08′N, 118°16′W (LAMNH); Granada Hills, 34°15′N, 118°32′W (LAMNH); Griffith Park, 34°08′N, 118°18′W (LAMNH); La Habra Heights, 33°57′N, 117°57′W (CAS); Los Angeles, 34°02′N, 118°21′W (LAMNH); Monrovia, 34°08′N, 118°01′W (LAMNH); Pasadena, 34°08′N, 118°07′W (LAMNH); San Gabriel, 34°05′N, 118°06′W (LAMNH); South Pasadena, 34°06′N, 118°07′W (LAMNH); Sun Valley, 34°13′N, 118°22′W (LAMNH); Venice, 34°00′N, 118°28′W (LAMNH); West Covina, 34°04′N, 117°56′W (UCR); Whittier, 33°57′N, 118°02′W (LAMNH); Woodland Hills, 34°09′N, 118°38′W (LAMNH, UCR); Madera County: Chowchilla, 37°37′N, 120°16′W (CAS); North Fork, 37°13′N, 119°30′W (CAS); Mendocino County: University of California Hopland Field Station, 39°00′N, 123°05′W (UCB); Monterey County: Arroyo Seco, 36°19′N, 121°16′W (CAS); Cone Mountain 900 m (coordinates not available) (UCR); Hastings Reserve, 36°23′N, 121°33′W (CAS); Napa County: Angwin 400 m, 38°34′N,

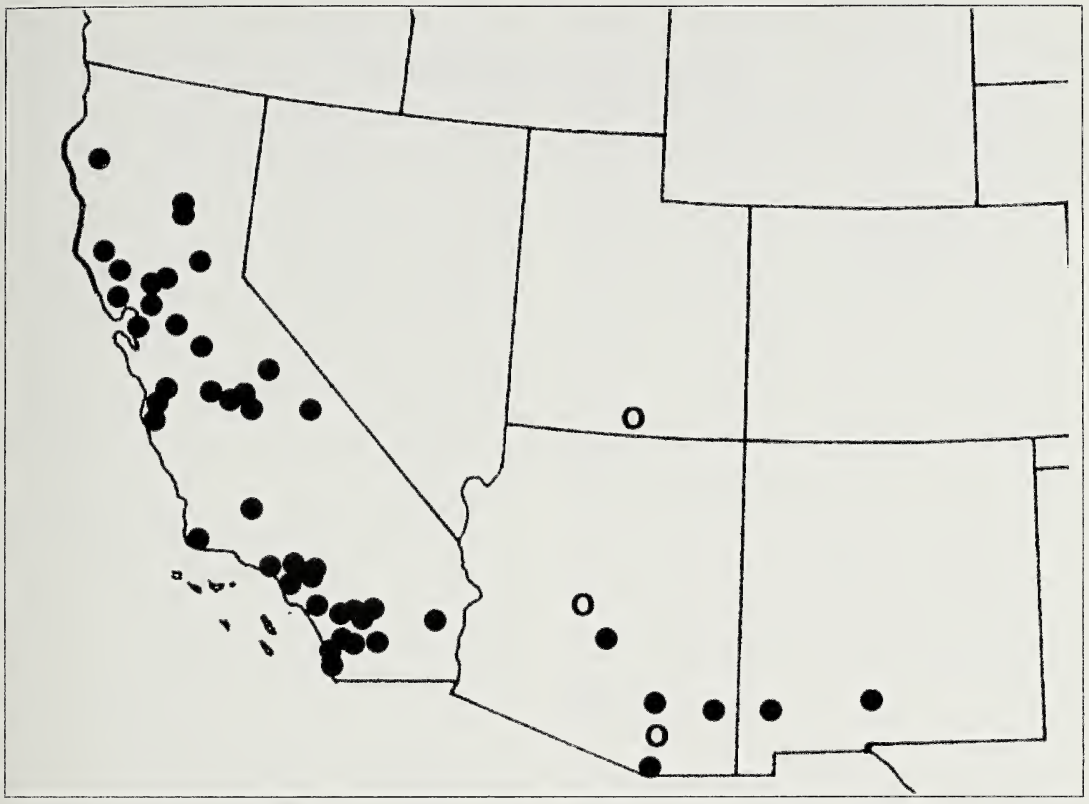


Figure 15.—Distribution of *Thiodina hespera* in the southwestern United States. Solid circles represent localities of spiders examined in this study. Open circles represent published localities of specimens which are probably *T. hespera* because it is the only species of *Thiodina* currently known from the southwestern U.S.A.

122°27′W (CAS); Orange County: Irvine, 33°39′N, 117°49′W (UCR); Riverside County: Banning, 33°55′N, 116°53′W (LAMNH); Bautista Canyon, 900 m, 33°38′N, 116°48′W (TRP); Hemet, 33°45′N, 116°59′W (NMNH); Menifee Valley, 33°40′N, 117°11′W (UCR); Moreno Valley Field Station, 33°55′N, 117°17′W (UCR); Riverside, 330 m, 33°57′06″N, 117°19′31″W (NMSU, NMNH, TRP, UCR); Wiley's Well, 20 km W of Blythe, 33°36′N, 114°54′W (UCR); Sacramento County: Sacramento, 38°34′N, 121°27′W (CAS); San Benito County: Pinnacles, 36°28′N, 121°12′W (CAS); San Diego County: Borrego Valley, 33°00′N, 116°07′W (CAS); Escondido, 33°07′N, 117°05′W (UCB); Indian Flats Campground, 33°21′N, 116°39′W, 1100 m (UCB); La Jolla, 32°50′N, 117°16′W (UCB); Lake Henshaw Dam, 33°14′N, 116°45′W (UCB); Mission Gorge, 32°48′N, 117°04′W (UCR); San Diego, 33°44′N, 117°07′W (CAS); San Diego Bay, 32°48′N, 117°10′W (UCR); Santa Barbara County: 23 mi W. Santa Barbara, 34°28′N, 120°11′W (UCR); Shasta County (UCR); Sonoma County: Guerneville, 38°30′N, 123°00′W (CAS); Stanislaus County: Del Puerto Canyon at north fork Del Puerto Creek 275–370 m, 37°26′21″N, 121°20′20″W (UCB); Modesto, 37°39′N, 121°00′W (UCB); Tulare County: Ash Mountain 520 m, 36°29′N, 118°50′W (CAS, UCB); Exeter (Lindcove Field Station); 36°17′N, 119°08′W (NMNH); Lindsay, 36°12′N, 119°05′W (NMNH); Visalia, 36°19′N, 119°19′W (NMNH); Yolo County: Davis, 38°33′N, 121°45′W (UCB); Yuba County: Smartville, 39°12′N, 121°17′W (CAS); Spenceville Wildlife Area, 39°07′N, 121°15′W (UCB); *New Mexico*: Doña Ana County: Mesilla Park, 32°16′N, 106°45′W (NMSU); Las Cruces, 32°18′N, 106°46′W (NMSU); Hidalgo County: Animas Mountains, 31°27′N, 108°44′W (NMSU).

Etymology.—The specific epithet signifies

that this species is found in the western United States.

Diagnosis.—A typical member of the genus, with a strong resemblance to *T. sylvana*, both in habitat and especially structure of the male palps. *Thiodina hespera* has one retromarginal tooth and can be separated from most *T. sylvana* which are multi-toothed. Males of *T. hespera* and *T. sylvana* have the ventral RTA thick at base with a slight to distinctly sinuate terminus (Figs. 6, 8) whereas *T. puerpera* has a ventral RTA that is thin basally and a gently curved terminus (Fig. 7). In comparison to *T. sylvana*, specimens of male *T. hespera* have a much larger spot of white scales on the carapace which extends further forward and is bordered by dark blotches surrounding the eyes (Fig. 2). Female epigyna are distinct from the other two species, with the transverse epigynal ridge close to epigastric furrow with visible underlying spermathecae mostly anterior of ridge (Fig. 11). The anterior copulatory openings are relatively much smaller in *T. hespera* (Fig. 11) compared to *T. sylvana* and *T. puerpera* (Figs. 9, 10).

Description.—*Holotype female:* Total length 7.0; carapace length 3.0; carapace width 2.5. PME much closer to ALE than PLE. Leg formula 4312. Carapace orange with scattered black setae; black blotches around eyes and dark central area with small patch of white scales in center of quadrangle formed by ALE and PLE; diverging dark streaks posterior to PLE. Obscure mottling on posterior third of carapace. No dark line around margin of carapace. Clypeus and chelicerae yellowish with fang orange. Chelicerae with three promarginal teeth and one simple retromarginal tooth. Endites light orange with dark fringe of anterior setae. Labium orange. Sternum yellow. Abdomen yellowish with scattered black setae and numerous black dots but no distinct dorsal stripes of white scales. Venter unmarked. Legs generally yellowish with numerous black setae. Pedipalpi yellowish.

Allotype male: Total length 5.6; carapace length 2.4; carapace width 2.1. PME much closer to ALE than PLE. Leg formula 1432. Carapace red-brown with scattered black setae; white scales forming large patch inside ocular quadrangle, with all eyes in large dark blotches, and just posterior and lateral to PLE on each side along the declivity; margin with dark line. Clypeus dark, with white edge (scales apparently lost) along ventral margin above chelicerae, chelicerae dark chesnut-brown in front, with some iridescence and orange-brown in back; with three promarginal teeth and one simple retromarginal tooth. Endites orange-brown with prolateral 1/3 nearly white. Labium orange-brown. Sternum yellow-brown. Abdomen yellowish with numerous black dots but no distinct dorsal stripes of white scales. Dark grayish leaf-like mark on venter. Legs with first femora almost black; tibiae with brown bands on distal and proximal ends, fainter on last two pairs of legs. Pedipalpi orange-brown with darker bulbs and lighter femora.

Genitalic variation.—Wolff (1985) described the apophyses of the male palpal tibia in *T. hespera* (as T. sp. A) as parallel, not divergent as in *T. puerpera* and *T. sylvana*; but we have seen both forms in *T. hespera* from the same locality and hence, it is not a reliable diagnostic character. Additionally, the ventral edge of the ventral process of the RTA of *T. hespera* can either be straight or show a slight undulation and also vary in the curve of its sinuate tip. Females are consistent in their genitalic morphology.

Distribution.—Widely distributed in the western United States, this species is known from New Mexico, Arizona, Utah and California (Fig. 15). Wolff (1985) also had records from western and south central Texas, but we have been unable to confirm these. It is found in Baja California and also probably found in northern mainland of northwestern Mexico. The Banks (1898, 1904) records are almost certainly *T. hespera* although ascribed to *T. sylvana* synonyms.

Natural history.—Mature individuals were collected throughout the year with a peak abundance in May (Fig. 16). Penultimate males were collected in January, March, April, June, August, September and November suggesting that there is little seasonal predictability for maturation. Two August-collected females from Riverside, California laid eggsacs shortly after capture; 20 and 17 spiderlings emerged from these eggsacs with no apparent infertile eggs nor spiderling death. *Thiodina hespera* is often associated with trees and is presumably arboreal; specimens have been recorded from apple trees, in citrus groves, sugarbush (*Rhus ovata*), *Pinus sabi-*

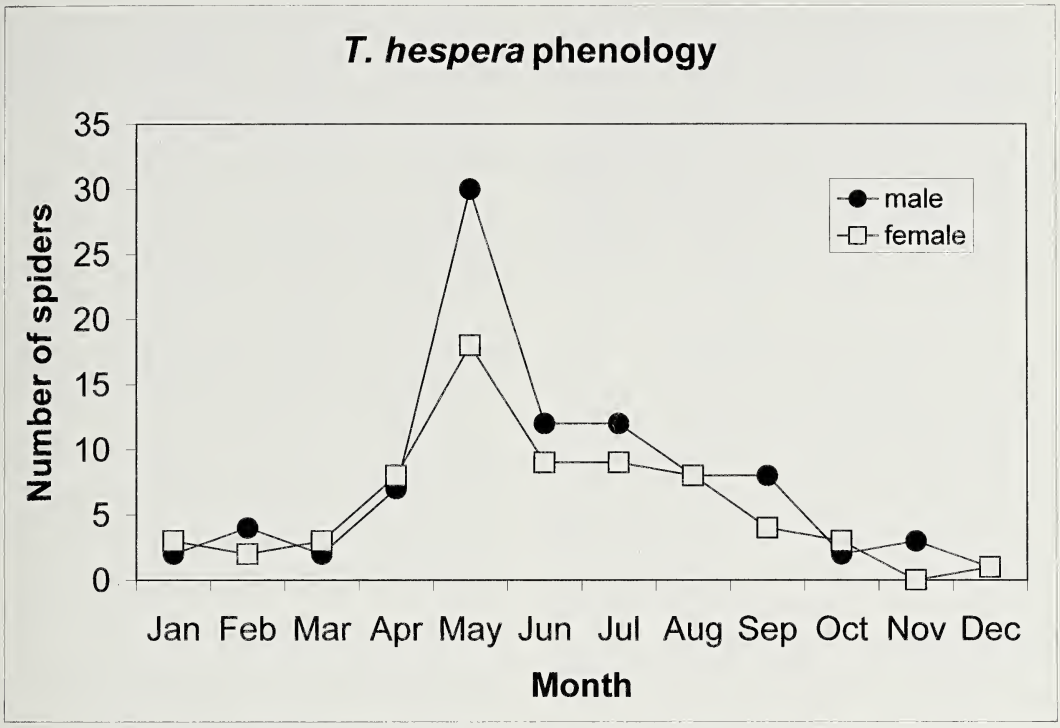


Figure 16.—Phenology of mature specimens of *Thiodina hespera*.

niana and on several species of oak trees, *Quercus* spp. One penultimate male was collected from the mud nest of the pompilid wasp, *Auplopus architectus metallicus*. Most of the collection localities appear to be lowland urban or suburban areas although this may merely reflect the bias of incidental collections. However, *T. hespera* has been taken in a variety of habitats including urban housing in Tucson, San Diego and many cities in the Los Angeles basin, from sea level to elevations of 900–1500+ meters in the Arizona mountains. Specimens have been found in the Kofa and Santa Rita Mountains of Arizona in rocky canyons in association with scattered trees and bushes (D.B.R., pers. obs.).

Carroll (1980) reports life history information for the species in citrus groves in California, stating that it is an abundant species in the canopy and lists insect prey taken by the adult spiders (Diptera: syrphids, muscids, chironomids, empidids; Lepidoptera: tortricids) and by the earliest-instar spiderlings (midges, thrips). In other ecosystems, Carroll (1980) mentions that *Thiodina* spiders also fed on oxyopid spiders and exhibited the nocturnal resting behavior of hanging suspended from foliage by a silk thread, which is thought to be an antipredator behavior to avoid night-hunting spiders. One mature female examined by us was collected while feeding on a conspecific subadult. Although the western *Thiodina* species is listed in other faunal surveys, it is a rare member of the spider fauna in ecosystems such as central California vineyards (<1% of total spiders, Costello & Daane 1995) and southern California coastal sage scrub (1 male *Thiodina* out of 14,553 total spider specimens, Prentice et al., 1998). This is a routinely encountered spider on the University of California Riverside campus and in an artificially landscaped Riverside, California apartment structure that is dominated by sycamore, alder and *Eucalyptus* trees (R. S. V., pers. obs.). It is equally common in suburban Las Cruces, New Mexico, where it is often found under or on mulberry trees (D.B.R., pers. obs.).

From faunal surveys in the literature, we add the following presumable *T. hespera* collections due to geography. In Arizona, *Thiodina* specimens are listed as *Dendryphantes retarius* from Madera Canyon, Santa Rita Mountains (Banks 1901), and as *Colonus re-*

tarius from Hot Springs (Banks 1903) [Note: Hot Springs no longer exists but the nearest extant town is Morristown (Trimble 1986)]. From Kane County, Utah, *Thiodina* specimens are listed as *T. sylvana* from Glen Canyon Reservoir (Chamberlin 1958) and as *Thiodina* sp. from Willow Tank Springs (Allred & Kaston 1983). From Fresno County, California, specimens were collected in Parlier and Reedley (Costello & Daane 1995).

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DESCRIPTION OF THE FEMALE OF *ACROPSOPILIO CHOMULAE* (GOODNIGHT & GOODNIGHT 1948) FROM CHIAPAS, MEXICO (OPILIONES, CADDIDAE, ACROPSOPILIONINAE)

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ABSTRACT. The tiny caddid harvestman *Acropsopilio chomulae* (Goodnight & Goodnight 1948), from Chiapas, Mexico, has been known only from the immature holotype. Mature females are described from specimens taken near the type locality. The absence of spermathecae in the ovipositor makes it likely that the species is parthenogenic.

RESUMEN. Hasta el momento, los únicos datos disponibles del pequeño opilión *Acropsopilio chomulae* (Goodnight & Goodnight 1948) de Chiapas (México) proceden del estudio del holotipo, un ejemplan inmaduro. En este trabajo se describen hembras maduras procedentes de cerca de localidad tipica. La ausencia de espermateca en el oviscapto sugiere que la especie es partenogenética.

Keywords: North America, harvestman, parthenogenesis

In my 1975 revision of the harvestman family Caddidae (Shear 1975), I was unable to treat the interesting species *Acropsopilio chomulae* (Goodnight & Goodnight 1948) in detail because the immature holotype was the only available specimen. Having described the species as *Caddo chomulae* in 1948, Goodnight and Goodnight later (1950) mentioned collecting numbers of mature individuals, but when I enquired in the early 1970s, they could not locate this material, and the present whereabouts of these specimens remains unknown. However, the American Museum of Natural History (AMNH) has a small collection of this species made near the type locality by Wilton and Jean Ivie. I take this opportunity to describe these specimens.

TAXONOMY

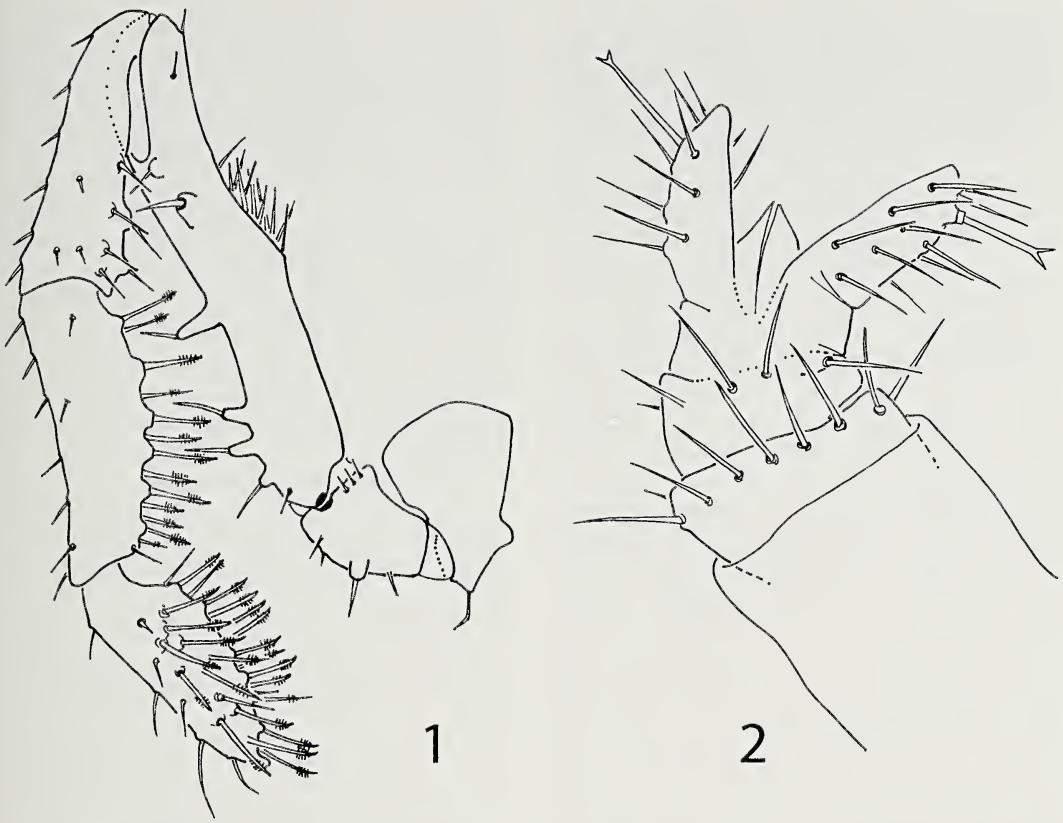
Family Caddidae Banks 1892
Subfamily Acropsopilioninae Roewer 1923
Acropsopilio chomulae (Goodnight & Goodnight 1948)
Figs. 1, 2

Caddo chomulae Goodnight & Goodnight 1948: 201.
Acropsopilio chommulae (sic): Ringuelet 1962:79.
Acropsopilio chomulae: Shear 1975:79.

Material examined.—MEXICO: *Chiapas*: 8 ♀, from 4 miles east of San Cristobal de las Casas (92°36 W, 16°42'N), 25 August 1966, W. & J. Ivie (AMNH).

Description of female.—Total length, 1.14 mm; width of eye tubercle, 0.42 mm. Eye tubercle occupies entire propeltidium when seen from above, projecting considerably over chelicerae, deeply impressed in median line. Eyes 0.17 mm in diameter, slightly protruding, circular. Free thoracic tergites (meso- and metapeltidium) only slightly distinct when seen from above (for general form of body, see Shear 1975, fig. 10). Body soft, not heavily sclerotic, devoid of spines or tubercles. Labrum triangular, pointed, large. Coxae and endites as in *A. boopis* (Crosby 1904) (Shear 1975, fig. 7), but endites of coxae II in some specimens entirely separating endites of coxae I from their coxae. Genital operculum large, broad, bluntly pointed. Sternum not sclerotized. Spiracles vestigial, closed.

Palpus (Fig. 1) longer in proportion to body length in mature specimens than in juvenile holotype. Palpal trochanter with one prominent seta and several smaller ones. Femur 0.67 mm long, 0.10 mm wide, with characteristic group of three seta-bearing tubercles near base, single seta-bearing tubercle near midline and at femoral apex on mesal side, brushlike group of small setae on lateral side about two-thirds from base of femur. Patella 0.34 mm long, 0.10 mm wide; tibia 0.32 mm long, 0.10



Figures 1, 2.—*Acropsopilio chomulae* female: 1. Right palpus, mesal view; 2. Ovipositor, ventral view.

mm wide, with 10–12 glandular setae ventrally. Tarsus 0.25 mm long, 0.10 mm wide; with small, immobile, vestigial claw, 20–24 glandular setae ventrally.

Legs relatively short and thin, leg IV much the longest. Femora I–IV 0.38, 0.57, 0.50, 0.76 mm long respectively; tibiae I–IV 0.25, 0.30, 0.34, 0.44 mm long respectively.

Ovipositor (Fig. 2) short, membranous, with two rings marked by apical transverse rows of setae, valves irregularly setose, sensillum single, apically bifurcate seta. Seminal receptacles not detected.

Color light brown, darker on abdominal dorsum, eye tubercle pale tan, eyes broadly ringed in black, palpus with femur and patella striking pure white, tibia and tarsus dark brown, legs medium tan.

DISCUSSION

As implied from an earlier description of the juvenile holotype, *A. chomulae* is a distinct species. It differs from *A. boopis* in having no spined tubercles on the palpal patella and tibia, from *A. venezuelensis* Gonzales-Sponga 1992 in having the apical spined tubercle of the palpal femur close to the distal end rather than set back about 1/3 the length of the femur, from *A. chilensis* in having the palpal tarsus shorter than the tibia, and from *A. neozealandiae* (Forster 1948) in stronger spined tubercles at the palpal femur base. In overall appearance and especially palpal morphology, *chomulae* most closely resembles *neozealandiae*.

Recently, I briefly summarized the biogeography and evolutionary relationships of the acropsopilionines (Shear 1996). Writing that paper, I was not aware of the description by González-Sponga (1992) of *Acropsopilio venezuelae*, from northern South America. This species provides a biogeographic link between *A. chilensis* Silvestri 1904 in southern South America and the northern hemisphere species *A. chomulae* and *A. boopis*. González-Sponga's discovery, the finding of *Austropsopilio sudamericanus* Shultz & Cekalovic 2003 in Chile and Argentina (Cokendolpher & Maury

1990; Shultz & Cekalovic 2003), and the description of *Hesperopilio mainae* Shear 1996 from Western Australia (Shear 1996) remind us that much fundamental data remains to be collected concerning these minute, relictual, hard-to-find harvestmen. The trans-Pacific distribution of several of the genera makes these animals important in establishing zoogeographical connections between Australia and temperate southern South America.

Ovipositors of *Acropsopilio chomulae* were mounted temporarily on microscope slides and examined under oil immersion and Nomarski differential interference contrast, on an Olympus BX50 microscope. No spermathecae were seen, as is the case with *A. boopis*. The absence of these structures makes it likely (but not certain; see Bertani & Silva Junior 2002) that *A. chomulae* is parthenogenic. Parthenogenesis is common in the Caddidae, but sexual species also occur, in a complex mosaic. *Caddo agilis* Banks 1892 females lack spermathecae, and only three males have ever been found among hundreds of specimens (Gruber 1974; Suzuki & Tsurusaki 1983). *Caddo pepperella* Shear 1975 may be a progenic isolate of *agilis* that arose after parthenogenesis had become established; males are unknown, spermathecae are lacking. The progenesis event may have happened at least twice, since the species is known from a small region of eastern North America and from Japan (Shear 1996). *Caddo agilis* has an Oligocene fossil record (Shear 1975) from Europe, so it is less likely that the origin of *agilis* from *pepperella* took place via peramorphosis.

Males are known for two of the three South African species of *Caddella* (Shear 1975), and for *Hesperopilio mainae* (Shear 1996).

Males have been described for *Austropsopilio fuscus* (Hickman 1957), but for no other species of the genus; females of *A. fuscus* have spermathecae. Despite the highly detailed description, Shultz and Cekalovic (2003) did not mention finding spermathecae in *A. sudamericanus*, which is known only from females.

Acropsopilio boopis males have never been collected either in North America (Shear 1975) or Japan (Suzuki 1976; Suzuki & Tsurusaki 1983), and *A. chilensis*, widespread in southern South America (Brazil, Chile, Argentina), is likewise known only from females (Maury et al. 1996; these authors evidently did not check for spermathecae). A single male is known for *A. venezuelae* González-Sponga 1992 (González-Sponga 1992), and there is always the possibility that males of the "females only" species are very short-lived, occupy a different habitat or simply have not been collected. I believe that parthenogenesis for *A. chomulae* represents the best hypothesis, though it is difficult to prove a negative–the complete absence of males. Only laboratory rearing can answer the question definitively, and the caddids, with their requirements for cool, moist conditions, are very difficult to keep alive in captivity.

A thorough comparative study of the male genitalia in the caddoids is lacking, and a remarkable range of variation in basic design is present. Most of the species for which penes have been illustrated have organs with heavily sclerotized, movable macrosetae (*Hesperopilio mainae* Shear is an exception). The spiny penes are closest in form to those of the Neopilionidae, which, like the caddoid penes, feature movable macrosetae. Neopilionids also have glandular-plumose hairs on the adult palpi (Hunt & Cokendolpher 1991).

No comparative information is available on the respiratory systems of *Acropsopilio* species, but the spiracles of *A. chomulae* are small and imperforate. One specimen was sacrificed in order to look for tracheae, and none were found. Such a small animal with its thin cuticle, living in a constantly humid environment, may be able to satisfy its respiratory needs by diffusion through the body wall.

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REMARKS ON THE NEW WORLD PSEUDOSCORPION GENERA *PARAWITHIUS* AND *VICTORWITHIUS*, WITH A NEW GENUS BEARING A REMARKABLE STERNAL MODIFICATION (PSEUDOSCORPIONES, WITHIIDAE)

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ABSTRACT. The withiid genus *Parawithius* Chamberlin is rediagnosed, based upon a detailed examination of the type species, *P. nobilis* (With) from Colombia, which is redescribed and illustrated. The subgenus *Parawithius* (*Victorwithius*) Feio is returned to full generic level. *Cystowithius*, a new genus of Withiidae, is described from high elevation localities in central and South America for four species: *Cystowithius smithersi* new species (type species) from Ecuador, *C. ecuadoricus* (Beier) new combination, from Ecuador and Peru, *C. colombicus* new species from Colombia, and *C. chamberlini* new species from Mexico and Guatemala. Males of *Cystowithius* are highly unusual due to the presence of sternal invaginations, a feature that has not been previously observed in pseudoscorpions. Populations of *Cystowithius smithersi* occur within the leaf sheaths of the giant rosette plant *Espeletia pycnophylla* var. *angelensis* (Compositae).

Keywords: Taxonomy, new species, new genus, Colombia, Ecuador, Peru, Mexico, Guatemala, *Espeletia*, high elevation, *Cystowithius*

The pseudoscorpion family Withiidae is distributed in most parts of the world with 34 genera and 153 species currently recognized (Harvey 1991). The family is divided into two subfamilies, Withiinae Chamberlin and Paragoniochernetinae Beier, but the relationships both within and between these groups are poorly known. The South American withiid fauna consists of seven endemic genera (Harvey 1991) which are currently placed in three tribes: *Cacodemonius* Chamberlin in the Cacodemoniini, *Protowithius* Beier 1955 in the Protowithiini, and *Balanowithius* Beier 1959, *Dolichowithius* Chamberlin 1931, *Neowithius* Beier 1932, *Parawithius* Chamberlin 1931 and *Tropidowithius* Beier 1955 in the Withiini. In addition, the cosmopolitan synanthropic species *Withius piger* (Simon 1879) has also been recorded from Chile. The composition and relationships of these genera are only poorly known and considerable problems exist in the systematics of the withiines, even at the generic level.

During a recent survey of the fauna associated with the leaf sheaths of the giant rosette plant *Espeletia pycnophylla* var. *angelensis* on the western slopes of Volcán Chiles, an extinct volcano 15 km north of Tulcán, in northern Ecuador, Smithers et al. (2001) found many pseudoscorpion specimens inhabiting the spaces formed between the sheaths. Detailed examination of the specimens showed that they represented a single species of Withiidae with a peculiar modification to the male sternites in which the anterior-lateral edge of sternites V–VIII were invaginated to form pockets within the inter-segmental membrane. Subsequent examination of museum collections revealed that while such a structure is rare among the Withiidae, further American specimens were found with such invaginations. The feature was found to be absent from other withiid genera and I here propose a new genus, here named *Cystowithius*, for these species. In addition, the type species of *Parawithius*, *P. nobilis* (With 1908), is redescribed based upon the male holotype and a second male specimen collected from a nearby locality, and the status of the species currently assigned to the subgenus *Parawithius* (*Victorwithius*) Feio 1944 is reassessed.

METHODS

The specimens that formed the basis for this study are lodged in the American Museum of

Natural History, New York (AMNH), the Natural History Museum, London (BMNH), the California Academy of Sciences, San Francisco (CAS), Museum Victoria, Melbourne (NMV), Naturhistorisches Museum, Wien (NHMW), Museum National d'Histoire Naturelle, Paris (MNHN), Pontificia Universidad Católica del Ecuador, Quito (PUCE), Bohart Museum of Entomology, University of California, Davis (UCD), Western Australian Museum, Perth (WAM) and Museum für Naturkunde der Humboldt-Universität, Berlin (ZMB). Terminology largely follows Chamberlin (1931a) and Harvey (1992). In particular, it should be noted that the terminology for the trichobothria used by Harvey (1992) differs slightly from that used by other workers. The ratio TS is the distance from the base of tarsus IV to the tactile seta, divided by the length of the entire tarsus. The tergal and sternal chaetotaxies (including those of the glandular setae) refer to the entire segment, and not merely half-segments as is often presented in descriptions of some cheliferoid pseudoscorpion taxa. All measurements are in mm and were made with an ocular micrometer on a compound or a dissecting microscope. Specimens were examined by either clearing in 50% lactic acid or by permanently mounting in Euparal on microscope slides. The scanning electron micrographs were obtained in a Philips XL30 scanning electron microscope after the specimens were prepared by dehydration in 1,1,1,3,3,3-Hexmethyldisilazane (HMDS), air-drying and mounting on SEM stubs with carbon tape.

SYSTEMATICS

FAMILY WITHIIDAE CHAMBERLIN 1931

SUBFAMILY WITHIINAE CHAMBERLIN 1931

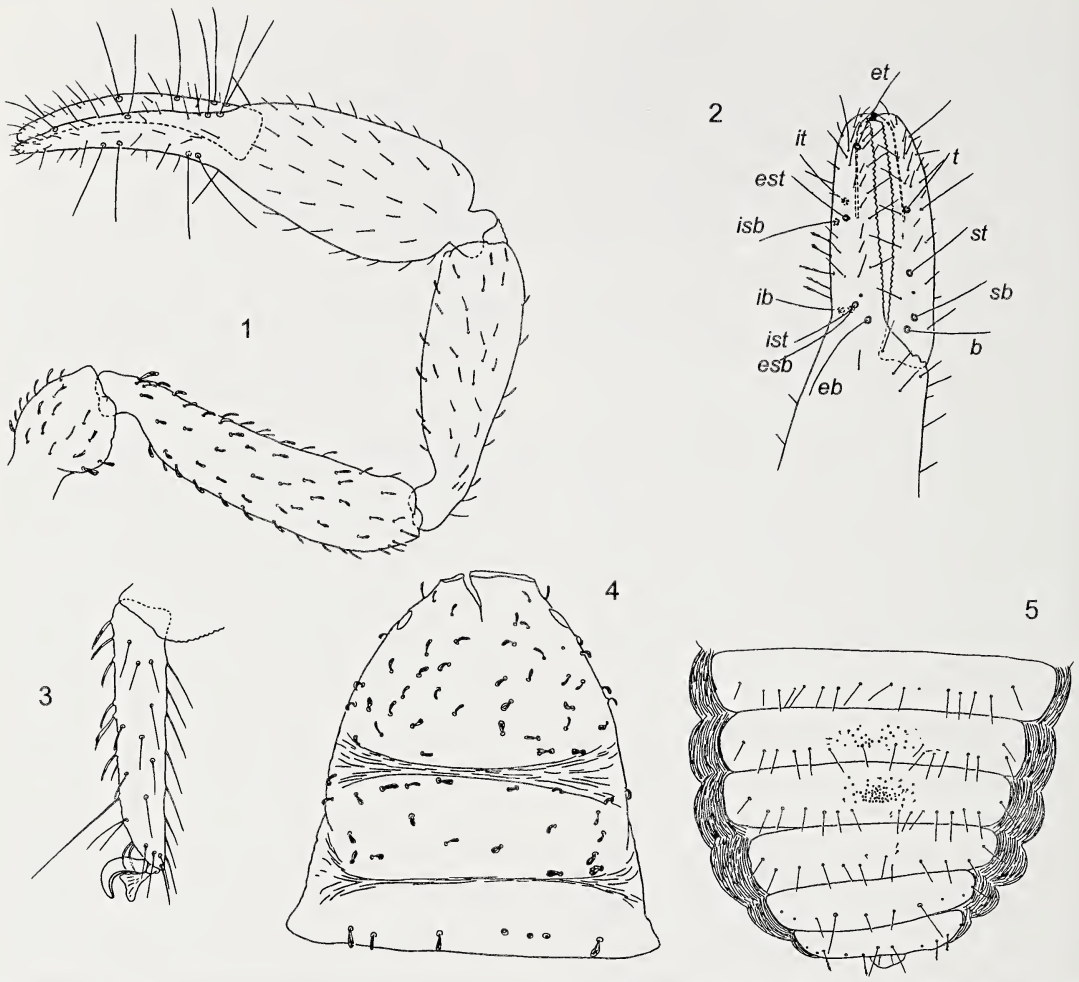
Genus *Parawithius* Chamberlin 1931

Parawithius Chamberlin 1931b: 292; Beier 1932a: 212; Beier 1959: 216; Harvey 1991: 650.

Type species.—*Chelifer nobilis* With 1908, by original designation.

Diagnosis.—The genus *Parawithius* is here defined by the following combination of characters: tactile seta of tarsus IV sub-distal (rather than sub-medial); carapace broadest posteriorly; trichobothria *est, isb* and *it* nearly adjacent to each other; male tergites without lateral tergal crests; patches of glandular setae only present on sternites VII-IX of males; males without sternal invaginations; and tergites without discrete the lateral fields characteristic of *Cacodemonius*.

Remarks.—The genus *Parawithius* comprises two distinct groups which were treated as subgenera by Beier (1959), *Parawithius* (*Parawithius*) and *Parawithius* (*Victorwithius*) Feio 1944, which differ in the position of trichobothria *isb* and *it,* which are nearly adjacent to each other in the nominate subgenus but which are somewhat separated in all species of *Victorwithius*. The subgenus *Parawithius* (*Parawithius*) currently contains the type species *P.* (*P.*) *nobilis* (With 1908) from Colombia, (*P.* (*P.*) *nobilis nobilis*), and Ecuador and Peru (*P.* (*P.*) *nobilis ecuadoricus* Beier 1959), and *P.* (*P.*) *iunctus* Beier 1932b and *P.* (*P.*) *pseudorufus* Beier 1932b from Paraguay. *Parawithius* (*Victorwithius*) consists of 12 species, *P.* (*V*). *coniger* Mahnert 1979, *P.* (*V*). *fiebrigi* Beier 1932b, *P.* (*V*). *gracilimanus* Mahnert 1979, *P.* (*V*). *incognitus* Beier 1959, *P.* (*V*). *mimulus* (Beier 1954), *P.* (*V*). *monoplacophorus* Feio 1944, *P.* (*V*). *proximus* Ellingsen 1905, *P.* (*V*). *rufeolus* Beier 1959, *P.* (*V*). *rufus* Balzan 1887, *P.* (*V*). *schlingeri* Beier 1959, *P.* (*V*). *similis* Beier 1959 and *P.* (*V*). *venezuelanus* Beier 1932b. The removal of all of those species previously placed in *Parawithius* (*Victorwithius*) to the full genus *Victorwithius* (see below) and the transfer of *P. nobilis ecuadoricus* to the new genus *Cystowithius* (see below) leaves only *P. nobilis* from Colombia, and *P. iunctus* and *P. pseudorufus* from Paraguay remaining in the genus *Parawithius*. I have examined material of all three of these species, including the type specimens of each and have confirmed that *P. nobilis* and *P. pseudorufus* are not conspecific with any of the species of *Cystowithius* described elsewhere in this paper, and that they lack the diagnostic features of *Cystowithius*. Beier (1932b) stated that the holotype of *P. iunctus* (ZMB 29667) was a male. In fact, the specimen is a female, as indicated on the determination label associated with the specimen. It is currently not possible to easily separate isolated female specimens of *Parawithius* and *Cystowithius*, so it is not certain to which genus the female holotype of *P. iunctus* belongs. It is here retained in *Parawithius* until the Paraguayan withiid fauna becomes better known.



Figures 1–5.—*Parawithius nobilis* (With), holotype ♂ unless stated otherwise: 1. Right pedipalp, dorsal; 2. Right chela, lateral; 3. Right tarsus IV, ♂ from 12 miles E. of Bogotá, Colombia; 4. Carapace, dorsal; 5. Posterior sternites, ventral. Trichobothrial abbreviations follow Chamberlin (1931) and Harvey (1992).

Parawithius nobilis (With 1908)
Figs. 1–6

Chelifer nobilis With 1908: 234–236, figs 4a–b.
Parawithius nobilis (With): Chamberlin 1931b: 292; Beier 1932a: 213; Roewer 1937: 309; Beier 1959: 216–217, fig. 25; Muchmore 1993: 99; Judson 1997: 30.
Parawithius (*Parawithius*) *nobilis* (With): Harvey 1991: 650.

Material examined.—Holotype male, Bogotá, *Cundinamarca*, COLOMBIA [4°36′N, 74°05′W], Keyserling collection (BMNH).

Other material: Cundinamarca: COLOMBIA 1 ♂, 12 miles E. of Bogotá [ca. 4°36′N, 73°52′W], 3 March 1955, E.I. Schlinger, E.S. Ross (CAS).

Diagnosis.—*Parawithius nobilis* differs from *P. iunctus* and *P. pseudorufus* by the presence of pale spots on the carapaceal metazone, by the slightly stouter pedipalpal segments (e.g. patella 3.24–3.30 times longer than broad, compared with 3.4–3.6 times longer than broad), and the morphology of the setae on the interior face of the pedipalpal segments, which are only slightly clavate in *P. nobilis* and clearly clavate in *P. iunctus* and *P. pseudorufus*.

Description.—*Adult males:* Color generally light red-brown; carapaceal metazone with large paired pale areas; tergites I–III with pale areas on each tergal half, tergites IV–IX with pale areas on each tergal half situated medi-

ally thus forming a distinct medial band. Pedipalp (Fig. 1): all segments granulate, except for chelal fingers, which are smooth; dorsal setae generally strongly foliate; trochanter 1.69–1.75, femur 4.22–4.25, patella 3.24–3.30, chela (with pedicel) 3.60–3.71, chela (without pedicel) 3.39–3.47, hand 1.73–1.78 times longer than broad, movable finger 0.99–1.04 times longer than hand. Fixed chelal finger with 8 trichobothria, movable chelal finger with 4 trichobothria (Fig. 2): *eb* and *esb* situated basally; *est, it* and *isb* grouped together sub-medially; *ist* and *ib* situated basally; *b* and *sb* situated near one another; *st* slightly closer to *sb* than to *t*. Venom apparatus present in both chelal fingers, venom ducts long, terminating in nodus ramosus near *est* in fixed finger and near *t* in movable finger. Chelal teeth strongly triangular, slightly retrorse; fixed finger with 35 teeth; movable finger with 34 teeth; accessory teeth absent. Chelicera with 5 setae on hand, *bs* and *sbs* dentate; movable finger with 1 submedial seta; galea short with 4 small terminal rami; flagellum of 4 blades; serrula exterior with 14–17 blades; lamina exterior present. Carapace (Fig. 4) 1.27–1.69 times longer than broad; lateral margins evenly convex, but posteriorly widened; with 2 non-corneate eyes, those of holotype apparently smaller than those other male; with ca. 52 setae, including 4 near anterior margin and 7–8 near posterior margin; with 2 deep furrows, the posterior furrow slightly closer to posterior carapaceal margin than to median furrow. Tergites with distinct medial suture, sternites barely divided. Chaetotaxy of tergites I-XII: 9–10: 9–10: 11: 12–15: 14–17: 15–16: 15–17: 17–18: 17: 14: 6: 2; mostly uniseriate but some tergites with a few setae placed anteriorly; all setae foliate. Chaetotaxy of sternites I-XII: 12: (2)10(2): (2)11(2): 14–16: 16: 16: 15–16: 11–12: 9–10: 9–11: 2; sternites VII-IX with patches of glandular setae, arranged 26–41: ca. 63–77: 3–5 respectively; setae uniseriate and acuminate, except for smaller setae on sternite XI which are denticulate; glandular setae small and conical in shape; ♂ without paired invaginations on anterior margins of sternites. Coxal chaetotaxy 12: 10: 10: 18; pedipalpal coxa with 2 apical setae and very small sub-oral seta. Internal genitalia not observed. Legs: junction between femora and patellae I and II only slightly oblique; femur + patella of leg IV 3.00 times longer than broad; tarsal tactile seta of leg IV situated sub-distally, ca. 0.74 of tarsus length; subterminal tarsal setae arcuate and acute; arolium slightly shorter than claws.

Dimensions (mm), males: Body length 2.32–2.64. Pedipalps: trochanter 0.422–0.435/0.248–0.250, femur 0.883–0.896/0.209–0.211, patella 0.762–0.782/0.235–0.237, chela (with pedicel) 1.196–1.229/0.331–0.332, chela (without pedicel) 1.125–1.150, hand length 0.567–0.591, movable finger length 0.588–0.592. Chelicera 0.237/0.122, movable finger length 0.180. Carapace 0.832–0.848/0.501–0.656 (width at medial area); eye diameter 0.045–0.105. Leg I: femur 0.179/0.157, patella 0.378/0.160, tibia 0.352/0.105, tarsus 0.340/0.069. Leg IV: femur + patella 0.662/0.224, tibia 0.511/0.128, tarsus 0.396/0.080, TS 0.294.

Remarks.—*Parawithius nobilis* has been infrequently recorded in the literature, and the only known specimens are the male holotype from Bogotá (With 1908), a male specimen from 'New Granada' (now Colombia) (With 1908), a male from near Bogotá (Beier 1959), and six adults from Lago Zurucuchu, Ecuador and a female from Huamachuco, Peru (Beier 1959). The specimens from Lago Zurucuchu and Huamachuco were regarded as a separate subspecies by Beier (1959) who named them *Parawithius nobilis ecuadoricus* Beier, but which are here treated as a distinct species of *Cystowithius* (see below). The holotype of *Chelifer nobilis* lodged in the BMNH is in good condition, but a fine covering of minute crystals has obscured the specimen in some places, in particular the coxal region, thus precluding the determination of the setal formula of the coxae. The description presented above is based upon the male holotype and the male from near Bogotá lodged in CAS. Both specimens are very similar in all morphological features including the size and shape of the pedipalpal segments and in the number of glandular setae on the male sternites. I have not examined the specimen lodged in the BMNH from New Granada that was referred to by With (1908).

Genus *Victorwithius* Feio 1944

Victorwithius Feio 1944: 1–3.

Cacodemoniellus Beier 1954: 326–327 (synonymized by Beier 1959: 216).

Parawithius (*Victorwithius*) Feio: Beier 1959: 216; Harvey 1991: 651.

Type species.—Of *Victorwithius*: *Victorwithius monoplacophorus* Feio 1944, by original designation; of *Cacodemoniellus*: *Cacodemoniellus mimulus* Beier 1954, by original designation.

Diagnosis.—Species of *Victorwithius* differ from other South American withiids by the following combination of characters: tactile seta of tarsus IV situated sub-distally; trichobothrium *it* situated mid-way between the tip of the finger and *isb*; and tergites without discrete the lateral fields characteristic of *Cacodemonius*.

Remarks.—The subgenus *Victorwithius* is a distinct and easily recognizable taxon that is here returned to full generic rank. It differs from *Parawithius* in the position of trichobothrium *it* which is situated mid-way between the tip of the finger and *isb* in *Victorwithius* but is situated close to *isb* in *Parawithius*. The distinction between *Victorwithius* and some other South American genera such as *Balanowithius* is difficult to confirm, and further research on the relationships of these genera is necessary to establish their interrelationships and hence the limits of the genera. The following species are placed in the genus *Victorwithius*:

Victorwithius coniger (Mahnert 1979) NEW COMBINATION
Victorwithius fiebrigi (Beier 1932b) NEW COMBINATION
Victorwithius gracilimanus (Mahnert 1979) NEW COMBINATION
Victorwithius incognitus (Beier 1959) NEW COMBINATION
Victorwithius mimulus (Beier 1954) NEW COMBINATION
Victorwithius monoplacophorus Feio 1944
Victorwithius proximus (Ellingsen 1905) NEW COMBINATION
Victorwithius rufeolus (Beier 1959) NEW COMBINATION
Victorwithius rufus (Balzan 1887) NEW COMBINATION
Victorwithius schlingeri (Beier 1959) NEW COMBINATION
Victorwithius similis (Beier 1959) NEW COMBINATION
Victorwithius venezuelanus (Beier 1932b) NEW COMBINATION

Genus *Cystowithius* new genus

Type species.—*Cystowithius smithersi* new species.

Etymology.—The generic epithet refers to the cyst-like invaginations that diagnose the genus (*kystis*, Greek for bladder, sac or cell), combined with the generic stem *Withius*. The name was first used for this taxon by the late J.C. Chamberlin, who labelled the Mexican specimens described below as "*Cystowithius* gen. nov." The gender is masculine.

Diagnosis.—Males of *Cystowithius* are unlike those of any other pseudoscorpion in the possession of paired sac-like invaginations on the anterior margins of sternites V-VIII (*C. smithersi* and C. *ecuadoricus*) or VI-VII (*C. colombicus*) or VI-VIII (*C. chamberlini*) (Figs. 18, 19).

Description.—Most dorsal setae strongly denticulate; setae on sternites acicular. Fixed chelal finger with 8 trichobothria, movable chelal finger with 4 trichobothria; trichobothria *est, it* and *isb* grouped together sub-medially. Venom apparatus present in both chelal fingers, venom duct terminating in nodus ramosus near *est* in fixed finger and near *t* in movable finger. Chelal teeth all closely spaced; accessory teeth absent. Chelicera with 5 setae on hand, *bs* and *sbs* denticulate, others acuminate; movable finger with 1 subdistal seta; flagellum of 4 blades, the most distal blade with several serrations on leading edge, other blades smooth; lamina exterior present. Carapace with 2 non-corneate eyes; with 2 distinct furrows, posterior furrow closer to posterior margin of carapace than to anterior furrow. Tergites I–X with medial suture, sternites IV–X with faint medial suture. Males with paired sac-like invaginations on anterior margins of sternites V–VIII or VI–VII or VI–VIII; males with patches of glandular setae on sternites VII–X, females with 2 glandular setae per segment on segments VII–IX (*C. smithersi*) or VIII–IX (*C. ecuadoricus*, *C. colombicus* and *C. chamberlini*); glandular setae small and conical in shape. Male genitalia with lateral apodeme long and triangular. Female genitalia with single oval median cribriform plate and 2 smaller lateral cribriform plates; with poorly defined membranous spermathecal sac irregularly covered with pores; and with 2 lateral hooked apodemes. Pleural membrane longitudinally striate. Posterior

maxillary lyrifissure present and sub-distally situated. Spiracular helix present. Legs: junction between femora and patellae I and II only slightly oblique; subterminal tarsal setae arcuate and acute; arolium slightly shorter than claws; claws slender and simple.

Remarks.—The presence of sternal invaginations in *Cystowithius* is unique within the Pseudoscorpiones. This feature has been observed in all males here assigned to the genus, but was found to be absent in other withiids (Table 1). The structure appears to be autapomorphic for the four species described below. While the feature is easily seen in slide-mounted specimens (either as permanent mounts or as temporary mounts in glycerol or lactic acid) using a compound microscope, it is still visible in material examined in ethanol using a dissecting microscope, as the anterolateral margins of the sternite are slightly curved and somewhat darker than the remaining sternal cuticle. It was not observed using a scanning electron microscope as the slight contraction of the specimen during the dehydration process hides from view the invagination (Fig. 22).

The conformation of the male genitalia of *Cystowithius* spp. resembles that of some other withiids as they possess an elongate, triangular lateral apodeme that bears an extended ejaculatory canal (Fig. 21). This feature also occurs in several species of *Withius*, including *W. hispanus* (L. Koch 1873), *W. faunus* (Simon 1879), *W. neglectus* (Simon 1878) (Heurtault 1971), *Metawithius yurii* (Redikorzev 1938) (Harvey 1988), *M. murrayi* (Pocock 1900) (pers. obs.), *M. philippinus* Beier 1937 (pers. obs.), *M. spiniventer* Redikorzev 1938 (pers. obs.), *Pycnowithius cavernicola* Mahnert 1988 (Mahnert 1988), *Rexwithius girardi* Heurtault 1993 (Heurtault 1993), *Trichotowithius abyssinicus* Beier 1944 (Dashdamirov 1992) and possibly in *Victorwithius monoplacophorus* Feio 1944 (Feio 1944). An alternative morphology in which the lateral apodeme and ejaculatory canal is not lengthened posteriorly occurs in some species of *Withius* including the type species *W. piger* (Simon 1878) (Heurtault 1971) and in several African species (Mahnert 1988), as well as in *Aisthetowithius rossi* Beier 1967 (Mahnert 1988), *Girardwithius pumilus* Heurtault 1993 (Heurtault 1993) and *Ectromachernes lamottei* Vachon 1952 (Vachon 1952). Although it is possible that those species in which the lateral apodeme is triangular may represent a monophyletic group, it should be noted that the vast majority of withiids have yet to have their male genitalia described in detail, thus precluding any comprehensive statements regarding the utility of this feature.

Although the species described here in *Cystowithius* clearly form a monophyletic group, the disposition of the tactile seta of leg IV varies considerably in its position. The tactile seta is sub-distal in *C. smithersi* (TS = 0.75–0.77), *C. ecuadoricus* (TS = 0.74–0.75) and *C. colombicus* (TS = 0.77–0.79) but is only slightly distad of medial in *C. chamberlini* (TS = 0.59–0.61). This variation may diminish the usefulness of this character in distinguishing between different genera of Withiidae.

Species of *Cystowithius* are generally found at high altitudes with three species occurring above 3,000 m in the northern Andes in Colombia, Ecuador and Peru, and above 2,000 m in Mexico (Fig. 7).

Key to species of *Cystowithius*

1. Chelal hand smooth; setae on chelal hand only barely denticulate; tactile seta of tarsus IV situated sub-medially (TS = 0.59–0.61); males with sternal invaginations on sternites VI-VIII ..... ***C. chamberlini*** new species
   Chelal hand evenly granulate; setae on chelal hand distinctly denticulate; tactile seta of tarsus IV situated sub-distally (TS = 0.74–0.79); males with sternal invaginations on sternites V-VIII 2
2(1). Larger species, e.g. chela (with pedicel) greater than 1.35 mm (Fig. 8) ..... ***C. smithersi*** new species
   Smaller species, e.g. chela (with pedicel) less than 1.20 mm (Fig. 8) 3
3(2). Setae on tergite XI long and only slightly clavate (Fig. 27) ..... *C. ecuadoricus* (Beier)
   Setae on tergite XI short and strongly clavate (Fig. 32) ..... ***C. colombicus*** new species

Table 1.—Withiidae in which the male sternal invaginations are absent. Asterisk denotes the type species of the genus.

Taxon	Specimens examined	Museum	Locality	Remarks
Balanowithius egregius Beier 1959*	holotype ♂, paratype ♀	CAS	Pichilingue, Ecuador	Personal observation
Cacodemonius satanas (With 1908)				Dr M. Judson (in litt.)
Cacodemonius segmentidentatus (Balzan 1887)				Dr M. Judson (in litt.)
Dolichowithius argentinus Beier 1959	holotype ♂	CAS	Salta, Argentina	Personal observation
Dolichowithius extensus Beier 1932b	1 ♂, 1 ♀ syntypes	BMNH	La Moka, Venezuela	Personal observation
Dolichowithius granulosus Hoff, 1945	1 paratype ♂	AMNH	Guyana	Personal observation
Ectromachernes mirabilis Beier 1944*	holotype ♂	BMNH	Jemme Forest, Ethiopia	Personal observation
Hyperwithius dawydoffi Beier 1951	4 ♂ syntypes	NHMW	Cao Nguyên Lâm Viên (Plateau von Langbian), Lâm Dong, Vietnam	Personal observation
Hyperwithius tonkinensis Beier 1951	1 ♂, 1 ♀, 2 protonymphs syntypes	NHMW	Lau Chau, Lau Chau, Vietnam	Personal observation
Juxtachelifer fructuosus Hoff 1956*	paratypes ♂, ♀ and tritonymphs	AMNH	Santa Fe, New Mexico, U.S.A.	Personal observation
Metawithius murrayi (Pocock 1900)	1 ♂, 1 ♀ syntypes	BMNH	North West Point, Christmas Island, Australia	Personal observation
Metawithius philippinus Beier 1937	several ♂, ♀ syntypes	ZMB	Philippines	Personal observation
Metawithius spiniventer Redikorzev 1938	several ♂, ♀ specimens	NHMW	Cao Nguyên Lâm Viên (Plateau von Langbian), Lâm Dong, Vietnam	Personal observation
Metawithius (Microwithius) yurii (Redikorzev 1938)	1 ♂	NMV	Sertung Island, Indonesia	Personal observation
Metawithius (Microwithius) tweediei Beier 1955	2 ♂, 1 ♀ syntypes	NHMW	Telom Valley, Cameron Highlands, Pahang, Malaysia	Personal observation
Nesowithius seychellesensis Beier 1940*	2 ♂ syntypes	BMNH	Praslin, Seychelles	Personal observation
New genus, similar to *Metawithius* Chamberlin 1931	several ♂, ♀ and tritonymphs	WAM	Manngarre Rainforest, Kakadu National Park, Northern Territory, Australia	Personal observation
Parawithius nobilis (With 1908)*	holotype ♂	BMNH	Bogotá, Colombia	Personal observation
Parawithius nobilis (With 1908)*	1 ♂	CAS	near Bogotá, Colombia	Personal observation

Table 1.—Continued.

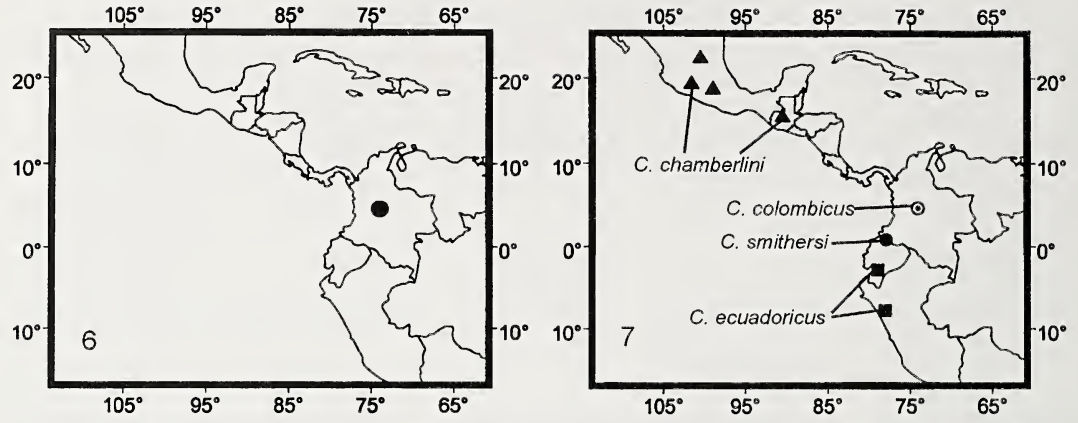
Taxon	Specimens examined	Museum	Locality	Remarks
Parawithius pseudorufus Beier 1932b	holotype ♂	ZMB 29668	Paraguay	Personal observation
Scotowithius helenae Beier 1977*				Dr M. Judson (in litt.)
Stenowithius angulatus (Ellingsen 1906)	1 ♂	CAS (JC-906.01001)	no data	Personal observation
Stenowithius bayoni (Ellingsen 1910)	7 adult syntypes of *Stenowithius ugandanus* Beier 1932b	BMNH 1932.11.12.14–20	Kampala, Uganda	Personal observation
Stenowithius duffeyi Beier 1961	11 adult syntypes	BMNH 1964.8.17.2–12	Boatswain-bird Island, Ascension Island	Personal observation
Thaumatowithius tibialis Beier 1940*	1 ♂, 2 ♀ syntypes	BMNH	Le Pouce, Mauritius	Personal observation
Trichotowithius abyssinicus Beier 1944*	1 ♂, 3 ♀ syntypes	BMNH	Jemme Forest, Ethiopia	Personal observation
Victorwithius coniger (Mahnert 1979)				Dr M. Judson (in litt.)
Victorwithius rufeolus (Beier 1959)	2 ♂ and ♀ syntypes	CAS	Pichilingue, Ecuador	Personal observation
Victorwithius schlingeri (Beier 1959)	holotype ♂	CAS	Tingo María, Monson Valley, Peru	Personal observation
Victorwithius similis (Beier 1959)	1 ♂ and 1 ♀ syntypes	CAS	10 miles N. of Trancas, Argentina	Personal observation
Victorwithius venezuelanus (Beier 1932b)	1 ♂ and 2 ♀ syntypes	BMNH	La Moka, Venezuela	Personal observation and Dr M. Judson (in litt.)
Withius hispanus (L. Koch 1873)	2 ♂	CAS (JC-511.04004–5)	Sardinia	Personal observation
Withius piger (Simon 1878)*	numerous specimens	WAM, CAS	Australia, Hawaii, Europe, North America, South America, India, etc.	Personal observation

Cystowithius smithersi new species
Figs. 7–23

Material examined.—Holotype male, Volcán Chiles, ca. 15 km N. of Tulcán, *Carchi Province,* ECUADOR, 0°48′35.0″N, 77°57′15.0″W, altitude 3,600 m, August 1997, in leaf sheath of *Espeletia pycnophylla*, P. Smithers, A. Bond, M. Burne (WAM T54598). Paratypes: ECUADOR: *Carchi Province*: 3 males, 3 females (1 with broodsac), 5 tritonymphs, same data as holotype (WAM T54599–54606); 1 male, 1 female, 1 tritonymph, same data as holotype (BMNH); 1 male, 1 female, 1 tritonymph, same data as holotype (PUCE); 1 male, 1 female, 1 tritonymph, same data as holotype (MHNG); 1 male, 1 female, 1 tritonymph, same data as holotype (MNHN).

Etymology.—The specific epithet honors Peter Smithers, University of Plymouth, who provided me with the opportunity to examine the specimens described here, and who first published upon the unusual biology of this species (Smithers et al. 2001).

Diagnosis.—*Cystowithius smithersi* differs



Figures 6–7.—Maps showing known distributions of species mentioned in the text: 6. *Parawithius nobilis*; 7. *Cystowithius* species.

from the other three species of the genus by its longer and more slender pedipalps, e.g. the chela (with pedicel) of *C. smithersi* is greater than 1.35 mm and the pedipalpal femur is greater than 0.90 mm. In addition, it differs from *C. chamberlini* in the evenly granulate chelal hand and the presence of male sternal invaginations on sternites V–VIII.

Description.—*Adults:* Color dark red-brown; carapaceal metazone with paired pale spots; tergites with paler areas, usually surrounding setal areoles. Pedipalp (Fig. 16): all segments granulate, except for chelal fingers, which are smooth; dorsal setae generally strongly foliate; femur 4.93–5.43 (♂), 4.70–5.28 (♀), patella 4.04–4.45 (♂), 3.83–4.19 (♀), chela (with pedicel) 4.24–4.59 (♂), 3.88–4.18 (♀), chela (without pedicel) 4.04–4.35

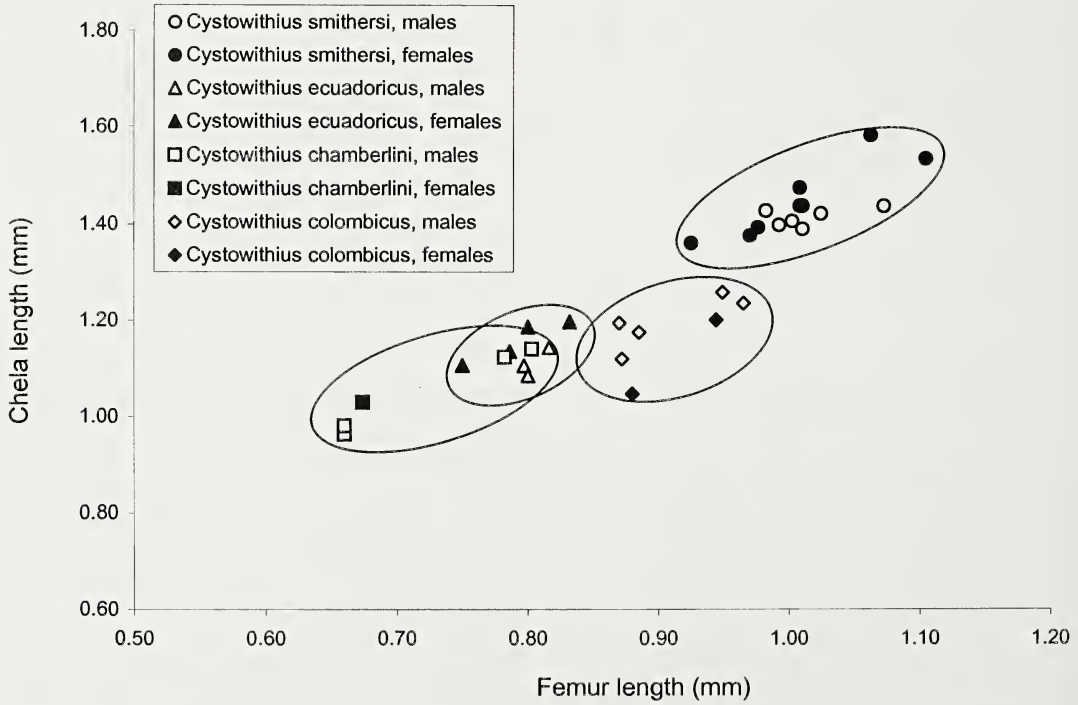


Figure 8.—Graph depicting pedipalpal chela (with pedicel) length versus pedipalpal femur length in *Cystowithius* species.

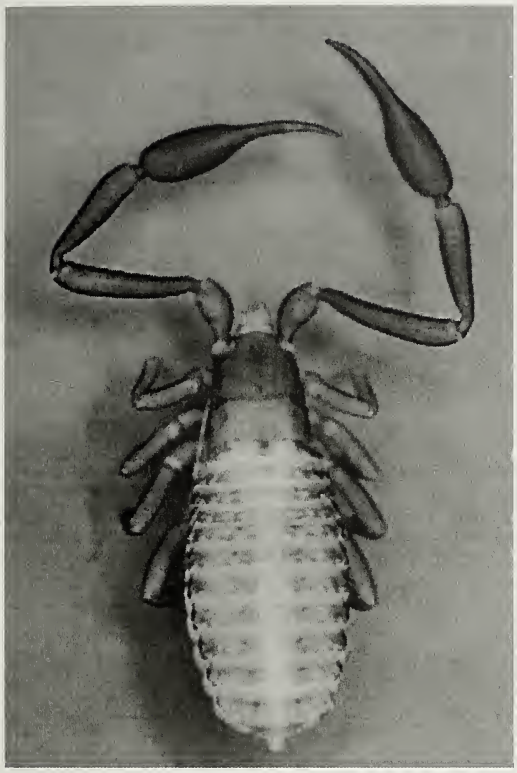
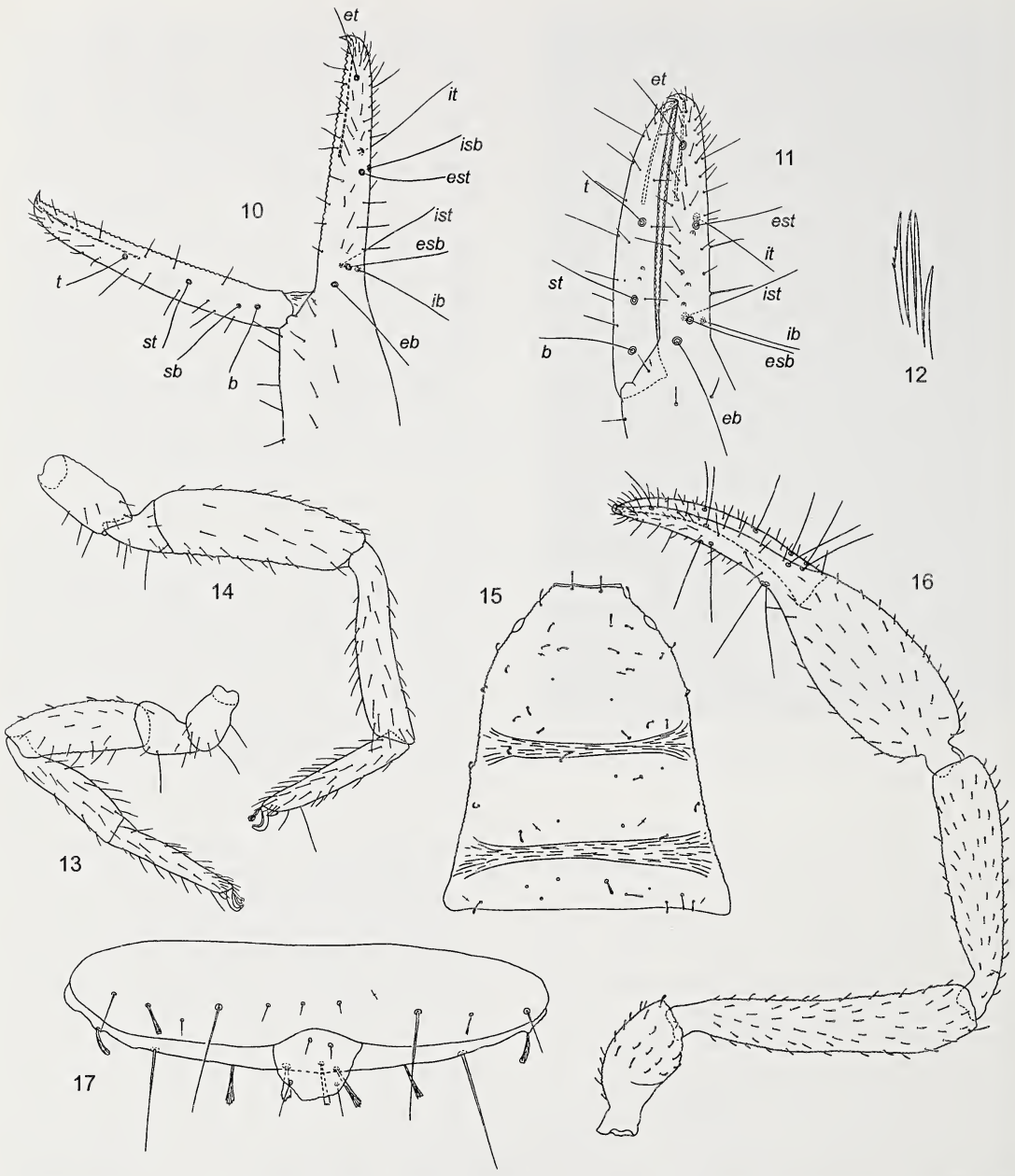


Figure 9.—*Cystowithius smithersi* new species, holotype male.

(♂), 3.71–4.00 (♀), hand 1.98–2.07 (♂), 1.74–1.95 (♀) times longer than broad, movable finger 1.04–1.15 (♂), 1.00–1.22 (♀) times longer than hand. Fixed chelal finger with 8 trichobothria, movable chelal finger with 4 trichobothria (Fig. 10): *eb* and *esb* situated basally; *est, it* and *isb* grouped together sub-medially; *ist* and *ib* situated basally; *b* and *sb* situated near one another; *st* mid-way between *sb* and *t*. Venom apparatus present in both chelal fingers, venom ducts long, terminating in nodus ramosus near *est* in fixed finger and near *t* in movable finger. Chelal teeth triangular, slightly retrorse; fixed finger with 42 (♂), 43 (♀) teeth; movable finger with 49 (♂), 52 (♀) teeth; accessory teeth absent. Chelicera: with 5 setae on hand, all acuminate; movable finger with 1 subdistal seta; galea with 3 small terminal rami; flagellum of 4 blades (Fig. 12); serrula exterior with 19 (♂, ♀) blades; lamina exterior present. Carapace (Fig. 15) 0.97–1.09 (♂), 1.13–1.32 (♀) times longer than broad; lateral margins evenly convex, but posteriorly widened; with 2 non-corneate eyes; with ca. 44 setae, including 4 near anterior margin and 10 near posterior margin; with 2 deep furrows, the posterior furrow slightly closer to posterior carapaceal margin than to median furrow. Tergites with distinct medial suture, sternites barely divided. Chaetotaxy of tergites I–XII: holotype ♂, 10: 9: 10: 13: 15: 15: 17: 18: 17: 13: 9 (including 2 tactile setae): 2; paratype ♀, 12: 10: 10: 17: 17: 16: 18: 18: 19: 16: 8: 2; mostly uniseriate but some tergites with a few setae placed anteriorly; all setae foliate. Chaetotaxy of sternites I–XII: holotype ♂, 13: (1)12(1): (2)12(2): 16: 19: 18[gls]: 16[gls]: 11[gls]: 9: 12: 2; paratype ♀, 15: (1)17(1): (2)12(2): 17: 20: 17[gls]: 17[gls]: 17[gls]: 14: 10: 2; sternites VII–IX with patches of glandular setae [gls], arranged ♂, ca. 75: 72: 60 respectively; ♀, 2: 2: 2, respectively; setae uniseriate and acuminate, except for lateral setae on sternite XI which are finely denticulate; glandular setae small and conical in shape; ♂ with paired invaginations on anterior margins of sternites V–VIII (Figs. 18, 19). Coxal chaetotaxy: paratype ♂, 10: 9: 10: 18; paratype ♀, 14: 13: 12: 22; pedipalpal coxa with 2 apical setae and very small suboral seta. Internal genitalia of male with lateral apodeme long and triangular (Fig. 21); of female with single oval median cribriform plate and 2 smaller lateral cribriform plates, and with poorly defined membranous spermathecal sac irregularly covered with pores; with 2 lateral hooked apodemes (Fig. 20). Legs (Figs. 13, 14): junction between femora and patellae I and II only slightly oblique; femur + patella of leg IV 3.80 (♂), 4.36 (♀) times longer than broad; tarsal tactile seta of leg IV situated subdistally, ca. 0.77 (♂), 0.75 (♀) of tarsus length; subterminal tarsal setae arcuate and acute; arolium slightly shorter than claws.

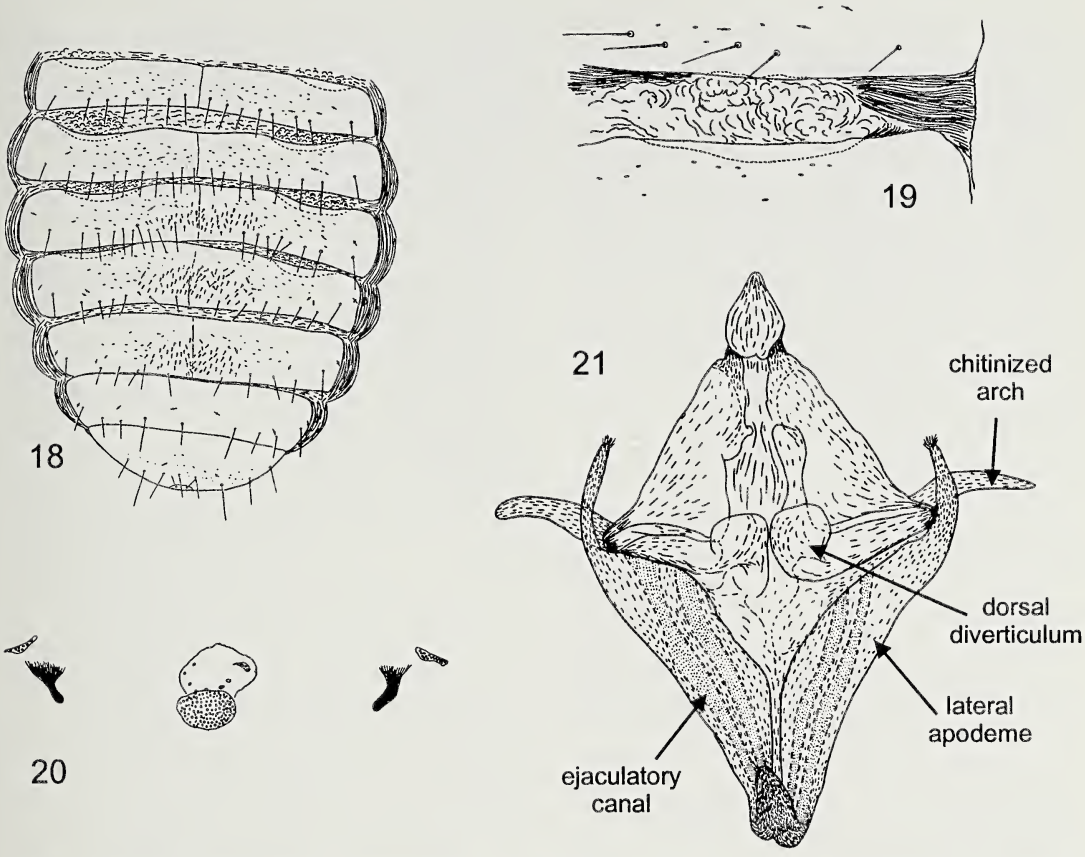
Dimensions (mm), males (females): Body length 2.40–2.75 (2.44–3.71). Pedipalps: trochanter 0.484–0.493/0.222–0.232 (0.464–0.515/0.224–0.246), femur 0.982–1.072/0.186–0.200 (0.925–1.104/0.193–0.215), patella 0.864–0.908/0.198–0.224 (0.789–0.960/0.206–0.229), chela (with pedicel) 1.392–1.440/0.307–0.340 (1.378–1.586/0.333–0.390), chela (without pedicel) 1.318–1.376 (1.306–1.517), hand length 0.634–0.672 (0.592–0.718), movable finger length 0.670–0.736 (0.656–0.776). Chelicera 0.250/0.128 (0.290/0.128), movable finger length 0.147 (0.197). Carapace 0.846–0.909/0.816–0.938 (0.845–0.944/0.640–0.832); eye diameter



Figures 10–17.—*Cystowithius smithersi* new species, paratype male unless stated otherwise: 10. Left chela, lateral; 11. Left chela, lateral, paratype tritonymph; 12. Flagellum; 13. Left leg I; 14. Left leg IV; 15. Carapace, dorsal, paratype female; 16. Right pedipalp, dorsal, paratype female; 17. Posterior abdominal segments, ventral, holotype male. Trichobothrial abbreviations follow Chamberlin (1931) and Harvey (1992).

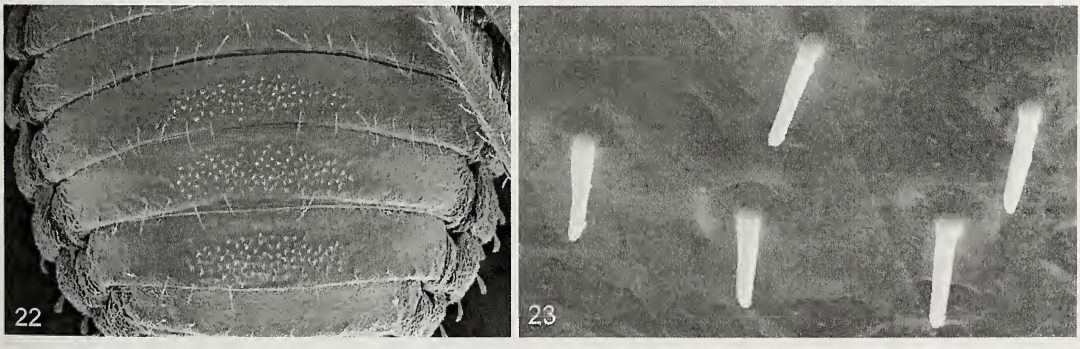
0.045–0.075 (0.045–0.076). Leg I: femur 0.192/0.154 (0.192/0.160), patella 0.445/0.159 (0.442/0.143), tibia 0.454/0.109 (0.454/0.103), tarsus 0.401/0.074 (0.435/0.074). Leg IV: femur + patella 0.802/0.211 (0.880/0.202), tibia 0.653/0.125 (0.706/0.122), tarsus 0.481/0.087 (0.557/0.083), TS 0.371 (0.416).

Tritonymphs: Color paler than adults. Pedipalp: trochanter 2.10, femur 4.47, patella 3.36, chela (with pedicel) 4.06, chela (without

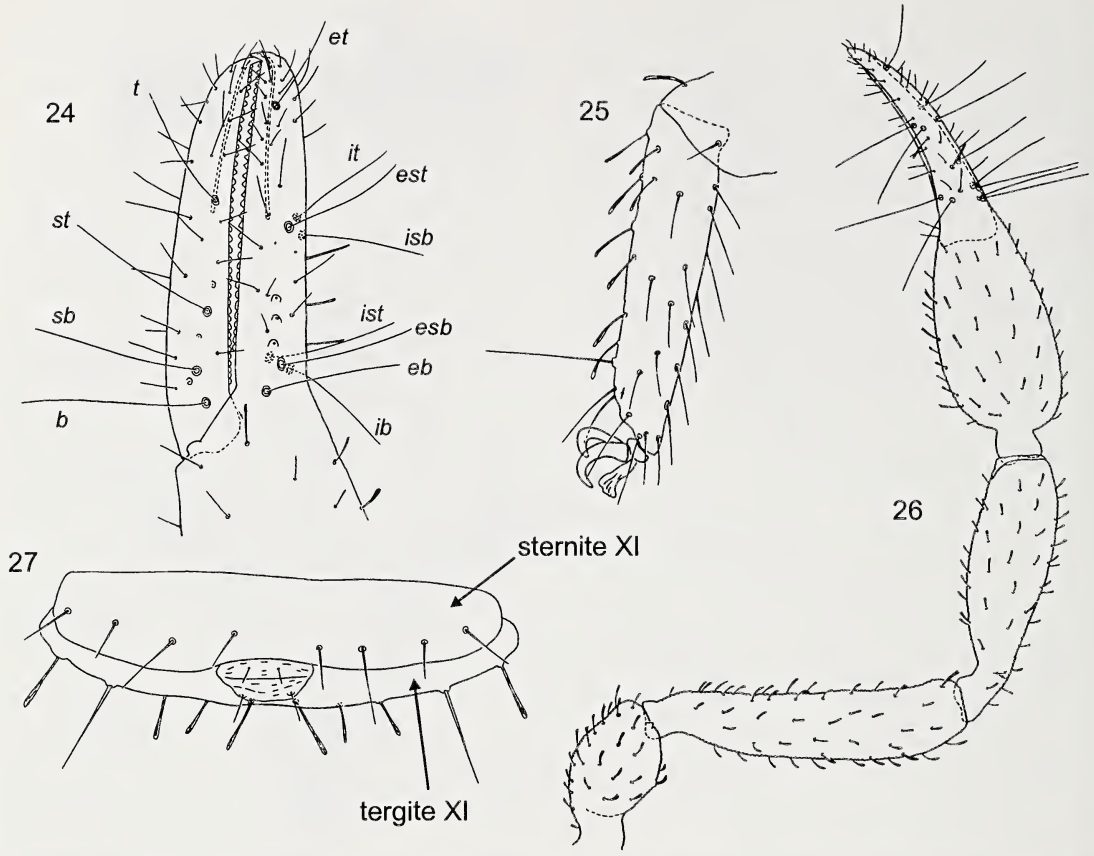


Figures 18–21.—*Cystowithius smithersi* new species, paratype male unless stated otherwise: 18. Posterior sternites, ventral; 19. Detail of invagination from left sternite VI; 20. Female genitalia, ventral, paratype female; 21. Male genitalia, dorsal.

pedicel) 3.83, hand 1.88 times longer than broad. Fixed chelal finger with 7 trichobothria, movable chelal finger with 3 trichobothria (Fig. 11): *isb* and *sb* absent. Carapace 1.08 times longer than broad; with 2 non-corneate eyes; with ca. 45 setae, including 4 near anterior margin and 7 near posterior margin; with 2 furrows, the posterior furrow slightly closer to posterior carapaceal margin than to median furrow. Chaetotaxy of tergites I-XII: 6: 6: 9: 9: 10: 10: 10: 10: 8: 7: 8: 2. Chaetotaxy of sternites I–XII: 4: (1)9(1): (2)7(2):



Figures 22–23.—*Cystowithius smithersi* new species, paratype male, scanning electron micrographs: 22. Posterior sternites, ventral; 23. Detail of glandular setae.



Figures 24–27.—*Cystowithius ecuadoricus* (Beier), lectotype male unless stated otherwise: 24. Left chela, lateral; 25. Left tarsus IV; 26. Right pedipalp, dorsal; 27. Posterior abdominal segments, ventral, paralectotype male. Trichobothrial abbreviations follow Chamberlin (1931) and Harvey (1992).

12: 11: 9: 10[gls]: 9[gls]: 8: 8 (including 2 tactile setae): 2; sternites VIII-IX each with 2 glandular setae [gls].

Dimensions (mm): Body length 2.54. Pedipalps: trochanter 0.384/0.183, femur 0.710/0.176, patella 0.592/0.176, chela (with pedicel) 1.120/0.276, chela (without pedicel) 1.058, hand length 0.518, movable finger length 0.550. Carapace 0.691/0.640.

Remarks.—*Cystowithius smithersi* occurs at a single locality in northern Ecuador where it was found among the leaf sheaths of the giant rosette plant *Espeletia pycnophylla* (Compositae). Smithers et al. (2001) found the giant rosette plant to harbor a wide variety of invertebrates that rely upon the peculiar leaf sheath microhabitat for permanent or temporary shelter. The leaf sheaths on the stems of these tall composites do not fall off when they die, but remain adhered to the stem to form a series of compact layers that insulate the plant from the very low nocturnal temperatures that occur in the area. The invertebrate communities in a population of *E. pycnophylla* was found to be dominated by Araneae, Coleoptera, larval Lepidoptera, Diptera, Hymenoptera and Pseudoscorpiones. The pseudoscorpions represented 9.9% of the day-time samples and 9.5% of the night-time samples, and were found to be more abundant in the central sections of the leaf sheath (Smithers et al. 2001).

Cystowithius ecuadoricus (Beier 1959)
NEW COMBINATION, NEW STATUS
Figs. 7, 8, 24–27

Parawithius (*Parawithius*) *nobilis ecuadoricus* Beier 1959: 217–218, fig. 26; Harvey 1991: 651.

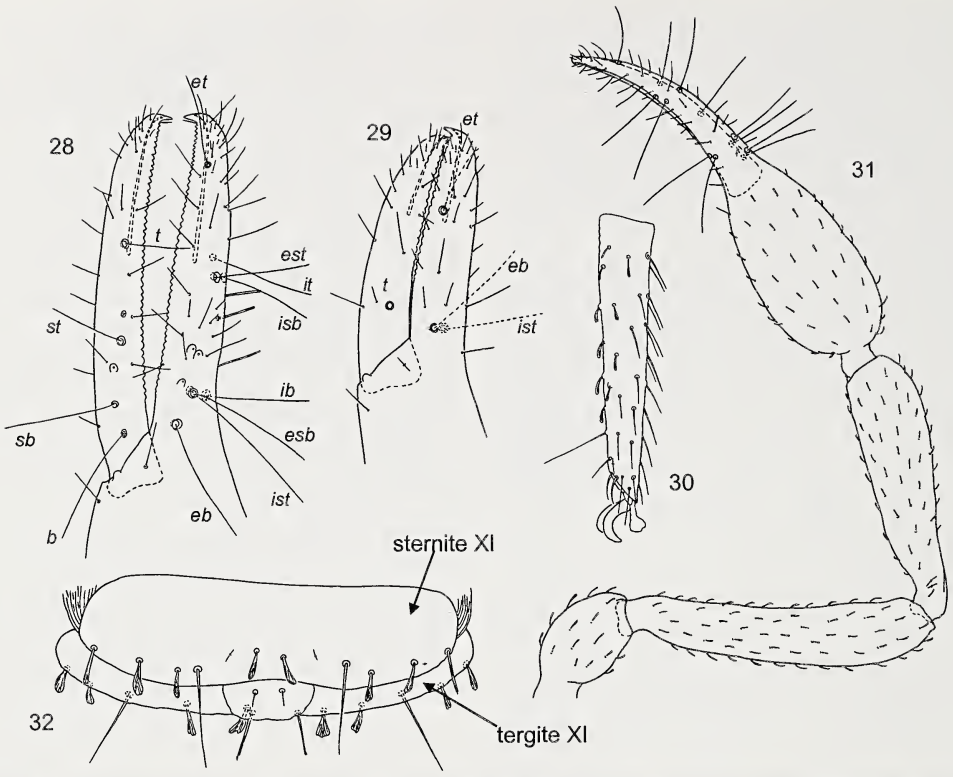
Material examined.—Lectotype male (present designation), Lago Zurucuchu, 11 miles W. of Cuenca, *Azuay Province,* ECUADOR [2°53′S, 78°59′W], 16 February

1955, E.I. Schlinger and E.S. Ross (CAS, Type No. 8691). Paralectotypes: ECUADOR: *Azuay Province:* 1 male, 2 females, same data as lectotype (CAS); 1 male, 1 female, same data (NHMW). PERU: *La Libertad:* 1 female, Huamachuco [7°48′S, 78°04′W], 3,200 m, 18 September 1955, unter Stein [under stone], Weyrauch (NHMW).

Diagnosis.—*Cystowithius ecuadoricus* is most similar to *C. colombicus* as both lack the smooth chelal hand found in *C. chamberlini*, and are slightly smaller than *C. smithersi* [e.g. chela (with pedicel) less than 1.20 mm in length (Fig. 8)]. *Cystowithius ecuadoricus* differs from *C. colombicus* in the possession of long, strongly denticulate setae on the chelal hand, and the long, weakly clavate setae on tergite XI and sternite XI.

Description.—*Adults:* Color dark red-brown; carapaceal metazone with paired pale spots. Pedipalp (Fig. 26): all segments granulate, except for chelal fingers, which are smooth; dorsal setae generally strongly foliate; trochanter 1.81–2.04 (♂), 1.78–1.98 (♀), femur 4.47–4.74 (♂), 4.19–4.47 (♀), patella 3.18–3.47 (♂), 3.06–3.35 (♀), chela (with pedicel) 3.65–4.01 (♂), 3.44–3.72 (♀), chela (without pedicel) 3.43–3.78 (♂), 3.29–3.53 (♀), hand 1.74–1.96 (♂), 1.61–1.71 (♀) times longer than broad, movable finger 0.86–1.11 (♂), 0.90–1.13 (♀) times longer than hand. Fixed chelal finger with 8 trichobothria, movable chelal finger with 4 trichobothria (Fig. 24): *eb* and *esb* situated basally; *est, it* and *isb* grouped together sub-medially; *ist* and *ib* situated basally; *b* and *sb* situated near one another; *st* slightly closer to *sb* than to *t*. Venom apparatus present in both chelal fingers, venom ducts long, terminating in nodus ramosus near *est* in fixed finger and near *t* in movable finger. External margin of fixed finger with three sense-spots situated linearly between *esb* and *est*; external margin of movable finger with three sense-spots, one situated slightly basal to *sb*, another between *sb* and *st*, and the other slightly anterior to *st*. Chelal teeth strongly triangular, slightly retrorse, becoming rounded basally; fixed finger with 34 (♂), 36 (♀) teeth; movable finger with 39 (♂), 40 (♀) teeth; accessory teeth absent. Chelicera: with 5 setae on hand, *bs* and *sbs* dentate; movable finger with 1 submedial seta; galea short with 2 or 3 small terminal rami; flagellum of 4 blades; serrula exterior with 18 blades (♂, ♀); lamina exterior present. Carapace 1.00–1.28 (♂), 1.10–1.28 (♀) times longer than broad; lateral margins evenly convex, but posteriorly widened; with 2 non-corneate eyes; with ca. 50 (♂), 54 (♀) setae, including 4 near anterior margin and 6 near posterior margin; with 2 deep furrows, the posterior furrow slightly closer to posterior carapaceal margin than to median furrow. Tergites with distinct medial suture, sternites faintly divided. Chaetotaxy of tergites I-XII: ♂, 7: 8: 9: 10: 10: 11: 12: 12: 11: 12: 11 (including 2 tactile setae): 2; ♀, 9: 10: 9: 10: 13: 13: 14: 14: 13: 12: 8 (including 2 tactile setae): 2; mostly uniseriate but some tergites with a few setae placed anteriorly; all setae foliate. Chaetotaxy of sternites I-XII: ♂, 13: (1)10(1): (2)13(2): 19: 21: 16[gls]: 10[gls]: 10[gls]: 8[gls]: 8 (including 2 tactile setae): 2; ♀, 13: (1)12(1): (2)13(2): 14: 17: 18: 16[gls]: 13[gls]: 10: 8 (including 2 tactile setae): 2; sternites VI–IX of ♂ with patches of glandular setae [gls], arranged 6: 42: 10: 8 (lectotype) respectively; sternites VII-VIII of ♀ with glandular setae [gls], arranged 2: 2 respectively; setae uniseriate and acuminate, except for smaller setae on sternite XI which are lightly denticulate; glandular setae small and conical in shape; ♂ with paired invaginations on anterior margins of sternites V-VIII. Coxal chaetotaxy: ♂, 10: 9: 13: 15, ♀, 10: 11: 10: 18; pedipalpal coxa with 2 apical setae and very small sub-oral seta. Internal genitalia not observed in detail, but apparently very similar to that of *C. smithersi*. Legs: junction between femora and patellae I and II only slightly oblique; femur + patella of leg IV 2.93 (♂), 3.04 (♀) times longer than broad; tarsal tactile seta of leg IV situated sub-distally (Fig. 25), 0.74–0.75 of tarsus length; subterminal tarsal setae arcuate and acute; arolium slightly shorter than claws.

Dimensions (mm), males (females): Body length 2.16–2.29 (2.06–2.93). Pedipalps: trochanter 0.384–0.403/0.198–0.212 (0.384–0.410/0.194–0.230), femur 0.797–0.816/0.168–0.179 (0.750–0.410/0.173–0.191), patella 0.674–0.688/0.195–0.212 (0.637–0.707/0.199–0.224), chela (with pedicel) 1.085–1.144/0.276–0.297 (1.107–1.198/0.311–0.345), chela (without pedicel) 1.018–1.106 (1.046–1.136), hand length 0.502–0.575 (0.501–0.589), movable finger length 0.497–0.558 (0.528–0.595). Chelicera 0.205/0.109 (0.226/0.128), movable finger length 0.148



Figures 28–32.—*Cystowithius colombicus* new species, holotype male, unless stated otherwise: 28. Left chela, lateral; 29. Left chela, lateral, paratype protonymph; 30. Right pedipalp, dorsal; 31. Left tarsus IV; 32. Posterior abdominal segments. Trichobothrial abbreviations follow Chamberlin (1931) and Harvey (1992).

(0.144). Carapace 0.749–0.800/0.624 (0.784–0.861/0.632–0.760) (width at medial area); eye diameter 0.070 (0.075–0.080). Leg I: femur 0.154/0.160 (0.162/0.155), patella 0.275/0.150 (0.328/0.145), tibia 0.338/0.098 (0.319/0.095), tarsus 0.304/0.067 (0.287/0.110). Leg IV: femur + patella 0.600/0.205 (0.608/0.200), tibia 0.485/0.116 (0.479/0.111), tarsus 0.346/0.074 (0.347/0.073), TS 0.256 (0.259).

Remarks.—Beier (1959) apparently overlooked the sternal invaginations on the male specimens of *P. nobilis ecuadoricus* and simply described the taxon as a subspecies of the somewhat similar looking *P. nobilis*. Despite the superficial resemblances between the two forms it is clear that they not only differ at the species level but also at the generic level due to the lack of sternal invaginations in *P. nobilis*. In his original publication, Beier (1959) did not select a primary type specimen from the original syntype series and merely listed six adults from Lago Zurucuchu as "typen" and a further female from Huamachuco as "paratype". I hereby select a male from the type locality as the lectotype. *Cystowithius ecuadoricus* is known from high elevation localities in Ecuador and Peru.

Cystowithius colombicus new species
Figs. 7, 8, 28–32

Material examined.—Holotype male, Paramo de Monserrate [7 km NE of Bogotá, 4°37′N, 74°04′W], *Cundinamarca*, COLOMBIA, 3,200–3,300 m, [H.] Stürm (NHMW). Paratypes: COLOMBIA: *Cundinamarca*: 1 female, same data as holotype (NHMW); 3 males, 1 female, 2 protonymphs, Paramo de Monserrate [7 km NE of Bogotá, 4°37′N, 74°04′W], 3,200 m, 1968, [H.] Stürm (NHMW); 1 male, same data (WAM T54607).

Etymology.—The specific epithet is an adjective derived from the country in which the specimens occur.

Diagnosis.—*Cystowithius colombicus* most closely resembles *C. ecuadoricus*, as both lack the smooth chelal hand found in *C. chamber-*

lini and are slightly smaller than *C. smithersi* [e.g. chela (with pedicel) less than 1.20 mm in length (Fig. 8)]. *Cystowithius colombicus* differs from *C. ecuadoricus* in the lack of long, strongly denticulate setae on the chelal hand (Fig. 31), and the long, strongly clavate setae on tergite XI and sternite XI (Fig. 32).

Description.—*Adults:* Color dark red-brown; carapaceal metazone with paired pale spots. Pedipalp (Fig. 31): all segments granulate, except for chelal fingers, which are smooth; dorsal setae generally strongly foliate; trochanter 1.89–2.10 (♂), 1.93 (♀), femur 4.78–5.25 (♂), 4.99–5.37 (♀), patella 3.88–4.46 (♂), 3.70–4.31 (♀), chela (with pedicel) 3.80–4.04 (♂), 3.24–3.63 (♀), chela (without pedicel) 3.60–3.81 (♂), 3.22–3.43 (♀), hand 1.63–1.97 (♂), 1.67–1.84 (♀) times longer than broad, movable finger 0.90–1.24 (♂), 0.90–0.92 (♀) times longer than hand. Fixed chelal finger with 8 trichobothria, movable chelal finger with 4 trichobothria (Fig. 28): *eb* and *esb* situated basally; *est, it* and *isb* grouped together sub-medially; *ist* and *ib* situated basally; *b* and *sb* situated near one another; *st* slightly closer to *sb* than to *t*. Venom apparatus present in both chelal fingers, venom ducts long, terminating in nodus ramosus near *est* in fixed finger and near *t* in movable finger. External margin of fixed finger with three sense-spots situated between *esb* and *est*; external margin of movable finger with one sense-spot situated between *sb* and *st*; external margin of movable finger also with peculiar small structure slightly anterior to *st* that contains three small nubbins. Chelal teeth strongly triangular, slightly retrorse, becoming rounded basally; fixed finger with 42 (♂), 44 (♀) teeth; movable finger with 42 (♂), 47 (♀) teeth; accessory teeth absent. Chelicera: with 5 setae on hand, *bs* and *sbs* dentate; movable finger with 1 submedial seta; galea short with 3 or 4 small terminal rami; flagellum of 4 blades; serrula exterior with 17 (♂, ♀) blades; lamina exterior present. Carapace 1.43 (♂), 1.29 (♀) times longer than broad; lateral margins evenly convex, but posteriorly widened; with 2 non-corneate eyes; with ca. 58 (♂), 61 (♀) setae, including 4 near anterior margin and 6 near posterior margin; with 2 deep furrows, the posterior furrow slightly closer to posterior carapaceal margin than to median furrow. Tergites with distinct medial suture, sternites faintly divided. Chaetotaxy of tergites I-XII: ♂, 6: 7: 9: 10: 13: 14: 14: 15: 16: 13: 12 (including 2 tactile setae): 2; ♀, 8: 8: 9: 13: 16: 16: 16: 17: 15: 16: 12 (including 2 tactile setae): 2; mostly uniseriate but some tergites with a few setae placed anteriorly; all setae strongly foliate. Chaetotaxy of sternites I-XII: ♂, 8: (1)10(1): (2)10(2): 12: 11: 12[gls]: 10[gls]: 10[gls]: 8[gls]: 10 (including 2 tactile setae): 2; ♀, 14: (1)10(1): (2)10(2): 13: 13: 13: 14[gls]: 13[gls]: 9: 12 (including 2 tactile setae): 2; sternites VII–IX of ♂ with patches of glandular setae [gls], arranged ca. 20: 27: 13 respectively; sternites VIII–IX of ♀ with glandular setae [gls], arranged 2: 2 respectively; setae uniseriate and acuminate, except for smaller setae on sternite XI which are strongly denticulate (Fig. 32); glandular setae small and conical in shape; ♂ with paired invaginations on anterior margins of sternites VI-VII. Coxal chaetotaxy: ♂, 10: 11: 9: 17, ♀, 10: 9: 11: 20; pedipalpal coxa with 2 apical setae and very small sub-oral seta. Internal genitalia not observed in detail, but apparently very similar to that of *C. smithersi*. Legs: junction between femora and patellae I and II only slightly oblique; femur + patella of leg IV 4.06 (♂), 4.00 (♀) times longer than broad; tarsal tactile seta of leg IV situated sub-distally (Fig. 30), 0.77 (♂), 0.79 (♀) of tarsus length; subterminal tarsal setae arcuate and acute; arolium slightly shorter than claws.

Dimensions (mm), males (females): Body length 2.00–2.11 (2.42). Pedipalps: trochanter 0.398–0.432/0.198–0.218 (0.422/0.219), femur 0.870–0.965/0.166–0.202 (0.880–0.944/0.164–0.189), patella 0.768–0.883/0.186–0.206 (0.750–0.800/0.174–0.216), chela (with pedicel) 1.120–1.260/0.277–0.332 (1.048–1.202/0.289–0.371), chela (without pedicel) 1.056–1.195 (0.992–1.196), hand length 0.498–0.600 (0.531–0.621), movable finger length 0.493–0.606 (0.480–0.570). Chelicera 0.221/0.109 (0.262/0.129), movable finger length 0.166 (0.160). Carapace 0.736/0.515 (0.840/0.650) (width at medial area); eye diameter 0.038 (0.083). Leg I: femur 0.173/0.138 (0.191/0.139), patella 0.360/0.135 (0.395/0.146), tibia 0.358/0.093 (0.381/0.097), tarsus 0.338/0.064 (0.358/0.075). Leg IV: femur + patella 0.674/0.166 (0.768/0.192), tibia 0.538/0.105 (0.604/0.122), tarsus 0.406/0.072 (0.461/0.090), TS 0.311 (0.365).

Protonymphs: Color very pale yellow-brown. Pedipalp: trochanter 1.75 femur 3.05,

patella 3.24, chela (with pedicel) 3.72, chela (without pedicel) 3.55, hand 1.78 times longer than broad. Fixed chelal finger with 3 trichobothria, movable chelal finger with 1 trichobothrium (Fig. 29): *eb, et, ist,* and *t* present; *et* sub-distal, *eb, ist* and *t* sub-basal. Carapace 1.00 times longer than broad; with 2 small non-corneate eyes; with 16 setae, including 4 near anterior margin and 4 near posterior margin; with 1 shallow furrow, situated near posterior carapaceal margin. Tergal and sternal chaetotaxy indeterminate due to poor preservation of specimens.

Dimensions (mm): Body length 0.82. Pedipalps: trochanter 0.198/0.113, femur 0.336/0.110, patella 0.269/0.083, chela (with pedicel) 0.548/0.083, chela (without pedicel) 0.523, hand length 0.261, movable finger length 0.258. Carapace 0.390/0.390.

Remarks.—*Cystowithius colombicus* is known from a single high altitude locality in Colombia, and the type specimens are labelled "Paramo Monserrate" or "Paramo de Monserrate". As indicated by Cooke (1972), the locality Cerro Monserrate is situated on the outskirts of Bogotá and is dominated by páramo, a high elevation habitat type that is found above the continuous forest line and below the perpetual snow line. The specimens were labeled by M. Beier as the types of a new species, but this name remains unpublished.

The movable chelal finger of *C. colombicus* bears a small pore slightly anterior to trichobothrium *st* that has three small nubbins situated within it.

Cystowithius chamberlini new species
Figs. 7, 8, 33–36

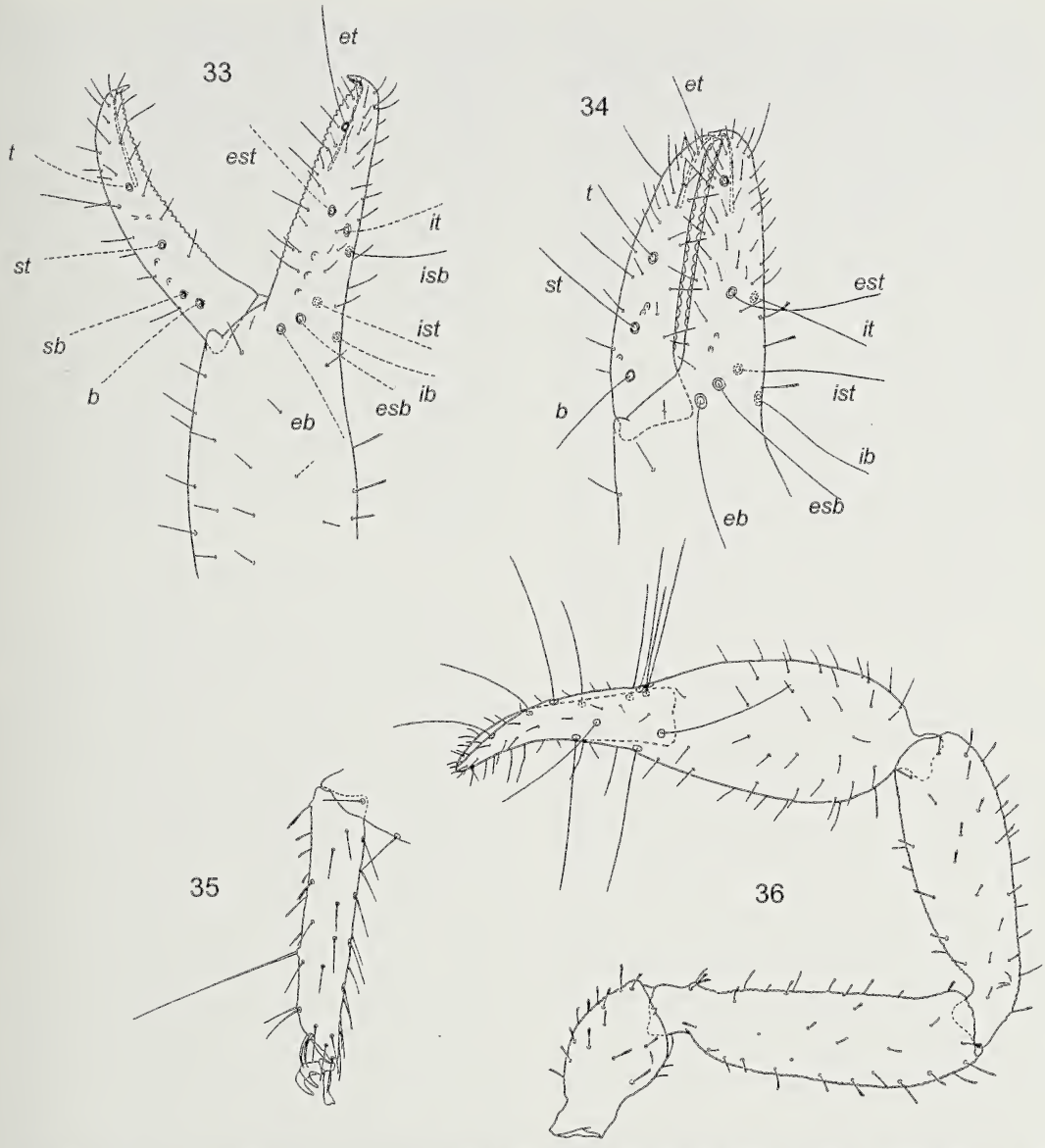
Material examined.—Holotype male, Matlalpan (see Remarks), *San Luis Potosí,* MEXICO, 5 April 1942, bosque, bajo cortezas (forest, under bark), F. Bonet (CAS, JC-1918.01001). Paratypes: MEXICO: *San Luis Potosí*: 5 males, 2 tritonymphs, same data as holotype (CAS, JC-1918.01002–7, 2 males on slides, remainder in ethanol); *Morelos*: 1 male, 1 female, Oaxtepec [18°54′N, 98°58′W], 24 August 1941, terreno cultivado, tronco podrido (cultivated land, rotten trunk), J. Alvarez (CAS, JC-1897.01001–2); *Michoacan*: 1 male, Pátzcuaro [19°31′N, 101°36′W], 1 September 1941, terrens cultivado, hierbas podridas (cultivated land, rotten herbs), T. Alvarez (CAS, JC-1780.01001).

Other material: GUATEMALA: 1 ♂, no other data, other than 'ex orchids' (UCD).

Etymology.—The specific name honors Joseph C. Chamberlin (1898–1962) who first recognized this peculiar genus of pseudoscorpion.

Diagnosis.—*Cystowithius chamberlini* differs from other *Cystowithius* species in the possession of a smooth chelal hand.

Description.—*Adults:* Color red-brown; carapaceal metazone with small paired pale spots; tergites with median section pale forming a longitudinal line along length of body. Pedipalp (Fig. 36): all segments granulate, except for chela which is smooth; setae generally strongly foliate, except for setae on chelal hand which are only long and slightly denticulate; trochanter 1.69–2.02 (♂), 1.96 (♀), femur 3.55–3.91 (♂), 3.62 (♀), patella 2.72–3.30 (♂), 3.30 (♀), chela (with pedicel) 3.30–3.51 (♂), 3.28 (♀), chela (without pedicel) 3.13–3.28 (♂), 3.10 (♀), hand 1.62–1.79 (♂), 1.68 (♀) times longer than broad, movable finger 0.86–1.00 (♂), 0.87 (♀) times longer than hand. Fixed chelal finger with 8 trichobothria, movable chelal finger with 4 trichobothria (Fig. 33): *eb* and *esb* situated basally; *est, it* and *isb* grouped together sub-medially; *ist* and *ib* situated basally; *b* and *sb* situated near one another; *st* slightly closer to *sb* than to *t*. Venom apparatus present in both chelal fingers, venom ducts long, terminating in nodus ramosus mid-way between *est* and *et* in fixed finger and near *t* in movable finger. Chelal teeth triangular, slightly retrorse and contiguous; fixed finger with? (♂), 36 (♀) teeth; movable finger with? (♂), 37 (♀) teeth; accessory teeth absent. Chelicera: with 5 setae on hand, *bs* and *sbs* dentate; movable finger with 1 subdistal seta; galea long with 3 or 4 small terminal rami; flagellum of 4 blades, the most distal blade with several serrations on leading edge, other blades smooth; serrula exterior with 17 (♂), 16 (♀) blades; lamina exterior present. Carapace 0.98–1.25 (♂), 1.19 (♀) times longer than broad; lateral margins evenly convex, but posteriorly widened; with 2 non-corneate eyes; with ca. 51 (♂), 44 (♀) setae, including 4 near anterior margin and 6 near posterior margin; with 2 deep furrows, the posterior furrow slightly closer to posterior carapaceal margin than to median furrow.



Figures 33–36.—*Cystowithius chamberlini* new species, holotype male unless stated otherwise: 33. Left chela, lateral; 34. Left chela, lateral, paratype tritonymph; 35. Right tarsus IV; 36. Right pedipalp, dorsal. Trichobothrial abbreviations follow Chamberlin (1931) and Harvey (1992).

Tergites I–X with medial suture, sternites IV–X with faint medial suture. Chaetotaxy of tergites I–XII: male holotype, 6: 7: 8: 10: 10: 11: 9: 10: 10: 10: 12 (including 2 tactile setae): 2; ♀ paratype, 8: 10: 11: 14: 15: 14: 14: 14: 15: 15: 10 (including 2 tactile setae): 2. mostly uniseriate but some tergites with a few setae placed anteriorly; all setae except tactile setae foliate. Chaetotaxy of sternites I–XII: male holotype, 9: (1)10(0): (2)12(2): 18: 19: 10[gls]: 9[gls]: 11[gls]: 10[gls] (including 2 tactile setae): 10 (including 4 tactile setae): 2; female paratype, 12: (1)10(1): (2)12(2): 18: 17: 14: 17: 18: 11 (including 2 tactile setae): 12 (including 4 tactile setae): 2; sternites VI–IX of ♂ with patches of glandular setae [gls], arranged 58: ca. 100: 83: 51, respectively; sternite VIII–IX of ♀ with glandular setae [gls] arranged 2: 2; all setae uniseriate and acuminate, except for smaller setae on sternite XI which are denticulate; glandular setae small and conical in shape; ♂ with paired in-

vaginations on anterior margins of sternites VI-VIII. Coxal chaetotaxy: male holotype, 10: 9: 12: 24; female paratype 9: 10: 8: 17; pedipalpal coxa with 2 apical setae and very small sub-oral seta. Internal genitalia of male similar to that of *C. smithersi*; of female with single oval median cribriform plate and 2 smaller lateral cribriform plates, and with poorly defined membranous spermathecal sac irregularly covered with pores; with 2 lateral hooked apodemes. Legs: junction between femora and patellae I and II only slightly oblique; femur + patella of leg IV 2.74 (♂), 3.02 (♀) times longer than broad; tarsal tactile seta of leg IV situated sub-distally (Fig. 35), ca. 0.61 (♂), 0.59 (♀) of tarsus length; subterminal tarsal setae arcuate and acute; arolium slightly shorter than claws.

Dimensions (mm), males (females): Body length ca. 2.20 (ca. 2.53). Pedipalps: trochanter 0.344–0.402/0.179–0.225 (0.357/0.182), femur 0.660–0.782/0.179–0.208 (0.674/0.186), patella 0.610–0.736/0.205–0.224 (0.656/0.199), chela (with pedicel) 0.964–1.141/0.275–0.333 (1.030/0.314), chela (without pedicel) 0.902–1.076 (0.974), hand length 0.488–0.566 (0.528), movable finger length 0.422–0.541 (0.458). Chelicera ? (?), movable finger length ? (?). Carapace 0.698–0.768/0.560–0.712 (0.728/0.612) (width at medial area); eye diameter 0.040–0.051 (0.048). Leg I: femur 0.163/0.144 (0.163/0.141), patella 0.352/0.137 (0.341/0.138), tibia 0.354/0.088 (0.324/0.085), tarsus 0.318/0.060 (0.326/0.065). Leg IV: femur + patella 0.621/0.227 (0.640/0.212), tibia 0.506/0.122 (0.496/0.149), tarsus 0.384/0.074 (0.519/0.077), TS 0.234 (0.232).

Tritonymphs: Color paler than adults. Pedipalp: trochanter 1.85, femur 3.15, patella 2.89, chela (with pedicel) 3.75, chela (without pedicel) 3.49, hand 2.04 times longer than broad. Fixed chelal finger with 7 trichobothria, movable chelal finger with 3 trichobothria (Fig. 34): *isb* and *sb* absent. Carapace 0.96 times longer than broad; with 2 non-corneate eyes; with ca. 51 setae, including 4 near anterior margin and 6 near posterior margin; with 2 furrows, the posterior furrow slightly closer to posterior carapaceal margin than to median furrow. Chaetotaxy of tergites I–XII: 6: 6: 8: 9: 9: 10: 10: 10: 10: 10: 8 (including 2 tactile setae): 2. Chaetotaxy of sternites I–XII: 3: (1)8(1): (2)7(2): 11: 9: 10: 11[gls]: 12[gls]: 10 (including 2 tactile setae): 12 (including 4 tactile setae): 2; sternites VIII-IX each with 2 glandular setae [gls].

Dimensions (mm): Body length 1.76. Pedipalps: trochanter 0.243/0.131, femur 0.438/0.139, patella 0.445/0.154, chela (with pedicel) 0.739/0.197, chela (without pedicel) 0.688, hand length 0.402, movable finger length 0.342. Carapace 0.576/0.600.

Remarks.—*Cystowithius chamberlini* has been found in central and southern Mexico, as well as in Guatemala, where collection data indicates that it occurs 'under bark' and 'ex orchids'. I was unable to locate the locality 'Matlalpan' and the possibility exists that J.C. Chamberlin incorrectly transcribed the locality data after he received the specimens from F. Bonet.

DISCUSSION

Members of the family Withiidae have a number of defining features, the most obvious being the presence of patches of glandular setae on some sternites of the males, and occasionally, of females and nymphs. However there are three genera currently attributed to the family that lack such setae: *Protowithius* Beier 1955, *Juxtachelifer* Hoff 1956 and *Termitowithius* Muchmore 1990. *Juxtachelifer* was originally named by Hoff (1956) for the North American species *J. fructuosus* Hoff 1956 and placed in its own tribe (Juxtacheliferini) within the Cheliferidae. Muchmore (1990a) transferred the genus to the Withiidae as it shared with other withiids the perpendicular suture line between femur and patella I; all other cheliferoids (Cheliferidae, Chernetidae and Atemnidae) possess a strongly oblique suture line (Harvey 1992). I have examined several male and female paratypes of *J. fructuosus* (lodged in AMNH) and while the general morphology of the species is strongly reminiscent of other withiids, the morphology of the male genitalia has features that appear to be shared with some cheliferids as intimated by Hoff (1956). Just one year prior to the description of *Juxtachelifer*, Beier (1955) named *Protowithius* from the Juan Fernandez Islands which he placed in the Protowithiini. Like *Juxtachelifer*, males of both species lacked the glandular setae characteristic of other withiids. A close relationship between *Juxtachelifer* and *Protowithius* has yet to be established but there are certain similarities

between the two genera that may indicate that they belong to their own clade. The third withiid that is known to lack male sternal glandular setae is *Termitowithius* from Tanzania. Muchmore (1990b) discussed the peculiar features of this genus. The polarity of the acquisition of the glandular setae will have ramifications for the phylogeny and classification of the Withiidae. If the absence of glandular setae is treated as plesiomorphic, then these three genera may lie outside the remainder of the family. In this case, *Protowithius*, *Juxtachelifer* and *Termitowithius* are not grouped into a monophyletic group, but the remaining withiid genera form a clade for which the name Withiinae would be used. If the absence of glandular setae is treated as an apomorphy then these three genera may be deemed to form a clade (for which the name Protowithiini is the oldest) within the Withiidae if it can be shown that the glandular setae have been lost just once. If the losses are deemed to be independent of each other, then an alternative classification will be required. In addition, there seems to be little support for either of the two withiid subfamilies currently recognized, Withiinae and Paragoniochernetinae, although the unusual morphology of the posterior carapacal margin of the Paragoniochernetinae (containing the African genera *Cyrtowithius* Beier 1955, *Ectromachernes* Beier 1944, *Paragoniochernes* Beier 1932, *Pseudatemnus* Beier 1947 and *Pseudochernes* Beier 1954) seems to suggest that this small subfamily of just 10 species may be monophyletic. The monophyly of the Withiinae remains to be proven and the status of many of the 31 genera that have been attributed to the group is uncertain. In this paper I have attempted to clarify the status of the New World genus *Parawithius* by redescribing the type species *P. nobilis*, by returning *Victorwithius* to full generic level and naming a distinctive new genus, *Cystowithius*. While it may seem imprudent to add yet another genus to the Withiidae, the peculiar and highly autapomorphic sternal invaginations found in the four species of *Cystowithius* suggests that the group is unequivocally monophyletic. Nevertheless, the relationships of the genus are presently difficult to ascertain, as the generic composition and interrelationships of the Withiidae is still uncertain.

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REVISION OF THE NEARCTIC SPIDER GENUS *CALYMMARIA* (ARANEAE, HAHNIIDAE)

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ABSTRACT. Thirty-one species of *Calymmaria* are described or redescribed and illustrated. Twenty-two species are described as new: *Calymmaria alleni*, *C. bifurcata*, *C. carmel*, *C. farallon*, *C. gertschi*, *C. humboldt*, *C. iviei*, *C. minuta*, *C. monterey*, *C. orick*, *C. rosario*, *C. rothi*, *C. scotia*, *C. sequoia*, *C. sierra*, *C. similaria*, *C. siskiyou*, *C. sueni*, *C. tecate*, *C. tubera*, *C. virginica* and *C. yolandae*. A key to all thirty-one species is provided. *Calymmaria quadrata* (Exline 1938) is synonymized with *C. emertoni* (Simon 1897), and *C. cavicola* (Banks 1896) and *C. montavencis* (Bishop & Crosby 1926) are synonymized with *C. persica* (Hentz 1847). *Tegenaria modesta* Banks 1898 and the replacement name *T. modestella* Roewer 1944 are treated as *nomina dubia*. The male palpus of *C. lora* (Chamberlin & Ivie 1942) and *C. emertoni* (Simon) are illustrated for the first time along with the internal structure of the female epigynum of *C. californica* (Banks 1896) and *C. shastae* (Chamberlin & Ivie 1937). Information is provided on habitat and web structure in the genus. A cladogram of the species of *Calymmaria* is presented based on a cladistic analysis of characters. The presence of a dorsal patellar fracture line is hypothesized to be an apomorphic character state that relates *Calymmaria* to five other agelenoid genera: *Willisus*, *Blabomma*, *Yorima*, *Cybaeota*, and *Cybaeina*.

Keywords: Taxonomy, phylogeny, new species, North America

The genus *Calymmaria* comprises 31 described species of Nearctic spiders traditionally placed in the family Agelenidae, but currently placed in Hahniidae. Twenty-nine species occur west of the Rocky Mountains in the Sierra Nevada, Coast and Cascade ranges from Baja California north to British Columbia. Two species are known from the Appalachian region of the eastern United States. There are currently no records of the genus from Central or South America.

Individuals of *Calymmaria* range in size from approximately 2 mm in *C. minuta* new species to nearly 10 mm in *C. suprema* Chamberlin & Ivie 1937 and *C. persica* (Hentz 1847). Most specimens of *Calymmaria* are yellow, gray or brown with darker markings on the carapace and dorsum of the abdomen. Species of *Calymmaria* often closely resemble one another making separation, especially of the females, difficult.

Within its range *Calymmaria* is locally abundant. In the mountainous regions of western North America, species inhabit cool, damp forests and have been collected at elevations from 50 m (*C. nana* (Simon 1897)) to 3300 m (*C. monicae* Chamberlin & Ivie 1937). They are common in forests of Ponderosa Pine (*Pinus ponderosa*), Jeffrey Pine (*Pinus jeffreyi*), White Fir (*Abies concolor*), Douglas-fir (*Pseudotsuga menziesii*), Sequoia (*Sequoia gigantea*), Redwood (*Sequoia sempervirens*), California White Oak (*Quercus lobata*), and Incense-cedar (*Libocedrus decurrens*). Webs are placed beneath and between bark, beneath moss on rocks and living trees, beneath fallen tree trunks, in caves and especially along streams. Chamberlin & Ivie (1937) reported that *Calymmaria* is common under boards and other objects near buildings, and there are a few records from inside houses. A specimen of *C. iviei* was collected from an old packrat nest.

In the Appalachian Mountains of the eastern United States, *Calymmaria* has not been collected below 200 m. *Calymmaria*'s normal

[1] Deceased.

habitats are in leaf litter, in dirt cavities, among mossy rocks along streams, beneath overhanging rocks and beneath *Rhododendron* roots. Many specimens have been collected from caves as far back as 23 m from the entrance (Blatchley 1896). Some specimens of *C. persica* in cave habitats show marked loss of pigment but no blind specimens are known. Another particularly favorable location for *Calymmaria* in the East is around and behind waterfalls.

Calymmaria usually places its unusual web beneath some object such as an overhanging rock. The thick sheet is formed into a conical basket (Figs. 1, 2), anchored above and below by thick supporting lines. The spider spins the basket in a circular path parallel to the ground. Above the basket, *Calymmaria* constructs a thin platform parallel with and very close to the object to which the basket is suspended from above. Beneath the platform, the spider hangs in an inverted position. Occasionally, specimens kept in the laboratory were observed on the outside of the basket. No significant intraspecific differences in web structure have been observed. *Calymmaria* apparently feeds on minute insects, particularly small Diptera. They readily accepted *Drosophila* spp. in the laboratory, capturing their prey by biting, retreating, and biting again. Usually the prey is dragged to the platform but occasionally the spider was observed feeding on the inside or outside of the basket.

Nothing is known of the life cycle of *Calymmaria*. Immature specimens are virtually impossible to identify without associated adults. In western North America, mature specimens can be collected during any month of the year. In eastern North America, specimens taken from habitats outside of caves tend to mature in mid to late summer.

This paper includes 31 species of *Calymmaria*, 22 described as new. All previously described species have been redescribed in an effort to provide consistent and adequate descriptions for all species. Several species are illustrated for the first time.

The genera *Calymmaria* and *Tegenaria* (Agelenidae) have many similar characteristics. Between 1847 and 1937, seven species of spiders had been described in the genus *Tegenaria* that eventually were placed in the genus *Calymmaria*. It was not until 1937 that six species of *Tegenaria* were recognized as a distinct group and removed from *Tegenaria* to form the new genus *Calymmaria*, along with three new species (Chamberlin & Ivie 1937). The name apparently is derived from the Greek root *Calymm* = veil (Borror 1971), no doubt referring to the shape of the web.

In 1938, Exline published a paper on Washington Agelenidae and Hahniidae, and provided a key, illustrations, and distribution records to three species of *Calymmaria*. In 1942, Chamberlin & Ivie described two additional species. In 1944, Roewer renamed *C. modesta* (Banks) as *Tegenaria modestella* Roewer since the specific epithet *modesta* was preoccupied by Keyserling (1879). *Tegenaria modestella* is considered to be a *nomen dubium* in the present paper. Roth (1952) reviewed the status of the four *Calymmaria* species listed as *Tegenaria* in Roewer (1944) and transferred them back to *Calymmaria*. This was reflected in Roewer's revision of his *Katalog* in 1954. In this later catalogue, Roewer (1954) recognized 13 species in the genus *Calymmaria*, and one species here placed in *Calymmaria* was listed as *Cybaeus montavencis* Bishop & Crosby 1926.

In 1956, Roth discussed name changes in the Agelenidae and reviewed the status of *C. californica* (Banks) noting this species' past inclusion in *Tegenaria*. In 1968, Roth revised the genus *Tegenaria* and reviewed the present disposition of species listed in *Tegenaria* in western hemisphere literature. The list included the six species of *Calymmaria* previously placed in *Tegenaria*. In 1972, Roth & Brame reviewed the genus *Calymmaria*, briefly discussing distribution and habitats. Finally, in 1981, Roth discussed the relationship of *Calymmaria* and *Willisus* based on the presence of a patellar fracture line in both genera.

Lehtinen (1967) moved *Calymmaria* from Agelenidae to Hahniidae, where they are currently (and perhaps unsatisfactorily) placed. Lehtinen argued that *Calymmaria* has a close relationship with two genera he placed in Hahniidae, *Dirksia* and *Ethobuella*.

METHODS

Approximately 2300 specimens were examined for this study. The senior author collected specimens throughout the known range of the genus and reared many juvenile specimens to adulthood in captivity. The majority of the specimens were obtained through loans

Figures 1–2.—Webs of *Calymmaria*. 1. *Calymmaria* sp. from Lake Tahoe area of California; 2. *C. persica* from North Carolina.

from museums and universities. The following is a list of institutions and individuals who provided specimens of *Calymmaria*, along with acronyms used to designate the origin of the material assigned to each species:

American Museum of Natural History (AMNH); Andrew J. Penniman Collection (AJPC); Burke Museum of Natural History (University of Washington) (BMSC); California Academy of Sciences Collection (CASC); Canadian National Collection (CNC); Darrell Ubick Collection (DUSC); Essig Museum Collection (University of California, Berkeley) (EMSC); Florida State Collection of Arthropods (FSCA); Frederick A. Coyle Collection (FACC); Illinois Natural History Survey (INHS); Museum of Comparative Zoology (MCZC); Museum National d'Histoire Naturelle (MNHN); Ohio State University Collection (OSUC); Oregon State University Collection (ORSC); Peck-Exline Collection (PESC); William A. Shear Collection (WASC); University of Arkansas Collection (UAIC); University of Vermont Collection (UVSC).

The species descriptions are based on holotypes or representative specimens of each species. Where the word "typical" is used refers to the generic description. Spination is so variable that it proved to be of little diagnostic use, although most species will generally fit the pattern given in the generic description. Only diagnostic characters and characters used in constructing the cladogram are included in the descriptions.

The anatomy of individual specimens was studied using a Wild Heerbrugg M-3 dissecting microscope equipped with a 20 × 20 grid micrometer. The total length, carapace length, carapace width, and length of femur I were measured in millimeters (range, with mean in parentheses) for five specimens of each sex, where possible and unless otherwise noted. Because size is highly variable in *Calymmaria*, more measurements were deemed unnecessary. The left palpi of male specimens were removed, embedded in fine sand, and illustrated utilizing the grid micrometer and gridded paper. The ventral and lateral aspect of each palpus was illustrated, along with the dorsal view of the palpal tibia. The epigyna of female specimens were dissected using a sharp-pointed scalpel, slicing from the forward margin backward. Tissue was removed from the epigyna by a fine needle. All genitalia were placed in plastic microvials filled with alcohol and returned to the original vial after study.

For comparison, genitalia were placed in numbered 10 mm glass dishes. These dishes were filled with fine sand in order to anchor the genitalia. A number of these small dishes were placed in a larger 9 cm petri dish. In this manner, genitalia could be easily compared side by side, without confusion.

Following identification, each vial (with neoprene stopper) was permanently labelled with the correct name and specimens were sorted to species. For additional information on methods (including field methods), see Heiss (1982).

TAXONOMY

Family Hahniidae

Genus *Calymmaria* Chamberlin & Ivie 1937

Calymmaria Chamberlin & Ivie 1937: 211.

Type species.—*Calymmaria monicae* Chamberlin & Ivie 1937, by original designation.

Diagnosis.—*Calymmaria* can be separated from similar spiders in North America (except *Willisus* and *Tegenaria*) in having the length of patella + tibia I at least one and one-quarter the length of the carapace. It can be separated from *Willisus* by the presence of denticles on the cheliceral retromargin and the general pattern of the genitalia. *Calymmaria* can be separated from *Tegenaria* in possessing a patellar fracture line and the absence of plumose setae.

Description.—Length: 2–10 mm. Cephalothorax: eyes eight, anterior median eyes smallest, others equal, secondary eyes with a canoe-shaped tapetum, eye rows nearly straight; chelicerae with three promarginal teeth and three or four retromarginal teeth and one to five denticles; carapace two-thirds as wide as long with scattered simple setae, usually light yellow to orange or red and marked with gray marginal and submarginal stripes and a V-shaped mark at the base of the cephalic region, eyes ringed with black; sternum nearly as long as wide, pointed behind, with apex of posterior margin extending between hind coxae. Abdomen: oval covered with fine simple setae, markings variable but usually with a dorsal basal lanceolate mark followed by spots or chevrons, venter usually gray with white or yellow lateral longitudinal stripes;

lacking obvious epiandrous glands (although they may be present but small; anonymous reviewer, pers. observ.); colulus twice as wide as long with 15 to 20 setae; posterior spinnerets longer than anterior, with distal segment of posterior spinneret one-half as long as basal segment and wedge-shaped. Legs: annulate to unmarked; relative length 4, 1, 2, 3; patella—tibia I at least one and one-quarter as long as carapace; patella I-IV with dorsal fracture line (Fig. 3); tarsi with six to eight trichobothria, paired lateral claws with 14 teeth, median claw with three teeth, semicircular setae and accessory claws present. Spination highly variable. The following formulas summarize variation in the number of spines found on spine-bearing surfaces of each segment, divided into thirds or fourths, beginning with the proximalmost and ending with the distalmost portion (after Platnick & Shadab 1975): femur I—prolateral 0-1-0; dorsal 0-1-0; femur II—dorsal 0-1-0; femur III—dorsal 0-1-0; femur IV—dorsal 0-1-0; patella I-IV—dorsal 1-0-1; tibia I—prolateral 0, 0-0-1, 0-1-0-1; dorsal 1-0-1; ventral 0-2-2-0; tibia II—prolateral 0-0-1, 0-1-1; retrolateral 0, 0-0-1; dorsal 0-2-2-0; ventral 0-2-2-0; tibia III-IV—prolateral 0-1-1; retrolateral 0-0-1, 0-1-1; dorsal 0-2-2-0; ventral 0-2-0, 0-2-2-0; metatarsus I—prolateral 0, 0-0-1; retrolateral 0, 0-0-1; ventral 0-2-2-3; metatarus II—prolateral 0, 0-1-0, 0-0-1; retrolateral 0, 0-1-0, 0-1-1, 1-1-1; metatarsus III—retrolateral 0, 0-0-1, 0-1-1, 1-1-1-1; ventral 0-2-2-3; metatarsus IV: prolateral 0-1-1-0, 1-1-0-1, 1-1-1-1; retrolateral 0-0-1-1, 1-1-1-1; ventral 0-2-2-3. Epigynum of female (Figs. 4, 5) simple with a single median opening externally; internally, usually with a midpiece composed of fused tubes ending in blind ducts near top; lateral ducts usually joined at base of midpiece; fertilization tubes long; spermatheca usually spherical. Palpus of male (Figs. 6, 7) complex, usually with a well-developed ventral patellar apophysis (PA); well-developed retrolateral tibial apophyses (RTA); tibia with one or two prolateral spines, usually several long ventral setae, and many short retrolateral setae; cymbium produced distad; embolus spine-like, sometimes thickened or bifurcate; conductor usually complex with basal and distal lobes; median apophysis and extrategular processes absent.

Distribution.—Baja California north to British Columbia; Appalachian Mountains of eastern U.S.A. (Map 1).

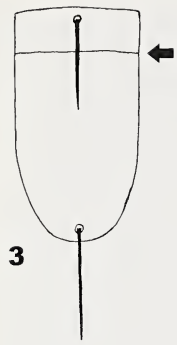
Natural History.—Cool, damp forests, beneath litter, under overhanging rocks, under and between bark of living and dead trees, under dead tree trunks, beneath moss on trees and rocks, in caves.

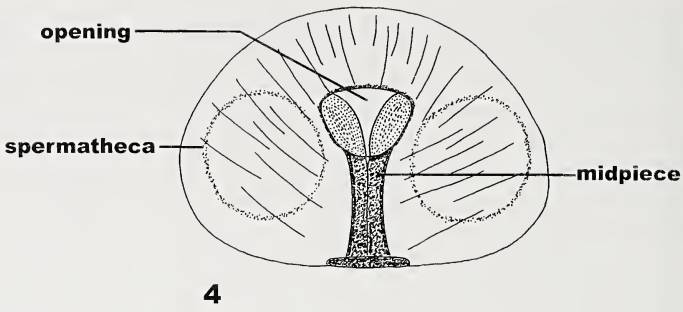
Species excluded.—The holotype of *Tegenaria modesta* Banks 1898 was lost. His description and illustration of *T. modesta* are too poor to allow the assignment of any of the known material from Mexico to the Banks species, and the name is here regarded as a *nomen dubium.* This name was found to be a junior primary homonym of *T. modesta* Keyserling 1879 by Roewer (1944) who replaced it with the name *Tegenaria modestella* Roewer 1944.

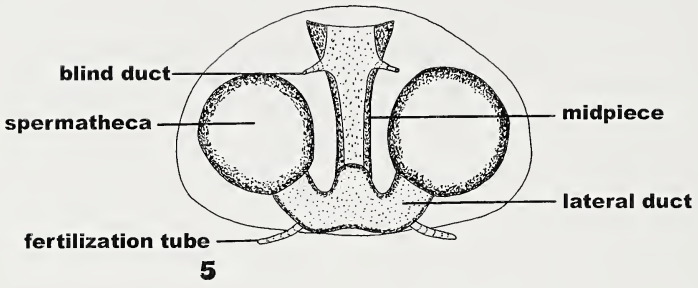
KEY TO THE SPECIES OF *CALYMMARIA*

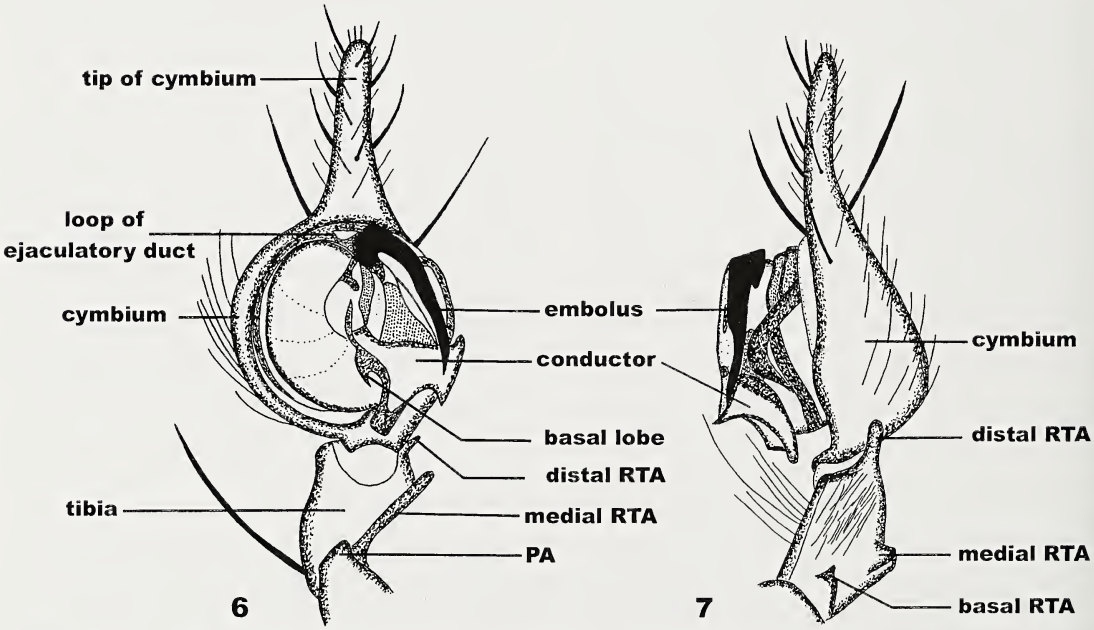
The following key will separate all 31 described species of *Calymmaria.* The key should be used along with the descriptions and illustrations. When using the key, emboli should be viewed ventrally, and RTA (retrolateral tibial apophyses) dorsally, unless otherwise stated.

1. Males 2
   Females 28
2. Embolus very wide at base, apex bifurcate (Figs. 15, 53) or tapering abruptly to a point (Figs. 28, 65, 70, 105) 3
   Embolus thin, if widened at base, tapering gradually or widened midway or thickened along its entire length 8
3. Apex of embolus bifurcate (Figs. 15, 53) 4
   Apex of embolus tapering abruptly 5
4. Apex of embolus with two sharp points (Fig. 15) ..... *Calymmaria bifurcata*
   Apex of embolus with lower point rounded (Fig. 53) ..... *Calymmaria minuta*
5. Embolus with apex thick and tapering only near point (Fig. 70) ..... *Calymmaria orick*









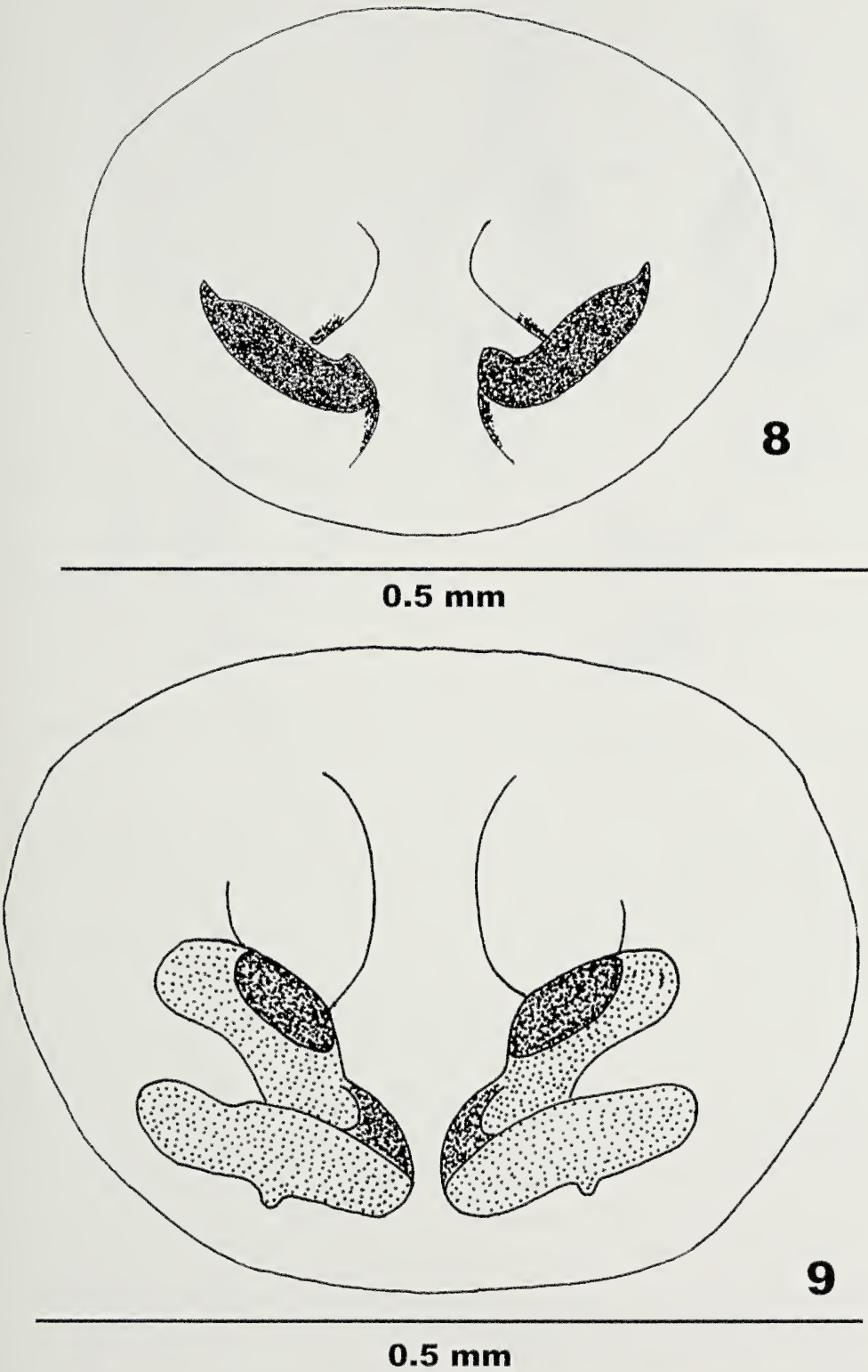
Figures 3–7.—Generalized morphology of *Calymmaria*. 3. Dorsal view of patella of *Calymmaria* showing fracture line (arrow); 4. Ventral view of epigynum of *Calymmaria*; 5. Dorsal view of epigynum of *Calymmaria*; 6. Ventral view of left palpus of *Calymmaria*; 7. Lateral view of left palpus of *Calymmaria*. RTA = Retrolateral tibial apophysis; PA = Patellar apophysis.

Embolus with apex tapering from base 6

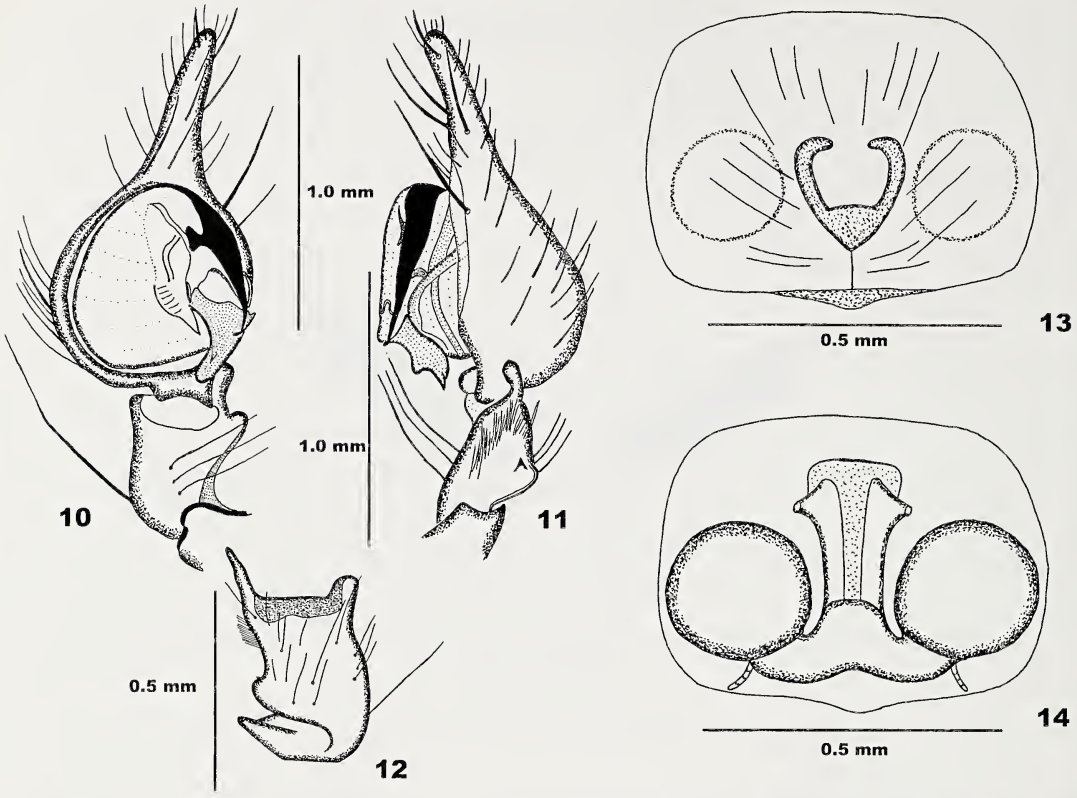
6. Embolus with sides rounded and tapering abruptly (Fig. 28) ..... *Calymmaria emertoni*

Embolus with sides angular and tapering abruptly (Figs. 65, 70, 105) 7

7. Embolus with apex long, lower angle of base sharp; PA small, rounded; basal RTA bifurcate (Fig. 65–67) ..... *Calymmaria nana*



Figures 8–9.—*Calymmaria alleni*. 8. Epigynum, ventral; 9. Epigynum, dorsal.



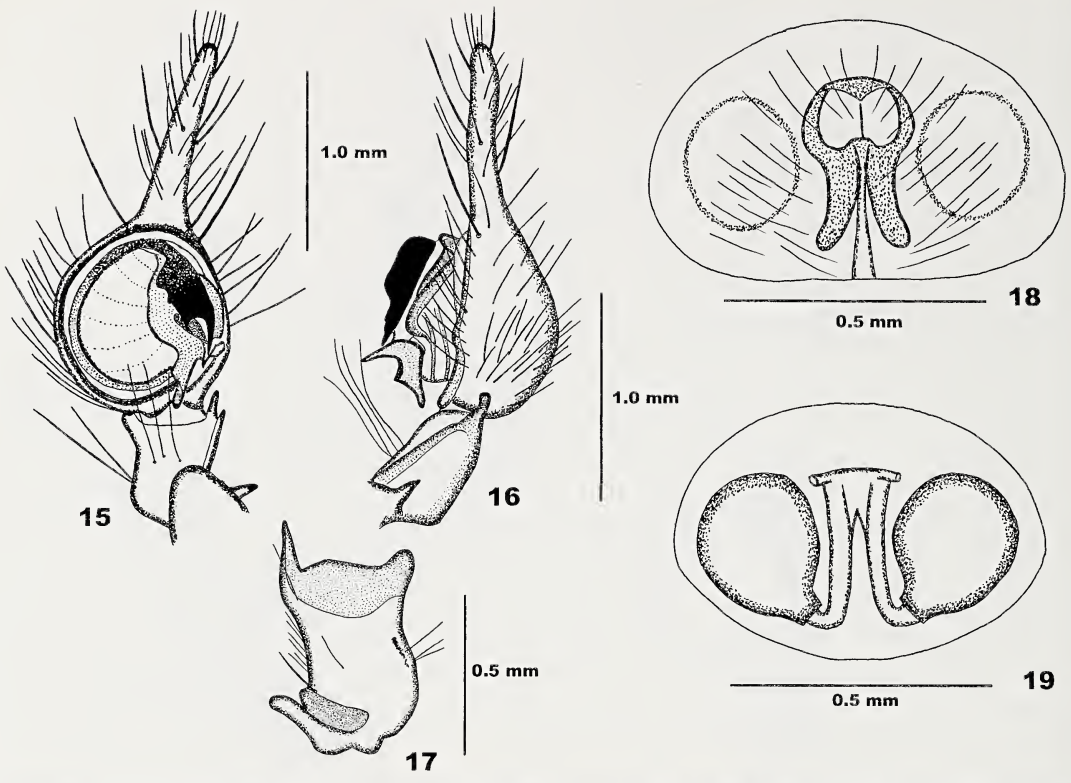
Figures 10–14.—*Calymmaria aspenola*. 10. Palpus, ventral; 11. Palpus, lateral; 12. Palpal tibia, dorsal; 13. Epigynum, ventral; 14. Epigynum, dorsal.

Embolus with apex shorter, lower angle of base less sharp; PA large, rounded; basal RTA entire (Fig. 105–107) ..... *Calymmaria siskiyou*

8. Ejaculatory duct conspicuously looped at base of embolus (Figs. 43, 80, 115) 9
   Ejaculatory duct not looped 11
9. Embolus thin, very long (Figs. 115–117) ..... *Calymmaria suprema*
   Embolus thicker 10
10. Embolus short, thick, with a swelling near apex when viewed laterally (Fig. 124) ..... *Calymmaria tubera*
    Embolus longer, thickest at base, with no swelling near apex when viewed laterally (Figs. 43–45) ..... *Calymmaria iviei*
11. Embolus thin or tapering gradually from base 12
    Embolus thick 19
12. Basal tibial apophysis complex, with many lobes (Figs. 73–75, 126–128), eastern U.S.A. 13
    Basal tibial apophysis simple, western U.S.A. 14
13. Medial RTA with two teeth, lobes of basal tibial apophysis from above pointed (Figs. 74, 75) ..... *Calymmaria persica*
    Medial RTA with one lobe, ventral and retrolateral lobes of basal apophysis large, rounded or quadrate from above (Figs. 127, 128) ..... *Calymmaria virginica*
14. Basal RTA with ventral lobe bifurcate and a rounded dorsal lobe; distal RTA with a basal lobe (Fig. 38, 39) ..... *Calymmaria gertschi*
    Basal RTA not as above; distal RTA without basal lobe 15
15. Basal RTA with teeth; medial RTA lobe-like laterally (Fig. 40–42) .. *Calymmaria humboldt*

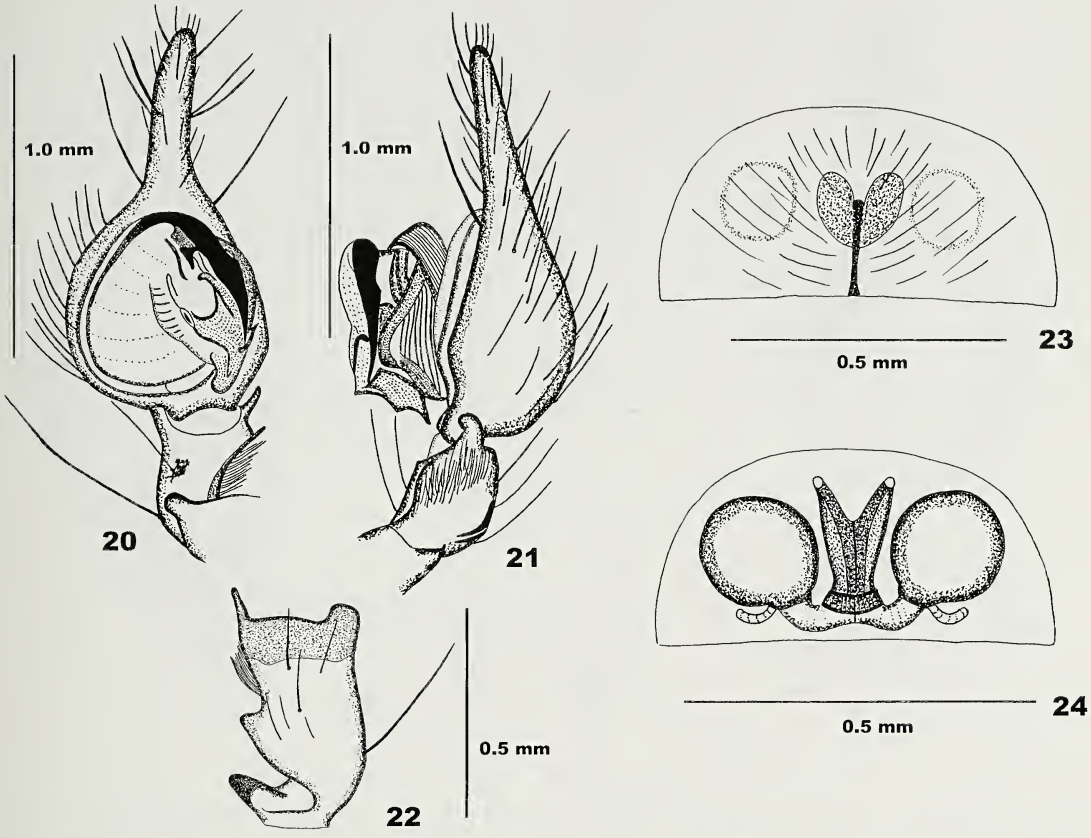
Map 1.—Distribution of genus *Calymmaria*.

Basal RTA entire; medial RTA not lobe-like laterally 16
16. Embolus with a swelling near base (Figs. 98–100); medial RTA with two rounded lobes ..... *Calymmaria sierra*
Embolus and medial RTA not as above 17
17. Embolus gradually tapering from base (Figs. 25–27) ..... *Calymmaria carmel*
Embolus tapering nearer the apex 18
18. Patellar apophysis absent; conductor with pointed lobes from below; medial RTA thick and flat from above (Figs. 131–133) ..... *Calymmaria yolandae*
Patellar apophysis well-developed; conductor and medial RTA not as above (Figs. 80–82) ..... *Calymmaria rothi*
19. Embolus with sharp bifurcation at apex (Figs. 110–112) ..... *Calymmaria sueni*
Embolus not bifurcate 20
20. Embolus with small rounded point at apex Figs. 85–87) ..... *Calymmaria scotia*



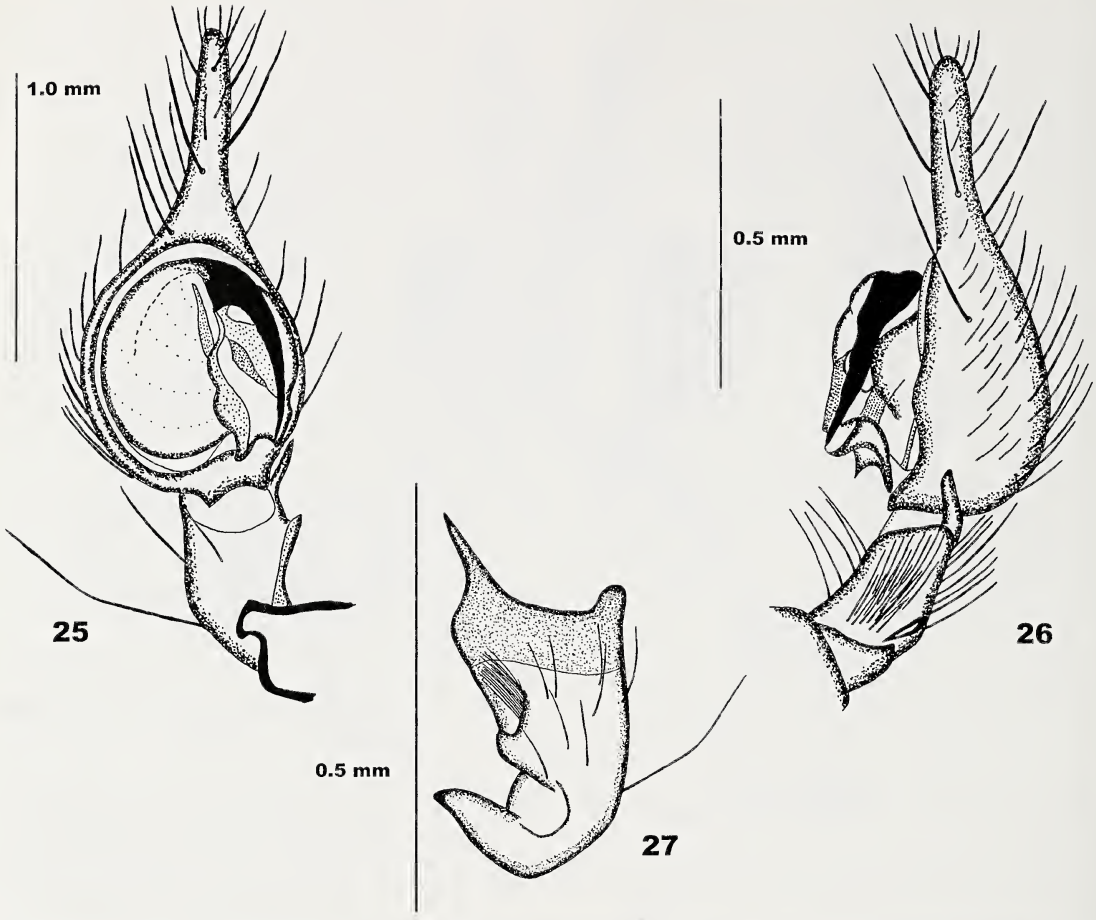
Figures 15–19.—*Calymmaria bifurcata*. 15. Palpus, ventral; 16. Palpus, lateral; 17. Palpal tibia, dorsal; 18. Epigynum, ventral; 19. Epigynum, dorsal.

Embolus with a sharp point 21
21. Embolus with an ectal tooth (Fig. 20, 21, 33, 34) 22
Embolus without an ectal tooth 23
22. Embolus with ectal tooth near base (Figs. 33, 34); Farallon Islands, California ..... *Calymmaria farallon*
Embolus with ectal tooth midway; mainland ..... *Calymmaria californica*
23. Medial RTA ridge-like (Figs. 93–95) ..... *Calymmaria shastae*
Medial RTA not as above 24
24. Medial RTA with a tooth near distal margin (Figs. 10–12) ..... *Calymmaria aspenola*
Medial RTA without such a tooth 25
25. Medial RTA bilobed (Figs. 91, 92, 121, 122) 26
Medial RTA not bilobed 27
26. Medial RTA with lobes behind one another from above; Baja California, Mexico (Figs. 120–122) ..... *Calymmaria tecate*
Medial RTA with lobes one after the other (Figs. 90–92) ..... *Calymmaria sequoia*
27. Embolus usually tapering abruptly when viewed laterally; conductor with sharp lobes; cymbium usually produced distad (Figs. 48–50) ..... *Calymmaria lora*
Embolus usually tapering less abruptly when viewed laterally; conductor with more rounded lobes; cymbium usually shorter (Figs. 58–60) ..... *Calymmaria monicae*
28. Spermatheca elongate, angular (Figs. 8, 9) ..... *Calymmaria alleni*
Spermatheca spherical 29
29. Lateral ducts of epigynum well-separated at base of midpiece (Figs. 19, 32, 64, 77, 89, 114, 130) 30
Lateral ducts fused at base of midpiece 36



Figures 20–24.—*Calymmaria californica*. 20. Palpus, ventral; 21. Palpus, lateral; 22. Palpal tibia, dorsal; 23. Epigynum, ventral; 24. Epigynum, dorsal.

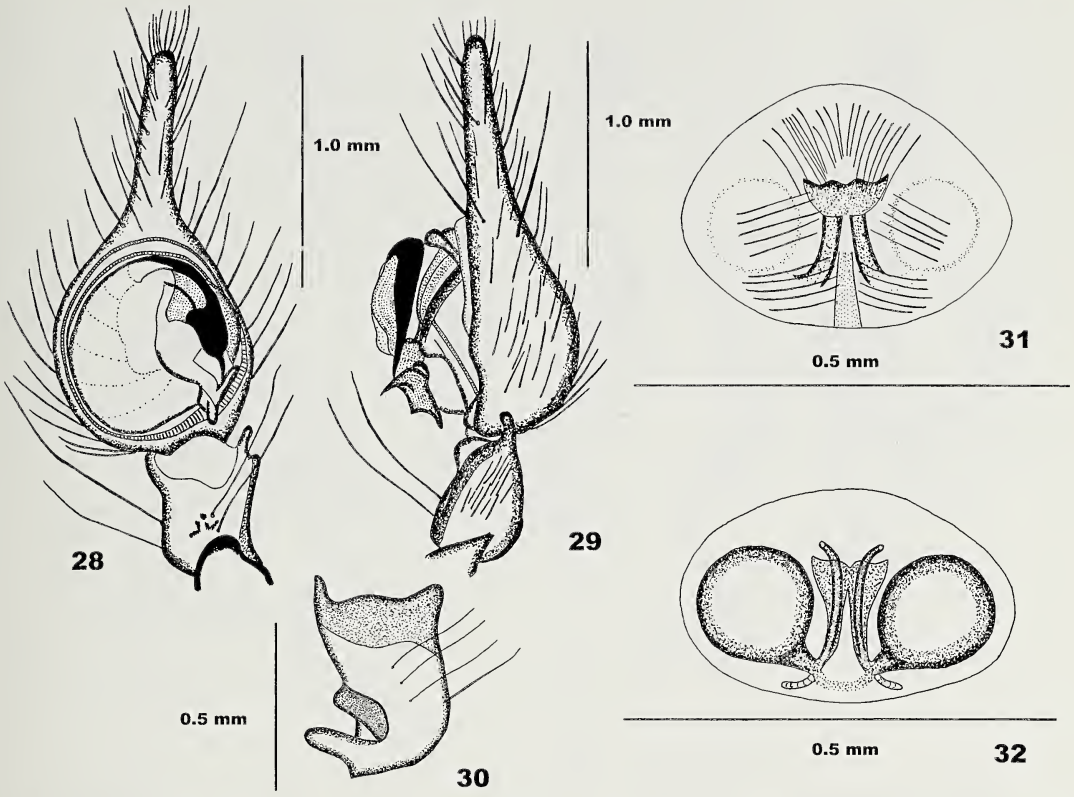
30. Epigynal midpiece composed of two well-developed fused ducts (Figs. 89, 114) 31
Epigynal midpiece with fusion of ducts less obvious 32
31. Epigynum externally with internal midpiece evident (Figs. 113, 114) .... *Calymmaria sueni*
Epigynum externally with internal midpiece not evident (Figs. 88–89) .. *Calymmaria scotia*
32. Distribution in eastern U.S.A. 33
Distribution in western U.S.A. 34
33. Epigynum externally with a wide sclerotized shield-like area (Fig. 129), internally lateral ducts thick (Fig. 130) ..... *Calymmaria virginica*
Epigynum externally with V-shaped opening (Fig. 76), internally with midpiece thin in middle and wide at top, lateral ducts short and separation at base of midpiece obscured (Fig. 77) ..... *Calymmaria persica*
34. Epigynum with lateral ducts almost fused at base of midpiece (Fig. 64) .....
..... *Calymmaria monterey*
Epigynum with lateral ducts well-separated 35
35. Epigynum with blind ducts extending upward from midpiece, form highly variable (Fig. 32) ..... *Calymmaria emertoni*
Epigynum with blind ducts extending laterally from midpiece, form also highly variable (Fig. 19) ..... *Calymmaria bifurcata*
36. Epigynum with midpiece almost as long as wide (Figs. 47, 57) 37
Epigynum with midpiece much longer than wide 38
37. Epigynum with blind ducts near top of midpiece; external opening not obvious (Figs. 56, 57) ..... *Calymmaria minuta*



Figures 25–27.—*Calymmaria carmel*. 25. Palpus, ventral; 26. Palpus, lateral; 27. Palpal tibia, dorsal.

Epigynum with blind ducts not near top of midpece; external opening obvious (Figs. 46, 47) ..... *Calymmaria iviei*

38. Epigynum externally with median area raised forming a sclerotized hood (Figs. 96, 108) 39
Epigynum not as above 40
39. Epigynum with midpiece longer than diameter of spermatheca (Fig. 97) ..... *Calymmaria shastae*
Epigynum with midpiece shorter than diameter of spermatheca ..... *Calymmaria siskiyou*
40. Epigynum with wide sclerotized area (Fig. 68) ..... *Calymmaria nana*
Epigynum not as above 41
41. Epigynum with midpiece equal to or shorter than the diameter of spermatheca (Fig. 24) ..... *Calymmaria californica*
Epigynum with midpiece longer 42
42. Epigynum with opening surrounded by thin but heavy sclerotization (Figs. 51, 52) ..... *Calymmaria lora*
Epigynum not as above 43
43. Epigynum externally with elongate sclerotized area (Fig. 102) ..... *Calymmaria sierra*
Epigynum not as above 44
44. Epigynum with lateral ducts usually divided (Figs. 37, 119) 45
Epigynum with lateral ducts usually single 46



Figures 28–32.—*Calymmaria emertoni*. 28. Palpus, ventral; 29. Palpus, lateral; 30. Palpal tibia, dorsal; 31. Epigynum, ventral; 32. Epigynum, dorsal.

45. Epigynum with midpiece tubes slightly separated above; blind ducts small (Fig. 37); Farallon Islands, California ..... *Calymmaria farallon*
Epigynum with midpiece tubes not separated above; blind ducts large (Fig. 119); mainland ..... *Calymmaria suprema*
46. Epigynum with midpiece tubes separated at top (Fig. 62) ..... *Calymmaria monicae*
Epigynum with midpiece tubes not well separated at top 47
47. Epigynum with midpiece very long, lateral ducts curved sharply (Fig. 104) ..... *Calymmaria similaria*
Epigynum not as above 48
48. Epigynum with midpiece narrow at top (Fig. 14) ..... *Calymmaria aspenola*
Epigynum with midpiece wide at top 49
49. Epigynum with midpiece narrow in middle (Fig. 79); Baja California, Mexico ..... *Calymmaria rosario*
Epigynum with midpiece wide in middle (Fig. 84); Sierra Nevada and Coastal range of California, U.S.A. ..... *Calymmaria rothi*

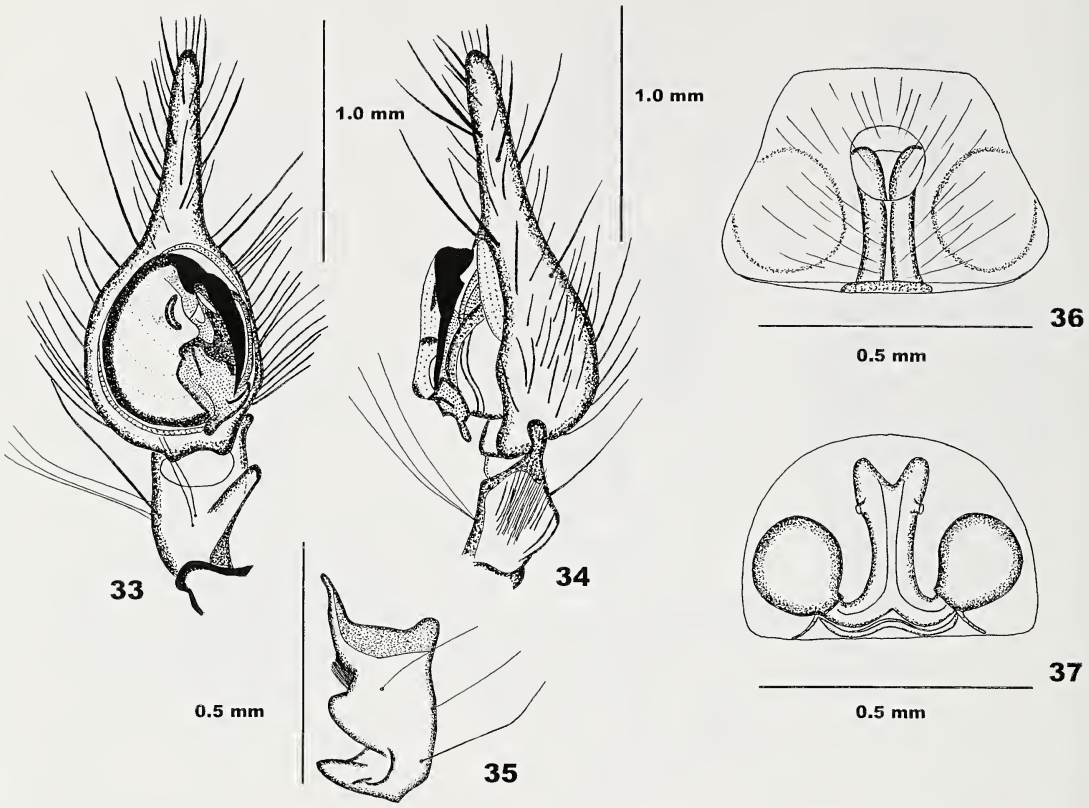
Calymmaria alleni new species
Figs. 8, 9; Map 2

Type.—Female holotype from 3700 feet, near Ash Mountain entrance, Sequoia National Park, Tulare County, California, U.S.A., 36°29′N, 118°49′W, 5 July 1956, W.J. Gertsch, V. Roth (AMNH).

Etymology.—The specific name is a patronym honoring Dr. Robert T. "Tommy" Allen, dissertation advisor of the senior author.

Diagnosis.—*Calymmaria alleni* is easily separated from other *Calymmaria* by the very peculiar form of the epigynum (Figs. 8, 9).

Description.—*Female:* Carapace typical. Dorsum of abdomen gray with lighter basal



Figures 33–37.—*Calymmaria farallon*. 33. Palpus, ventral; 34. Palpus, lateral; 35. Palpal tibia, dorsal; 36. Epigynum, ventral; 37. Epigynum, dorsal.

lanceolate mark and four pairs of pale yellow spots; venter gray with yellow lateral longitudinal stripes and three pairs of yellow medial spots. Legs annulate, spination typical. Epigynum externally with wide opening flanked by elongate angular sclerotized areas (Fig. 8); internally with midpiece lacking, medial ducts separate and elongate, rounded. Lateral ducts separate and very short; spermathecae elongate (Fig. 9). *Male:* Unknown.

Measurements.—(n = 3): Total length, 3.41–4.09 (4.02); carapace length, 1.49–1.83 (1.62); carapace width, 1.18–1.36 (1.24); femur I length, 1.61–1.95 (1.77).

Distribution.—Sequoia National Park, Tulare County, California (Map 2).

Natural History.—Mature specimens collected from July and October in a cave and at an elevation of 1100 m.

Material Examined.—U.S.A.: *California:* Tulare County, Sequoia National Park, near Ash Mountain entrance (3700′), 5 July 1956 (W.J. Gertsch, V. Roth), 2 ♀ (AMNH), west of Soda Springs, in cave, 11 July 1958 (V. Roth), 1 ♀ (AMNH), 7 miles NE. Ash Mountain entrance, 10 October 1959 (V. Roth, W.J. Gertsch), 1 ♀ (AMNH).

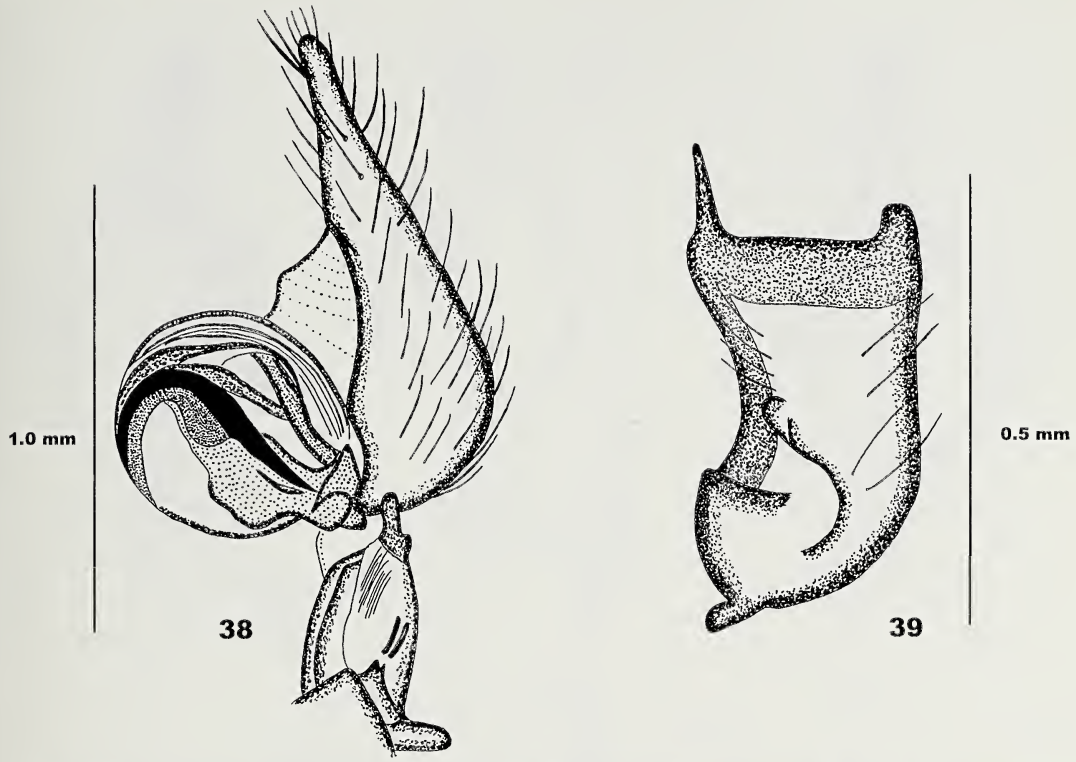
Calymmaria aspenola Chamberlin & Ivie 1942

Figs. 10–14; Map 2

Calymmaria aspenola Chamberlin & Ivie 1942: 23, figs. 32, 33, 34; Roewer 1954: 45.

Types.—Male holotype and female allotype from Aspen Valley, Yosemite National Park, Tuolumne County, California, U.S.A., 37°49′N, 119°46′W (AMNH).

Diagnosis.—*Calymmaria aspenola* resembles *C. monicae* in general appearance. The epigynum of the female is variable, but usually specimens of *C. aspenola* can be separated from *C. monicae* by the thicker midpiece in which the ducts are not separated at the top (Fig. 14). Males are easily separated from other *Calymmaria* by the conspicuous sharp tooth near the medial RTA (Fig. 10).



Figures 38–39.—*Calymmaria gertschi*. 38. Palpus, ventro-lateral view; 39. Palpal tibia, dorsal.

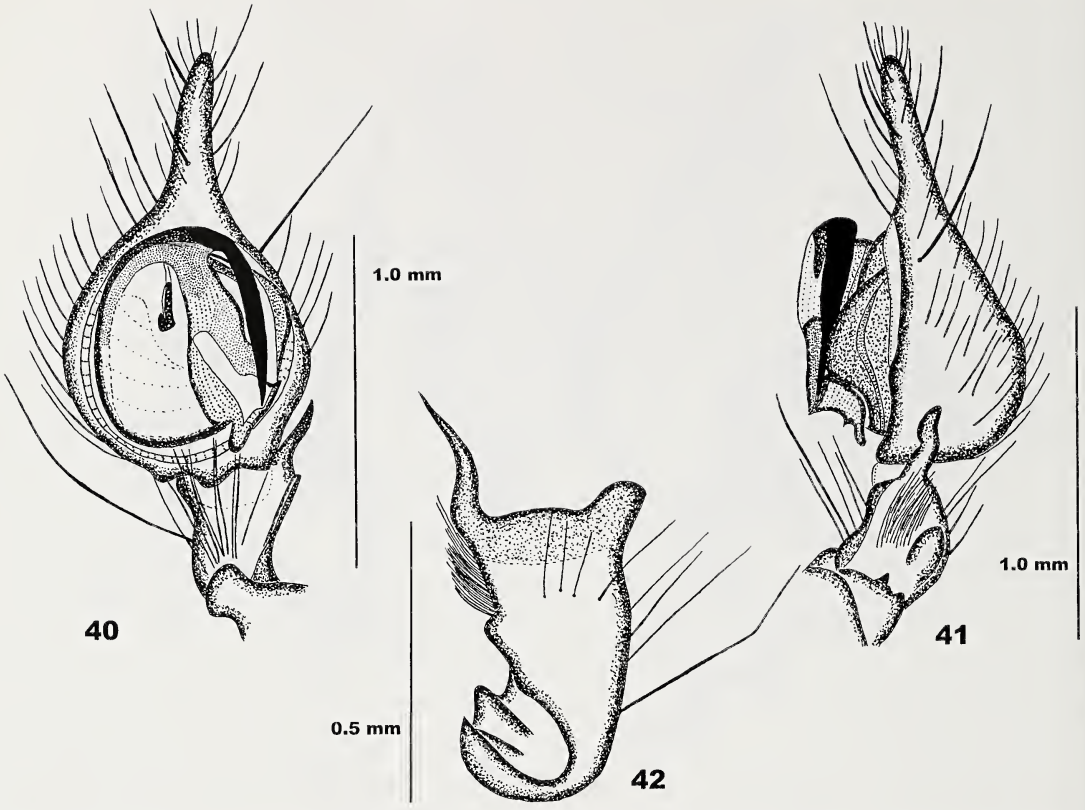
Description.—*Female:* Carapace typical. Dorsum of abdomen pale yellow with gray basal lanceolate mark followed by five transverse chevrons; venter gray with two yellow lateral longitudinal stripes. Legs annulate, spination typical. Epigynum externally with heart-shaped opening and thin sclerotized line below (Fig. 13); internally with midpiece wide, lateral ducts united medially in hump (Fig. 14). *Male*: Same as in female but with markings darker. Male palpus with PA large, rounded (Fig. 10); basal RTA thick and blunt, medial RTA large, shorter, rounded and with a sharp tooth near distal margin, distal RTA long, rounded (Figs. 10, 11); tibia with one prolateral spine, three long ventral setae, and many short retrolateral setae; cymbium elongate distad, with one spine near base of tip and four spines on tip; embolus thick and tapering, conductor with basal lobe pointed (Fig. 10).

Measurements.—*Female:* Total length, 4.34–5.89 (5.17); carapace length, 1.86–2.26 (2.01); carapace width, 1.36–1.61 (1.45), femur I length, 1.86–2.18 (2.04). *Male:* Total length, 4.65–5.21 (4.92); carapace length, 2.08–2.48 (2.29); carapace width, 1.86–2.11 (1.93); femur I length, 2.48–3.10 (2.82).

Distribution.—Sierra Nevada and Coast Ranges in California (Map 2).

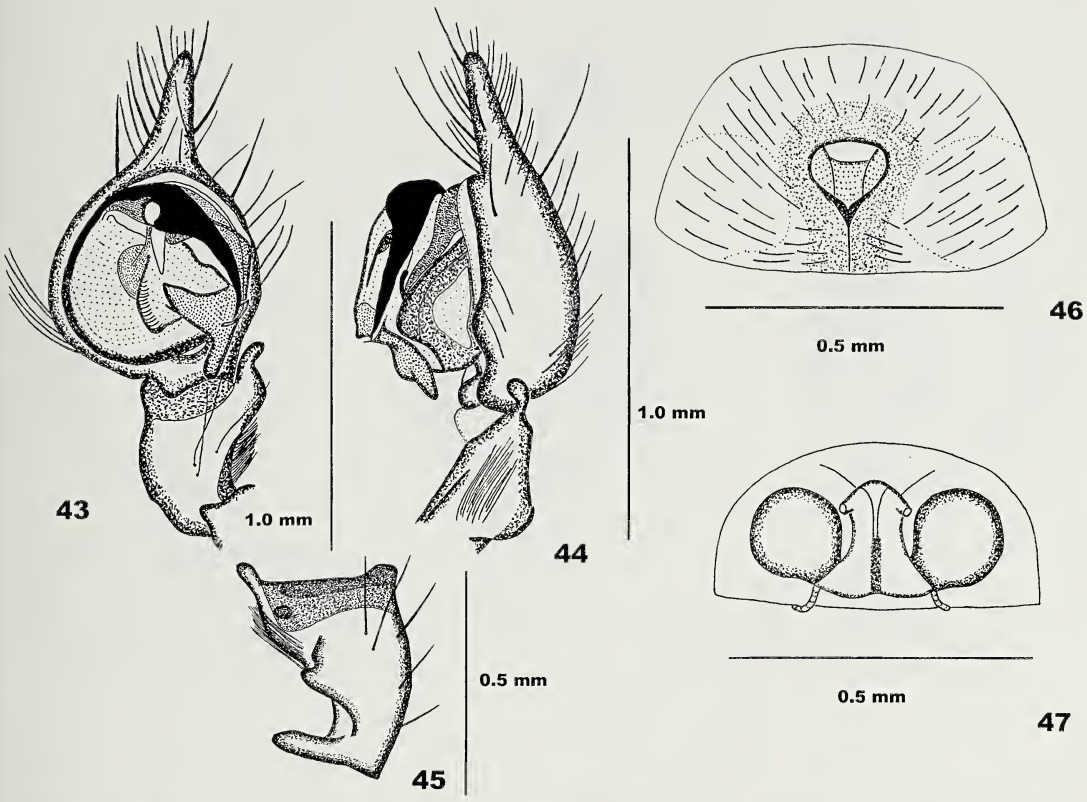
Natural History.—Mature specimens collected in February, March, July, August, and September from caves and dense forests (especially Douglas-fir) at elevations up to 2100 m.

Material Examined.—U.S.A.: *California:* Alameda County, 21 miles SE of Livermore on Mines Road, 12 February 1967 (V. Roth), 3 ♀, 2 immatures (AMNH); Alpine County, Ebbets Pass (8730′), 5 August 1953 (W.J. and J. W. Gertsch), 1 ♀, 2 immatures (AMNH), 10 September 1959 (no collector), 1 ♂, 12 ♀ (AMNH), 2 September 1961 (W.J. Gertsch, W. Ivie), 2 ♀ (AMNH); El Dorado County, Riverton 11 July 1953 (W.J. Gertsch), 2 ♀ (AMNH), 5 miles N. of Pollock Pines, 6 July 1958 (W.J. Gertsch, V. Roth), 2 ♀ (AMNH), Fallen Leaf Lake, 9 September 1959 (W.J. Getsch, V. Roth), 3 ♀ (AMNH), Placerville, 9 April 1960 (W.J. Gertsch, W. Ivie, R. Schrammel), 2 ♀, 2 immatures (AMNH), Lake Tahoe, Bliss State Park, 21 September 1961 (W. Ivie, W.J. Gertsch), 1 ♂, 3 ♀, 6 im-



Figures 40–42.—*Calymmaria humboldt*. 40. Palpus, ventral; 41. Palpus, lateral; 42. Palpal tibia, dorsal.

matures (AMNH), S. of Meyers (7377′), 19 September 1963 (W.J. Gertsch), 1 ♀ (AMNH), Blodgett Forest Experiment Station, 13 miles E. of Georgetown (4000–4500′), 29–30 May 1970 (E.I. Schlinger), 1 ♀ (EMSC), 29 May 1971 (M. Bentzien), 1 ♀ (EMSC); Humboldt County, Carlotta, September 1961 (W. Ivie, W.J. Gertsch), 2 ♀, 4 immatures (AMNH); Los Angeles County, San Gabriel Mountains, on CA Hwy 2, montane forest (7000′), 27 September 1957 (R.X. Schick), 1 ♀ (AMNH); Mariposa County, Camp, Yosemite National Park, 18 September 1941 (W. Ivie), 1 ♂ paratype (AMNH), Glacier Point, Yosemite National Park (7200–7500′), 27 September 1944 (B. Malkin), 1 ♂, 3 ♀ (AMNH), Tamarack Flat, Yosemite National Park, 3 September 1958 (no collector), 1 ♂ 3 ♀ (AMNH), 11 September 1959 (W.J. Gertsch, V. Roth), 2 ♂, 2 ♀, 1 immature (AMNH), Buck Meadows, 11 September 1959 (no collector), Grouse Creek, 12 September 1959 (no collector), 8 ♂, 6 ♀, 1 immature (AMNH), Porcupine Flat Campground, Yosemite National Park, under logs and granite chips, 22 September 1961 (W. Ivie, W.J. Gertsch), 21 ♂, 34 ♀, 8 immatures (AMNH); San Diego County, Alpine, 10 September 1959 (no collector), 1 ♂, 1 immature (AMNH); Strawberry Creek, 17 September 1959 (V. Roth, W.J. Gertsch), 1 ♂, 3 ♀, 2 immatures (AMNH); Tulare County, Quaking Aspen Camp, Sequoia National Forest, 9 September 1959 (no collector), 4 ♀ (AMNH), Tulare County, 6 miles E. of Camp Connell, 10 September 1959 (no collector), 7 ♀, 1 ♂, 2 immatures (AMNH); Tuolumne County, Aspen Valley, Yosemite National Park, 11 August 1931 (W. Ivie), 1 ♂ holotype, 1 ♀ allotype, 1 ♂ paratype, 4 female paratypes (AMNH), Pinecrest, approx. 10 miles E. of Sonora, pine forest, 2 May 1970 (S.C. Williams), 1 ♀ (CASC); no county, Yosemite National Park, 16 August 1950 (V. Roth), 1 ♂, 1 immature (AMNH).



Figures 43–47.—*Calymmaria iviei*. 43. Palpus, ventral; 44. Palpus, lateral; 45. Palpal tibia, dorsal; 46. Epigynum, ventral; 47. Epigynum, dorsal.

Calymmaria bifurcata new species
Figs. 15–19; Map 2

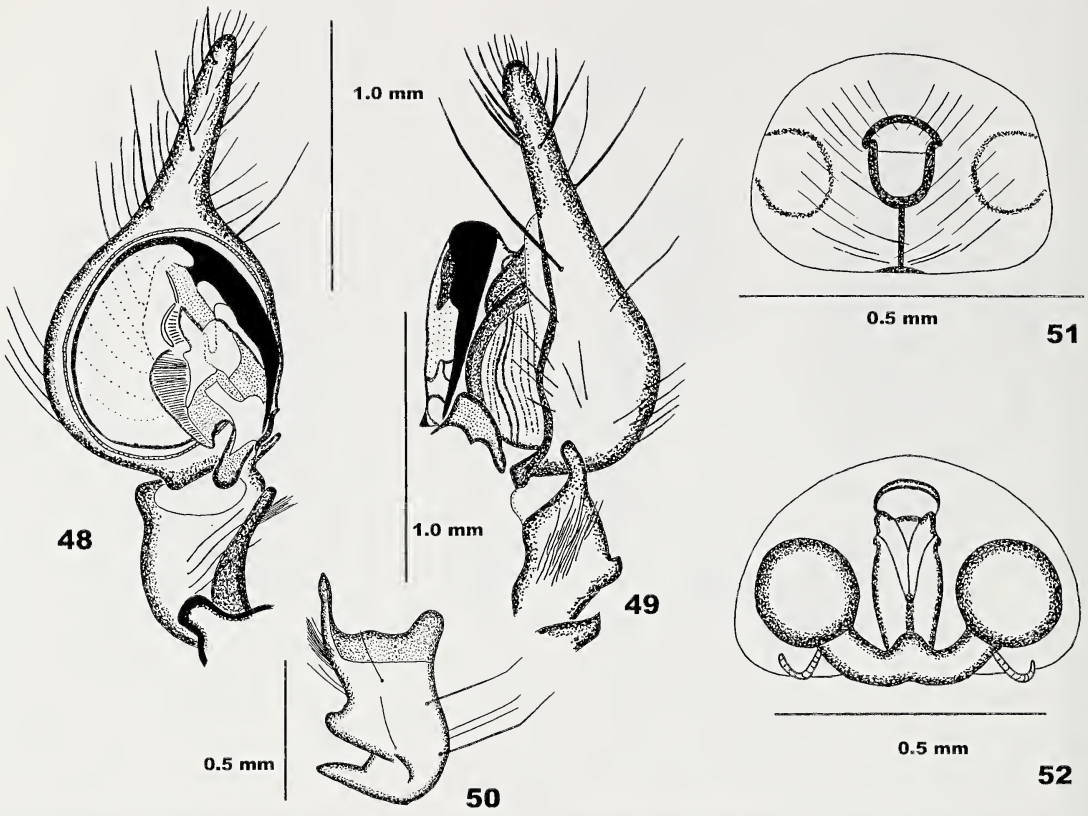
Calymmaria emertoni (misidentification): Chamberlin & Ivie 1937: 215, 232, 233, figs. 20, 21; Exline 1938: 21, fig. 28; Roewer 1954: 46; Bonnet 1956: 939.

Types.—Male holotype and female allotype from Carlotta, edge of redwood lumber camp, Humboldt County, California, U.S.A., 40°32′N, 124°03′W, 27 September 1963, W.J. Gertsch (AMNH).

Etymology.—The specific name is an adjective referring to the bifurcate embolus.

Diagnosis.—*Calymmaria bifurcata* females are very similar to females of *C. emertoni* and sometimes are difficult to separate. In general, the ducts of the epigynal midpiece are larger and diverge near the top in *C. bifurcata* (Fig. 19), while diverging further down in *C. emertoni* (Fig. 32), but many exceptions occur. Specimens of *C. bifurcata* are usually larger than those of *C. emertoni*. *Calymmaria bifurcata* occurs in northern California and in Oregon while *C. emertoni* is commonly collected in Oregon, Washington and British Columbia (Map 2). In Oregon the surest way to separate the females is to collect them along with the readily identifiable males. Male *C. bifurcata* are easily separated from other *Calymmaria* by the bifurcate embolus (Fig. 15). In 1937 Chamberlin & Ivie incorrectly identified and figured the male of *C. bifurcata* as *C. emertoni* (p. 233), an error no doubt caused by the similarity in the females.

Description.—*Female:* Carapace typical. Dorsum of abdomen pale yellow with dark gray basal lanceolate mark usually flanked by large yellow spots and followed by four or five transverse chevrons, venter gray with two pale yellow lateral longitudinal stripes. Legs annulate, spination typical. Epigynum of female externally with large, usually heavily sclerotized opening from which ducts of midpiece diverge below (Fig. 18); internally ducts of midpiece diverge near top, lateral ducts short and do not unite medially, blind ducts



Figures 48–52.—*Calymmaria lora*. 48. Palpus, ventral; 49. Palpus, lateral; 50. Palpal tibia, dorsal; 51. Epigynum, ventral; 52. Epigynum, dorsal.

short and near top of midpiece (Fig. 19). *Male*: Carapace similar to female but usually darker yellow to orange with fewer markings. Abdomen as in female. Spination typical Male palpus with PA rounded and very wide (Fig. 15); basal RTA thick and rounded, narrower in middle when viewed from above (Fig. 17), medial RTA short and flat, distal RTA long and rounded; cymbium elongate distad, usually with three spines at base of tip and six spines on tip; tibia with two prolateral spines and three or four long ventral setae; embolus thick at base with tip bifurcate, conductor with narrow lobe and base arising beyond base of embolus (Fig. 15).

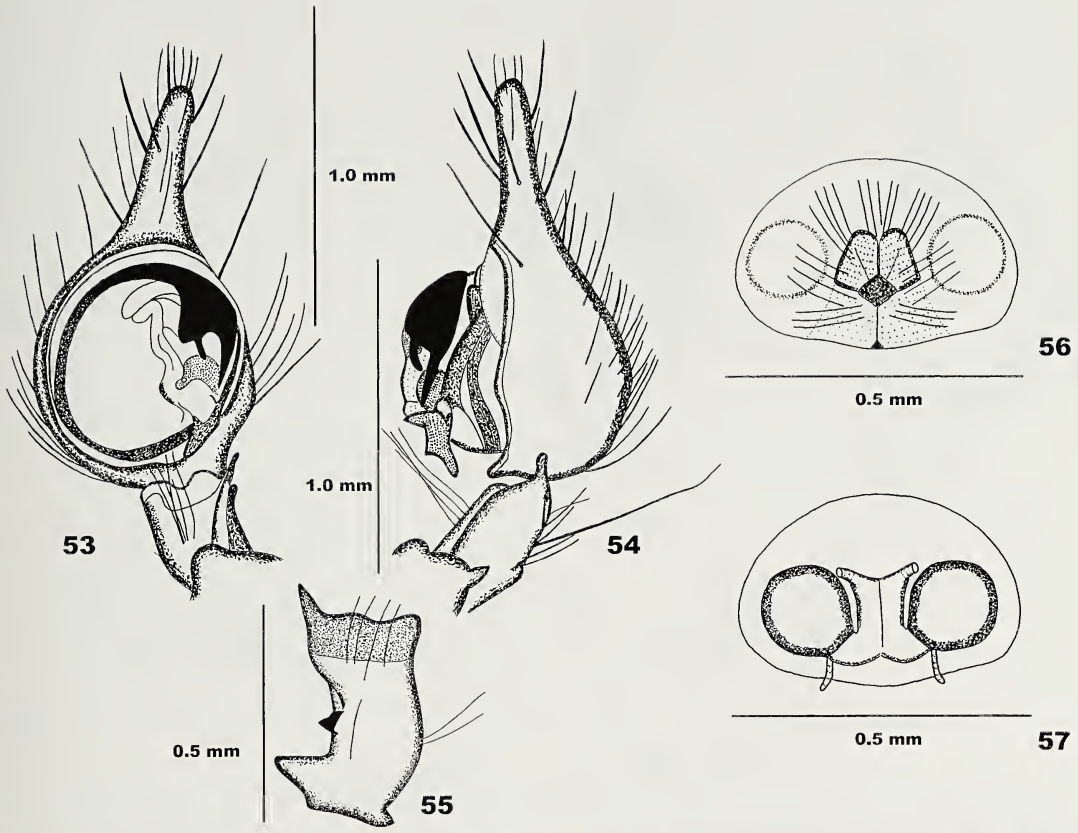
The illustration of the embolus supposedly representing *C. emertoni* given by Chamberlin & Ivie (1937, p. 233, fig. 21) was not that of the species described by Simon (1897), but rather represents *C. bifurcata*.

Measurements.—*Female:* Total length, 5.89–8.25 (6.98); carapace length, 2.54–3.84 (3.08); carapace width, 1.89–2.64 (2.23); femur I length, 3.32–5.08 (4.11). *Male:* Total length, 6.51–6.98 (6.62); carapace length, 2.79–3.66 (3.25); carapace width, 2.20–2.64 (2.45); femur I length, 4.65–5.89 (5.21).

Distribution.—Northern California and Oregon (Map 2).

Natural History.—Mature specimens collected in July, August and September from redwood and Douglas-fir forests, and from under rocks and fallen logs, sometimes in relatively dry conditions.

Material Examined.—U.S.A.: *Oregon*: Coos County, Bandon, 30 September 1959 (V. Roth), 1 ♂ (AMNH); Douglas County, 4 miles S. of Canyonville, 3 August 1959 (V. Roth, W.J. Gertsch), 1 ♂, 9 immatures (AMNH), Reedsport, dense Douglas-fir, 30 September 1959 (V. Roth), 1 ♂ (AMNH); Jackson County, Lithia Park, Ashland, 31 August 1959 (W.J. Gertsch, V. Roth), 21 ♂, 18 ♀, 9 immatures (AMNH); Josephine County, 2 miles N. of Selma, 22 August 1959 (V. Roth, W.J. Gertsch), 3 ♂, 2 ♀, 2 immatures



Figures 53–57.—*Calymmaria minuta*. 53. Palpus, ventral; 54. Palpus, lateral; 55. Palpal tibia, dorsal; 56. Epigynum, ventral; 57. Epigynum, dorsal.

(AMNH); Klamath County, cave, Crater Lake National Park, 11 August 1951 (D. Lowrie), 1 ♂ (AMNH); Linn County, Cascadia, underside of rock in forest, dry situation, 11 September 1948 (V. Roth), 1 male (AMNH), 1 miles W. of Cascadia, 23 July 1949 (V. Roth, F. Beer), 1 ♂, 2 immatures (AMNH), House Rock Forest Camp, 13 miles E. of Cascadia, 23 July 1949 (V. Roth, F. Beer), 4 ♂, 2 ♀, 1 immature (AMNH), Trout Creek Forest Camp, near Cascadia, 31 July 1951 (V. Roth), 2 ♂ (AMNH); Marion County, 18 September 1954 (V. Roth), 1 ♂ (AMNH); *California:* Del Norte County, Fort Dick, 31 September 1959 (V. Roth), 1 ♂, 1 ♀ (AMNH); Humboldt County, Pepperwood, redwood forest, 12 August 1950 (V. Roth), 2 ♂ (AMNH), Carlotta, 15 September 1961 (W. Ivie, W.J. Gertsch), 2 ♂ (AMNH), Orick, 16 September 1961 (W. Ivie, W.J. Gertsch), 2 ♂, 5 ♀ (AMNH), Carlotta, edge of redwoods by lumber camp, 27 September 1963 (W.J. Gertsch), 4 ♂, 3 ♀, 9 immatures (AMNH).

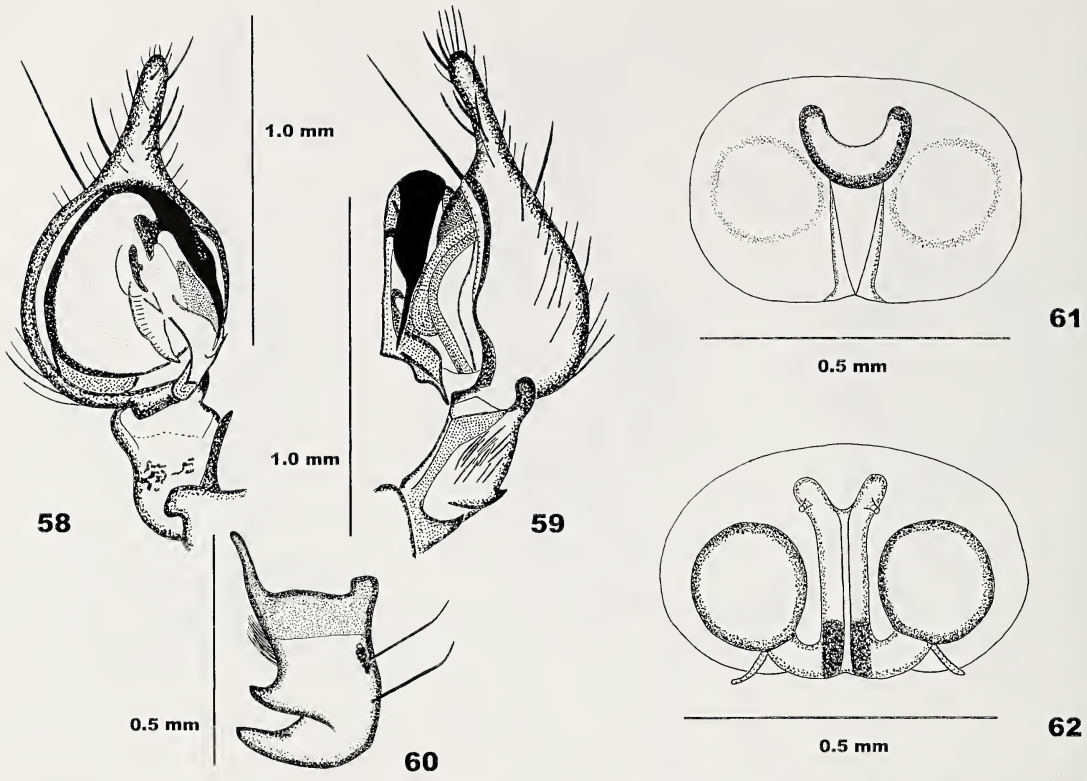
Calymmaria californica (Banks 1896)
Figs. 20–24; Map 3

Tegenaria californica Banks 1896: 90. Banks 1898: 230; 1904: 340; 1910: 16; Coolidge 1907: 375; Petrunkevitch 1911: 537; Emerton 1920: 326; Moles & Johnson 1921: 43; Worley 1932: 53; Schenkel 1950: 82–84, fig. 30.

Calymmaria californica (Banks): Chamberlin & Ivie 1937: 213, figs. 4, 5; Roewer 1954: 45; Bonnet 1956: 939; Roth 1956: 177.

Types.—Male holotype and female allotype from Palo Alto, Santa Clara County, California, U.S.A., 37°26′N, 122°08′W, no date, R.W. Doane (AMNH, examined).

Diagnosis.—*Calymmaria californica* closely resembles *C. monicae* and *C. aspenola*, but in *C. californica* the ducts of the epigynal midpiece in the female are much shorter, hardly higher than the diameter of the spermathecae (Fig. 24). The males of *C. californica* are easily distinguished by the conspicuous ectal tooth midway on the embolus (Fig. 20).



Figures 58–62.—*Calymmaria monicae*. 58. Palpus, ventral; 59. Palpus, lateral; 60. Palpal tibia, dorsal; 61. Epigynum, ventral; 62. Epigynum, dorsal.

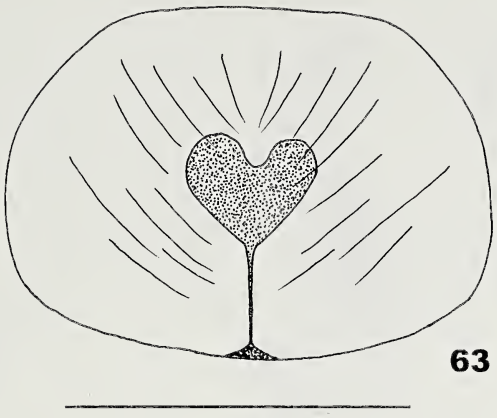
Description.—*Female:* Carapace typical. Dorsum of abdomen pale gray with darker basal lanceolate mark flanked by large pale gray or silver spots and followed by four or five very wide pale gray transverse chevrons; venter gray with two pale yellow lateral longitudinal stripes. Legs weakly to strongly annulate, spination typical. Epigynum of female externally with opening obscure and flanked by rounded sclerotized areas, below opening with a darker sclerotized line (Fig. 23); internally with ducts of midpiece widest at top and well-separated, blind ducts short, midpiece equal to or only slightly higher than diameter of spermathecae, lateral ducts thick and united medially (Fig. 24). *Male:* Carapace and abdomen same as in female, but darker. Legs annulate, spination typical.Male palpus with PA small and knob-like (Fig. 20); basal RTA large, rounded, medial RTA two small ridges, distal RTA short, thick, and slightly hooked ventrally (Fig. 20); tibia with one prolateral spine, one or two long ventral setae, and numerous short retrolateral setae; cymbium elongate distad, with two spines near base of tip and five or six spines on tip; embolus thick and tapering gradually to a point with a conspicuous ectal tooth midway (Fig. 20), conductor with lobe short, rounded.

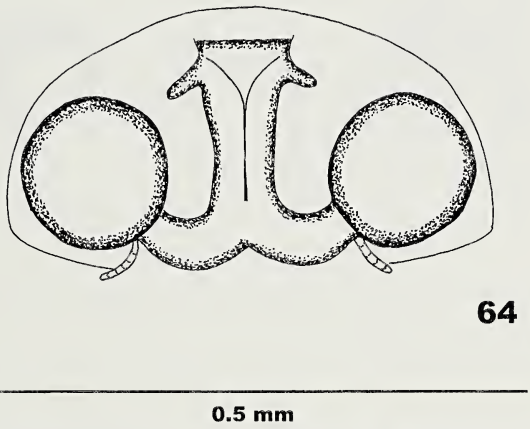
Measurements.—*Female:* Total length, 4.19–5.33 (4.85); carapace length, 1.86–2.33 (1.97); carapace width, 1.27–1.58 (1.44); femur I length, 1.86–2.54 (2.11). *Male:* Total length, 4.00–4.86 (4.32); carapace length, 1.74–2.33 (2.18); carapace width, 1.40–1.92 (1.76); femur I length, 2.08–2.98 (2.69).

Distribution.—Southern California to northern California, mainly in the Coast Ranges, and Yosemite National Park (Map 3).

Natural History.—Mature specimens collected in January, February, April, September, October, November, and December, from canyons and from beneath the bark of Douglas-fir.

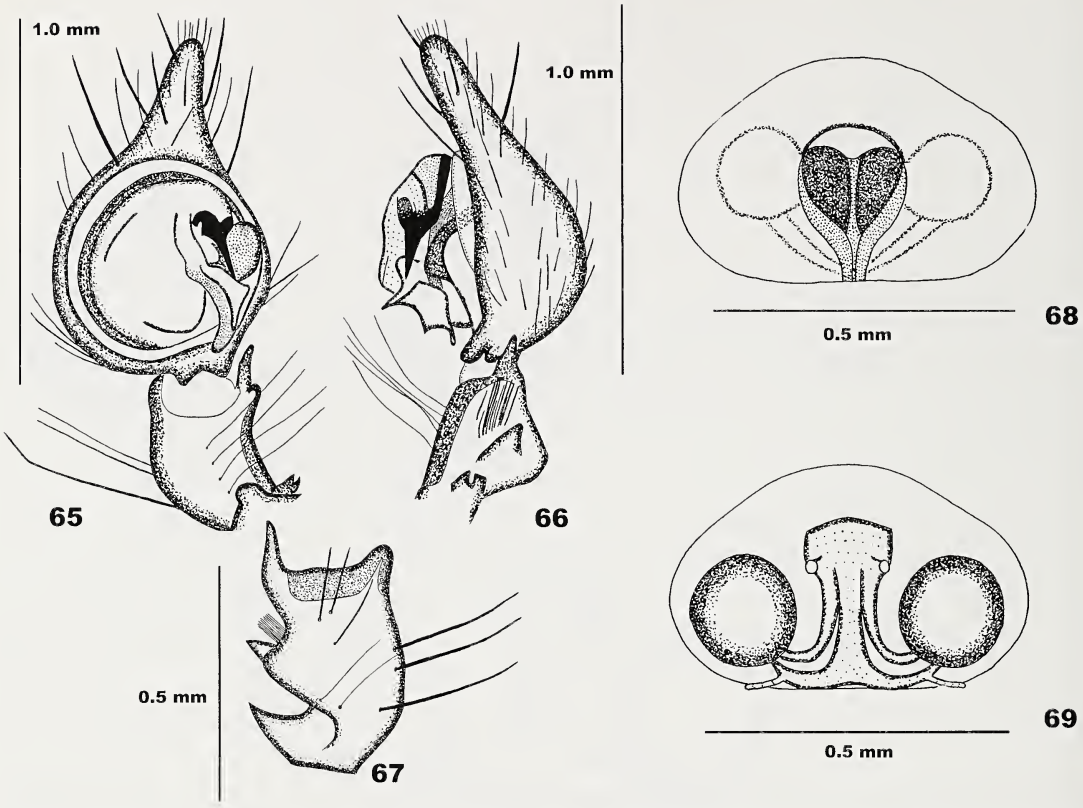
Material Examined.—U.S.A.: *California:* Alameda County, Berkeley, no date (no collector), 3 ♀ (AMNH), February 1920 (Dietrich), 1 ♀ (AMNH), Castro Valley, 7 January





Figures 63–64.—*Calymmaria monterey*. 63. Epigynum, ventral; 64. Epigynum, dorsal.

1939 (W.M. Pearce), 1 ♀ (AMNH), Redwood Park, Oakland, 12 March 1940 (no collector), 1 ♀ (CASC), Oakland, 1 February 1954 (V. Roth, R. Schuster), 5 ♀ (AMNH), Canyon off Niles Canyon, 1 January 1964 (V. Roth), 1 ♂, 8 ♀, 9 immatures (AMNH), off Niles Canyon on Palomres Road, 2 January 1964 (V. Roth), 2 ♀, 3 immatures (AMNH), 25 miles S. of Livermore on Mines Road, 7 December 1969 (V. Roth), 4 ♀, 1 immature (AMNH), Contra Costa County, Tilden Park, Berkeley Hills, 8 April 1950 (E.I. Schlinger), 1 ♀ (AMNH), SE. corner of Mt. Diablo State Park, 13 January 1964 (V. Roth, P. Craig), 1 ♀ (AMNH); Humboldt County, Carlotta, 15 September 1961 (W. Ivie, W.J. Gertsch), 1 ♀, 3 ♂, 15 immatures (AMNH); Los Angeles County, Los Angeles, November (W.J. Gertsch), 1 ♂, 3 ♀ (AMNH), Tapia Park, Santa Monica Mountains, 20 February 1954 (R.X. Schick), 1 ♀ (AMNH); Marin County, 8 November 1919 (Dietrich), 1 ♂ (AMNH), slope of Mt. Tamalpais 10 January 1963 (V. Roth, P. Craig), 1 ♀ (AMNH), west slope of Mt. Tamalpais, 10 January 1963 (V Roth, P. Craig), 7 ♀, 2 immatures (AMNH), Ridge between San Anselmo and North San Rafael, 22 January 1977 (L. Freihofer), 1 ♂ (CASC); Mariposa County, 6 miles S. of Mather, 4 September 1958 (V. Roth), 1 ♂, 1 ♀, 2 immatures (AMNH); Monterey County, Pacific Grove, 24 December 1951 (B. Malkin), 1 ♀ (AMNH); Napa County, Oakville, 31 December 1953 (V. Roth), 2 ♀ (AMNH); San Francisco County, San Francisco, 6 November 1934 (no collector), 1 ♀ (CASC); Santa Clara County, Santa Cruz Mountains, Soda Springs Canyon, 24 April 1977 (D. C. Rentz, E. W. Kirschbaum),



Figures 65–69.—*Calymmaria nana*. 65. Palpus, ventral; 66. Palpus, lateral; 67. Palpal tibia, dorsal; 68. Epigynum, ventral; 69. Epigynum, dorsal.

2 ♀ (CASC), Stanford University, no date (no collector), 1 ♂ (AMNH), no date (R. W. Doane), 1 ♂ holotype, 1 ♀ allotype (AMNH); San Mateo County, Woodside, Winter 1957–1958 (Washburn), 1 ♂ (AMNH); Santa Cruz County, Carmel, 21 December 1953 (V. Roth), 1 ♀, 2 immatures (AMNH), 1 miles N. of Santa Cruz, 23 December 1953 (V. Roth), 2 ♀ (AMNH); Siskiyou County, 29 September 1951 (W.M. Pearce), 1 ♂ (AMNH); Sonoma County, Cazadero, 13 March 1918 (H. van Duzee), 3 ♀ (CASC), Glen Ellen, 15 February 1954 (V. Roth, R. Schuster), 2 ♀ (AMNH), 2 miles W. of Cazadero, 30 October 1954 (H. B. Leech), 2 ♂, 1 ♀ (AMNH), W. of Mark West Reservoir, in Douglas-fir litter, 22 January 1958 (F. R. Schuster), 1 ♀ (AMNH), Guerneville, 4 April 1960 (W.J. Gertsch, W. Ivie, R. Schrammel), 1 ♀ (AMNH), N. of Guerneville, October 1962 (V. Roth), 2 ♂ (AMNH), Annadel State Park, under bark of *Eucalyptus*, 11 November 1979 (D. Ubick), 1 ♂, 1 ♀ (DUSC); no county, no specific locality (J.C. Chamberlin), 3 ♂, 1 ♀ (AMNH).

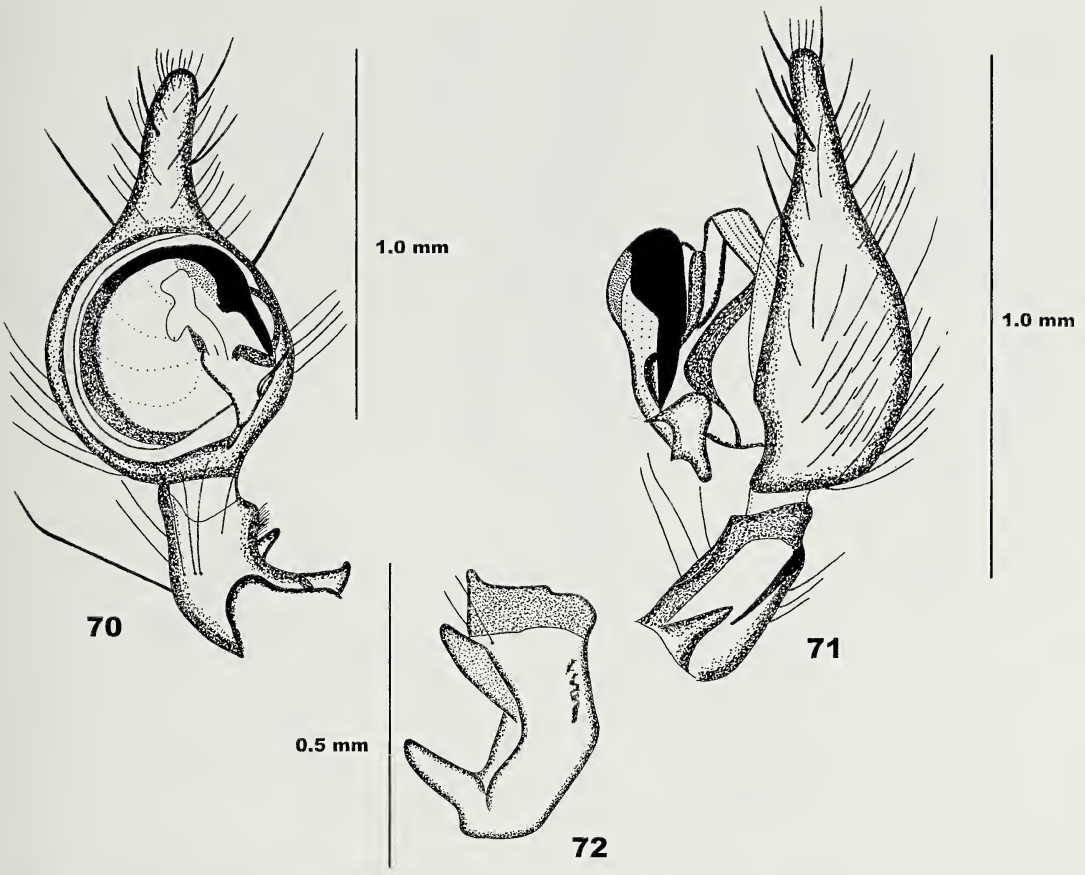
Calymmaria carmel new species
Figs. 25–27; Map 3

Type.—Male holotype from Carmel, Monterey County, California, U.S.A., 36°33′N, 121°55′W, 31 March 1954, J. O'Dell (AMNH).

Etymology.—The specific name is a noun in apposition taken from the type locality.

Diagnosis.—*Calymmaria carmel* can be distinguished from other *Calymmaria* by the gradually tapering embolus and conductor with small basal lobe. The two specimens available exhibit a wide variation in size and coloration.

Description.—*Male:* Carapace typical. Dorsum of abdomen pale yellow with basal gray lanceolate mark expanded in middle and followed by four gray transverse chevrons; venter pale gray with wide yellow lateral lon-



Figures 70–72.—*Calymmaria orick*. 70. Palpus, ventral; 71. Palpus, lateral; 72. Palpal tibia, dorsal.

gitudinal stripes. Legs annulate, spination typical. Male palpus with PA knob-like and slightly hooked (Fig. 25); basal RTA thick and bluntly pointed, medial RTA pointed, distal RTA long and pointed; tibia with one prolateral spine, ventrally with four or five long setae, many dense, short retrolateral setae, and numerous dorsal spines; cymbium elongate distad, with two spines near base of tip and five spines on tip; embolus thick at base and gradually tapering, conductor with small rounded basal lobe. *Female:* Unknown.

Measurements.—(n = 2): Total length, 4.68–6.20; carapace length, 2.23–3.10; carapace width, 1.80–2.33; femur I length, 2.82–5.21.

Distribution.—Monterey and San Bernardino Counties, California (Map 3).

Natural History.—Mature specimens collected from March and October.

Material Examined.—U.S.A.: *California:* Monterey County, Carmel, 31 March 1954 (J. O'Dell), 1 ♂ holotype (AMNH); San Bernardino County, Mountain Home Creek, 15 October 1959 (V. Roth), 1 ♂ (AMNH).

Calymmaria emertoni (Simon 1897)
Figs. 28–32; Map 3

Tegenaria emertoni Simon 1897: 17; Petrunkevitch 1911: 538.

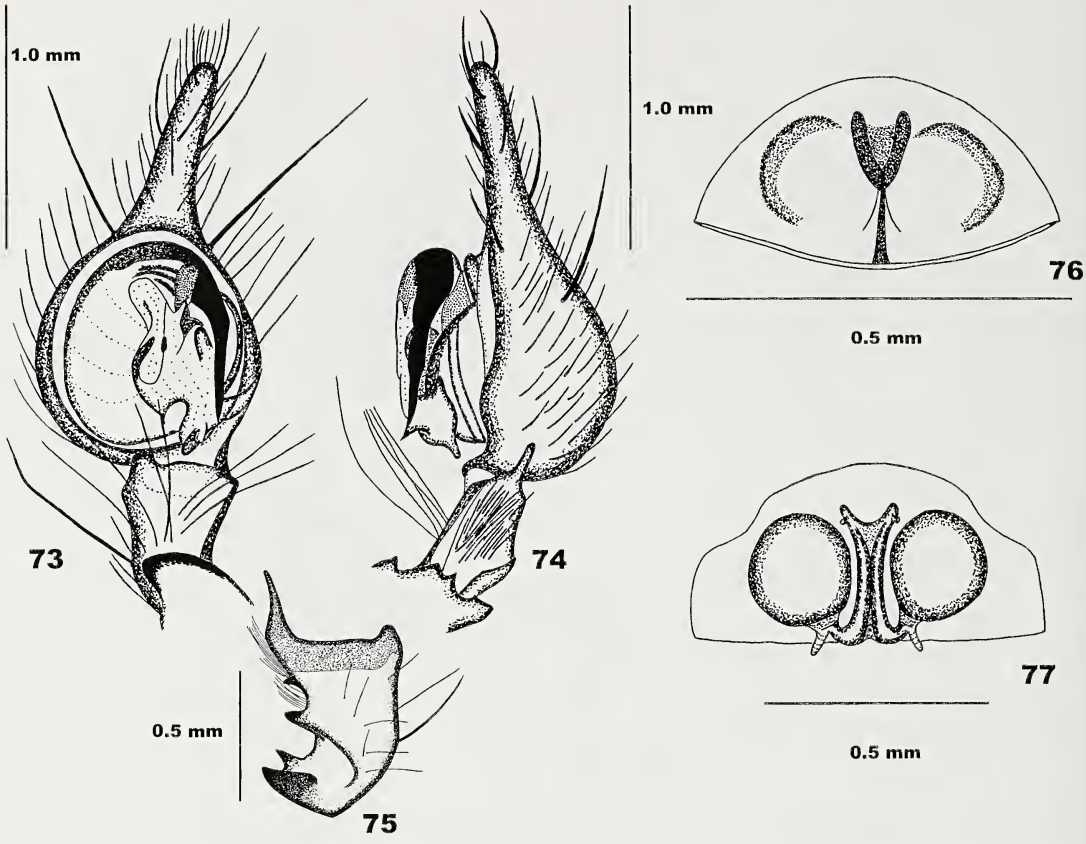
Tegenaria californica: Exline 1936: 25, fig. 2 (misidentification).

Tegenaria quadrata Exline 1936: 22, fig. 4, Roewer 1944: 33. NEW SYNONYMY.

Calymmaria quadrata (Exline): Chamberlin & Ivie, 1937:213; Exline 1938: 23, fig. 27; Roewer 1954: 46; Bonnet 1956: 940; Roth 1968: 31.

Calymmaria emertoni (Simon): Chamberlin & Ivie, 1937: 215, fig. 10, *not* 11; Exline 1938: 21, figs. 3; 27, 29, not 29; Roewer 1954: 46; Bonnet 1956: 940; Roth 1968: 31.

Types.—*Tegenaria emertoni*: male holotype from "Washington Territory", U.S.A. (MNHN, examined); *Tegenaria quadrata*: female holotype from Seattle, King County,



Figures 73–77.—*Calymmaria persica*. 73. Palpus, ventral; 74. Palpus, lateral; 75. Palpal tibia, dorsal; 76. Epigynum, ventral; 77. Epigynum, dorsal.

Washington, U.S.A., 47°36′N, 122°19′W (PESC, examined).

Diagnosis.—*Calymmaria emertoni* is a highly variable species closely resembling *C. bifurcata* from which female specimens are not readily separated (see diagnosis of *C. bifurcata*). Male *C. emertoni* resemble *C. nana*, but the embolus is rounded at the sides (Fig. 28).

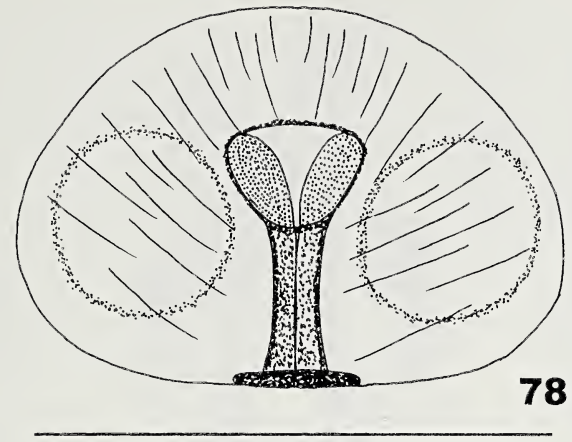
Description.—*Female:* Carapace typical. Dorsum of abdomen yellow with gray basal lanceolate mark followed by four gray transverse chevrons; venter gray with two yellow lateral longitudinal stripes. Legs annulate, spination typical. Epigynum of female externally with wide sclerotization below opening and fused ducts of midpiece visible (Fig. 31); internally with ducts of midpiece united near top and well separated below, blind ducts long (Fig. 32). *Male:* Same as in female but darker. Male palpus with PA short, broad (Fig. 28); basal RTA from above long, rounded at tip, medial RTA flat, wide from above, distal RTA short (Fig. 29); tibia with one prolateral spine, two long ventral setae, several short retrolateral setae; cymbium elongate distad, with two spines near base of tip, six spines on tip; embolus with thick base abruptly tapering to point, conductor with no basal lobe (Fig. 28).

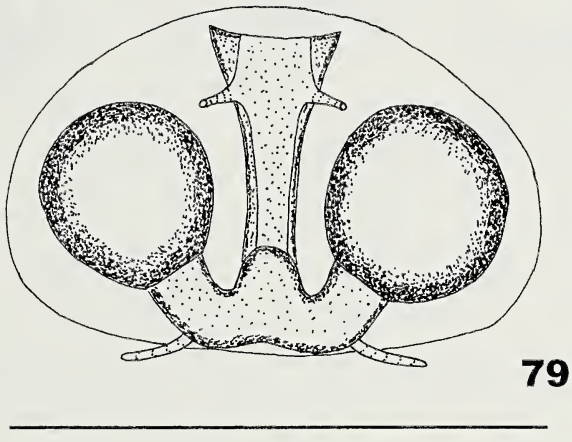
Measurements.—*Female:* Total length, 5.02–7.95 (6.68); carapace length, 2.05–3.22 (2.65); carapace width, 1.43–2.48 (2.00); femur I length, 2.45–4.37 (3.31). *Male:* Total length, 5.58–6.54 (6.10); carapace length, 2.82–3.13 (2.97); carapace width, 2.23 2.54 (2.41); femur I length, 4.65–5.52 (5.07).

Distribution.—Coast Ranges of northern California, western Oregon, and Washington (Map 3).

Natural History.—Mature specimens collected in every month except January and February. Occasionally specimens have been collected from buildings.

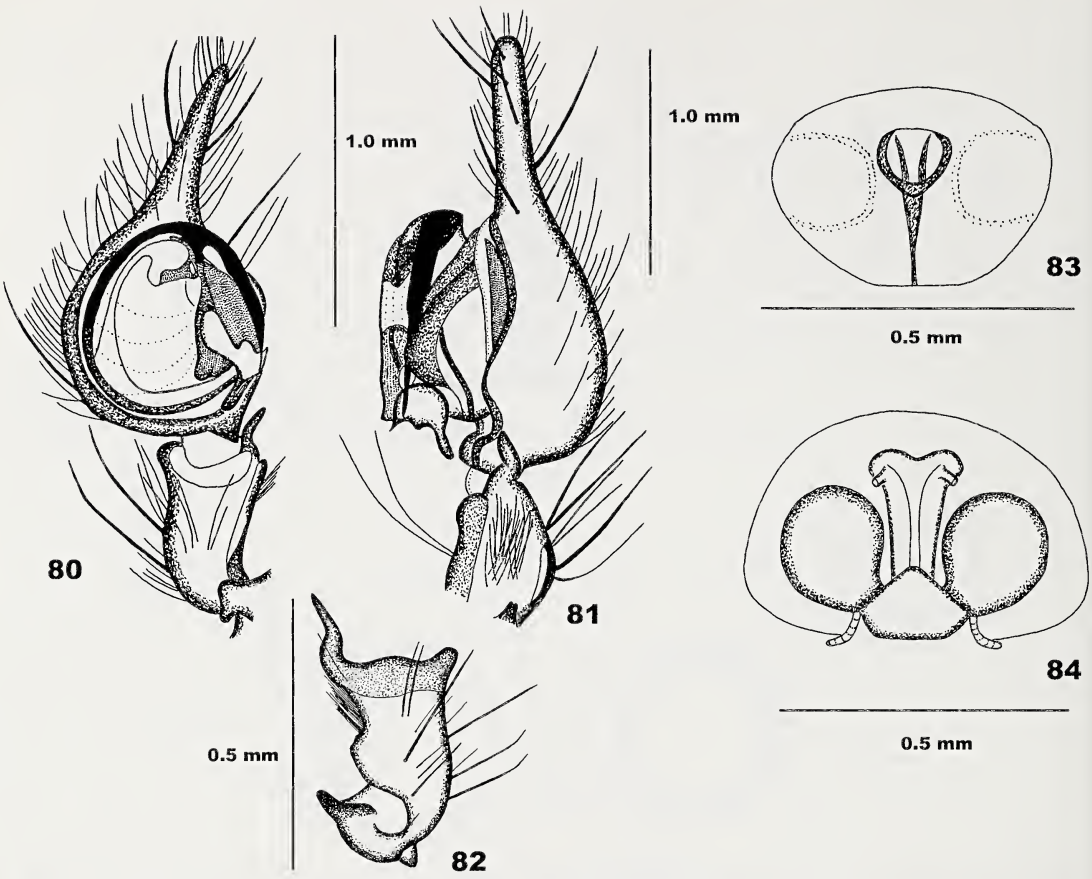
Material Examined.—CANADA: *British*





Figures 78–79.—*Calymmaria rosario*. 78. Epigynum, ventral; 79. Epigynum, dorsal.

Columbia: Kyuquot, under woodpile in shed, 2 April 1952 (S. L. Neave), 2 ♀ (AMNH), Moketas Island, 6 September 1958 (no collector), 2 ♂, 4 ♀ (AMNH), Union Island, under ground litter, 25 September 1959 (S. L. Neave), 1 ♀, 1 immature (AMNH); Wellington, Vancouver Island, 1–19 May 1950 (R. Guppy), 1 ♀ (AMNH), September 1950 (R. Guppy), 2 ♂ (AMNH); 1–20 November 1950 (R. Guppy) 1 ♀ (AMNH); Tofino, 10–13 May 1950 (R. Guppy), 1 ♀ (AMNH), 1–21 August 1950 (R. Guppy), 1 ♂ (AMNH), 5–20 June 1951 (R. Guppy), 1 ♀ (AMNH). U.S.A.: *Washington*: Clallam County, Sol Duc Hot Springs, Olympic National Park, 27 August 1959 (V. Roth, W.J. Gertsch), 1 ♀, 3 immatures (AMNH); Clark County, 10 miles N. of Vancouver, 10 September 1935 (R.V. Chamberlin, W. Ivie), 4 ♀ (AMNH); Grays Harbor County, Quinault, 30 August 1936 (C. Lloyd), 1 ♂ (AMNH); Island County, Rosario Beach, Whidby Island, 19 August 1955 (V. Roth), 1 ♂, 3 ♀, 1 immature (AMNH); Jefferson County, S. of Bogachiel, 26 August 1959 (W.J. Gertsch, V. Roth), 2 ♂, 1 ♀ (AMNH); King County, Mercer Island, 22 March 1937 (M. E. Russel) 1 ♀ (AMNH), Seattle, 8 October 1930 (H. Exline), 1 ♀ (AMNH), no date (? Kincaid), 1 ♀ (PESC); Lewis County, Ohanapecosh Campground, Mt. Rainier National Park, 12 June 1969 (ROM Field Party), 1 ♀ (CNC); San Juan County, Mt. Constitution, 5 August 1935 (H. Exline), 1 ♀ (AMNH), East Sound, Orcas Island, 17 Au-

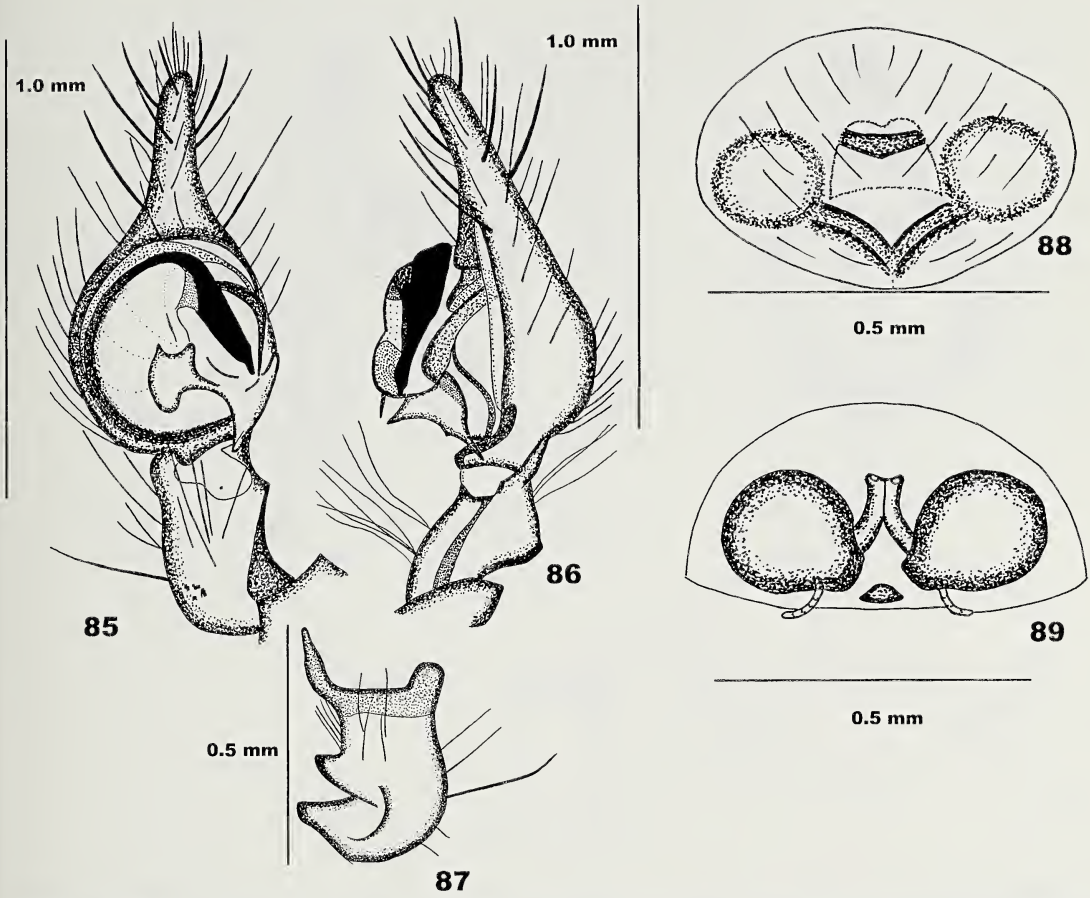


Figures 80–84.—*Calymmaria rothi*. 80. Palpus, ventral; 81. Palpus, lateral; 82. Palpal tibia, dorsal; 83. Epigynum, ventral; 84. Epigynum, dorsal.

gust 1936 (H. Exline), 1 ♀ (AMNH); Skamania County, 10 miles W. of Spirit Lake, 16 August 1955 (V. Roth), 1 ♀ (AMNH); Snohomish County, Everett, November–December 1934 (A. Lumley), 1 ♀ (AMNH), Arlington, 11 September 1935 (R.V. Chamberlin, W. Ivie), 1 female (AMNH), 4 miles NW. of Monroe, 27 August 1959 (V. Roth, W.J. Gertsch), 1 ♀, 2 immatures (AMNH); Thurston County, Olympia, September 1933 (Christopher), 1 ♂ (AMNH), 22 August 1954 (V. Roth), 1 ♂, 1 ♀ (AMNH); Whatcom County, Mt. Baker Glacier, 7 September 1965 (J. and W. Ivie), 1 ♀ (AMNH): *Oregon;* Benton County, Mary's Peak (3900′), 21 August 1952 (V. Roth), 1 ♂, 1 ♀ (AMNH), McDonald Forest, N. of Corvalis, 29 September 1959 (V. Roth), 1 ♂, 3 ♀, 2 immatures (AMNH); Curry County, Pistol River, 17 September 1956 (B. Malkin), 1 ♂, 2 ♀ (AMNH); Douglas County, Roseburg, Bogus Creek Forest Camp, 13 September 1955 (V. Roth, Capizzi), 2 ♂ (AMNH), 9 miles SW. Cottage Grove, 23 August 1959 (W.J. Gertsch, V. Roth), 1 ♂, 1 female, 1 immature (AMNH), Idleyld Park, N. Umpqua River, 23 August 1959 (V. Roth, W.J. Gertsch), 2 ♂, 11 ♀, 5 immatures (AMNH); Lane County, Triangle Lake, 30 September 1959 (V. Roth), 1 ♂, 1 ♀ (AMNH); Marion County, Silver Creek Falls, 27 September 1959 (V. Roth), 1 ♂ (AMNH); no county, 2 miles S. of Dolphin Log Cabin, 3 April 1948 (V. Roth), 1 ♀ (AMNH).

Calymmaria farallon new species
Figs. 33–37; Map 4

Types.—Male holotype and female allotype from South Farallon Island, former sea cave above landing, San Francisco County, California, U.S.A., 37°44′N, 123°02′W, 13 April 1970, W.E. Azevedo (CASC).



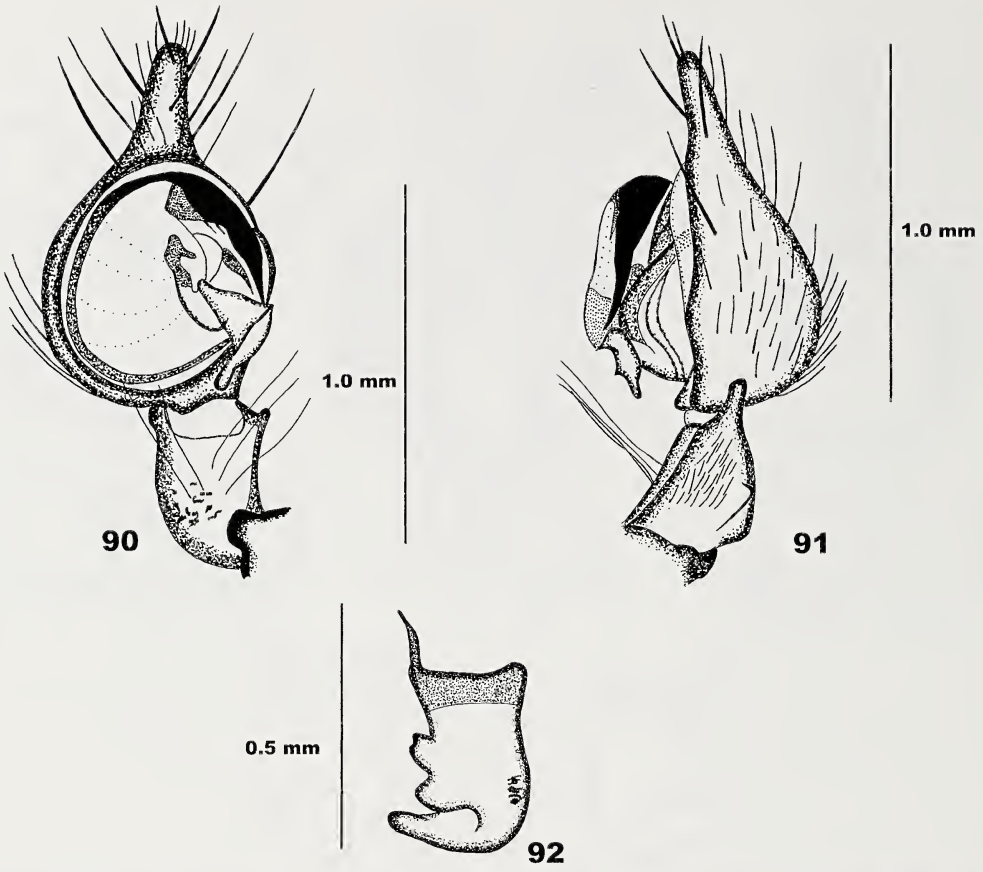
Figures 85–89.—*Calymmaria scotia*. 85. Palpus, ventral; 86. Palpus, lateral; 87. Palpal tibia, dorsal; 88. Epigynum, ventral; 89. Epigynum, dorsal.

Etymology.—The specific name is a noun in apposition taken from the type locality.

Diagnosis.—This is a large species of *Calymmaria*. Females resemble *C. suprema*, but the midpiece of the epigynum is wide at the top. Males are readily separated from all other species of *Calymmaria* except *C. californica* by the presence of an ectal tooth near the base of the embolus. *Calymmaria farallon* males are separated from *C. californica* by its large size and ectal tooth more basal than distal (Fig. 34).

Description.—*Female:* Carapace typical. Dorsum of abdomen pale gray with basal dark gray lanceolate mark followed by dark gray mottling; venter pale gray with wide yellow lateral longitudinal stripes. Legs unmarked to strongly annulate, spination typical. Epigynum of female externally with large opening and sclerotized below (Fig. 36); internally with wide midpiece, small blind ducts, and thick, divided lateral ducts (Fig. 37). *Male:* Carapace typical. Dorsum of abdomen pale yellow with faint gray basal lanceolate mark followed by four pairs of irregular spots fused caudally; venter pale yellow. Legs unmarked or weakly annulate, spination typical. Male palpus with PA large and round; basal RTA thick and bluntly pointed, medial RTA rounded, distal RTA long and rounded (Fig. 33); tibia with one prolateral spine and several long setae, two long setae, short dense retrolateral setae; cymbium elongate distad, with two spines near base of tip and six spines on tip; embolus thick and tapering to a point with an ectal tooth near base (Fig. 33), conductor with small rounded basal lobe.

Measurements (n = 4 of each sex).—*Female:* Total length, 7.50–9.83 (8.29); carapace length, 2.85–4.31 (3.41); carapace width



Figures 90–92.—*Calymmaria sequoia*. 90. Palpus, ventral; 91. Palpus, lateral; 92. Palpal tibia, dorsal.

2.17–3.10 (2.64); femur I length, 3.29–5.02 (4.03). *Male:* Total length, 5.55–7.35 (6.47); carapace length, 2.91–3.60 (3.31); carapace width, 2.26–2.51 (2.41); femur I length, 4.03–4.65 (4.49).

Distribution.—Farallon Islands, San Fransisco County, California (Map 4).

Natural History.—Mature specimens collected from the ceiling of caves on the Farallon Islands in April, September, and October.

Material Examined.—U.S.A.: *California*: San Francisco County, South Farallon Islands, former sea cave above east landing, 13 April 1970 (W. E. Azevedo), 2 ♂, 2 ♀ (CASC); Southeast Farallon, on ceiling with web in entrance of cave on N. side of Shubrick Pt., 15 October 1977 (M. G. Kellog), 1 ♀ (CASC), Rabbit Cave, 16 September 1978 (V.F. Lee), 1 ♂, 1 immature (CASC); Northeast Farallon Island, cave N. of Breaker Cove ("Cricket Cave"), 19 September 1978 (V.F. Lee), 1 ♂, 1 ♀ (CASC).

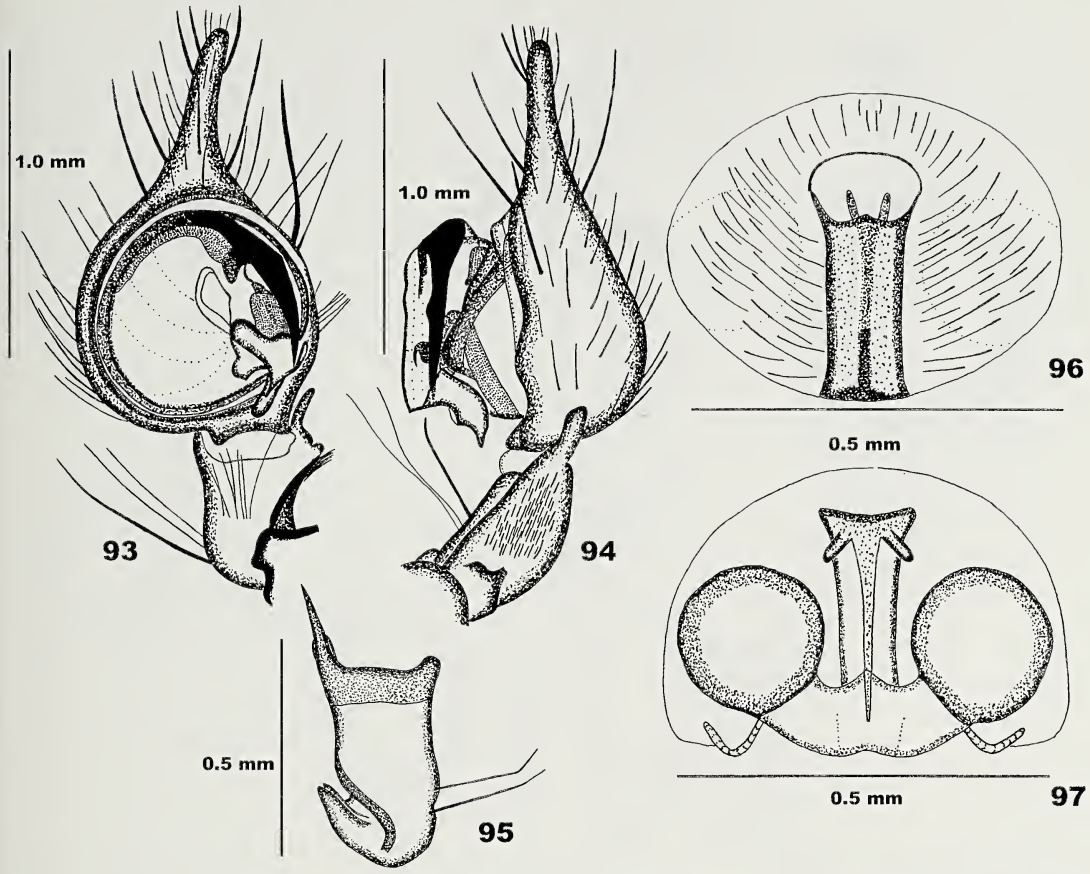
Calymmaria gertschi new species
Figs. 38, 39; Map 4

Type.—Male holotype from Anchor Bay, Mendocino County, California, U.S.A., 38°48′N, 123°34′W, 12 September 1961, W. Ivie, W.J. Gertsch (AMNH).

Etymology.—The specific name is a patronym honoring Dr. Willis J. Gertsch, co-collector of the type specimen.

Diagnosis.—*Calymmaria gertschi* is easily separated from other *Calymmaria* by the bilobed basal and distal RTA's (Figs. 38,39).

Description.—*Male:* Carapace typical, few markings: Dorsum of abdomen pale yellow with pale gray basal lanceolate mark followed by four distinct transverse chevrons; venter



Figures 93–97.—*Calymmaria shastae*. 93. Palpus, ventral; 94. Palpus, lateral; 95. Palpal tibia, dorsal; 96. Epigynum, ventral; 97. Epigynum, dorsal.

pale gray with faint yellow lateral longitudinal stripes. Legs faintly annulate, spination typical. Male palpus with PA a small angle (Fig. 38); basal RTA with a ventral bifurcate lobe and a dorsal club-shaped lobe; medial RTA two small ridges, distal RTA bilobed; tibia with dense short ventral setae; cymbium short distad, with two spines near base of tip and six spines near tip; embolus long, thin, tapering to a point, basal lobe of conductor poorly developed. *Female:* Unknown.

Measurements.—*(n = 1):* Total length, 4.12; carapace length, 1.82; carapace width, 1.49; femur I length, 2.36.

Distribution.—Anchor Bay, Mendocino County, California (Map 4).

Natural History.—One mature specimen collected in September.

Material Examined.—Known only from the type.

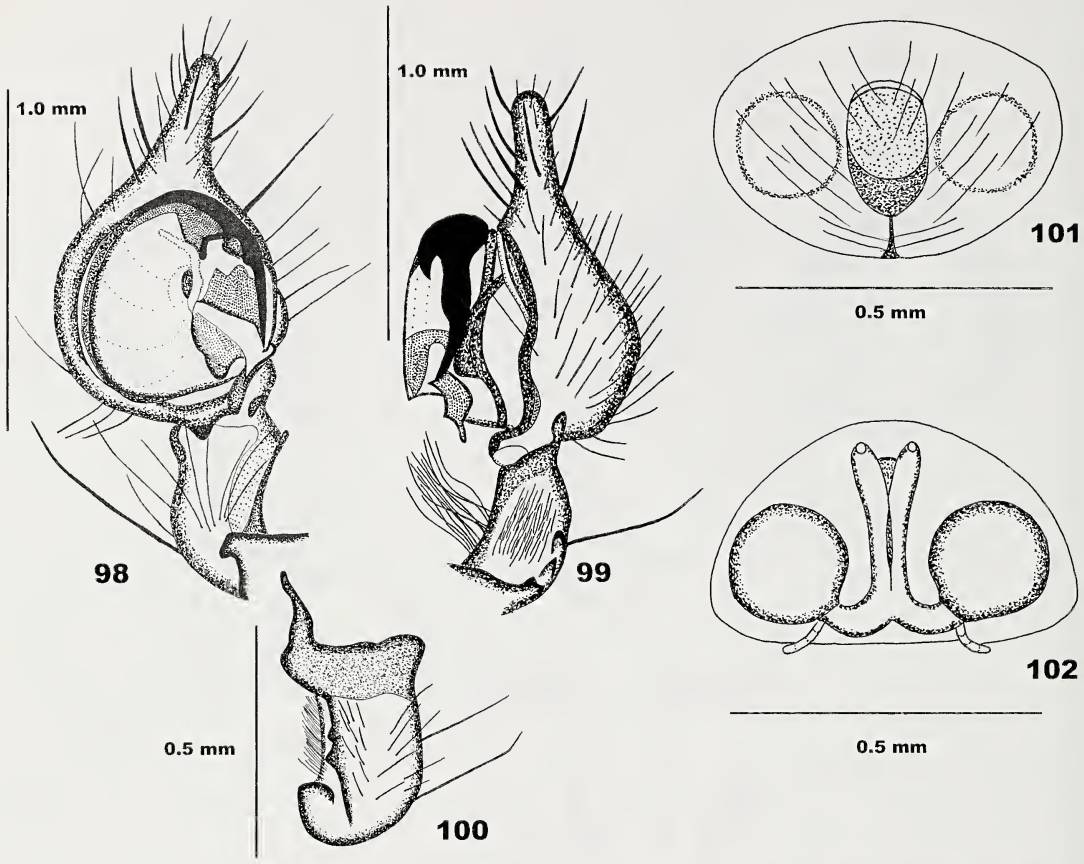
Calymmaria humboldt new species
Figs. 40–42; Map 4

Type.—Male holotype from redwood grove in Weott, Humboldt County, California, U.S.A., 40°19′N, 123°55′W, 21 September 1964, J. and W. Ivie (AMNH).

Etymology.—The specific name is a noun in apposition taken from the type locality.

Diagnosis.—*Calymmaria humboldt* can be separated from other *Calymmaria* by the toothed basal RTA, lobe-like medial RTA (Fig. 41), and the thin, long embolus (Fig. 40).

Description.—*Male:* Carapace typical, dorsum of abdomen gray with basal lanceolate mark flanked by large pale yellow spots and followed by four pairs of yellow spots decreasing in size and becoming transverse stripes caudally; venter gray with pale gray lateral longitudinal stripes. Legs weakly an-



Figures 98–102.—*Calymmaria sierra*. 99. Palpus, ventral; 99. Palpus, lateral; 100. Palpal tibia, dorsal; 101. Epigynum, ventral; 102. Epigynum, dorsal.

nulate, spination typical. Male palpus with PA large and knob-like (Fig. 40); basal RTA with two large teeth separated by two small teeth, medial RTA lobelike, distal RTA long, rounded and curved (Fig. 41); tibia with one long prolateral spine, several long ventral setae, and dense short dorsal setae; cymbium moderately elongate distad, with three spines near base of tip and six spines on tip; embolus long, thin tapering, conductor with small round basal lobe (Fig. 40). *Female:* Unknown.

Measurements.—*(n = 1):* Total length, 5.22; carapace length, 2.45; carapace width, 2.02; femur I length, 2.48.

Distribution.—One specimen from Humboldt County, California (Map 4).

Natural History.—Mature specimen collected from redwoods in September.

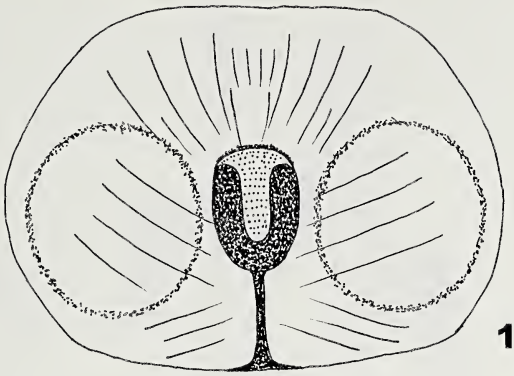
Material Examined.—Known only from the type.

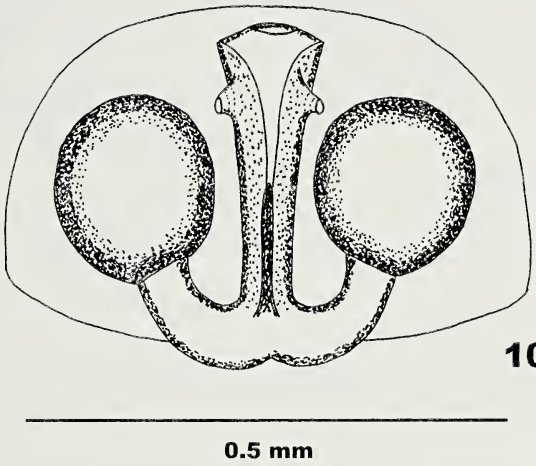
Calymmaria iviei new species
Figs. 43–47; Map 5

Types.—Male holotype from 6 miles S. of Fish Camp, Mariposa County, California, U.S.A., 37°23′N, 119°38′W, 12 September 1959, no collector (AMNH); female allotype from Fish Camp, Mariposa County, California, U.S.A., 37°28′N, 119°38′W, 5 September 1958, V. Roth (AMNH).

Etymology.—The specific name is a patronym in honor of Wilton Ivie, collector of a large number of *Calymmaria* specimens examined in this study.

Diagnosis.—Female *Calymmaria iviei* can be easily separated from other *Calymmaria* by the lack of external sclerotization of the epigynum (Fig. 46), and the short, truncate midpiece (Fig. 47). Males can be separated by the short PA, thickened embolic base with coiled





Figures 103–104.—*Calymmaria similaria*. 103. Epigynum, ventral; 104. Epigynum, dorsal.

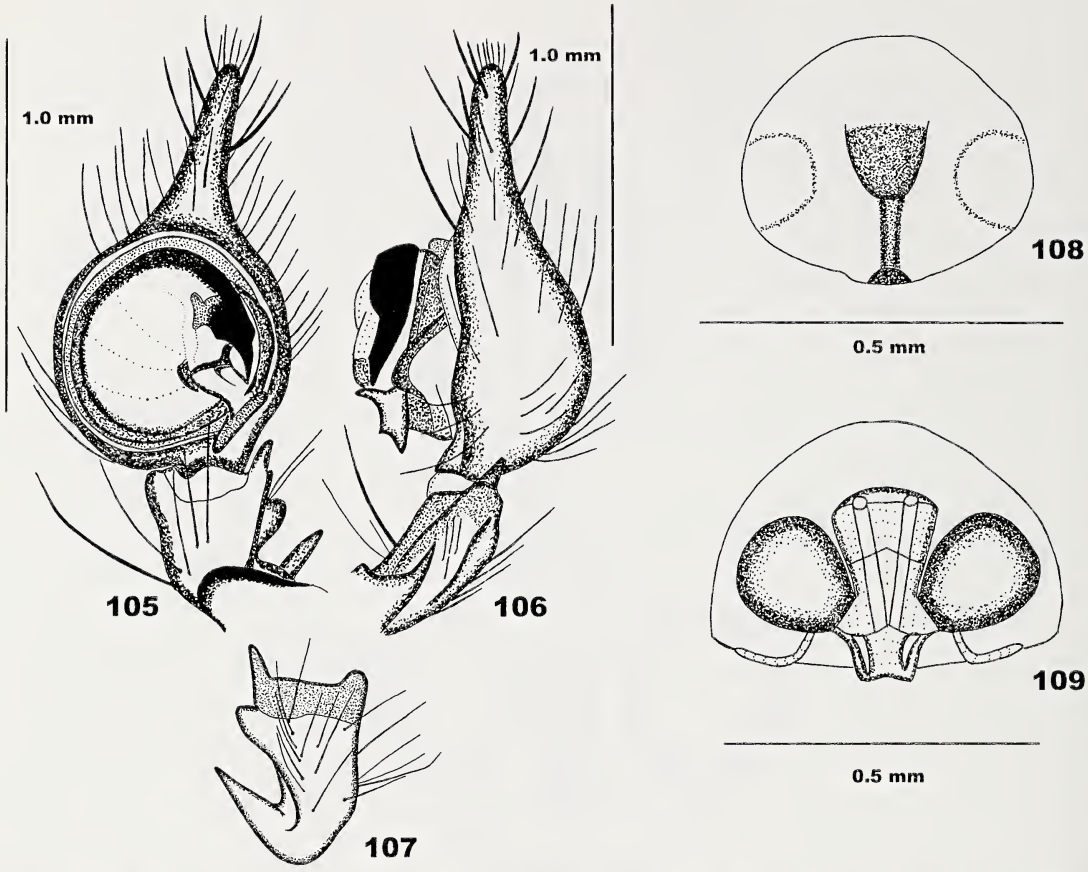
ejaculatory duct (Fig. 43), and the bilobed medial RTA (Fig. 45).

Description.—*Female:* Carapace typical. Dorsum of abdomen gray with basal lanceolate mark flanked by two pairs of yellow spots and followed by five transverse chevrons; venter gray with yellow lateral longitudinal stripes. Legs annulate, spination typical. Epigynum of female externally with wide opening and little sclerotization (Fig. 46); internally with midpiece short and truncate, blind ducts very short, lateral ducts fused medially and very wide (Fig. 47). *Male:* Carapace orange, typical. Abdomen as in female but markings usually more distinct. Legs weakly annulate, spination typical. Male palpus with PA a short point (Fig. 43); basal RTA long, rounded from above, medial RTA bilobed, distal RTA short, rounded, and constricted at base (Figs. 43, 44); tibia with three moderately long prolateral spines, three long ventral setae, and many long retrolateral setae; cymbium short distad, with two spines near base of tip and six spines on tip; embolus thick at base with conspicuous coil in ejaculatory duct, tapering to a sharp point, conductor with elongate, rounded basal lobe (Fig. 43).

Measurements.—*Female:* Total length, 4.02–5.21 (4.36); carapace length, 1.49–1.74 (1.60); carapace width, 1.09–1.30 (1.17); femur I length, 1.43–1.77 (1.60). *Male:* total length, 3.72–4.19 (3.91); carapace length, 1.67–1.89 (1.78); carapace width, 1.49–1.59 (1.54); femur length, 1.86–2.17 (1.96).

Distribution.—San Francisco Bay area north into Mendocino County, California, and Yosemite National Park (Map 5).

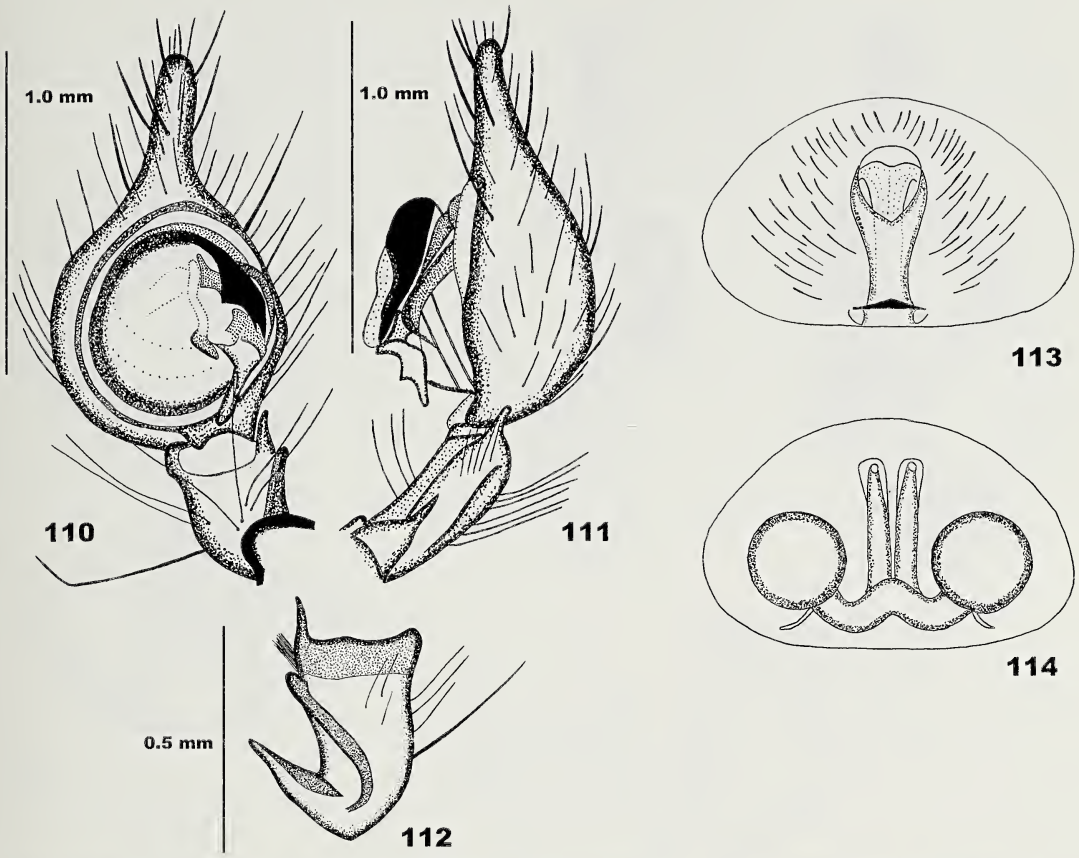
Natural History.—Mature specimens tak-



Figures 105–109.—*Calymmaria siskiyou*. 105. Palpus, ventral; 106. Palpus, lateral; 107. Palpal tibia, dorsal; 108. Epigynum, ventral; 109. Epigynum, dorsal. Scale bar was inadvertently omitted from the original drawing for Fig. 107.

en in January, February, March, May, September, and December. One specimen was collected from an old packrat nest.

Material Examined.—U.S.A.: *California*: Alameda County, Castro Valley, 9 March 1941 (W.M. Pearce), 10 ♀ (AMNH), Livermore, 25 miles S. on Mines Rd., 17 December 1968 (V. Roth), 4 ♀ (AMNH); Contra Costa County, Marsh Creek Springs, 5 May 1940 (W.M. Pearce), 1 ♀ (AMNH), Diablo, 25 March 1947 (B. Malkin, D. G. Kelley), 1 ♀ (AMNH); Madera County, 5 miles S. of Fish Camp, just over county line, 22 September 1961 (W. Ivie, W.J. Gertsch), 2 ♂, 2 ♀, 5 immatures (AMNH); Mariposa County, Wawona Camp, Yosemite National Park, 17 September 1941 (W. Ivie), 1 female (AMNH), Fish Camp, 5 September 1958 (V. Roth), 3 ♀, 1 immature (AMNH), 2 miles S. of Fish Camp, 12 September 1959 (no collector), 1 ♂ (AMNH), 1 miles S. of Fish Camp; 23 September 1961 (W. Ivie, W.J. Gertsch), 10 ♂, 6 ♀, 1 immature (AMNH); Mendocino County, 1 miles SE. of Caspar on Caspar Creek, 13 September 1961 (W.J. Gertsch, W. Ivie), 1 ♀ (AMNH); Napa County, Oakville, 13 December 1953 (V. Roth), 1 ♀ (AMNH), 3 miles W. of Oakville, 15 February 1954 (V. Roth, R.O. Schuster), 2 ♀ (AMNH), 10 miles S. of Monticello, 6 January 1957 (R.O. Schuster), 1 ♀ (AMNH), 17 February 1957 (R.O. Schuster), 2 ♀ (AMNH); Sonoma County, Junction of Porter Creek Road and Calistoga Road, in old packrat nest, 15 February 1960 (J. S. Buckett), 1 ♀ (AMNH); Yolo County, 5.4 miles S. of Winters, 17 January 1960 (Smith, R.O. Schuster), 1 ♀ (AMNH).



Figures 110–114.—*Calymmaria sueni*. 110. Palpus, ventral; 111. Palpus, lateral; 112. Palpal tibia, dorsal; 113. Epigynum, ventral; 114. Epigynum, dorsal. Scale bars were inadvertently omitted from the original drawings for Figs. 113 and 114.

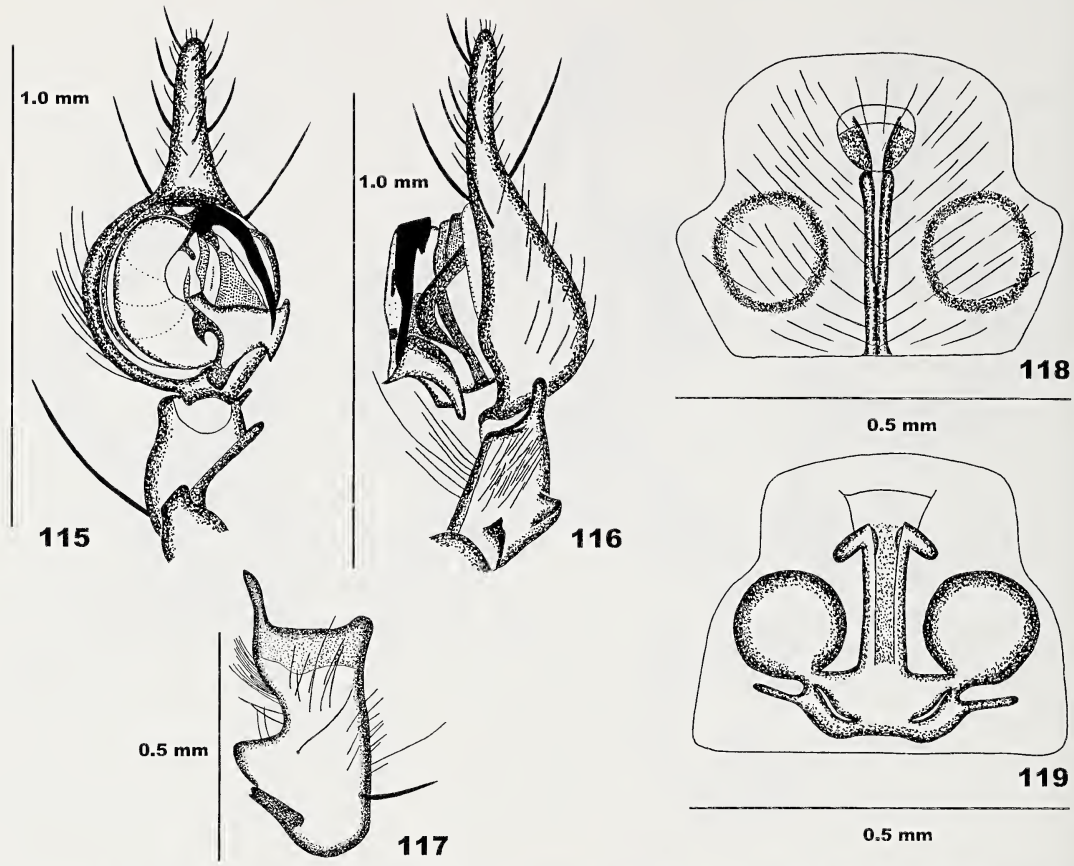
Calymmaria lora Chamberlin & Ivie 1942
Figs. 48–52; Map 5

Calymmaria lora Chamberlin & Ivie 1942: 22, figs. 30, 31; Roewer 1954: 46.

Types.—Male holotype from Friant, Fresno County, California, U.S.A., 36°59′N, 119°42′W, March 1913, R.V. Chamberlin (AMNH, examined).

Diagnosis.—*Calymmaria lora* resembles *C. aspenola* and *C. monicae*. Female specimens of *C. lora* can usually be separated from other *Calymmaria* by the thick sclerotization around the epigynal opening (Fig. 51). Male specimens of *C. lora* are very difficult to separate from *C. monicae*. Males of *C. lora* usually possess a very small raised area distal to the medial RTA (Fig. 50), the PA is more rounded, and the distal lobes of the conductor are usually longer and rounder (Fig. 48). Specimens of both sexes of *C. lora* vary greatly in size and markings.

Description.—*Female:* Carapace typical. Dorsum of abdomen pale yellow or silver with gray basal lanceolate mark followed by four pairs of gray spots, the last pair contiguous; venter gray with small pale spots. Legs annulate, spination typical. Epigynum externally with large opening surrounded by heavy sclerotization (Fig. 51); internally with wide midpiece, very small blind ducts, strong sclerotization around opening, and wide lateral ducts fused medially (Fig. 52). *Male:* Same as in female.Male palpus with PA large, truncate (Fig. 48); basal RTA thick, round, usually with a very small raised area near its distal margin, medial RTA knob-like, distal RTA long, rounded (Figs. 49, 50); tibia with two large prolateral spines, usually four ventral long setae, many short retrolateral setae; cym-



Figures 115–119.—*Calymmaria suprema*. 115. Palpus, ventral; 116. Palpus, lateral; 117. Palpal tibia, dorsal; 118. Epigynum, ventral; 119. Epigynum, dorsal.

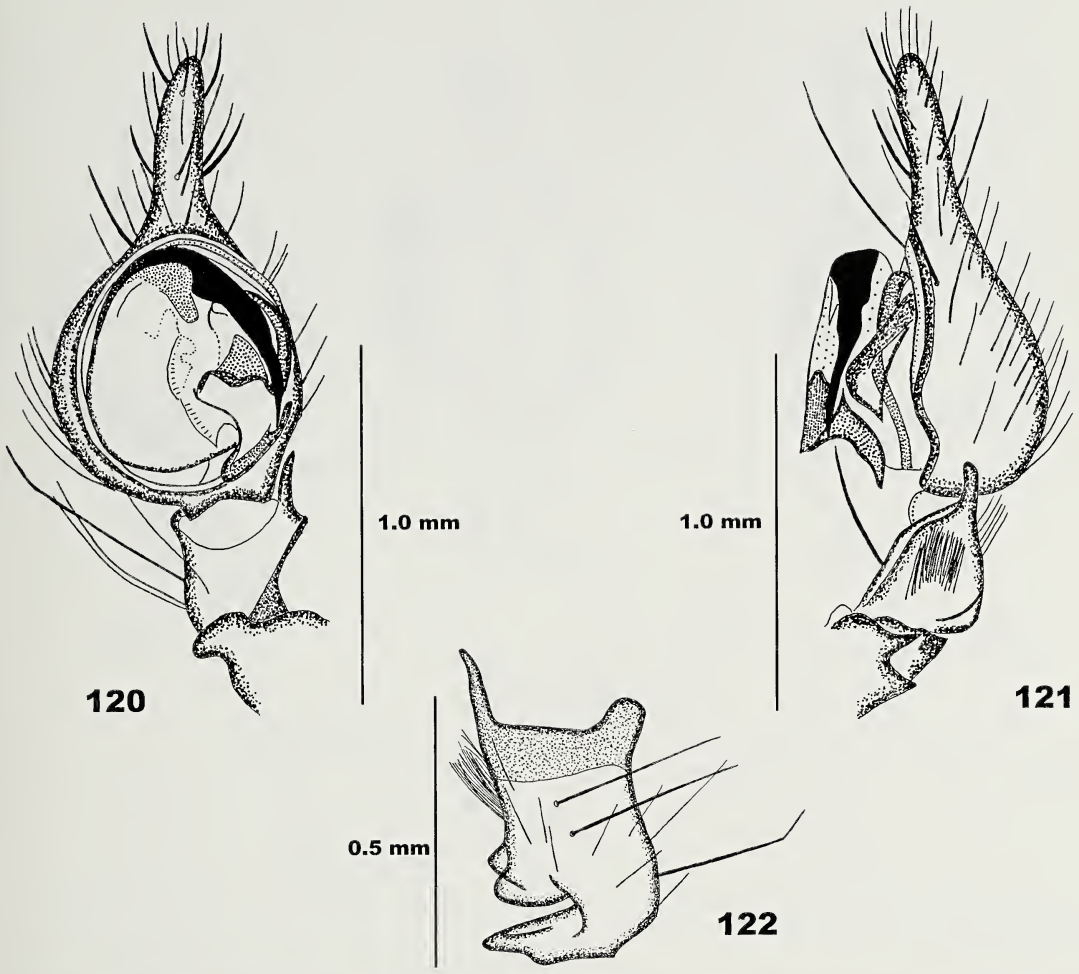
bium elongate distad, with two spines near base of tip and five or six spines on tip; embolus thick and tapering to a long point, conductor with basal lobe pointed (Fig. 48).

Measurements.—*Female:* Total length, 5.02–6.83 (5.87); carapace length, 2.17–3.19 (2.60); carapace width, 1.43–2.51 (1.87); femur I length, 2.48–3.72 (2.93). *Male:* Total length, 5.27–7.35 (6.36); carapace length, 2.60–3.72 (3.07); carapace width, 2.17–2.82 (2.49); femur I length 3.47–5.89 (4.61).

Distribution.—San Francisco Bay area in California, north to Sonoma County and south to Los Angeles County; Sierra Nevada Mountains from Tulare County north to Placer County (Map 5).

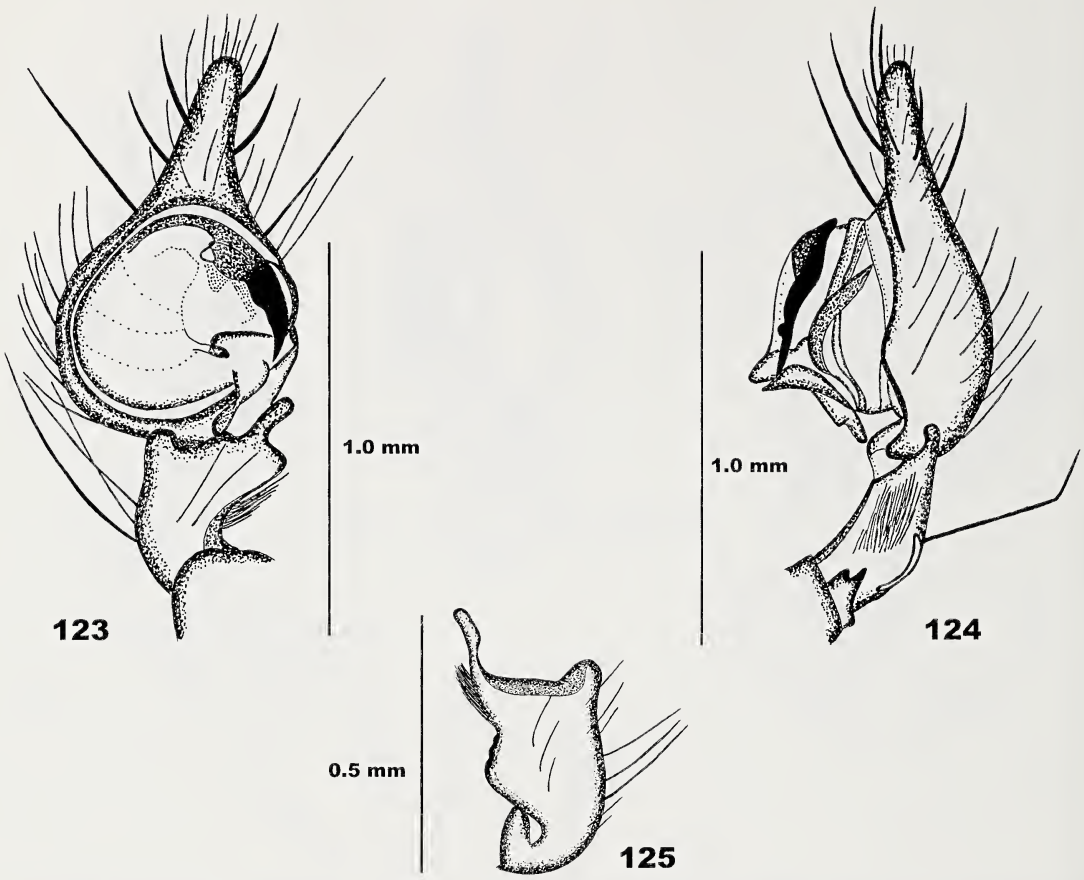
Natural History.—Mature specimens collected from every month except February and June, taken from beneath bark of California sycamore and giant sequoia at elevations from 390 to 2100 m.

Material Examined.—U.S.A.: *California*: Contra Costa County, Clayton, 30 April 1939 (E. S. Ross), 1 ♀ (AMNH); Marsh Creek Springs, 5 May 1940 (W.M. Pearce), 2 ♀, 1 immature (AMNH), no specific locality, 2 April 1941 (W.M. Pearce), 4 ♀, 4 immatures (AMNH), Mt. Diablo, 25 March 1947 (B. Malkin, D. Kelley), 2 ♀ (AMNH), SE. corner, 13 January 1961 (V. Roth, P. Craig), 5 ♀, 3 immatures (AMNH); Fresno County, Friant, March 1913 (R.V. Chamberlin), 1 ♀ holotype, 1 ♀ paratype (AMNH), Shaver Lake, 15 July 1952 (M. Cazier, W.J. Gertsch, R. Schrammel), 1 ♀ (AMNH), September 1959 (no collector), 22 ♂, 19 ♀, 16 immatures (AMNH), Cherry Gap (6000′), 6 August 1959 (R.X. Schick), 2 ♀, 2 immatures (AMNH), Cedar Grove, Kings Canyon National Park, 13 September 1959 (V. Roth, W.J. Gertsch), 7 ♂, 15 ♀, 6 immatures (AMNH), Dinkey Creek Campground under rocks, Sierra National Forest, 28–29 August 1979 (D. Ubick), 5 ♂, 5 ♀, 3 immatures (DUSC); Los Angeles



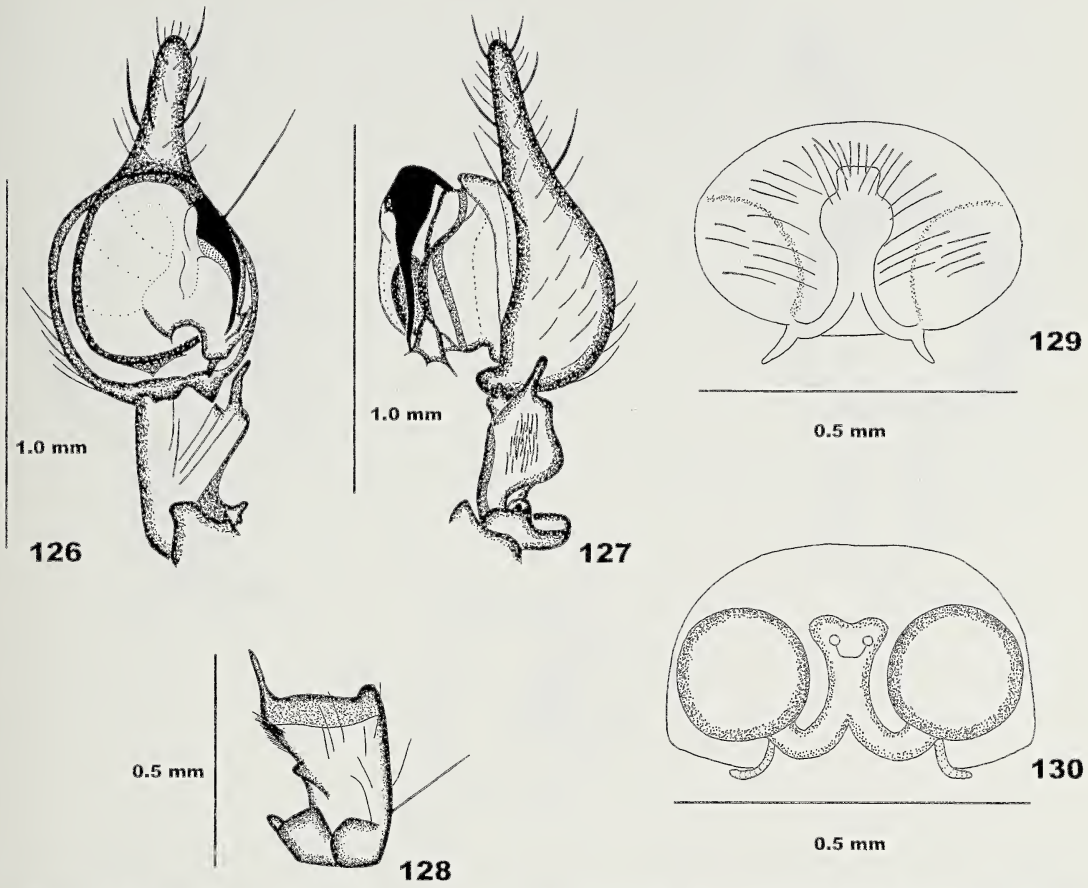
Figures 120–122.—*Calymmaria tecate*. 120. Palpus, ventral; 121. Palpus, lateral; 122. Palpal tibia, dorsal.

County, San Gabriel Mountains on Highway 2 in montane forest (7000′), 27 September 1957 (R.X. Schick), 1 ♂, 1 immature (AMNH); Madera County, Bass Lake, 9 July 1958 (W.J. Gertsch, V. Roth), 1 ♀ (AMNH), North Fork, March 1970 (E. Dietrich), 2 ♀ (AMNH); Marin County, Mill Valley, 20 November 1955 (H. B. Leech), 1 ♂ (AMNH); Mariposa County, Buck Meadows, 11 September 1939 (no collector), 19 ♂, 19 ♀, 5 immatures (AMNH), 15 September 1959 (no collector), 1 ♂ (AMNH), 2 miles S. of Fish Camp, 12 September 1959 (no collector), 2 ♂, 2 ♀ (AMNH), El Portal, 8 April 1960 (W. Ivie, W.J. Gertsch, R. Schrammel), 2 ♀ (AMNH), 1 miles S. of Fish Camp, 23 September 1961 (W. Ivie, W.J. Gertsch), 14 ♂, 8 ♀, 14 immatures (AMNH); Mono County, Big Bend Campground, 5 miles W. of Lee Vining, 21 September 1961 (W. Ivie, W.J. Gertsch), 1 ♂, 5 ♀, 5 immatures (AMNH); Monterey County, Carmel, no date (no collector), 1 ♂ (AMNH), Monterey, October 1945 (A.F. Archer), 4 ♂ (AMNH); Napa County, 4 miles N. of St. Helena, 31 December 1953 (G. A. Marsh, R.O. Schuster, V. Roth), 1 ♂, 7 ♀, 7 immatures (AMNH), N. side of Howell Mountain, 2 miles NE. of Angwin (1300′), 20 October 1975 (H. B. Leech), 1 ♂, 7 ♀ (CASC), 10 November 1975 (H. B. Leech), 2 ♂, 1 ♀, 2 immatures (CASC); Placer County, Tahoe City, 8 July 1956 (W.J. Gertsch), 1 ♀ (AMNH); 3 miles N. [?], 20 September 1961 (W. Ivie, W.J. Gertsch), 1 ♂ (AMNH); Riverside County, Idyllwild, 11 August 1955 (W.J. Gertsch), 1 ♀ (AMNH), Mill Canyon,



Figures 123–125.—*Calymmaria tubera*. 123. Palpus, ventral; 124. Palpus, lateral; 125. Palpal tibia, dorsal.

Banning site #4 (6500′), 24 May 1960 (Chenault), 2 ♀ (CASC); San Bernardino County, Big Pines Rec. Area, San Gabriel Mountains (6860′), 15 October 1955 (R.X. Schick), 1 ♂, 1 ♀ (AMNH); San Francisco County, in house, 29 October 1972 (H. B. Leech), 1 ♂ (CASC); Santa Clara County, Stanford, 15 January 1928 (J.C. Chamberlin), 1 ♂ (AMNH); Coyote River, 3 miles S. of Gilroy Hot Springs, under exfoliating bark on trunk of living *Platanus racemosa*, 24 November 1966 (H. B. Leech), 1 ♀ (CASC); Santa Cruz County, Ben Lomond, 4 July 1958 (W.J. Gertsch, V. Roth), 2 ♂ (AMNH); Solano County, Green Valley, 24 March 1954 (E. Schlinger), 1 ♀ (AMNH); Sonoma County, Cazadero, 13 April 1913 (H. Van Dusee), 1 ♀ (AMNH); Tulare County, Wilsonia, 13 September 1959 (V. Roth, W.J. Gertsch), 1 ♂ (AMNH), Quaking Aspen Camp, Sequoia National Forest, 9 September 1959 (no collector), 1 ♂ (AMNH), Big Trees; Sequoia National Park, 15 July 1952 (no collector), 1 ♀ (AMNH), Cedar Grove, Kings River Canyon, Kings Canyon National Park (4633′), 16 July 1952 (W.J. Gertsch), 2 ♀ (AMNH), Main Camp, Sequoia National Park, 5 July 1959 (V. Roth, W.J. Gertsch), 2 ♀ (AMNH), near Ash Mountain entrance, Sequoia National Park (3700′), 5 July 1956 (W.J. Gertsch, V. Roth), 5 ♀, 7 ♂ (AMNH), 9 July 1958 (W.J. Gertsch, V. Roth), 4 ♀, 2 immatures (AMNH), 4 October 1959 (V. Roth, W.J. Gertsch), 1 ♀ (AMNH), 3 miles W. of Gent Forest, 9 July 1958 (V. Roth, W.J. Gertsch), 1 ♀ (AMNH), Camp Nelson, Sequoia National Forest, 11 July 1958 (V. Roth), 1 ♂ (AMNH), near Camp Nelson, Belknap Springs, 11 July 1958 (W.J. Gertsch, V. Roth), 1 ♀ (AMNH), Soda Creek, west of Camp Nelson, 11 July 1958



Figures 126–130.—*Calymmaria virginica*. 126. Palpus, ventral; 127. Palpus, lateral; 128. Palpal tibia, dorsal; 129. Epigynum, ventral; 130. Epigynum, dorsal.

(V. Roth, W.J. Gertsch), 1 ♂, 7 ♀ (AMNH), 14 September 1959 (V. Roth, W.J. Gertsch), 1 male, 2 ♀, 5 immatures (AMNH), Double Bunk Meadows, 6 miles W. of Johnsondale, 15 September 1959 (no collector), 2 ♂, 2 ♀, 3 immatures (AMNH), Soda Springs, W. of Springville, 20 September 1959 (W.J. Gertsch, V. Roth), 2 ♂ (AMNH), 7 miles NE. of Ash Mountain entrance, Sequoia National Park, 30 September 1959 (W.J. Gertsch, V. Roth), 1 ♂ (AMNH), 15 October 1959 (V. Roth), 1 ♂ (AMNH), Halstead Meadow, under rock, Sequoia National Park, 23 August 1979 (D. Ubick), 1 ♂ (DUSC); Tuolumne County, Aspen Valley, Yosemite National Park, 4 September 1959 (V. Roth, W.J. Gertsch), 3 ♀ (AMNH); Ventura County, summit of Mt. Pinos, W. of Lebec, 15 September 1960 (V. Roth), 5 ♂, 10 ♀ (AMNH), 31 July to 1 August 1961 (V. Roth), 2 ♀ (AMNH).

Calymmaria minuta new species
Figs. 53–57; Map 5

Types.—Male holotype from 5 miles N. of Scotia, Humboldt County, California, U.S.A., 40°32′N, 124°05′W, 1 October 1959, V. Roth (AMNH); female allotype from 5 miles W. of Forest Glen, Trinity County, California, U.S.A., 40°22′N, 123°24′W, 21 August 1959, W.J. Gertsch, V. Roth (AMNH).

Etymology.—The specific name is an adjective referring to the relatively small size of this species.

Diagnosis.—*Calymmaria minuta* can be separated from other *Calymmaria* by its small size, the heavily sclerotized epigynum (Fig. 56), and the bifurcate embolus of the male (Fig. 53).

Description.—*Female:* Carapace typical. Dorsum of abdomen dark gray with a pair of

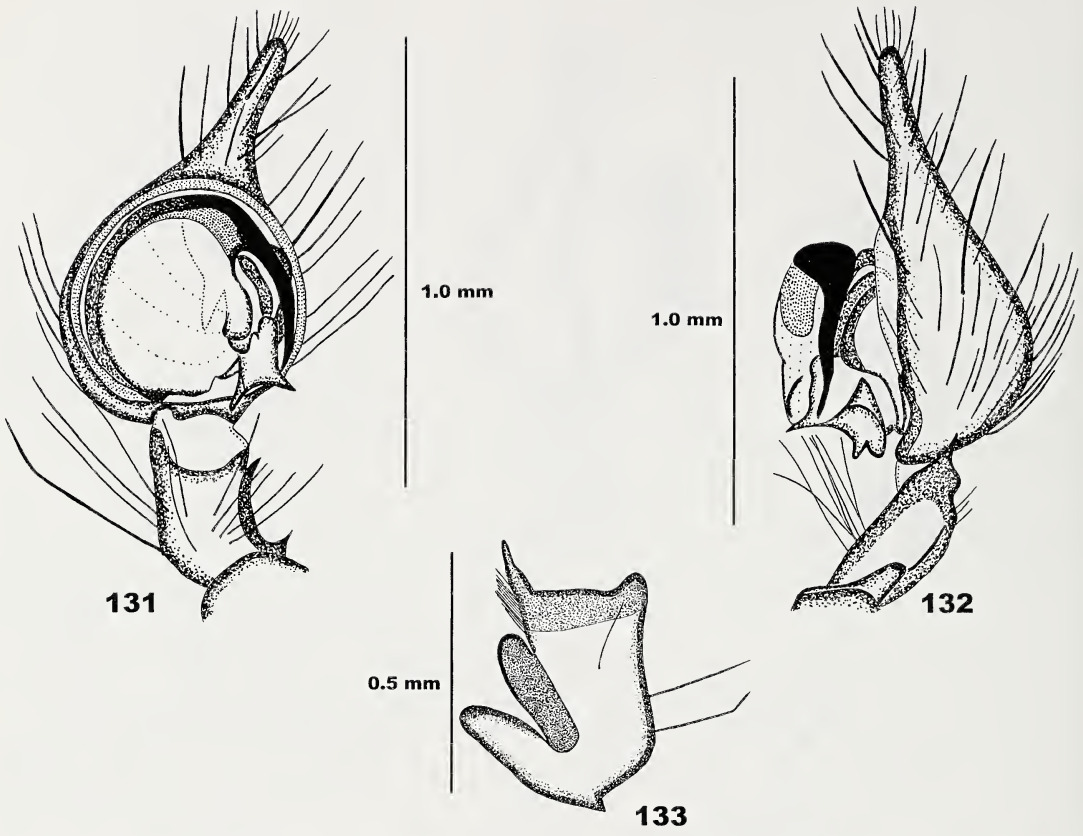


Figure 131–133.—*Calymmaria yolandae*. 131. Palpus, ventral; 132. Palpus, lateral; 133. Palpal tibia, dorsal.

pale yellow spots followed by two transverse chevrons; venter pale gray with pale yellow lateral longitudinal stripes. Legs faintly annulate, spination typical. Epigynum externally with small opening surrounded by a wide area of sclerotization (Fig. 56); internally with midpiece very short, thick, with short blind ducts at top, lateral ducts short and thick (Fig. 57). *Male:* Same as in female. Male palpus with PA large, round (Fig. 53); basal RTA triangular from above, medial RTA toothlike, distal RTA short (Fig. 55); tibia with two long prolateral setae, several long ventral setae; cymbium moderately elongate distad, with two spines near tip of base and six spines on tip; embolus very thick basally, bifurcate, with lower division lobelike, conductor small with basal lobe poorly developed (Fig. 53).

Measurements.—*Female* (n = 2): Total length, 2.29–3.10; carapace length, 1.30–1.49; carapace width, 0.99–1.09; femur I length, 1.49–1.55. *Male* (n = 3): Total length, 3.72–4.50 (4.01); carapace length, 1.77–2.11 (1.94); carapace width, 1.49–1.58 (1.55); femur I length, 2.36–3.10 (2.83).

Distribution.—Mendocino, Humboldt and Trinity Counties, California (Map 5).

Natural History.—Mature specimens collected in August, September, and October.

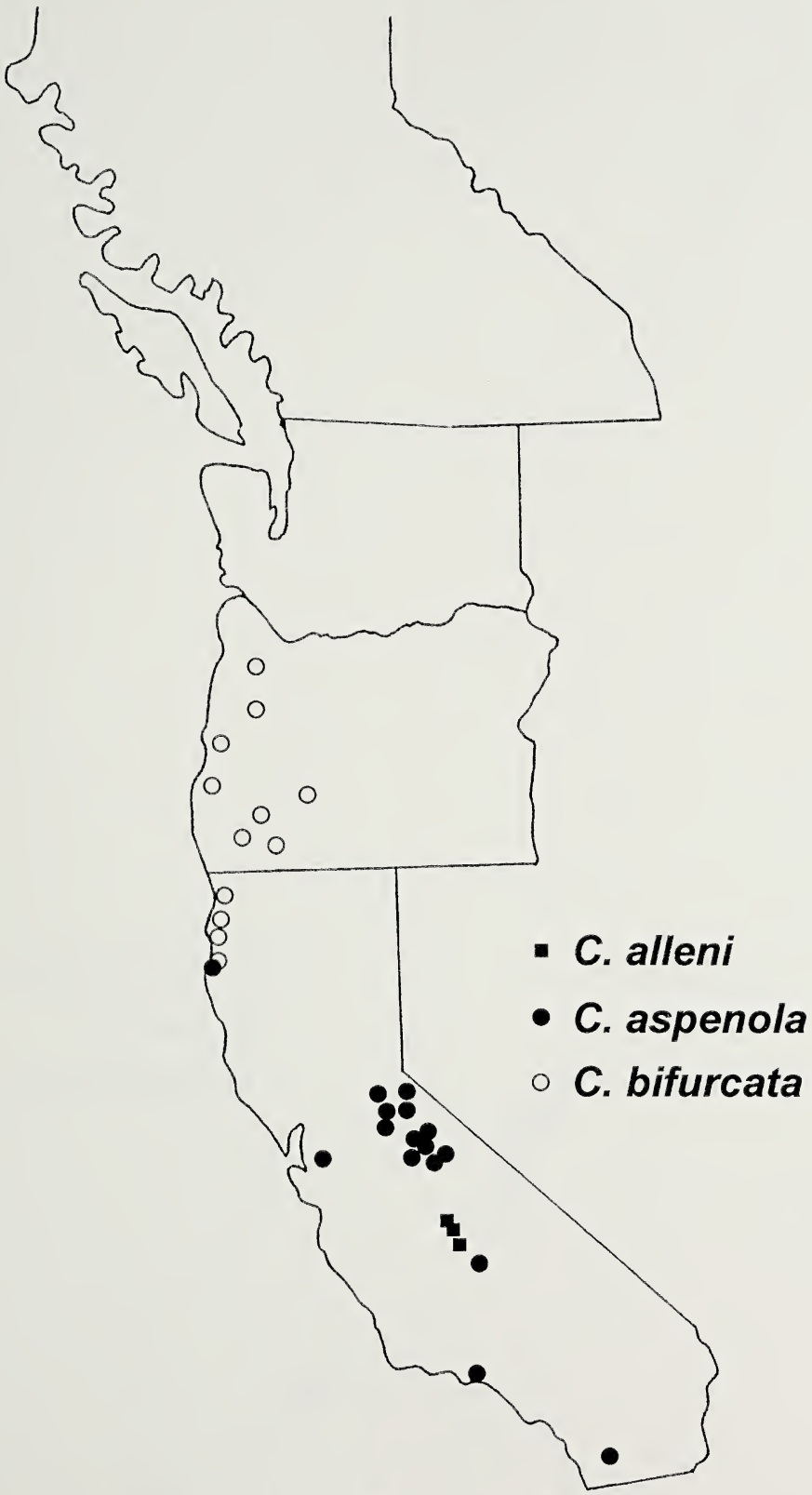
Material Examined.—U.S.A.: *California*: Humboldt County, Scotia, 1 October 1959 (V. Roth), 1 ♂, 3 immatures (AMNH); Mendocino County, 1 miles SE. of Caspar, 13 September 1961 (W.J. Gertsch, W. Ivie), 1 ♂ (AMNH); Trinity County, 5 miles W. of Forest Glen, 21 August 1959 (W.J. Gertsch, V. Roth), 1 male, 2 ♀ (AMNH).

Calymmaria monicae Chamberlin & Ivie 1937

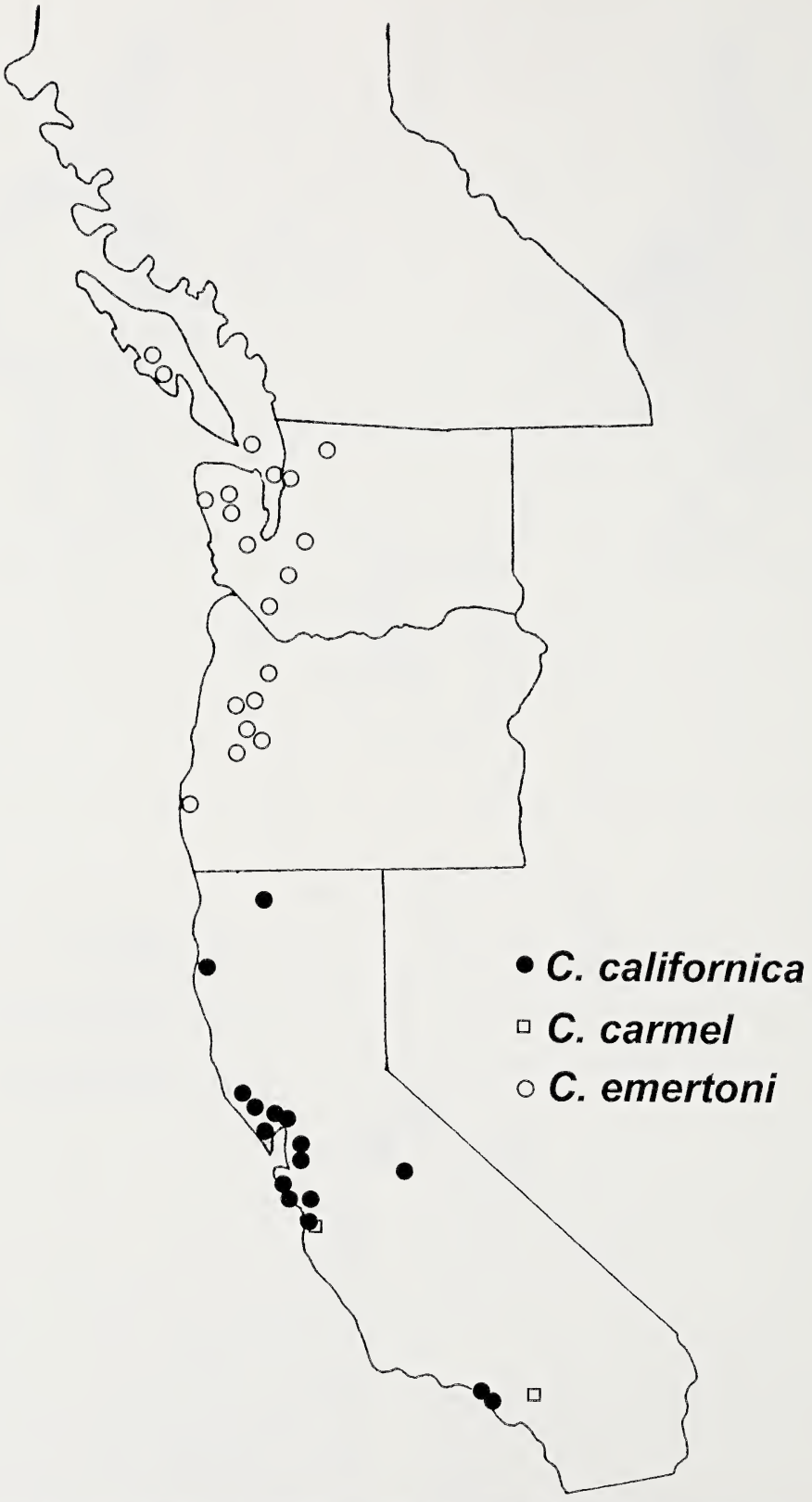
Figs. 58–62; Map 6

Calymmaria monicae Chamberlin & Ivie 1937: 213, 229, figs. 1–3, 14–17; Roewer 1954: 46; Bonnet, 1956: 940.

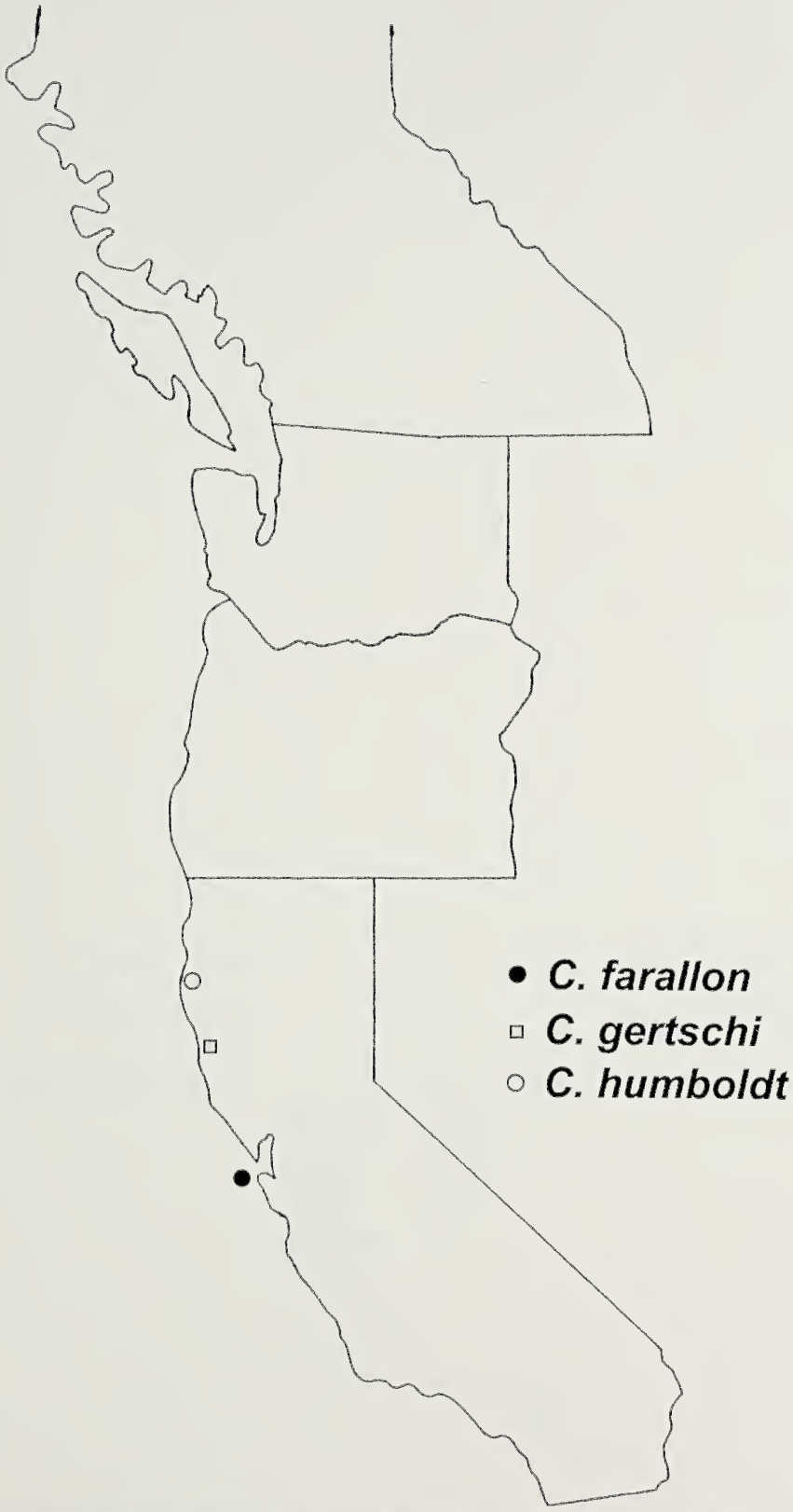
Types.—Male holotype and female allotype from Santa Monica, Los Angeles County,



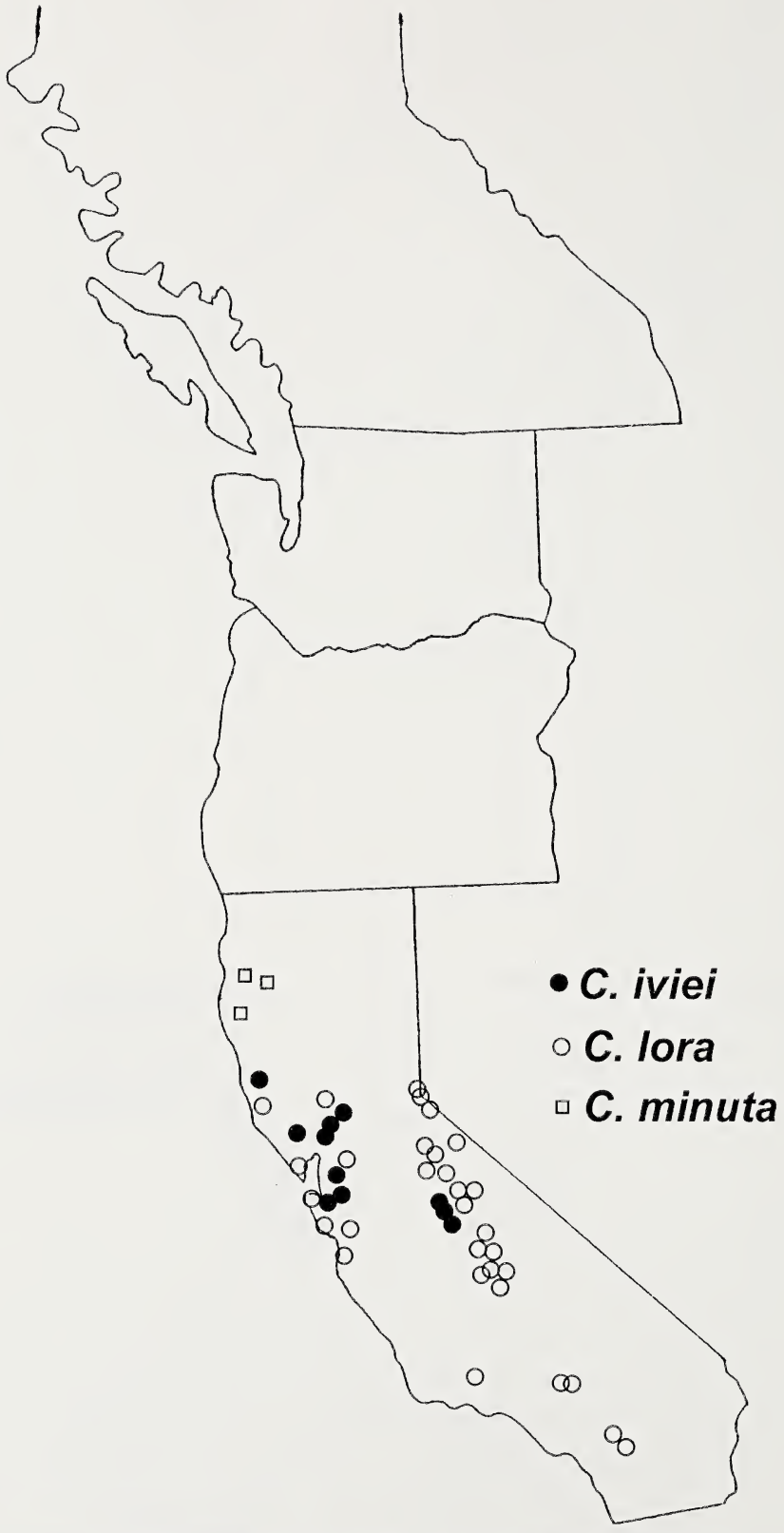
Map 2.—Distribution of *C. alleni* (■), *C. aspenola* (●), and *C. bifurcata* (○).



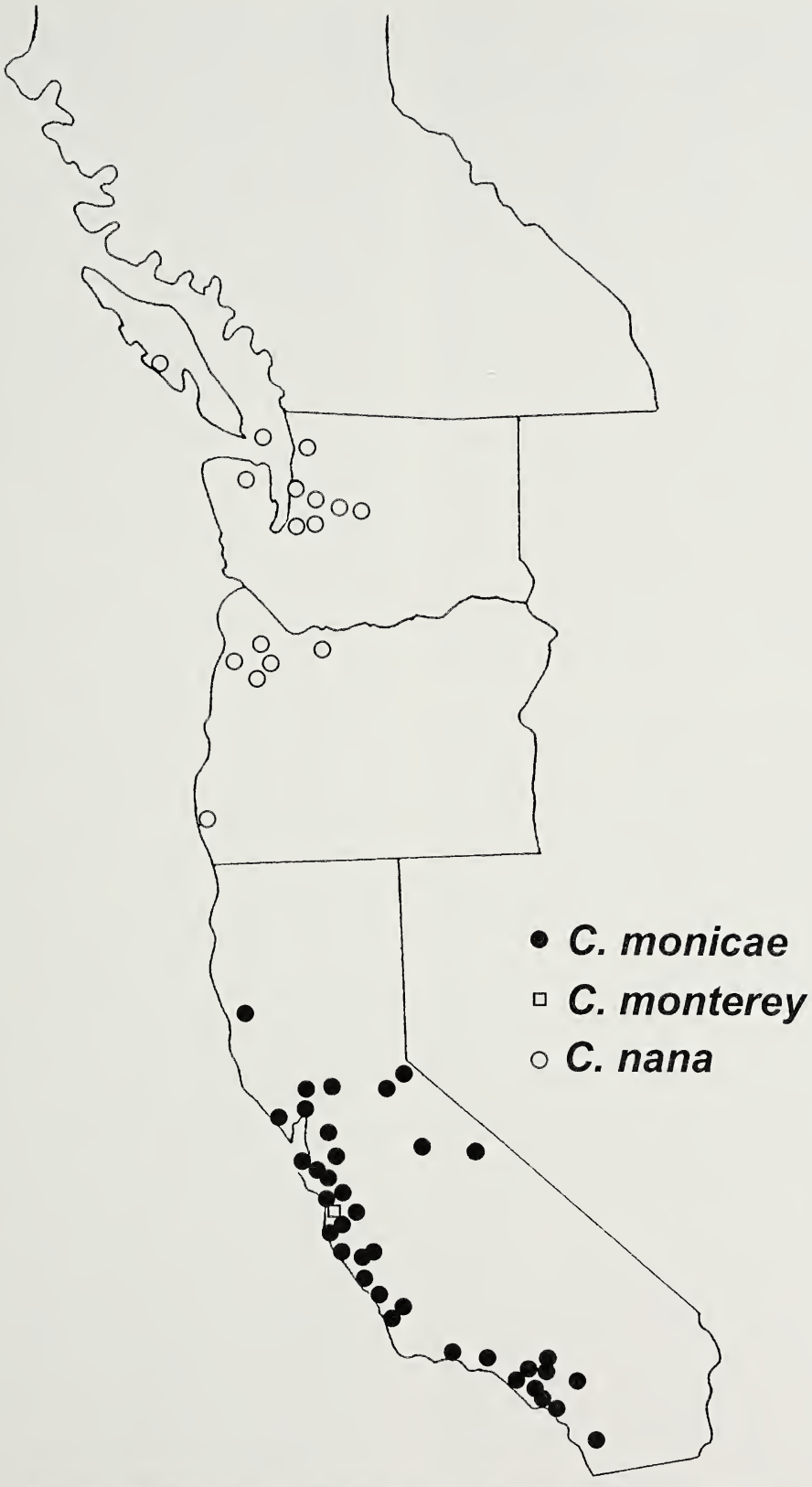
Map 3.—Distribution of *C. californica* (●), *C. carmel* (□), and *C. emertoni* (○).



Map 4.—Distribution of *C. farallon* (●), *C. gertschi* (□), and *C. humboldt* (○).



Map 5.—Distribution of *C. iviei* (●), *C. lora* (○), and *C. minuta* (□).



Map 6.—Distribution of *C. monicae* (●), *C. monterey* (□), and *C. nana* (○).

California, U.S.A., 34°01′N, 118°29′W (AMNH, examined).

Diagnosis.—*Calymmaria monicae* closely resembles *C. aspenola*, *C. californica*, and *C. lora*. Female *C. monicae* can be separated from *C. aspenola* by the thinner epigynal midpiece with ducts separated at the top (Fig. 62), from *C. californica* by having the midpiece much longer than the diameter of the spermathecae (Fig. 24), and from *C. lora* by the lack of heavy sclerotization around the opening (Fig. 61). Male *C. monicae* can be easily separated from *C. aspenola* by the lack of the retrolateral tooth near the medial RTA (Fig. 51), and from *C. californica* by the distinct medial RTA and lack of the ectal embolic tooth (Figs. 20, 21). Male specimens of *C. monicae* are difficult to separate from *C. lora*. The palpi of male *C. lora* usually possess a very small raised area near the medial RTA (Fig. 50), but this character is not always reliable. Usually the PA in *C. monicae* is more hooked than in *C. lora* (Fig. 58), and specimens of *C. lora* are usually larger in overall size.

Description.—*Female:* Carapace typical. Dorsum of abdomen yellow with basal gray lanceolate mark followed by darker gray mottling; venter gray with pale yellow lateral longitudinal stripes. Legs annulate, spination typical. Epigynum externally with large opening heavily sclerotized below (Fig. 61); internally with ducts of midpiece separated above, blind ducts below top, short, lateral ducts thick and fused medically (Fig. 62). *Male:* same as in female only darker. Male palpus with PA truncate and slightly hooked (Fig. 58); basal RTA long, thick, pointed, medial RTA thick at base and pointed upward, distal RTA rounded; tibia with two prolateral spines and many short retrolateral setae; cymbium moderately elongate distad, with one spine near base of tip and five spines on tip; embolus thick, tapering to a sharp point, conductor with basal lobe pointed (Fig. 58).

Measurements.—*Female:* Total length, 3.88–5.58 (4.79); carapace length, 1.64–2.20 (1.98); carapace width, 1.09–1.67 (1.43); femur I length, 1.58–2.20 (2.02). *Male:* Total length, 4.84–5.43 (5.06); carapace length, 2.08–2.48 (2.31); carapace width, 1.83–2.05 (1.94; $n = 2$); femur I length, 2.95–3.91 (3.18).

Distribution.—Exceedingly common throughout California, from San Diego north to Mendocino County, with most specimens from southern California and San Francisco areas. Scattered records from the Sierra Nevada Mountains from Tulare County north to El Dorado County (Map 6).

Natural History.—Mature specimens collected at any time of the year, particularly from canyons around Los Angeles and at elevations up to 3300 m.

Material Examined.—U.S.A.: *California*: Alameda County, Berkeley, October 1919 (Dietrich), 2 ♂ (AMNH), Oakland, on Mountain Boulevard, 17 October 1953 (V. Roth, R. Schuster), 3 ♀ (AMNH), 1 February 1954 (V. Roth, R. Schuster), 2 ♀ W. of Orinda, 27 December 1953 (V. Roth, Marsh, R. Schuster), 4 ♀ (AMNH), Hayward, 3 February 1954 (J. Tyler), 1 ♀ (AMNH); Contra Costa County, Clayton, 3 April 1941 (W.M. Pearce), 1 ♀ (AMNH); El Dorado County, 3 miles W. of Riverton, 13 September 1959 (no collector), 1 ♂ (AMNH), Fallen Leaf Lake, 9 December 1959 (W.J. Gertsch, V. Roth), 1 ♀ (AMNH); Inyo County, Bishop Creek (10,000 to 11,000′), 17 August 1941 (W.M. Pearce), 1 ♂ (AMNH); Los Angeles County, November (W.J. Gertsch), 1 ♀ (AMNH), November to December 1922 (G. Grant), 1 ♂ (AMNH), November 1952 (no collector), 3 ♂, 6 ♀ (AMNH), Claremont, no date (no collector), 1 ♀ (AMNH), El Segundo, 24 February 1948 (W.M. Pearce), 16 ♀, 2 immatures (AMNH), Glendale, 24 November 1950 (E.I. Schlinger), 1 ♂, 1 ♀ (AMNH), 1 January 1951 (E.I. Schlinger), 1 ♂, 1 ♀ (AMNH), 1 January 1956 (no collector), 1 ♀ (AMNH), 27 December 1956 (E.I. Schlinger), 1 ♀ (AMNH), Los Angeles, no date (no collector), 1 ♀ (AMNH), February 1952 (no collector), 1 ♀ (AMNH), Big Rock Camp, San Gabriel Mountains; 9 April 1955 (R.X. Schick), 1 ♀ (AMNH), Big Tujunga Canyon, San Gabriel Mountains, 3 June 1955 (R.X. Schick), 1 ♀ (AMNH), costal sage, coastal oak woodlands, Big Tujunga Canyon, 24 February 1957 (R.X. Schick), 1 ♀ (AMNH), UCLA, 16 December 1955 (W. McDonald), 1 ♂ (AMNH), Sepulveda Canyon, March 1956 (R.X. Schick), 1 ♀ (AMNH), Santa Monica, 25 December 1932 (W. Ivie), 4 ♂, 5 ♀, 1 immature (AMNH); October 1955 (no collector), 3 ♂, 2 ♀, 1 immature (AMNH), Santa Monica Mountains; 25 December 1932 (no collector), 5 ♀ (AMNH),

February 1952 (R.X. Schick), 1 ♀ (AMNH), 25 December 1952 (W. Ivie), 1 ♂, 1 ♀ (AMNH); January to February 1953 (R.X. Schick), 2 ♀ (AMNH), April 1953 (R.X. Schick), 2 ♀ (AMNH), April 1953 (no collector), 3 ♀, 3 immatures (AMNH), December 1953 (no collector), 4 ♀ (AMNH), Tapia Park, Santa Monica Mountains, 20 February 1954 (R.X. Schick), 1 female (AMNH), 6 March 1954 (R.X. Schick), 2 ♀, 1 immature (AMNH), 20 March 1955 (R.X. Schick), 2 ♀, 1 immature (AMNH); Madera County, 5 miles S. of Fish Camp, just over county line, 23 September 1961 (W. Ivie, W.J. Gertsch), 7 ♂, 1 ♀, 8 immatures (AMNH); Marin County, Taylorville, 28 September 1919 (Dietrich), 1 ♀ (AMNH), Samuel P. Taylor State Park, 8 May 1949 (H. B. Leech), 1 ♀ (AMNH), Inverness, 8 November 1953 (V. Roth, G. Marsh); 1 ♀ (AMNH), 1 March 1964 (P. H. Arnaud), 1 ♀ (CASC), Bolinas, 26 March 1954 (E.I. Schlinger), 1 ♀ (AMNH), 27 September 1963 (J. and W. Ivie), 2 ♂, 2 ♀ (AMNH); Muir Woods in California laurel, 10 January 1964 (V. Roth, P. Craig), 6 ♀ (AMNH), 4 miles outside Muir Woods near Mill Valley, 10 January 1964 (no collector), 4 ♀ (AMNH); Mendocino County, 2 miles N. of Piercy, 19 August 1959 (V. Roth, W.J. Gertsch), 1 ♀ (AMNH); Monterey County, no date (no collector), 2 ♀ (AMNH), Cypress Point, 17 mile Drive, Pacific Grove, 10 October 1938 (W.M. Pearce), 2 ♂, 2 ♀, 2 immatures (AMNH), 25 September 1961 (W. Ivie, W.J. Gertsch), 1 ♀ (AMNH), 5 October 1963 (J. and W. Ivie), 2 ♂, 4 ♀, 4 immatures (AMNH), King City Rd., 27 April 1943 (no collector), 1 ♀ (AMNH), Monterey, October 1945 (A.F. Archer), 2 ♂ (AMNH), Pacific Grove, 28 March 1947 (B. Malkin), 2 ♀ (AMNH), 3 April 1960 (W. Ivie, R. Schrammel), 9 ♀, 1 immature (AMNH), Carmel, 23 December 1951 (B. Malkin), 2 ♂, 1 ♀ (AMNH), 5 April 1954 (no collector), 1 ♀ (AMNH), 7 April 1954 (no collector), 1 immature (AMNH), 8 April 1954 (no collector), 5 ♀ (AMNH), Del Monte Forest, outside Monterey, closed cone pine forest, 29 April 1959 (R.X. Schick), 2 ♀ (AMNH), Big Sur, 2 April 1960 (W.J. Gertsch, W. Ivie, R. Schrammel), 5 ♀ (AMNH), Redwood Canyon, 4 miles S. of Gorda, 2 April 1960 (W.J. Gertsch, W. Ivie, R. Schrammel), 4 ♀, 1 immature (AMNH); Napa County, N. side of Howell Mountain, 2 miles NNE. of Angwing (1300′), 21 November 1977 (H. B. Leech), 1 ♂ (CASC); Orange County, Laguna Beach, 28 December 1932 (W. Ivie), 2 ♂, 4 ♀ (AMNH); Santa Barbara County, Santa Barbara, March 1913 (R.V. Chamberlin), 4 ♀ (AMNH), 25 December 1932 (W. Ivie), 3 ♂, 5 ♀ (AMNH), 21–27 November 1948 (H. L. Shantz), 1 ♀ (AMNH), 17 July 1953 (H. L. Shantz), 1 ♀ (AMNH), 18 miles NE. of Santa Barbara, 1 April 1960 (W.J. Gertsch, W. Ivie, R. Schrammel), 2 ♀ (AMNH), Sisquoc, 29 July 1961 (V. Roth), 1 ♀ (AMNH); San Benito County, 4 miles W. of San Juan Bautista, 21 December 1953 (V. Roth), 1 ♀ (AMNH), Pinnacles National Monument, 7 October 1958 (V. Roth), 1 ♂ (AMNH); San Bernardino County, Camp 0-ongo near Running Springs, San Bernardino Mountains, 8–12 August 1966 (C. L. Hogue), 1 ♀ (LCMC); San Diego County, Alpine, 9 May 1947 (W.M. Pearce), 2 ♀ (AMNH); San Francisco County, San Francisco Bay District, no date (no collector), 4 ♀ (AMNH), no date (R. F. Sternitsky), 1 female (AMNH), San Francisco, 27 December 1932 (no collector), 1 ♀ (AMNH), 29 November 1934 (no collector), 1 ♀ (CASC), Golden Gate Park, no date (no collector), 1 ♀ (CASC), 10 March 1935 (no collector), 1 ♀ (CASC), 1 October 1972 (D. Ubick), 2 ♂, 1 immature (DUSC), Glen Canyon Park, 14 June 1979 (D. Ubick), 1 ♂ (DUSC); San Luis Obispo County, Pismo Beach, 1 April 1960 (W.J. Gertsch, W. Ivie, R. Schrammel), 1 ♀ (AMNH), Cambia, 2 April 1960 (W.J. Gertsch, W. Ivie, R. Schrammel), 1 ♀ (AMNH), Reservoir Canyon, San Luis Obispo, 15 October 1979 (W.J. Gertsch, V. Roth), 1 ♂ (AMNH); San Mateo County, La Honda, no date (no collector), 5 ♀, 3 immatures (AMNH), Jaspar Ridge, 1920–1921 (J.C. Chamberlin), 4 ♀, 1 immature (AMNH), San Gregorio Beach, Spring 1921 (no collector), 1 female (AMNH), Spring 1961 (no collector), 1 ♀ (AMNH), Miramar, 5 December 1953 (V. Roth), 3 ♂, 5 ♀, 3 immatures (AMNH), 1 miles S. of Sharp Park, 5 December 1953 (V. Roth), 4 ♀ (AMNH), south of Woodside, 17 September 1964 (J. and W. Ivie), 1 ♀ (AMNH), Portola State Park, 22 November 1970 (M. M. Bentzien), 3 ♀ (UCBC); Santa Clara County, Stanford, 15 January 1928 (J.C. Chamberlin), 1 ♂, 2 ♀ (AMNH), San Jose, 2 November 1974 (D. Ubick), 1 ♂, 1 ♀ (DUSC); Santa Cruz Coun-

ty, Capitola, March 1913 (R.V. Chamberlin), 3 ♀ (AMNH), Boulder Creek, 23 December 1953 (V. Roth), 2 ♀, 1 immature (AMNH), Ben Lomond, 6 July 1956 (V. Roth, W.J. Gertsch), 2 ♀ (AMNH), 23 September 1961(W. Ivie, W.J. Gertsch), 1 ♂ (AMNH), Cave Gulch, 16 November 1974 (no collector), 2 ♂ (DUSC); Sonoma County, Sonoma, 5 February 1955 (B. Malkin), 1 ♀ (AMNH); Tulare County, 2.5 miles [?] California Hot Springs, 5 October 1959 (V. Roth), 1 ♂ (AMNH); Ventura County, Wheeler Springs, 10 October 1968 (V. Roth), 1 ♂ (AMNH), 24 October 1958 (V. Roth), 1 ♂ (AMNH); Yolo County, Davis, 5 March 1948 (E.I. Schlinger), 1 ♀ (AMNH).

Calymmaria monterey new species
Figs. 63, 64; Map 6

Type.—Female holotype from Big Sur, Monterey County, California, U.S.A., 36°16′N, 121°48′W, 18 July 1953, W.J. Gertsch (AMNH).

Etymology.—The specific name is a noun in apposition taken from the type locality.

Diagnosis.—*Calymmaria monterey* is a large species separated from other *Calymmaria* by the wide epigynal midpiece and long blind ducts (Fig. 64).

Description.—*Female:* Carapace typical. Dorsum of abdomen yellow with gray basal lanceolate mark flanked by dark gray spots and followed by four transverse chevrons; venter gray with yellow lateral longitudinal stripes. Legs annulate, spination typical. Epigynum externally with heart-shaped opening (Fig. 63); internally with wide midpiece, blind ducts long, lateral ducts thick and united medially (Fig. 64). *Male:* Unknown.

Measurements.—Total length, 6.75–9.67 (7.65); carapace length, 3.13–3.72 (3.44); carapace width, 2.23–2.51 (2.41); femur I length, 4.90–5.89 (5.43).

Distribution.—Monterey County, California (Map 6).

Natural History.—Mature specimens collected in July and September.

Material Examined.—U.S.A.: *California:* Monterey County, Big Sur, 18 July 1953 (W.J. Gertsch), 3 ♀ (AMNH), 2 April 1960 (W.J. Gertsch, W. Ivie, R. Schrammel), 4 ♀, 2 immatures (AMNH), Carmel, 10 September 1953. (no collector), 1 ♀ (AMNH).

Calymmaria nana (Simon 1897)
Figs. 65–69; Map 6

Tegenaria nana Simon 1897: 8–17, 1898: 251–252; Banks 1910: 16; 1913: 181, fig. 47; Petrunkevitch 1911:538; Exline 1936: 23, fig. 1.

Calymmaria nana (Simon): Chamberlin & Ivie 1937: 215, figs. 22, 23; Exline 1938: 21, 22, figs: 32, 33; Roewer 1954: 46; Bonnet 1956: 940.

Type.—Female holotype from "Washington Territory" in MNHN, examined.

Diagnosis.—*Calymmaria nana* can be easily separated from other *Calymmaria* by the peculiar shape of the epigynum (Figs. 68, 69); and the short, thick-based embolus in the male (Fig. 65), which resembles the embolus in *C. emertoni* but is less rounded at the sides.

Description.—*Female:* Carapace typical. Dorsum of abdomen pale yellow with basal gray lanceolate mark flanked by a pair of gray transverse chevrons; venter gray with yellow lateral longitudinal stripes. Legs weakly annulate, spination typical. Epigynum externally with wide, heavily sclerotized opening (Fig. 68); internally with midpiece truncate at top, blind ducts very short, lateral ducts arising from top of midpiece (Fig. 69). *Male:* Same as in female. Male palpus with PA small, knob-like (Fig. 65); basal RTA with two truncate lobes (Fig. 66), medial RTA pointed, distal RTA thick at base; tibia with three prolateral spines, four long ventral setae, and many short retrolateral setae; cymbium very short distad, with two spines near base of tip and four spines on tip; embolus thick at base, tapering abruptly, conductor with basal lobe poorly developed (Fig. 65).

Measurements.—*Female:* Total length, 3.72–4.68 (4.23); carapace length, 1.55–1.80 (1.66); carapace width, 1.12–1.36 (1.23); femur I length, 1.55–1.89 (1.77). *Male:* Total length, 3.72–5.11 (4.21); carapace length, 1.61–2.17 (1.87); carapace width, 1.46–1.58 (1.53); femur I length, 2.48–2.85 (2.57).

Distribution.—Western British Columbia, Washington and Oregon. One possibly erroneous record from the San Francisco Bay area in California (Map 6).

Natural History.—Mature specimens collected from fir needles, under rocks and boards, under maple and cedar duff, and in leaf litter in every month except January, at elevations from 50 to 1500 m.

Material Examined.—CANADA: British

Columbia; Side Saanich Inlet, 14 September 1935 (RV. Chamberlin, W. Ivie), 2 ♂, 1 ♀ (AMNH). U.S.A.: *Washington*; Clallam County, Port Angeles, 2 February 1933 (no collector), 1 ♀ (AMNH); King County, April 1951 (B. Malkin), 1 ♀ (AMNH), Seattle, no date (? Kincaid), 1 ♀ (AMNH), 25 April 1932 (H. Exline), 1 ♀ (AMNH), University of Washington Campus (150′), 3 June 1963 (J.R. Thomson), 1 ♀ (BMSC), Volunteer Park (400′), 11 August 1963 (J.R. Thomson), 1 ♂ (BMSC), Foster Island (25′), 14 May 1963 (J. R. Thomson), 1 ♀ (BMSC), 9 September 1963 (J.R. Thomson), 2 female (BMSC), Sallal Prairie, 5.1 miles ESE. of N. Bend, under Rock (640′), 9 April 1977 (C. Stoner), 1 ♀ (BMSC), 8.6 miles NNE. of N. Bend on North Fork County Road (1120′), 23 April 1977 (W. Jones), 1 ♀ (BMSC), 1.6 miles S. of Des Moines on Highway 509, under maple duff (150′), 27 November 1975 (R. Crawford), 2 ♀ (BMSC), Kittitas County, 8 miles WNW. of Thorp in Taneum Canyon under rocks (2440′), 27 April 1974 (J.P. Pelham), 1 ♀ (BMSC), 3.8 miles SSW. of Thorp in Robinson Canyon, under rock (2200′), 30 March 1975 (R. Crawford), 1 ♀ (BMSC); Pierce County, Mt Rainier National Park, 9 August 1929 (RV. Chamberlin), 1 ♀ (AMNH), 6 July 1938 (W. Ivie), 1 ♀ (AMNH), Elbe, in leaf litter (1300′), 14 September 1975 (R. Crawford), 1 ♀ (BMSC); San Juan County, Doubleneck, 27 July 1935 (H. Exline), 1 ♀ (AMNH), Friday Harbor, 18 August 1935 (H. Exline), 1 ♀ (AMNH); Skagit County, 1.6 miles NNW. La Conner on Indian Reservation Road 204, from maple and cedar duff (140′), 6 March 1976 (R. Crawford), 1 ♀ (BMSC); Skamania County, 6.3 miles NW. of Trout Lake on Road N88, under loose bark (2740′), 9 October 1976 (R. Crawford), 1 ♀ (BMSC); Snohomish County, Edmonds, 16 August 1927 (no collector), 2 ♂ (AMNH); Thurston County, Olympia, 29 November 1930 (H. Exline), 1 ♀ (AMNH), 1 October 1932 (H. Exline), 1 ♀ (AMNH), 6–10 June 1944 (H. Exline Frizzell), 1 ♀ (AMNH); *Oregon*; Benton County, 10 miles N. of Corvallis, under board, 31 August 1947 (V. Roth), 1 ♀ (AMNH), 12 miles N. of Corvallis at Camp Adair, 25 September 1947 (V. Roth), 2 ♂, 3 ♀ (AMNH), Corvallis, in forest, 7 February 1948 (V. Roth), 1 ♀ (AMNH), 8 miles N. Corvallis, in McDonald Forest, 27 December 1949 (V. Roth, R. Beer), 1 ♀ (AMNH), 30 September 1950 (V. Roth), 1 ♀ (AMNH), 10 miles W. of Corvallis, 19 March 1951 (V. Roth), 2 ♀ (AMNH); Curry County, 8 miles E. of Gold Beach, 29 April 1951 (V. Roth), 2 ♀ (AMNH); Hood River County, 10 miles S. of Parkdale, 16 September 1949 (V. Roth), 3 ♀ (AMNH); Marion County, Salem, 18 September 1954 (V. Roth), 1 ♂ (AMNH); Tillamook County, Beaver Creek, 7 September 1932 (H. Exline), 1 ♀ (AMNH); Washington County, Forest Grove, 28 November 1940 (W. Ivie), 1 ♀, 1 immature (AMNH); Yamhill County; McMinnville, 23 March 1952 (B. Malkin, K.M. Fender), 1 ♀ (AMNH), Newburg, on highway, in fir needles, 22 September 1954 (V. Roth), 1 ♂ (AMNH); *California:* Alameda County, Berkeley, 13 December 1953 (V. Roth), 1 ♀ (AMNH).

Calymmaria orick new species
Figs. 70–72; Map 7

Type.—Male holotype from Orick, Humboldt County, California, U.S.A., 41°17′N, 124°03′W, 16 September 1961, W.J. Gertsch (AMNH).

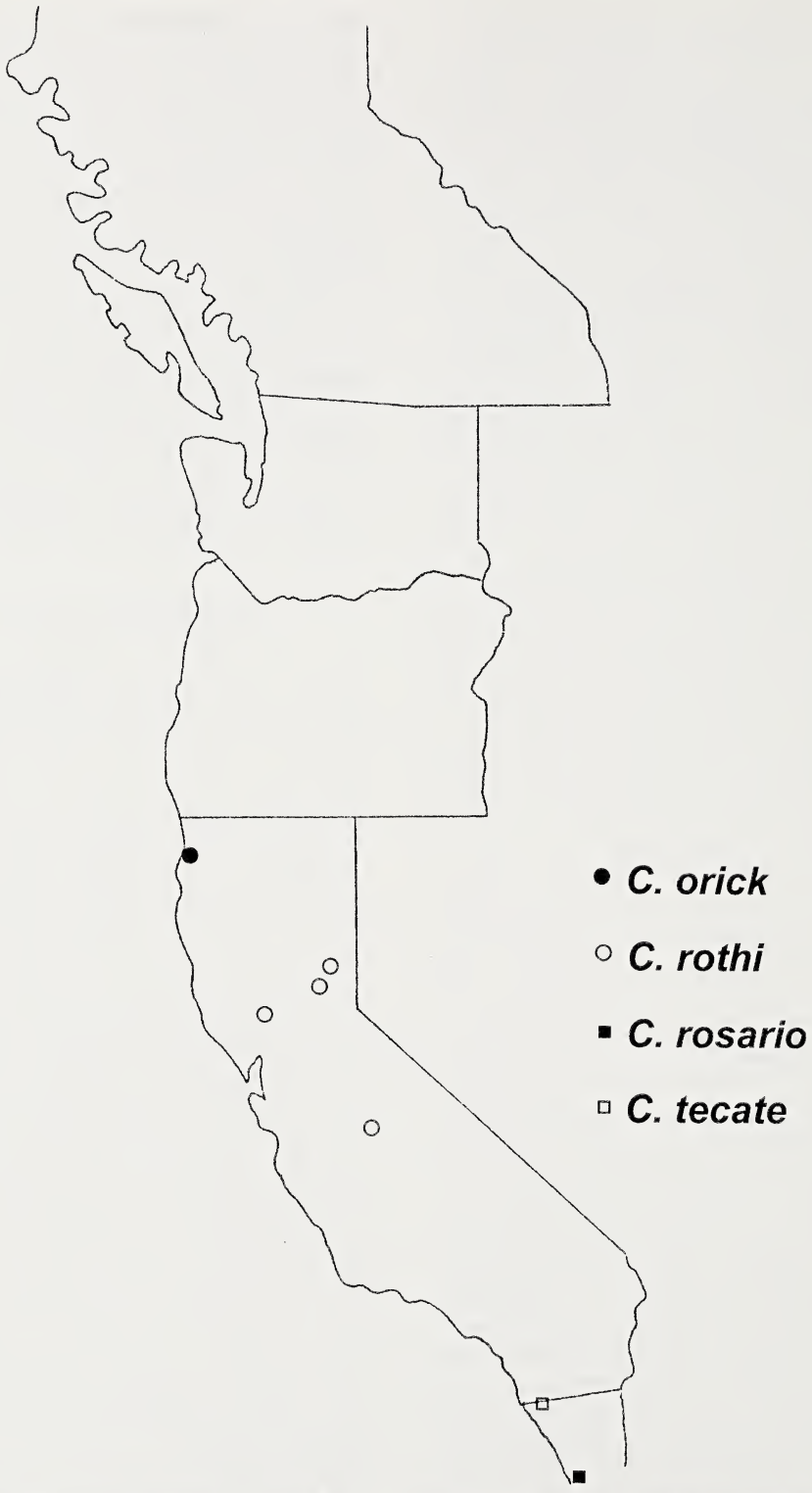
Etymology.—The specific name is a noun in apposition taken from the type locality.

Diagnosis.—*Calymmaria orick* resembles *C. emertoni*, *C. nana*, and *C. siskiyou* but the tip of the embolus is longer and thicker (Fig. 70).

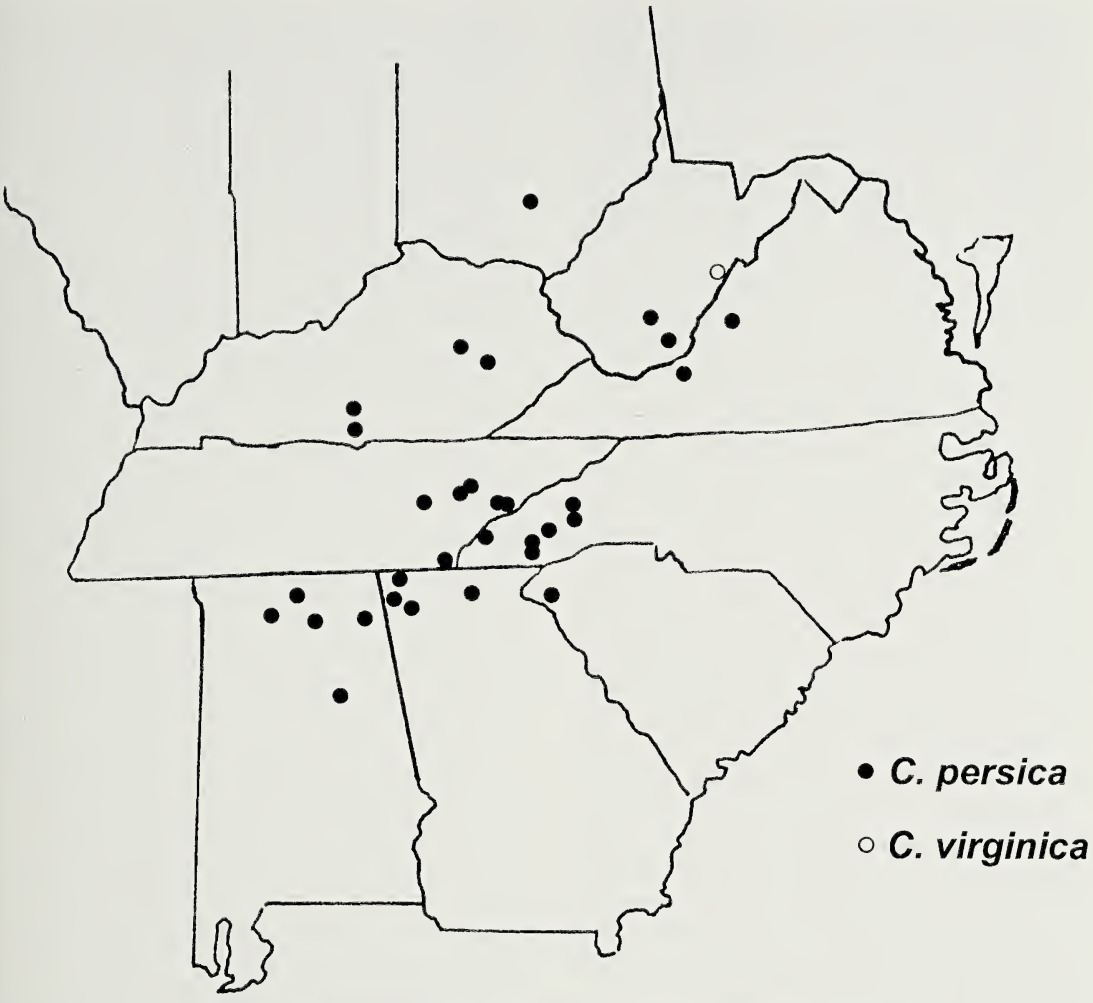
Description.—*Male:* Carapace typical. Dorsum of abdomen gray with basal lanceolate mark flanked by two large yellow spots and three transverse chevrons; venter gray with one pair of basal yellow spots and two yellow lateral longitudinal stripes. Legs weakly annulate, spination typical. Palpus with PA large, round (Fig. 70); basal RTA long, pointed, medial RTA long, pointed distad, distal RTA very short, round (Fig. 71); tibia with one prolateral spine, three ventral setae; cymbium somewhat short distad, with two spines near base of tip and six spines on tip; embolus thick near base tapering abruptly into thick point, conductor lacking basal lobe (Fig. 70). *Female:* Unknown.

Measurements.—*(n = 1):* Total length, 3.47; carapace length, 1.55; carapace width, 1.30, femur I length, 1.92.

Distribution.—Humboldt County, California (Map 7).



Map 7.—Distribution of *C. orick* (●), *C. rothi* (○), *C. rosario* (■), and *C. tecate* (□).



Map 8.—Distribution of *C. persica* (●) and *C. virginica* (○).

Natural History.—One mature specimen collected in September.

Material Examined.—Known only from the type.

Calymmaria persica (Hentz 1847)
Figs. 73–77; Map 8

Tegenaria persica Hentz 1847: 463, fig. 23; Roewer 1944: 33.

Tegenaria cavicola Banks 1896: 203; Roewer 1944: 33. NEW SYNONYMY.

Cybaeus montavencis Bishop & Crosby 1926: 201, figs. 51–53; Bonnet 1956: 1302. NEW SYNONYMY.

Calymmaria cavicola (Banks): Chamberlin & Ivie 1937: 213; Muma 1945: 95; Roth 1952: 287; 1968: 31; Beatty & Nelson 1979: 52.

Calymmaria montavencis (Bishop & Crosby): Chamberlin & Ivie 1937: 213; 1944: 129.

Calymmaria persica (Hentz): Roth 1952: 287; Roth 1968: 31.

Types.—*Tegenaria persica*: male holotype from Alabama (lost). *Tegenaria cavicola*: female holotype from Salt Petre Cave, Crawford County, Indiana, U.S.A., 38°14′N, 86°21′W (MCAC, examined). *Calymmaria monatvencis*: male holotype and female allotype from Grandfather Mountain, Avery County, North Carolina, U.S.A., 36°06′N, 81°48′W (AMNH, examined).

Diagnosis.—*Calymmaria persica* can be easily separated from the other species occurring in the Appalachian Mountains, *C. virginica*, by the form of the epigynum (Figs. 76, 77), and the many differences in the RTA and embolus (Figs. 73–75). *Calymmaria persica* is

a highly variable species, especially in size, which has led to its separation into several species. There appears to be little variation in genitalia among specimens.

Description.—*Female:* Carapace typical. Dorsum of abdomen yellow with pale gray basal lanceolate mark followed by three dark gray transverse chevrons and one spot; venter gray with wide pale yellow lateral longitudinal stripes. Legs annulated, spination typical.. Epigynum externally with v-shaped sclerotization around opening (Fig. 76); internally with midpiece long, ducts well-separated at top, blind ducts short, lateral ducts thin, short (Fig. 77). *Male:* Same as in female Male palpus with PA wide, rounded (Fig. 73); basal RTA with several lobes, medial RTA with proximal and distal lobes, distal RTA long (Figs. 74, 75); tibia with one prolateral spine, several long ventral setae, many short retrolateral setae; cymbium elongate distad, with two spines near base of tip and six spines on tip; embolus thick at base, tapering gradually, conductor with basal lobe pointed (Fig. 73).

Measurements.—*Female:* Total length, 4.03–9.70 (6.60); carapace length, 1.55–4.06 (2.67); carapace width, 1.21–2.82 (1.95); femur I length, 1.83–6.00 (3.64). *Male:* Total length, 6.08–7.28 (6.53); carapace length, 2.95–3.41 (3.19); carapace width, 2.34–2.64 (2.48); femur I length, 2.39–6.20 (4.69).

Distribution.—Ohio to Alabama along the Appalachian Mountains (Map 8).

Natural History.—Mature specimens collected from woods, caves, along streams, behind waterfalls, in every month of the year from elevations of 60–2000 m.

Material Examined.—U.S.A.: *Indiana*: Crawford County, Salt Petre Cave, no date (N. Banks), 1 immature (MCZC); *Ohio*: Hocking County, Old Main's Cave, 29 August 1921 (N. Banks), 1 ♂ (OSUC); *Kentucky*: no county, Boones Cave, Dix River, 9 September 1921(Finckhouser), 1 ♀ (AMNH); Breathitt County, Quicksand, 25 June 1925 (S.C. Bishop), 5 ♀ (AMNH), 26 June 1925 (S.C. Bishop), 1 ♀ (AMNH); Powell County, Mauldin Cave, 26 October 1966 (Reddell, T. Barr), 1 ♂ (AMNH); Simpson County, Old Smoky Cave, 200 to 500 ft. from entrance, 25 July 1981 (R. Crawford), 2 ♂, 3 immatures (BMSC): Warren County, Bowling Green, September 1929 (no collector), 3 immatures (AMNH); *West Virginia*: Speedway Roadside Park, Rt. 20, 16 April 1966 (D. Lickliter), 1 ♀, 1 immature (AMNH), Jackson's Park, Unity Road, Athens, 23 April 1966 (W. Shear), 1 ♀, 1 immature (AMNH), old pumphouse, Athens, 25 November 1966 (W. Shear), 2 ♀ (WASC); Raleigh Col, Grandview State Park, natural tunnel no. 1, in double sheet webbing on tunnel roof, 21 May 1966 (W. Shear), 2 ♀ (WASC), picnic area no. 2, under a stone, 21 May 1966 (W. Shear), 1 immature (WASC), Grandview State Park, 3 July 1966 (W. Shear), 1 ♀ (WASC), tunnels area, 23 September 1967 (W. Shear), 1 ♂ (WASC), in cave, 14 May 1980 (J. Amrine), 1 ♀ (UAIC); no county, Norman Cave, 31 March 1972 (J.A. Kochalka), 2 ♀ (UVSC); *Virginia*: Giles County, no location, 6 July 1946 (H.K. Wallace), 1 ♀; immature (FSCA), 21 August 1948 (H.K. Wallace), 2 ♂ (AMNH), White Pine Lodge, 19 August 1948 (H.K. Wallace), 1 ♂ (H.K. Wallace), 1 ♂ (AMNH); *North Carolina*: Buncombe County, Mt. Pisgah, no date (no collector), 1 ♀ (AMNH), Lodge to summit, 14 October 1926 (C.R. Crosby), 1 ♀ (AMNH); Graham County, 5 miles E. of Bryson City, 2 October 1960 (W.J. Gertsch, W. Ivie), 1 ♀ (AMNH); Jackson County, Cullowhee Mountain, 28 November, 1969 (F. Coyle), 1 ♀ (FACC), Wolf Creek, 5 miles from Cullowhee (2400′), 9 August 1980 (J. S. Heiss), 2 ♂ (UAIC), White Water Falls (2400′), 9 August 1980 (J. S. Heiss), 4 ♂ (UAIC); Macon County, Elliot Pk. Forest, 7.5 miles SE. of Highlands on Bull Pen Road (2900′), 10 September 1975 (F. Coyle), 1 ♂ (FACC), Buck Creek, clearcut, 1.6 miles NW. of intersection of Buck Creek and state road 1538 (3500′), 10 September 1976 (F. Coyle), 2 ♂ (FACC), Horse Cove, clearcut, 3.6 miles E. of Highlands, pitfall (3000′), 10 September 1976 (F. Coyle), 1 ♂ (FACC), Dry Falls, Nantahala National Forest (3200′), 8 August 1980 (J. S. Heiss), 2 ♂ (UAIC); McDowell County, Ridgecrest, 26 June 1951 (A.F. Archer), 1 ♀ (AMNH); Swain County, Deep Creek near Bryson City, 8 July 1933 (W. Ivie), 2 immatures (AMNH); Yancey County, Mt. Mitchell, 30 September 1960 (W.J. Gertsch, W. Ivie), 2 ♀ (AMNH); *Tennessee*: no county, George Light Cave, 20 March 1965 (J.A. Payne), 1 ♀ (AMNH); Anderson County, 30 miles W. of Knoxville, no date (no collector), 1 ♀, 4 immatures (AMNH); Blount County, September 1931 (W.M. Barrows), 2 ♂ (AMNH); Marion

County, Indian Cave, Little Cedar Mountain, 4.5 miles SE. of Jasper; 29 July 1967 (S. Peck, A. Fiske), 1 immature (AMNH); Roane County, Harriman; 11 July 1933 (W. Ivie), 1 ♀ (AMNH), Kingston 12 July 1933 (W. Ivie), 3 ♀, 3 immatures (AMNH); Sevier County, Le Conte Lodge (6500′), October 1926 (S.C. Bishop), 1 ♂ (AMNH), Elkmont, 10 September 1928 (no collector), 1 ♀ (AMNH), Clingman's Dome and below, Great Smoky Mountains National Park, 6 September 1935 (no collector), 3 ♂, 2 ♀ (AMNH); Warren County, Cumberland Cavern; Higginbotham Entrance, from web on walls in first 500 ft., 24 July 1981 (R. Crawford), 1 immature (BMSC); *South Carolina*: Oconee County, Stumphouse Cave, 2 February 1967 (J.A. Payne), 1 ♀, 6 immatures (AMNH); *Georgia*: Chatooga County, Parker Cave, 2 miles NE. of Sunligna, 12 June 1967 (J. Holsinger, S. Peck, A. Fiske, R. Baroody), 1 ♀ (AMNH); Dade County, Byers Cave, 1.5 miles SW. of Rising Fawn, 18 June 1967 (J. Holsinger, S. Peck, A. Fiske, R. Baroody), 1 ♀ (AMNH), 3 July 1967 (S. Peck & A. Fiske), 5 ♀, 2 immatures (AMNH); Muskogee, Ft. Benning, 24 October 1943 (no collector), 1 ♀ (AMNH); Union and Lumpkin County, on line 2 miles W. of Neels Gap on Appalachian Trail (3500′), 13 September 1975 (D. Pittillo), 1 ♂, 1 ♀ (FACC); Walker County, Bible Springs Cave, 2 miles NE. of Lookout Mountain, no date (J. Holsinger, S. Peck, R. Baroody, A. Fiske), 1 ♀ (AMNH), Mt. Cove Cave, 1 miles E. of Lookout Mountain, 20 June 1967 (S. Peck, A. Fiske), 1 immature (AMNH); *Alabama*: Blount County, Bangor Cave, 1 miles N. of Bangor, 28 June 1967 (S. Peck, A. Fiske), 1 ♂, 5 immatures (AMNH); Coosa County, Hatchet Creek, 18 April 1940 (A.F. Archer), 1 ♀ (AMNH); DeKalb County, DeSoto Park, December 1937 (W.B.Jones), 1 ♂ (AMNH), 7 October 1950 (A.F. Archer), 2 ♀ (AMNH); Jackson County, Blowing Cave, near Garth, 29 February 1940 (W.B.Jones, A.F. Archer), 1 ♀, 2 immatures (AMNH); Madison County, Herrin Cave, near New Hope, 26 September 1939 (Jones and Flanagan), 1 ♂ (AMNH), Alladin Cave, Sharp Cove, 1 December 1939 (W.B.Jones, A.F. Archer), 2 ♀, 4 immatures (AMNH), Monte Sano, summer 1940 (A.F. Archer), 1 ♀, 7 immatures (AMNH), December 1940 (A.F. Archer), 2 ♀, 7 immatures (AMNH), Cave Spring Cave no. 60, Chapman Mountain, 8 September 1965 (S. Peck), 1 immature (AMNH); Marshall County, Honeycomb Cave, Guntersville Dam, 11 January 1939 (A.F. Archer), 2 ♀ (AMNH); Morgan County, Sans Souci Cave, 5 miles S. of Decatur, no date (no collector), 3 ♀ (AMNH); Walker County, Warrior River, 20 October 1912 (H.H. Smith), 2 ♂ (AMNH); *Mississippi*: Wilkinson County, 1 airline miles SE. of Fort Adams, 30 March 1974 (D.A. Rossman), 1 ♀ (AMNH).

Calymmaria rosario new species
Figs. 78, 79; Map 7

Type.—Female holotype from under reeds on a hillside along a lagoon, El Rosario, Baja California, Mexico, 30°03′N, 115°43′W, 5 May 1961, W.J. Gertsch, V. Roth (AMNH).

Etymology.—The specific name is a noun in apposition taken from the type locality.

Diagnosis.—*Calymmaria rosario* can be separated readily by the distinctive form of the epigynum (Figs. 78, 79).

Description.—*Female:* Carapace typical. Dorsum of abdomen gray with basal lanceolate mark flanked by silver patches, mottled gray behind; venter gray. Legs annulate, spination typical. Male: unknown. Epigynum externally with large opening heavily sclerotized below (Fig. 78); internally with midpiece long, blind ducts long, lateral ducts thick and fused at midline in a hump (Fig. 79).

Measurements.—*(n = 1):* Total length, 4.34; carapace length, 1.86; carapace width, 1.24; femur I length, 1.58.

Distribution.—One specimen from Baja California, Mexico (Map 7).

Natural History.—One mature specimen collected from hillside near lagoon in May (Map 7).

Material Examined.—Known only from the type.

Calymmaria rothi new species
Figs. 80–84; Map 7

Types.—Male holotype and female allotype from Monarch Mine, Sierra City, Sierra County, California, U.S.A., 39°33′N, 120°37′W, 7 September 1959, W.J. Gertsch, V. Roth (AMNH).

Etymology.—The specific name is a patronym honoring Vincent D. Roth, who did much to advance our knowledge of *Calymmaria* and related spiders.

Diagnosis.—*Calymmaria rothi* resembles *C. aspenola* and *C. monicae* in the form of the epigynum, but the epigynal midpiece is thinner than in *C. aspenola*, and the ducts of the midpiece are not as widely separated at the top as they are in *C. monicae* (Fig. 62). Male *C. rothi* are easily separated from other *Calymmaria* by the thin embolus and the hooked PA (Fig. 80).

Description.—*Female:* Carapace typical. Dorsum of abdomen yellow with gray basal lanceolate mark followed by four transverse chevrons and a large spot; venter gray with yellow lateral longitudinal stripes. Legs annulate, spination typical. Epigynum externally with opening heavily sclerotized below (Fig. 83); internally with midpiece long, thin, blind ducts long, lateral ducts thick, fused at midline in a hump (Fig. 84). *Male:* Same as in female only darker. Male palpus with PA hooked (Fig. 80); basal RTA with bifurcate apex (Fig. 81), medial RTA with two small teeth (Fig. 82), distal RTA long, rounded; tibia with three prolateral spines, several long ventral setae, many retrolateral short setae; cymbium elongate distad, with two spines near base and five spines on tip; embolus long, thin, and tapering, conductor with large, round, basal lobe (Fig. 80).

Measurements.—*Female:* Total length, 5.27–7.75 (6.95); carapace length, 2.23–3.72 (2.93); carapace width, 1.71–2.48 (2.16); femur I length, 2.79–4.03 (3.72). *Male:* Total length, 6.20–7.28 (6.69); carapace length, 3.10–3.72 (3.41); carapace width, 2.54–3.04 (2.73); femur I length, 4.31–6.20 (4.86).

Distribution.—Napa, Sierra, Nevada and Mariposa Counties, California (Map 7).

Natural History.—Mature specimens collected in March and September, some specimens collected from a mine.

Material Examined.—U.S.A.: *California*: Mariposa County, 2 miles S. of Fish Camp, 12 September 1959 (no collector), 1 ♂, 3 immatures (AMNH); Napa County, Samuel Spring, 13 March 1954 (E. Schlinger), 1 ♀ (AMNH); Nevada County, Truckee, in house. Lake Tahoe area (6000′), December 1975 (M. Whiting), 1 ♂ (AMNH); Sierra County, The Cups, Sierra City, 6 September 1959 (V. Roth, W.J. Gertsch), 1 ♂, 5 ♀ (AMNH), Monarch Mine, 7 September 1959 (W.J. Gertsch, V. Roth), 1 ♂, 5 immatures (AMNH).

Calymmaria scotia new species
Figs. 85–89; Map 9

Types.—Male holotype and female allotype from 5 miles N. of Scotia, Humboldt County, California, U.S.A., 40°32′N, 124°05′W, 1 October 1959, V. Roth (AMNH).

Etymology.—The specific name is a noun in apposition taken from the type locality.

Diagnosis.—*Calymmaria scotia* is easily separated from other *Calymmaria* by the distinctive form of the epigynum (Figs. 88, 89) and the peculiarly shaped embolus (Fig. 85).

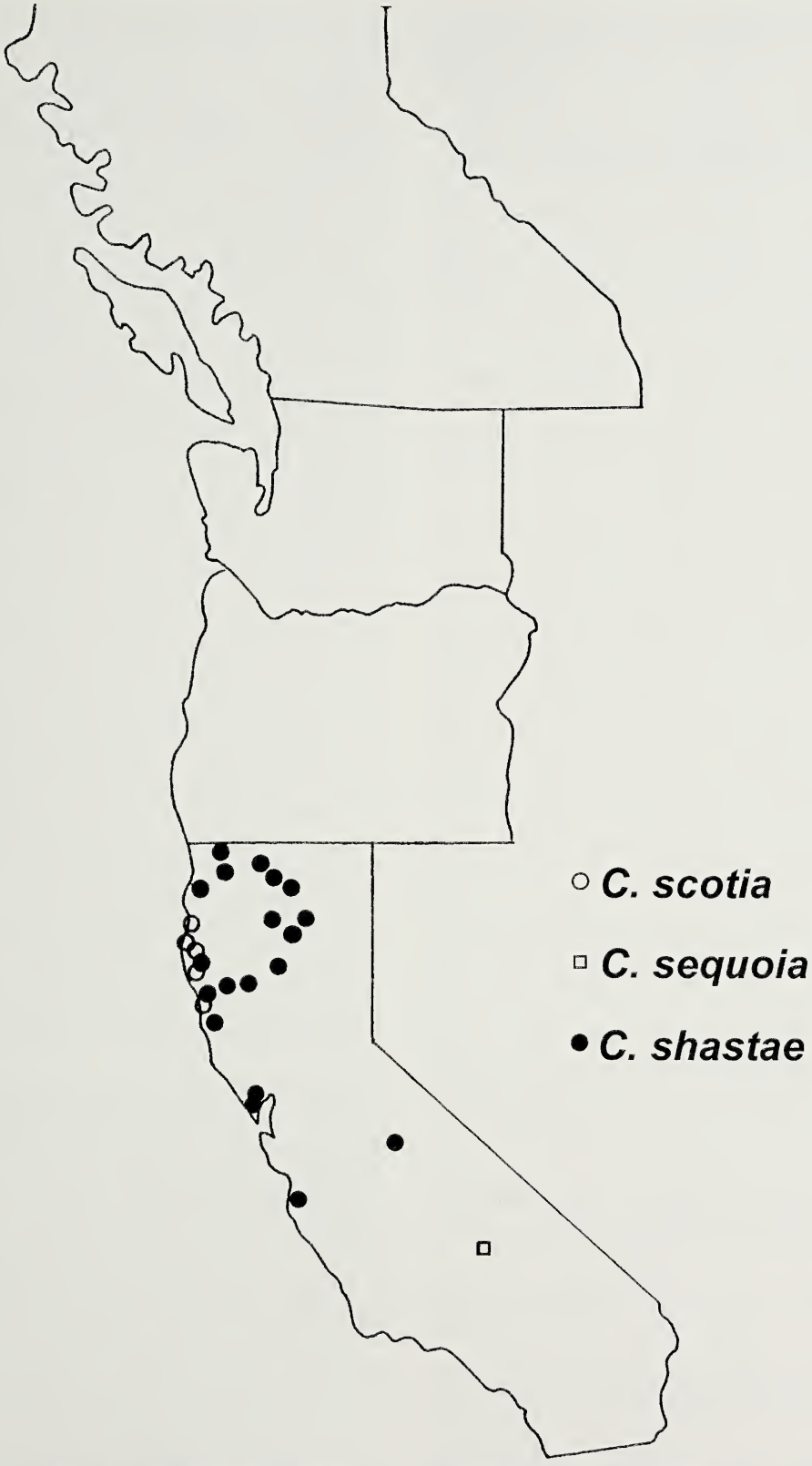
Description.—*Female:* Carapace typical. Dorsum of abdomen gray with paler basal lanceolate mark flanked by large yellow spots and followed by four pairs of yellow spots; venter gray with yellow lateral longitudinal stripes. Legs annulate, spination typical. Epigynum externally with opening bordered below by a transverse sclerotized band, and with v-shaped sclerotization near epigastric furrow (Fig. 88); internally with midpiece very short, blind ducts very small, lateral ducts widely separated (Fig. 89). *Male:* Same as in female, legs generally unmarked. Male palpus with PA short, pointed, distal RTA long, round (Fig. 86); tibia with one prolateral spine and several long ventral setae; cymbium moderately short distad, with two spines near base of tip and six spines on tip; embolus gradually tapering to nipple-like point, conductor with large basal lobe.

Measurements.—*Female:* Total length, 3.57–4.28 (3.78); carapace length, 1.49–1.55 (1.54); carapace width, 0.93–1.19 (1.08); femur I length, 1.52–1.86 (1.62). *Male:* Total length, 2.79–3.47 (3.16); carapace length, 1.27–1.64 (1.49); carapace width, 0.99–1.27 (1.13); femur I length; 1.49–2.02 (1.79).

Distribution.—Humboldt and Mendocino Counties, California (Map 9).

Natural History.—Mature specimens collected in February, September and October.

Material Examined.—U.S.A.: *California*: Humboldt County, 1 miles S. of Dyerville, 19 September 1953 (R. Schuster, G. Mash), 1 ♀ (AMNH), F. K. Lane State Park, near Phillipsville, 1 October 1959 (V. Roth), 1 ♀ (AMNH), 5 miles N. of Scotia, 1 October 1959 (V. Roth), 1 ♂, 1 ♀ (AMNH), 2 miles N. of Phillipsville, 14 September 1961 (W. Ivie, W.J. Gertsch), 1 ♂, 1 ♀ (AMNH); Mendocino County, Caspar Creek, 1 miles SE.



Map 9.—Distribution of *C. scotia* (○), *C. sequoia* (□), and *C. shastae* (●).

Caspar, 13 September 1961 (W.J. Gertsch, W. Ivie), 1 ♂, 1 ♀ (AMNH), 4.2 miles S. of Piercy, 17 February 1967 (V. Roth), 1 ♀ (AMNH).

Calymmaria sequoia new species
Figs. 90–92; Map 9

Type.—Male holotype from Quaking Aspen Camp, Sequoia National Forest, Tulare County, California, U.S.A., 36°07′N, 118°32′W, 9 September 1959, no collector (AMNH).

Etymology.—The specific name is a noun in apposition taken from the type locality.

Diagnosis.—*Calymmaria sequoia* can be separated by the thick embolus, triangular shaped conductor (Fig. 90), and multi-lobed medial RTA (Fig. 92).

Description.—*Male:* Carapace typical. Dorsum abdomen gray with basal lanceolate mark flanked by yellow patches and followed by four transverse chevrons; venter gray with yellow lateral longitudinal stripes. Legs weakly annulate or unmarked; spination typical. Palpus with PA rounded (Fig. 90); basal RTA long, rounded, medial RTA with two lobes, the distal lobe bifurcate (Fig. 92), distal RTA long, round; tibia with long ventral setae, and many short retrolateral setae; cymbium short distad, with two spines near base of tip and seven spines on tip; embolus thick, tapering, conductor with basal lobe. *Female:* Unknown.

Measurements.—Total length, 3.44–4.03 (3.76); carapace length, 1.61–1.86 (1.77); carapace width, 1.24–1.52 (1.44); femur I length, 1.74–2.17 (2.00).

Distribution.—Sequoia National Forest, Tulare County, California (Map 9).

Natural History.—Mature specimens collected in September. *Calymmaria aspenola* and *C. lora* were present in the same collection.

Material Examined.—U.S.A.: *California*: Tulare County, Quaking Aspen Camp, Sequoia National Forest, 9 September 1959 (no collector), 11 ♂ (AMNH).

Calymmaria shastae Chamberlin & Ivie 1937
Figs. 93–97; Map 9

Calymmaria shastae Chamberlin & Ivie 1937: 214, figs. 6, 7, 24; Roewer 1954: 46; Bonnet 1956: 940.

Types.—Male holotype and female allotype from Weed, Siskiyou County, California, U.S.A., 41°25′N, 122°23′W (AMNH, examined).

Diagnosis.—*Calymmaria shastae* females resemble *C. siskiyou* but the epigynal "hood" is longer in *C. shastae* (Fig. 96). Males can be separated from other *Calymmaria* by the form of the basal and medial RTA (Figs. 94. 95), and embolus.

Description.—*Female:* Carapace typical. Dorsum of abdomen yellow with gray basal lanceolate mark flanked by yellow patches and followed by five gray transverse chevrons; Venter gray with two yellow lateral longitudinal stripes. Legs usually unmarked, spination typical. Epigynum externally with large opening and heavy sclerotization below (Fig. 96); internally with midpiece elongate, blind ducts long, lateral ducts thick, short, united medially in a point (Fig. 97). *Male:* Same as in female but usually darker. Male palpus with PA short, wide, truncate (Fig. 93); basal RTA truncate at tip, medial RTA a low ridge, distal RTA wide, rounded; tibia with two prolateral spines, several long ventral setae, and dense short retrolateral setae; cymbium moderately elongate distad, with two spines near base of tip and six spines on tip; embolus thickest in middle, long, tapering, with swelling laterally (Fig. 94), conductor with rounded basal lobe.

Measurements.—*Female:* Total length, 4.96–5.74 (5.40); carapace length, 2.17–2.51 (2.34); carapace width, 1.55–1.86 (1.71); femur I length, 2.17–3.09 (2.70). *Male:* Total length, 4.37–5.74 (5:28); carapace length, 2.05–2.76 (2.51); carapace width, 1.61–2.17 (1.98); femur I length, 2.17–3.88 (3.13).

Distribution.—Northern California (Map 9).

Natural History.—Mature specimens collected in every month except January, March, July and December, from woods and caves at elevations up to 2100 m.

Material Examined.—U.S.A.: *California*: Humboldt County, Miranda, 4 June 1939 (no collector), 6 ♀ (AMNH), 2 miles S. of Weott, redwoods, 1 October 1959 (V. Roth), 1 ♀ (AMNH), 5 miles W. of Pepperwood, 6 April 1960 (W.J. Gertsch, W. Ivie), 1 female (AMNH); Marin County, Novato, 15 May 1954 (E. Schlinger), 1 ♀ (AMNH), San Geronimo, 19 September 1963 (J. and W. Ivie), 3 ♀, 4 immatures (AMNH); Mendocino County, Caspar Creek, 1 miles SE. of Caspar, 13 Sep-

tember 1961 (W.J. Gertsch, W. Ivie), 1 ♀ (AMNH), 4.1 miles SW. of Leggett, on top of grade, 17 February 1967 (V. Roth), 3 ♀ (AMNH); Monterey County, Pacific Grove, white dune area, 25 September [no year] (W.J. Gertsch, W. Ivie), 1 ♂, 1 immature (AMNH); San Francisco County, Twin Peaks, 6 November 1934 (no collector), 1 ♀ (AMNH); Shasta County, 8 September 1935 (RV. Chamberlin, W. Ivie), 1 ♂, 1 ♀ (AMNH), Subway Cave, 1 miles N. of Old Station, 2 September 1959 (W.J. Gertsch, V. Roth), 11 ♂, 17 ♀, 11 immatures (AMNH), 16 September 1965 (J. and W. Ivie), 1 ♂, 6 ♀, 3 immatures (AMNH), Shingletown, 4 September 1959 (V. Roth, W.J. Gertsch), 1 ♂ (AMNH), 13 September 1959 (no collector), 1 ♂ (AMNH), Tower, 7 April 1960 (W.J. Gertsch, W. Ivie, R. Schrammel), 1 ♀ (AMNH), Potter Creek Cave, 7 September 1961 (W.J. Gertsch), 1 ♀ (AMNH), 5 miles W. of Manzanita Lake, 19 September 1961 (W. Ivie, W.J. Gertsch), 3 ♀, 1 immature (AMNH); Siskiyou County, no date (no collector), 1 ♂, 2 ♀ (AMNH), 1 miles E. of Somesbar, 22 August [no year] (W.J. Gertsch, V. Roth), 1 ♀ (AMNH), Weed, 8 September 1935 (R.V. Chamberlin, W. Ivie), 1 ♂, 1 ♀ (AMNH), Bartle, 18 June 1942 (W.M. Pearce), 1 ♀ (AMNH), 18 September 1961 (W. Ivie, W.J. Gertsch), 4 ♀, 1 immature (AMNH), 18 miles N. of Happy Camp, 22 August 1959 (W.J. Gertsch, V. Roth), 1 ♀ (AMNH), 3 miles E. of McCloud, 2 September 1959 (W.J. Gertsch, V. Roth), 1 ♀, 1 immature (AMNH), Panther Meadows, Shasta Ski Bowl, 2 September 1959 (W.J. Gertsch, V. Roth), 1 ♂, 2 ♀, immature (AMNH), 5 miles W. of Mt. Shasta, 2 September 1959 (W.J. Gertsch, V. Roth), 2 ♀, 1 immature (AMNH), Panther Mountain Road, Mt. Shasta (7000′); 17 September 1961 (W.J. Gertsch, J. Gertsch), 8 ♂, 3 ♀ (AMNH), Deadhorse Summit, near Pondosa (5500′), 18 September 1961 (W. Ivie, W.J. Gertsch), 7 ♂, 12 ♀, 7 immatures (AMNH); Tehama County, 2 miles N. of Paskenta, Dead Mule Spring, Covelo Road (5150′), 29 August 1972 (H. B. Leech), 1 ♂ (CASC), Deer Creek, 19 September 1961 (W. Ivie, W.J. Gertsch), 1 ♂, 2 ♀ (AMNH), south of Lassen National Park, near junction, 19 September 1961 (W. Ivie, W.J. Gertsch), 1 ♀, 2 immatures (AMNH).

Calymmaria sierra new species
Figs. 98–102; Map 10

Types.—Male holotype and female allotype from 2 miles N. of Calpine, Sierra County, California, U.S.A., 39°41′N, 120°26′W, 6 September 1959, W.J. Gertsch, V. Roth (AMNH).

Etymology.—The specific name is a noun in apposition taken from the type locality.

Diagnosis.—Female *Calymmaria sierra* can be separated from other *Calymmaria* by the heavily external sclerotization of the epigynum (Fig. 101). Male *C. sierra* can be separated by the thin embolus, the small hooked PA (Fig. 98), and the bilobed medial RTA.

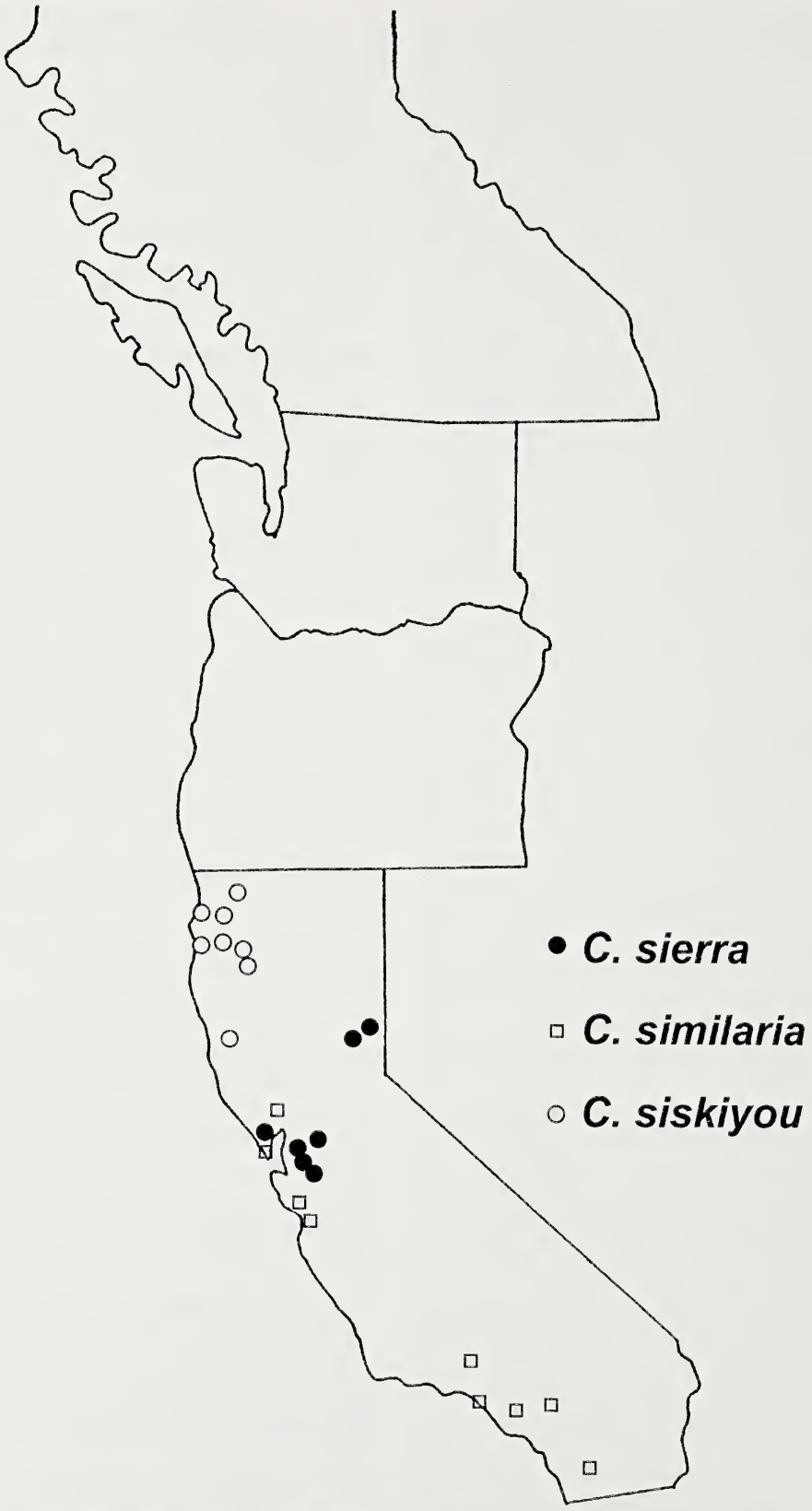
Description.—*Female:* Carapace typical. Dorsum of abdomen gray with basal lanceolate mark flanked by two pairs of yellow spots and followed by three yellow transverse chevrons; venter gray with two yellow lateral longitudinal stripes. Legs usually unmarked, spination typical. Epigynum externally with heavy sclerotization around the opening (Fig. 101); internally with midpiece short, wide near top, blind ducts long, lateral ducts thick and united medially in a hump (Fig. 102). *Male*: Same as in female, with markings less distinct. Male palpus with PA small, hooked (Fig. 98); basal RTA with bifurcate tip (Fig. 99); medial RTA with two lobes (Figs. 99, 100), distal RTA long, round; tibia with two prolateral spines, six long ventral setae, and many short retrolateral setae; cymbium short distad, with two spines at base of tip and six spines on tip; embolus thin, long, tapering, conductor with large, rounded basal lobe (Fig. 98).

Measurements.—*Female:* Total length, 4.34–4.65 (4.50); carapace duration, 1.71–2.02 (1.86); carapace width, 1.24–1.43 (1.34); femur I length, 1.61–2.14 (1.90). *Male:* Total length, 3.57–4.43 (4.01); carapace length, 1.71–2.02 (1.84); carapace width, 1.36–1.71 (1.53); femur I length, 1.92–2.42 (2.15).

Distribution.—San Francisco Bay area and Sierra Nevada Mountains of California (Map 10).

Natural History.—Mature specimens collected in January, May, September, October, November and December.

Material Examined.—U.S.A.: *California*: Alameda County, Castro Valley, 7 January 1939 (W.M. Pearce), 1 ♀ (AMNH), 18 January 1939 (W.M. Pearce), 1 ♂ (AMNH), 1 July 1939 (W.M. Pearce), 1 ♂ (AMNH), Oakland, 28 January 1953 (R. Schuster), 1 ♀ (AMNH), Mountain Boulevard and Park, 17 October 1953 (R. Schuster, V. Roth), 3 ♂, 4 ♀, 2 im-



Map 10.—Distribution of *C. sierra* (●), *C. similaria* (□), and *C. siskiyou* (○).

matures (AMNH); Contra Costa County, Marsh Creek Springs, 5 May 1940 (W.M. Pearce), 1 ♀ (AMNH), 2 miles W. of Orinda, 12 December 1953 (V. Roth), 2 ♂, 6 ♀, 3 immatures (AMNH); Marin County, 427 Rose Ave., Mill Valley, 12 November 1953 (H. B. Leech), 1 ♂ (AMNH), Mill Valley, 16 October 1955 (H. B. Leech), 1 ♀, 1 immature (AMNH), W. slope of Mt. Tamalpais, 10 January 1963 (V. Roth, P. Craig), 1 ♀ (AMNH), 4 miles outside of Muir Woods, 10 January 1964 (V. Roth), 2 ♀, 1 immature (AMNH); Plumas County, southside of Lake Almandor, 5 September 1959 (W.J. Gertsch, V. Roth), 4 ♂, 4 ♀ (AMNH); Sierra County, 2 miles N. of Calpine, 6 September 1959 (W.J. Gertsch, V. Roth), 2 ♂, 4 ♀, 1 immature (AMNH), Sierra City, The Cups, 6 September 1959 (V. Roth, W.J. Gertsch), 1 ♂, 2 ♀ (AMNH).

Calymmaria similaria new species
Figs. 103, 104; Map 10

Type.—Female holotype from Arrowhead Lake, San Bernardino County, California, U.S.A., 34°11′N, 117°15′W, 6 May 1936, S.C. Bishop (AMNH).

Etymology.—The specific name is an adjective referring to this species' similarity to *C. aspenola*.

Diagnosis.—The epigynum of *C. similaria* is similar to that of *C. aspenola* externally, but the midpiece is not as wide as in *C. aspenola* and the lateral ducts do not meet medially in a hump (Fig. 104).

Description.—*Female:* Carapace typical. Dorsum of abdomen gray with basal lanceolate mark and three pairs of yellow spots decreasing in size caudally; venter gray with yellow lateral longitudinal stripes. Legs annulate, spination typical. Epigynum variable, externally with large opening heavily sclerotized laterally and below (Fig. 103); internally with midpiece long, widest at top. Blind ducts short, lateral ducts thick and fused medially (Fig. 104). *Male:* Unknown.

Measurements.—Total length, 4.40–5.77 (5.29); carapace length, 1.71–2.17 (2.02); carapace width, 1.24–1.67 (1.50); femur I length; 1.86–2.45 (2.08).

Distribution.—Coast Ranges of California (Map 10).

Natural History.—Mature specimens collected in every month except January, September, October.

Material Examined.—U.S.A.: *California:* Alameda County, Berkeley, Strawberry Canyon, 22 March 1947 (B. Malkin), 1 ♀ (AMNH); Kern and Ventura Cos., 31 July to 1 August 1961 (Roth and Roth), 2 ♀, 2 immatures (AMNH); Los Angeles County, Saddle Peak, Santa Monica Mountains, 11 February 1953 (R.X. Schick), 1 ♀ (AMNH), San Antonio Canyon near Claremont, 1 July 1956 (V. Roth, W.J. Gertsch), 4 ♀, 3 immatures (AMNH); Marin County, Inverness, 8 November 1953 (V. Roth), 1 ♀ (AMNH); Monterey County, Pacific Grove, March 1913 (R.V. Chamberlin), 3 ♀, 2 immatures (AMNH), Pebble Beach, 25 March 1957 (A. M. Nadle), 3 ♀ (AMNH); Napa County, Oakville, 31 December 1953 (V. Roth), 2 ♀, 2 immatures (AMNH); San Bernardino County, Arrow head Lake, 6 May 1936 (S.C. Bishop), 5 ♀, 3 immatures (AMNH); San Diego County, Mt. Palomar, 30 June 1956 (W.J. Gertsch, V. Roth), 5 ♀, 3 immatures (AMNH); San Francisco County, 9 April (no year) (R.F. Sternitzky), 1 ♀ (AMNH); Santa Cruz County, Ben Lomond, 25 June 1952 (M. Cazier, W.J. Gertsch, R. Schrammel), 1 ♀ (AMNH), Felton, 3 April 1960 (W.J. Gertsch, W. Ivie, R. Schrammel), 2 ♀, 2 immatures (AMNH).

Calymmaria siskiyou new species
Figs. 105–109; Map 10

Types.—Male holotype from 18 miles N. of Happy Camp, Siskiyou County, California, U.S.A., 42°03′N, 123°22′W, 22 August 1959, W.J. Gertsch, V. Roth (AMNH); female allotype from Little French Creek, 2 miles E. of Del Loma, Trinity County, California, U.S.A., 40°46′N, 123°17′W, 6 April 1960, W.J. Gertsch, W. Ivie, R. Schrammel (AMNH).

Etymology.—The specific name is a noun in apposition taken from the type locality.

Diagnosis.—*Calymmaria siskiyou* females resemble *C. shastae* in external form of the epigynum, but the sclerotization is much wider (Fig. 108). Internally the midpiece in *C. siskiyou* is much wider than in *C. shastae* and the blind ducts do not protrude (Fig. 109). Male specimens of *C. siskiyou* are similar to *C. emertoni* and *C. nana*, but can be separated from *C. emertoni* by the rounded sides of the embolus (Fig. 28), and from *C. nana* by the larger PA, elongate cymbium, and longer pointed basal RTA (Fig. 65).

Description.—*Female:* Carapace typical.

Dorsum of abdomen yellow with gray basal lanceolate mark followed by four transverse chevrons; venter gray with yellow lateral longitudinal stripes. Legs annulate, spination typical. Epigynum externally with large opening heavily sclerotized below (Fig. 108); internally with midpiece very short, wide blind ducts not protruding, lateral ducts thick, short above, thin, longer below (Fig. 109). *Male:* Carapace bright orange. Abdomen as in female. Male palpus with PA large, round (Fig. 105); basal RTA long, pointed, medial RTA large, rounded, distal RTA truncate retrolaterally; tibia with three prolateral spines, three long ventral setae, rows of long spines dorsally (Fig. 107); cymbium moderately elongate distad, with six spines on tip; embolus thick at base, tapering abruptly to a point, conductor with no basal lobe (Fig. 105).

Measurements.—*Female:* Total length, 4.65–5.25 (5.02); carapace length; 1.89–2.28 (2.15); carapace width, 1.40–1.77 (1.59); femur I length, 2.01–2.48 (2.26). *Male (one specimen):* Total length, 4.03; carapace length, 2.05; carapace width, 1.83; femur I length, 2.64.

Distribution.—Northwestern California (Map 10).

Natural History.—Mature specimens collected in April, August, and September from redwoods.

Material Examined.—U.S.A.: *California*: Humboldt County, 14 miles W. of Willow Creek, 21 August 1959 (V. Roth), 2 ♀ (AMNH), 5 miles SW. of Orleans, 22 August 1959 (W.J. Gertsch, V. Roth), 1 ♀ (AMNH), Carlotta, 15 September 1961 (W. Ivie, W.J. Gertsch), 1 ♀ (AMNH), Orick, 16 September 1961 (W. Ivie, W.J. Gertsch), 1 ♀ (AMNH); Mendocino County, Navarro River, 6 miles S. of Albion, in redwoods, 13 September 1961 (W. Ivie, W.J. Gertsch), 1 ♀ (AMNH); Siskiyou County, 18 miles N. of Happy Camp, 22 August 1959 (W.J. Gertsch, V. Roth), 1 ♂, 3 ♀ (AMNH); Trinity County, 2 miles E. of Hayfork Summit, 21 August 1959 (W. Ivie, V. Roth), 1 ♀, (W.J. Gertsch, V. Roth), 1 ♀ (AMNH), Little French Creek, 2 miles E. of Del Loma, 6 April 1960 (W.J. Gertsch, W. Ivie, R. Schrammel), 1 ♀ (AMNH).

Calymmaria sueni new species
Figs. 110–114; Map 11

Types.—Male holotype and female allotype from under rock at Lake Creek, Crater Lake National Park, Klamath County, Oregon, U.S.A., 42°56′N, 122°09′W, no date, D. Lowrie (AMNH).

Etymology.—The specific name is a patronym in honor of Dr. James Y. Suen, chair of the Department of Otolaryngology at University of Arkansas Medical School. Dr. Suen treated the senior author during his illness and was a good friend to him as well.

Diagnosis.—*Calymmaria sueni* can be separated by the short epigynal midpiece and thin, well-separated lateral ducts (Fig. 114), and the bifurcate embolus thickened midway (Fig. 110).

Description.—*Female:* Carapace typical. Dorsum of abdomen pale yellow with gray basal lanceolate mark followed by four gray transverse chevrons and a large spot; venter gray with two yellow lateral longitudinal stripes. Legs unmarked, spination typical. Epigynum externally with heavy sclerotization around and below the opening (Fig. 113); internally with midpiece short, thin, blind ducts small, lateral ducts thin, well-separated (Fig. 114). *Male:* Same as female only darker. Male palpus with PA large, round (Fig. 110); basal RTA long, tapering, pointed, medial RTA a long ridge rounded distad, distal RTA long, rounded; tibia with one promarginal spine, five long ventral setae, and five retrolateral setae; cymbium moderately elongate distad, with two spines near base of tip and five spines on tip; embolus thick in middle and bifurcate at tip, conductor with foot-shaped basal lobe (Fig. 110).

Measurements.—*Female (n = 2):* total length, 3.44–4.09; carapace length, 1.55–1.58; carapace width, 1.05–1.09; femur I length, 1.55. *Male (n = 1):* Total length, 4.00; carapace length, 2.05; carapace width, 1.58; femur I length, 2.23.

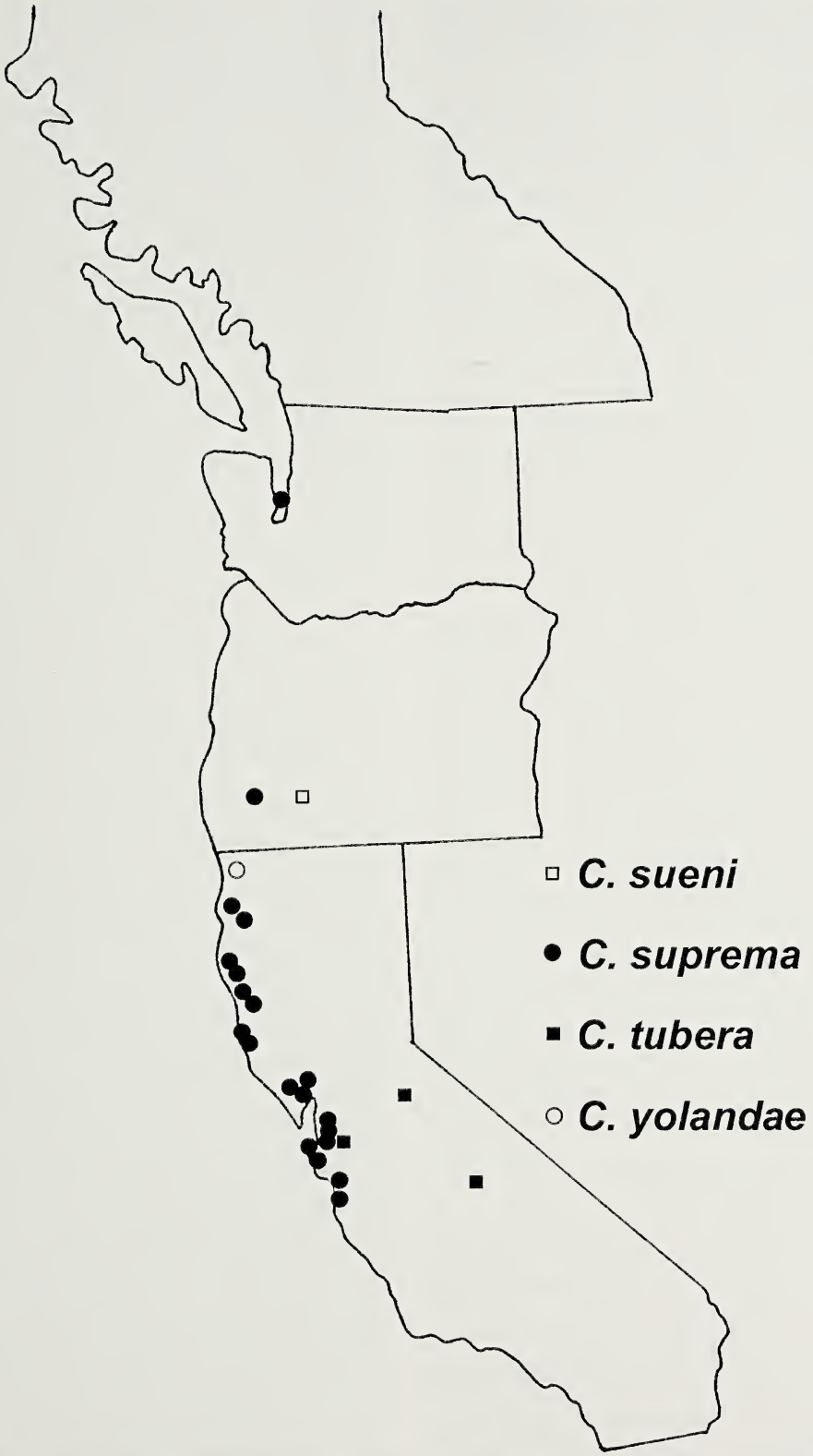
Distribution.—Crater Lake National Park, Oregon (Map 11).

Natural History.—Mature specimens taken from under rock.

Material Examined.—U.S.A.: *Oregon*: Klamath County, Crater Lake National Park, Lake Creek, under rock, no date (D. Lowrie), 1 ♂, 2 ♀ (AMNH).

Calymmaria suprema Chamberlin & Ivie 1937
Figs. 115–119; Map 11

Calymmaria suprema Chamberlin & Ivie 1937; 214, figs. 12, 13, 18, 19; Roewer 1954: 47; Bonnet 1956: 940.



Map 11.—Distribution of *C. sueni* (□), *C. suprema* (●), *C. tubera* (■), and *C. yolandae* (○).

Types.—Male holotype and female allotype from Big Basin, Santa Cruz County, California, U.S.A., 37°10′N, 122°13′W (AMNH, examined).

Diagnosis.—*Calymmaria suprema* can be separated from other *Calymmaria* by the long epigynal midpiece in the females (Fig. 119), and in the males by the long, thin, embolus with looped ejaculatory duct near the base (Fig. 115).

Description.—*Female:* Carapace typical. Dorsum of abdomen gray with basal lanceolate mark flanked by patches of yellow and followed by four gray transverse chevrons; venter gray with two yellow lateral longitudinal stripes. Legs annulate, spination typical. Epigynum externally with large opening and long, narrow, heavy sclerotization below (Fig. 118); internally with midpiece thick and long, blind ducts thick, long, lateral ducts thick (Fig. 119). *Male:* Carapace typical. Dorsum of abdomen yellow with very pale gray basal lanceolate mark flanked by one pair of gray spots and followed by four gray transverse chevrons; venter as in female. Legs annulate, spination typical. Male palpus with PA large, knob-like (Fig. 115); distal RTA long, round (Fig. 116); tibia with one prolateral spine, four long ventral setae, and many short retrolateral setae; cymbium elongate distad, with two spines near base of tip and seven spines on tip; embolus long, thin, tapering, with ejaculatory duct looped near base, conductor with basal lobe large, pointed (Fig. 115).

Measurements.—*Female:* Total length, 6.51–8.63 (7.63); carapace length, 2.45–3.81 (3.41); carapace width, 1.61–2.76 (2.37); femur I length, 2.85–4.96 (4.33): *Male:* Total length, 6.90–9.75 (8.55); carapace length, 3.26–4.65 (4.11); carapace width, 2.64–3.66 (3.33); femur I length, 4.84–6.90 (6.17).

Distribution.—Western Washington, Oregon, south to San Francisco Bay area of California (Map 11).

Natural History.—Mature specimens collected in every month except May, from caves, redwood forests, and human habitations such as basements and garages.

Material Examined.—CANADA: *British Columbia*: Victoria, Goldstream Campground, 27–28 June 1969 (ROM Field Party), 1 ♀ (CNC). U.S.A.: *Washington*: King County, NE. Seattle, Univ. of Washington campus, by light at museum basement door (200′), 16 April 1974 (R. Crawford), 1 ♀ (BMSC), in basement of building (200′), 14 November 1981 (R. Crawford), 1 ♀ (BMSC): *Oregon*; Douglas County, Idleyld Park, N. Umpqua, 23 August 1959 (V. Roth, W.J. Gertsch), 3 ♂, 1 ♀ (AMNH); *California*: Alameda County, Berkeley, October (E. Dietrich), 1 ♂ (AMNH), Strawberry Canyon, 7 April 1960 (W. Ivie, W.J. Gertsch, R. Schrammel), 2 ♂, 1 immature (AMNH), Castro Valley, 23 October 1938 (W.M. Pearce), 4 ♂, 1 ♀ (AMNH), 19 September 1942 (W.M. Pearce), 10 ♂, 7 ♀ (AMNH), Niles Canyon, 21 March 1941 (W.M. Pearce), 4 ♀, 1 immature (AMNH), Mountain Boulevard, Oakland, 11 October 1953 (R. Schuster, G. Marsh), 1 ♂, 1 ♀ (AMNH), 17 October 1953 (V. Roth, R. Schuster), 3 ♂, 6 ♀, 3 immatures (AMNH), Oakland, 1 February 1954 (V. Roth, R. Schuster), 2 ♀ (AMNH), Niles, off Niles Canyon on Palomres Road, 1 January 1964 (V. Roth), 4 ♀ (AMNH); Contra Costa County, Orinda Village, 15 November 1969 (E.I. Schlinger), 1 ♀ (EMSC); Humboldt County, Pepperwood, 1 July 1952 (W.J. Gertsch, M. Cazier, R. Schrammel), 5 ♀, 1 immature (AMNH), 10 miles W. of Willow Creek, 21 August 1959 (W.J. Gertsch, V. Roth), 1 ♂, 1 ♀ (AMNH), 18 miles W. of Willow Creek, 21 August 1959 (V. Roth, W.J. Gertsch), 3 ♂, 1 ♀, 1 immature (AMNH), 9 miles E. of Carlotta, 1 October 1959 (V. Roth), 3 ♂, 15 ♀ (AMNH), 5 miles N. of Scotia, 1 October 1959 (V. Roth), 1 ♀ (AMNH), 2 miles N. of Phillipsville, 14 September 1961 (W. Ivie, W.J. Gertsch), 2 ♂, 3 ♀, 6 immatures (AMNH), 5 miles S. of Scotia, 14 September 1961 (W. Ivie, W.J. Gertsch), 33 ♂, 49 ♀, 13 immatures (AMNH), Carlotta, 15 September 1961 (W. Ivie, W.J. Gertsch), 1 ♀ (AMNH), 27 September 1963 (W.J. Gertsch), 1 ♂, 2 ♀ (AMNH), Orick, 16 September 1961 (W. Ivie, W.J. Gertsch), 1 ♂, 1 ♀ (AMNH), Phillipsville, 2 September 1963 (J. and W. Ivie), 5 ♂, 1 ♀, 4 immatures (AMNH), Redwoods State Park, near Miranda, 30 September 1963 (W.J. Gertsch), 3 ♂, 5 ♀, 2 immatures (AMNH); Marin County, Muir Woods National Monument, among leaves, 24 October 1953 (V. Roth); 2 ♀ (AMNH), Samuel P. Taylor State Park, redwoods, 24 October 1953 (V. Roth), 1 ♂, 2 immatures (AMNH), 8 November 1953 (V. Roth, R. Schuster), 1 ♀ (AMNH), Mill Valley, among redwoods, 7 July 1956 (W.J. Gertsch,

V. Roth), 7 ♀ (AMNH), in house, 20 October 1963 (E. S. Ross), 2 ♂ (CASC), ¼ miles N. of Laurel Dell, Mt. Tamalpais, 8 September 1969 (M. M. Bentzien), 1 ♂ (EMSC), Ridge between San Anselmo and San Rafael, 17 February 1977 (L. G. Freihofer), 1 ♀ (CASC); Mariposa County, Wawona Camp, Yosemite National Park, 17 September 1941 (W. Ivie), 3 immatures (AMNH); Mendocino County, Longvale, 30 June 1952 (W.J. Gertsch), 3 ♂, 5 ♀, 1 immature (AMNH), Ryan Creek, 8 March 1955 (P. D. Hurd), 1 ♀ (AMNH), Russian Gulch State Park, Mendocino, 19 August 1959 (W.J. Gertsch, V. Roth), 9 ♂, 1 ♀, 1 immature (AMNH), 13 September 1961 (W.J. Gertsch, W. Ivie), 1 ♀, 1 immature (AMNH), 2 miles N. of Piercy, 19 August 1959 (W.J. Gertsch, V. Roth), 1 ♀, 3 immatures (AMNH), Piercy, 6 April 1960 (W.J. Gertsch, W. Ivie, R. Schrammel), 1 ♀, 5 immatures (AMNH), Rockport, 19 August 1959 (V. Roth, W.J. Gertsch), 1 ♀ (AMNH), Navarro River, 6 miles S. of Albion, in redwoods; 13 September 1961 (W. Ivie, W.J. Gertsch), 2 ♂, 10 ♀, 7 immatures (AMNH), 5 miles E. of Anchor Bay, 12 September 1961 (W.J. Gertsch, W. Ivie), 1 ♂, 2 immatures (AMNH), Caspar Creek; 1 miles SE. of Caspar, 13 September 1961 (W.J. Gertsch, W. Ivie), 2 ♂, 7 ♀, 4 immatures (AMNH), Greenwood Creek, Elk, 13 September 1961 (W. Ivie, W.J. Gertsch), 2 ♂, 5 ♀, 4 immatures (AMNH), 22 September 1963 (W.J. Gertsch), 1 ♂, 1 ♀ (AMNH), 16 February 1967 (V. Roth), 5 ♀, 1 immature (AMNH), 12 to 15 miles E. of Noyo, 13 September 1961 (W.J. Gertsch, W. Ivie), 9 ♂, 8 ♀, 2 immatures (AMNH), Hartsook Inn, Piercy, 23 September 1963 (W.J. Gertsch), 10 ♂, 13 ♀ (AMNH), Leggett, 20 September 1964 (J. and W. Ivie), 1 ♀ (AMNH), Albion, 16 February 1967 (V. Roth), 20 ♀, 5 immatures (AMNH), 17 February 1967 (V. Roth), 2 ♀ (AMNH), summit on Highway 1 before S. fork of Eel River, outside Leggett, 15 September 1971 (V. Roth), 1 immature (AMNH), fen area, Inglenook Fen (30–50′), 15 December 1973 (C.E. Griswold), 3 ♀ (EMSC), 4 miles N. of Fort Bragg (30′), no date (C.E. Griswold), 1 ♀ (EMSC); Napa County, 2 miles W. of Oakville, 31 December 1953 (V. Roth), 1 ♀ (AMNH), Clay Cave, common in first room on open-type platform web, 26 November 1959 (R.E. Graham); 1 ♂ (AMNH), 2 miles NNE. of Angwin, N. side of Howell Mountain (1300′), 24 January 1977 (H. B. Leech), 1 ♂ (CASC); San Francisco County, December 1922 (C. Grant), 1 ♂, 1 ♀ (AMNH), San Francisco, Golden Gate Park, 3 October 1972 (D. Ubick), 2 ♂, 3 ♀ (DUSC), Strybing Arboretum, 30 September 1976 (P. Arnaud), 2 ♂ (CASC), right outside wall (75 m), 18 October 1976 (P. Arnaud), 2 ♂ (CASC), entrance, outside wall (75 m), 12 October 1977 (P. Arnaud), 1 ♂ (CASC); San Mateo County, La Honda, 7 November 1921 (J.C. Chamberlin), 3 ♀ (AMNH), Montara, 15 August 1958 (R.E. Leech), 1 ♂, 1 ♀ (CASC); Santa Clara County, Stanford, 24 December 1922 (J.C. Chamberlin), 1 ♀ (AMNH); Santa Cruz County, Ben Lomond (1600′), 2 June 1945 (L.W. Saylor), 1 female (AMNH), 23 June 1952 (W.J. Gertsch, M. Cazier, R. Schrammel), 2 ♂, 3 ♀ (AMNH), 20 July 1953 (W.J. and J. W. Gertsch), 9 ♂, 2 immatures (AMNH), 6 July 1956 (V. Roth, W.J. Gertsch), 3 ♂, 1 ♀ (AMNH), 2 April 1960 (W.J. Gertsch, W. Ivie, R. Schrammel), 1 female (AMNH), 3 April 1960 (W.J. Gertsch, W. Ivie, R. Schrammel), 5 ♀ (AMNH), 23 September 1961 (W. Ivie, W.J. Gertsch), 15 ♀, 6 immatures (AMNH), 1 miles N. of Santa Cruz, 23 December 1953 (V. Roth), 1 ♀ (AMNH), Felton, 16 August 1959 (W.J. Gertsch, V. Roth), 7 ♂, 8 ♀ (AMNH), 3 April 1960 (W.J. Gertsch, W. Ivie, R. Schrammel), 1 ♀ (AMNH), Empire Cave, 7 August 1962 (R. E. Graham), 1 ♀ (AMNH), 2 miles NE. of Soquel, Bales Creek, redwood forest, 24–25 April 1970 (M. M. Bentzien), 2 ♂, 2 ♀, 1 immature (EMSC); Sonoma County, 3 miles W. of Glen Ellen, 15 February 1954 (V. Roth, R. Schuster), 1 ♀, 2 immatures (AMNH), 5 miles E. of Guerneville, 18 August 1959 (V. Roth, W.J. Gertsch), 1 ♀ (AMNH), Guerneville, 4 April 1960 (W.J. Gertsch, W. Ivie, R. Schrammel), 9 ♀ (AMNH).

Calymmaria tecate new species
Figs. 120–122; Map 7

Type.—Male holotype from 11 miles S. of Tecate, Baja California, Mexico, 32°24′N, 116°38′W, 10 November 1957, V. Roth (AMNH).

Etymology.—The specific name is a noun in apposition taken from the type locality.

Diagnosis.—*Calymmaria tecate* is easily separated from other *Calymmaria* by the presence of a retrolateral apophysis on the palpus

(Fig. 120), and the bilobed medial RTA (Fig. 122).

Description.—*Male:* Carapace typical. Dorsum of abdomen light yellow with gray basal lanceolate mark followed by dark gray mottling; venter gray with pale yellow lateral longitudinal stripes. Legs weakly annulate, spination typical. Palpus with PA rounded and hooked, RTA present and pointed (Figs. 120, 121); basal RTA from above long and bluntly pointed, medial RTA with two rounded lobes, one behind the other (Fig. 122), distal RTA long, rounded; tibia with one prolateral spine, and many short retrolateral setae; cymbium moderately elongate distad, with two spines near base of tip and seven spines on tip; embolus thickened at base and middle, tapering, conductor with pointed basal lobe (Fig. 120). *Female:* Unknown.

Measurements.—*(n = 1):* Total length, 4.90; carapace length, 2.42; carapace width, 1.89; femur I length, 3.72.

Distribution.—Tecate, Baja California, Mexico (Map 7).

Natural History.—One mature specimen collected in November from a culvert.

Material Examined.—MEXICO: *Baja California:* 11 miles S. of Tecate, in culvert, 10 November 1957 (V. Roth), 1 ♂, 1 immature (AMNH).

Calymmaria tubera new species
Figs. 123–125; Map 11

Types.—Male holotype from off Niles Canyon on Palomres Road, Alameda County, California, U.S.A., 37°34′N, 121°57′W, 2 January 1964, V. Roth (AMNH).

Etymology.—The specific name is a noun in apposition from the Latin *tuber,* a swelling or hump, referring to this species' distinctively shaped embolus.

Diagnosis.—*Calymmaria tubera* can be easily separated from other *Calymmaria* by the presence of a loop in the ejaculatory duct (Fig. 123), by the swelling on the embolus (Fig. 124), by the bifurcate basal RTA (Fig. 124), and toothed medial RTA (Fig. 125).

Description.—*Male:* Carapace typical. Dorsum of abdomen gray with basal lanceolate mark flanked by two pairs of large yellow spots and followed by three yellow transverse chevrons; venter gray with two yellow thin lateral longitudinal stripes. Palpus with PA large, round (Fig. 123); basal RTA bifurcate, medial RTA with three rounded teeth (Fig. 125), distal RTA long, rounded; tibia with two prolateral spines, two long ventral setae, and many short retrolateral setae; cymbium short distad, with two spines near base of tip and six spines on tip; embolus short, thick, with ejaculatory duct looped at base, and with a large swelling near apex when viewed laterally (Fig. 124). *Female:* Unknown.

Measurements.—*(n = 3):* Total length, 3.72–4.65 (4.04); carapace length, 1.71–2.42 (1.99); carapace width, 1.33–1.89 (1.59); femur I length, 1.64–2.02 (1.83; *n* = 2).

Distribution.—Alameda and Mariposa Counties, California (Map 11).

Natural History.—Mature specimens collected in January, August, and September from beneath rocks.

Material Examined.—U.S.A.: *California*: Alameda County, Niles, off Niles Canyon Rd., 1 January 1964 (V. Roth), 1 ♂ (AMNH), on Palomres Rd., 2 January 1964 (V. Roth), 1 ♂ (AMNH); Fresno County, under rocks on hillside above Graveyard Meadows, vicinity of Graveyard Peak, 12 August 1959 (B. Firstman), 1 ♂ (AMNH); Mariposa County, 12 miles E. of Buck Meadows, 11 September 1959 (no collector), 1 ♂ (AMNH).

Calymmaria virginica new species
Figs. 126–130; Map 8

Types.—Male holotype from Minnehaha Springs, Pocahontas County, West Virginia, U.S.A., 38°09′N, 79°58′W, July 1947, K.W. Haller (AMNH); female allotype from Cranberry Glades Natural Area, Monongahela National Forest, Pocahontas County, West Virginia, U.S.A., 38°12′N, 80°16′W, 20 May 1967, W.A. Shear (AMNH).

Etymology.—The specific name refers to (West) Virginia, where the species has been collected.

Diagnosis.—*Calymmaria virginica* can be easily separated from the only other species occurring in the eastern U.S.A., *C. persica*, by the trilobed PA (Fig. 127), and the thin, tapering embolus (Fig. 126).

Description.—*Female:* Carapace typical. Dorsum of abdomen pale yellow with gray basal lanceolate mark followed by three gray transverse chevrons and a gray spot; venter gray with two pale yellow lateral longitudinal stripes. Legs unmarked, spination typical. Epigynum externally with shield-like sclerotiza-

tion and lateral ducts clearly visible (Fig. 129) internally with midpiece short, blind ducts very short, lateral ducts thin and separated below (Fig. 130). *Male:* Same as in female, but legs annulate. Male palpus with PA short, truncate (Fig. 126); basal RTA with three lobes, the ventral lobe large and rounded, the retrolateral lobe truncate, and the prolateral lobe long and pointed, medial RTA short, pointed, distal RTA long, round (Fig. 127); tibia with one prolateral spine, several long ventral setae, and short retrolateral setae; cymbium moderately elongate distad, with one spine near base of tip and five spines on tip; embolus tapering, conductor with basal lobe pointed (Fig. 126).

Measurements.—*Female (n = 2):* Total length, 3.41–3.97; carapace length, 1.43–1.59; carapace width, 1.05–.09; femur I length, 1.40–1.58. *Male (n = 1):* Total length, 3.78; carapace length, 1.61; carapace width, 1.49; femur I length, 2.42.

Distribution.—Pocahontas County, West Virginia (Map 8).

Natural History.—Nothing is known of the natural history of this species.

Material Examined.—U.S.A.: *West Virginia*: Pocahontas County, Minnehaha Springs, July 1947 (K. W. Haller), 1 ♂ (AMNH), Cranberry Glades Natural Area, Monongahela National Forest, 20 May 1967 (W. A. Shear), 2 ♀ (WASC).

Calymmaria yolandae new species
Figs. 131–133; Map 11

Type.—Male holotype from Patrick, Del Norte County, California, U.S.A., 41°52′N, 123°50′W, 16 September 1961, W. Ivie, W.J. Gertsch (AMNH).

Etymology.—Named in honor of the senior author's mother, Yolanda Heiss.

Diagnosis.—*Calymmaria yolandae* can be separated from other *Calymmaria* by the lack of a PA, the slender embolus, peculiarly shaped conductor (Fig. 131), and flat, large medial RTA (Fig. 133).

Description.—*Male:* Carapace typical. Dorsum of abdomen pale yellow with gray basal lanceolate mark followed by three gray transverse chevrons; venter gray. Legs unmarked, spination typical. Palpus with PA lacking; basal RTA long, round medial RTA wide, flat from above, distal RTA small, pointed (Fig. 132); tibia with one prolateral spine and seven long ventral setae; cymbium moderately elongate distad, with two spines near base of tip and seven spines on tip; embolus long, thin, conductor with basal lobes round, (Fig. 131). *Female:* Unknown.

Measurements.—*(n = 1):* Total length, 4.03; carapace length, 1.80; carapace width, 1.40; femur I length, 2.17.

Distribution.—Del Norte County, California (Map 11).

Natural History.—One mature specimen collected in September.

Material Examined.—Known only from the type.

PHYLOGENY

A cladogram for the species of *Calymmaria* was developed using the method of cladistic analysis as outlined by Hennig (1965, 1966), Ross (1974), Nelson & Platnick (1981) and Wiley (1982). A data matrix of character states was constructed for groups considered closely related to *Calymmaria*. This data matrix was used to establish the plesiomorphic and apomorphic state of characters in *Calymmaria*. In addition to the cladistic procedures discussed by the above authors, I have made use of one additional criterion: the more complex form of a character is assumed to be its apomorphic state. This latter criterion has been discussed by Platnick (1975a, 1975b).

Several apomorphic character states in *Calymmaria* can be determined by the criteria stated above. All species of *Calymmaria* possess a dorsal fracture line of the patella on all legs (Fig. 3). The patellar fracture line is absent from most Nearctic agelenid and all other hahniid genera. The presence of the patellar fracture line is considered the apomorphic state of this character, and those possessing it are hypothesized to form a monophyletic lineage. This monophyletic lineage consists of the following genera: *Calymmaria*, *Willisus*, *Blabomma*, *Yorima*, *Cybaeota*, and *Cybaeina* (Fig. 134). These genera (except *Calymmaria*) were used for the outgroup comparisons to establish plesiomorphic and apomorphic character states in *Calymmaria*. In the following discussion, the characters within *Calymmaria* are presented along with the evidence used to determine character states.

The length of the patella plus the tibia on the first pair of legs in *Calymmaria* is very long in relation to the length of the carapace.

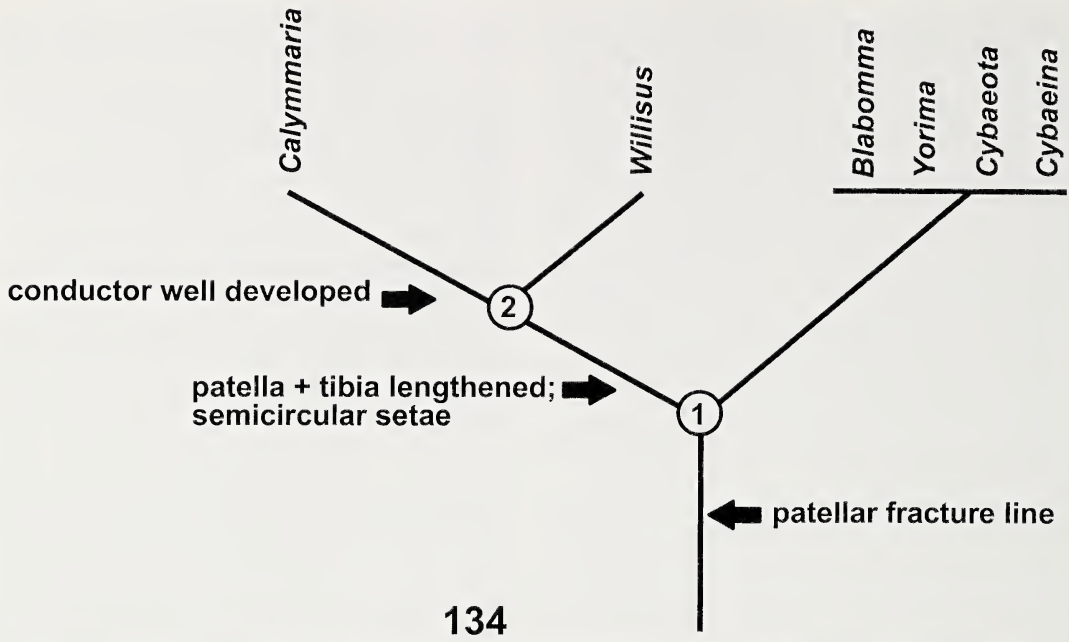


Figure 134.—Cladogram of genera related to *Calymmaria*. See text for further explanations.

It is much shorter in related genera except *Willisus*. The short patella-tibia is considered to be the plesiomorphic state, the long patella-tibia the apomorphic state.

Between the claws of *Calymmaria* are semicircular setae. The setae do not occur in any related genus except *Willisus*. The absence of semicircular setae is considered the plesiomophic character state, its presence apomorphic.

In *Calymmaria* the conductor of the male palpus is well developed with many distal lobes and sometimes a basal lobe (Fig. 6). The basal lobe may be sclerotized or not sclerotized. In related genera the conductor is usually not modified into many lobes. The form of the unmodified conductor is considered plesiomorphic. The form of the conductor in which many lobes are developed is considered apomorphic.

The embolus of the male palpus in *Calymmaria* may be a simple long spine, or may be thickened and flattened at the base, thickened along its entire length, bifurcate, or with an ectal tooth. In related genera, the embolus is usually long, round, and whip-like or a simple spine. The simple, long, round, spine-like embolus is considered to be the plesiomorphic state, and the thickened, shortened, flattened, bifurcate, and toothed forms are considered to be apomorphic.

In *Calymmaria* the basal RTA may be a simple one-lobed apophysis (Fig. 7), or may be very complex with several lobes (Figs. 75, 128). In related genera the basal RTA is usually not modified into many lobes, and is frequently absent. The simple single-lobed RTA is considered the plesiomorphic state, the multi-lobed form apomorphic. Near the base of the embolus of some species of *Calymmaria*, the ejaculatory duct makes a distinct loop. The ejaculatory duct does not make a loop in any of the related genera. The absence of the loop of the ejaculatory duct is considered the plesiomorphic state, its presence apomorphic.

A cladogram was developed using the apomorphic character states that have been discussed. *Calymmaria* shares a dorsal patellar fracture line with *Willisus*, *Blabomma*, *Yorima*, *Cybaeota*, and *Cybaeina*. These six genera are here hypothesized to form a monophyletic lineage (Fig. 134), although it is quite possible that this single apomorphic character is a case of homoplasy. Within this hypothesized lineage, *Calymmaria* and *Willisus* share two apomorphic character states: elongated first patella-tibia, and semicircular setae between the claws. *Willisus* and *Calymmaria* are

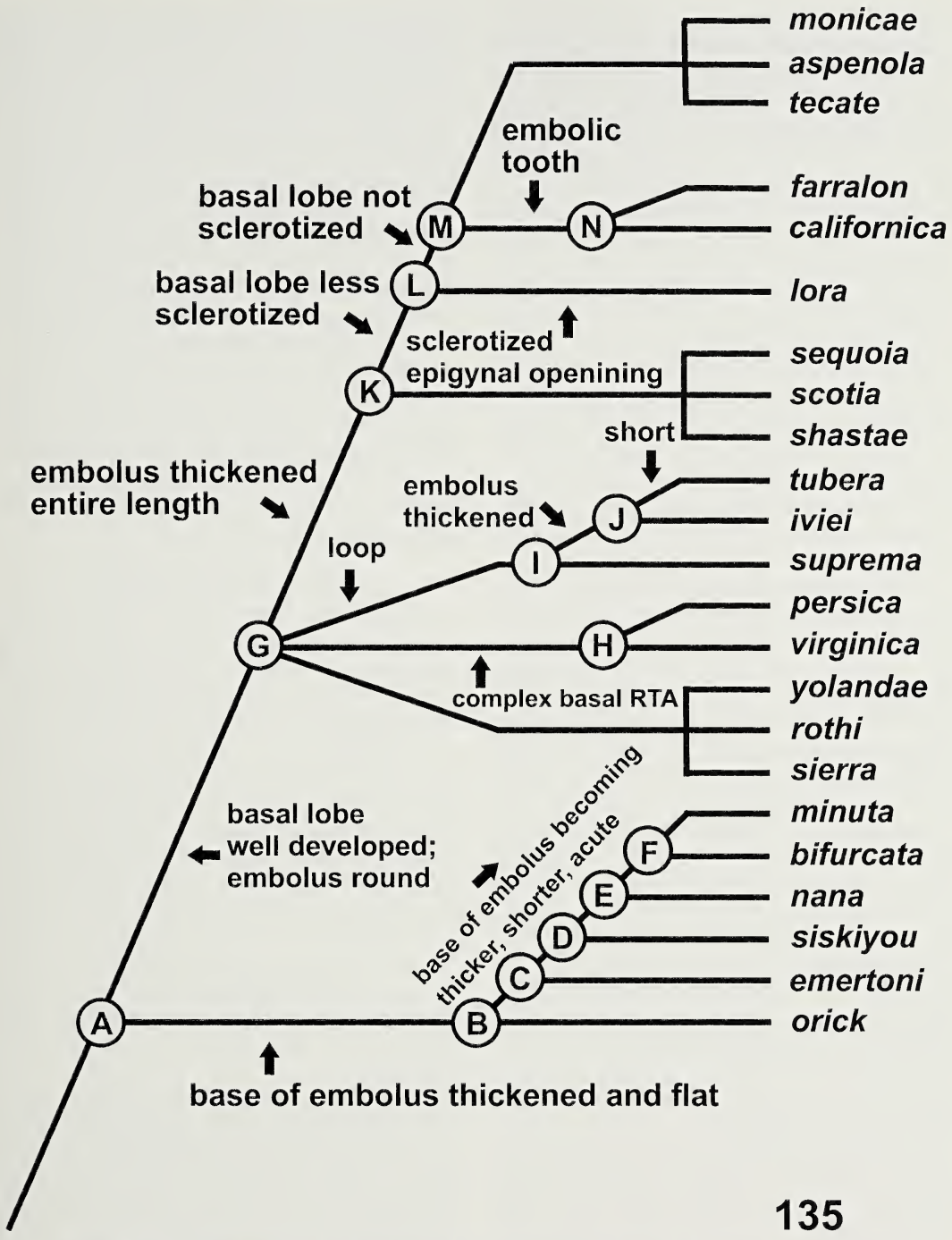


Figure 135.—Cladogram of the species of *Calymmaria*. See text for further explanations.

here considered to be sister groups. The apomorphic character state separating *Calymmaria* and *Willisus* is the complex multi-lobed palpal conductor in *Calymmaria*.

From the data concerning plesiomorphic and apomorphic character states, a preliminary cladogram was constructed to examine possible relationships among the species of *Calymmaria*. Eight species could not be placed in the cladogram: *C. alleni*, *C. carmel*;

C. gertschi, *C. humboldt*, *C. monterey*, *C. rosario*, *C. similaria*, and *C. sueni*. Character analysis of these species did not yield useful information. This group includes all *Calymmaria* species known from only one sex, and also *C. sueni*. See Appendix for information about characters included in the analysis.

It is postulated that the hypothetical ancestor, A (Fig. 135), possessed a well-developed conductor lacking a basal lobe, a thin, round, spine-like embolus, a simple basal RTA, and a straight ejaculatory duct. From this hypothetical ancestor, two lineages arose. In one lineage, the embolus became thickened and flattened at the base. This lineage gave rise to hypothetical ancestors B-F in which the base of the embolus may have progressively become thicker, shorter, and more acute. Six extant species arose from ancestors B-F respectively: *C. orick*, *C. emertoni*, *C. siskiyou*, *C. nana*, *C. bifurcata*, and *C. minuta*.

In the second lineage arising from hypothetical ancestor A, the remaining species of *Calymmaria* share an apomorphic character state, a palpal conductor with a well-developed basal lobe. This lineage is represented by hypothetical ancestor G. The available data indicate that four lineages arose from ancestor G. The extant species *C. rothi*, *C. sierra*, and *C. yolandae* apparently have changed little from ancestor *G. Calymmaria persica* and *C. virginica* share a similar complex basal RTA. These two species are considered to have arisen from the common hypothetical ancestor H. In the third lineage arising from ancestor G, the ejaculatory duct became looped. This lineage led to hypothetical ancestor I. *Calymmaria suprema* apparently changed little from ancestor I. Hypothetical ancestor I gave rise to ancestor J, in which the embolus became thickened and shortened. Two extant species arose from ancestor J, *C. iviei* and *C. tubera*.

In the fourth lineage arising from hypothetical ancestor G, the embolus became thickened along its entire length. This apomorphy gave rise to hypothetical ancestor K. Ancestor K, like ancestor G, also represents an unresolved polytomy from which a number of lineages arose. *Calymmaria shastae*, *C. scotia* and *C. sequoia* have apparently changed little from ancestor K. Lineages L-N arose from ancestor K. The basal lobe of the conductor became progressively less sclerotized. Hypothetical ancestor L gave rise to the extant species *C. lora*, in which the basal lobe is only partly sclerotized. Ancestor L also gave rise to hypothetical ancestor M, in which the basal lobe completely loses its sclerotization. Hypothetical ancestor M represents another unresolved polytomy. One lineage arising from ancestor M gave rise to hypothetical ancestor N, which possessed an ectal embolic tooth. Ancestor N gave rise to the extant species *C. californica* and *C. farallon*. The second lineage arising from ancestor M represents the unresolved polytomy including *C. monicae*, *C. aspenola*, and *C. tecate*.

A complete understanding of the evolutionary history of *Calymmaria* must obviously await a better understanding of cladistic and biogeographic relationships among the species as well as the relationship of *Calymmaria* to other groups. It is hoped this work will enable such research to proceed.

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Appendix.—Characters used in the cladistic analysis. This matrix was compiled by the second author subsequent to the analysis discussed in the text.

Characters		
1	Basal lobe of conductor	0 = absent or not well developed; 1 = well-developed
2	Base of embolus	0 = thickened & flat; 1 = embolus round
3	basal RTA	0 = simple or without two subequal lobes; 1 = with two subequal lobes
4	ejaculatory duct	0 = not looped; 1 = looped.
5	embolus thickness	0 = not thick; 1 = thickened
6	embolus length	0 = normal length; 1 = shortened
7	embolus shape	0 = flat; 1 = round
8	sclerotization of basal lobe	0 = well sclerotized; 1 = lightly sclerotized; 2 = highly sclerotized.
9	ectal embolic tooth	0 = absent; 1 = present

Species	Known Sexes	Characters 1	2	3	4	5	6	7	8	9
C. alleni	F	?	?	?	?	?	?	?	?	?
C. aspenola	M, F	1	1	0	0	1	0	1	2	0
C. bifurcata	M, F	0	0	0	0	1	1	0	0	0
C. californica	M, F	1	1	0	0	1	0	1	2	1
C. carmel	M	1	0	0	0	1	0	1	0	0
C. emertoni	M, F	0	0	0	0	1	1	0	0	0
C. farallon	M, F	1	1	0	0	1	0	1	2	1
C. gertschi	M	0	1	0	0	0	0	1	0	0
C. humboldt	M	1	1	0	0	0	0	1	0	0
C. iviei	M, F	1	1	0	1	1	0	1	0	0
C. lora	M, F	1	1	0	0	1	0	1	1	0
C. minuta	M, F	0	0	0	0	1	1	0	0	0
C. monicae	M, F	1	1	0	0	1	0	1	2	0
C. monterey	F	?	?	?	?	?	?	?	?	?
C. nana	M, F	0	0	0	0	1	1	0	0	0
C. orick	M	0	0	0	0	1	1	0	0	0
C. persica	M, F	1	1	1	0	1	0	1	0	0
C. rosario	F	?	?	?	?	?	?	?	?	?
C. rothi	M, F	1	1	0	0	0	0	1	0	0
C. scotia	M, F	1	1	0	0	1	0	1	0	0
C. sequoia	M	1	1	0	0	1	0	1	0	0
C. shastae	M, F	1	1	0	0	1	0	1	0	0
C. sierra	M, F	1	1	0	0	0	0	1	0	0
C. similaria	F	?	?	?	?	?	?	?	?	?
C. siskiyou	M, F	0	0	0	0	1	1	0	0	0
C. sueni	M, F	1	0	0	0	1	1	0	0	0
C. suprema	M, F	1	1	0	1	0	0	1	0	0
C. tecate	M	1	1	0	0	1	0	1	2	0
C. tubera	M	1	1	0	1	1	1	1	0	0
C. virginica	M, F	1	1	1	0	0	0	1	0	0
C. yolandae	M	1	1	0	0	0	0	1	0	0

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THE GENUS *BRATTIA* BEYOND SOUTH AMERICA (ARANEAE, LINYPHIIDAE)

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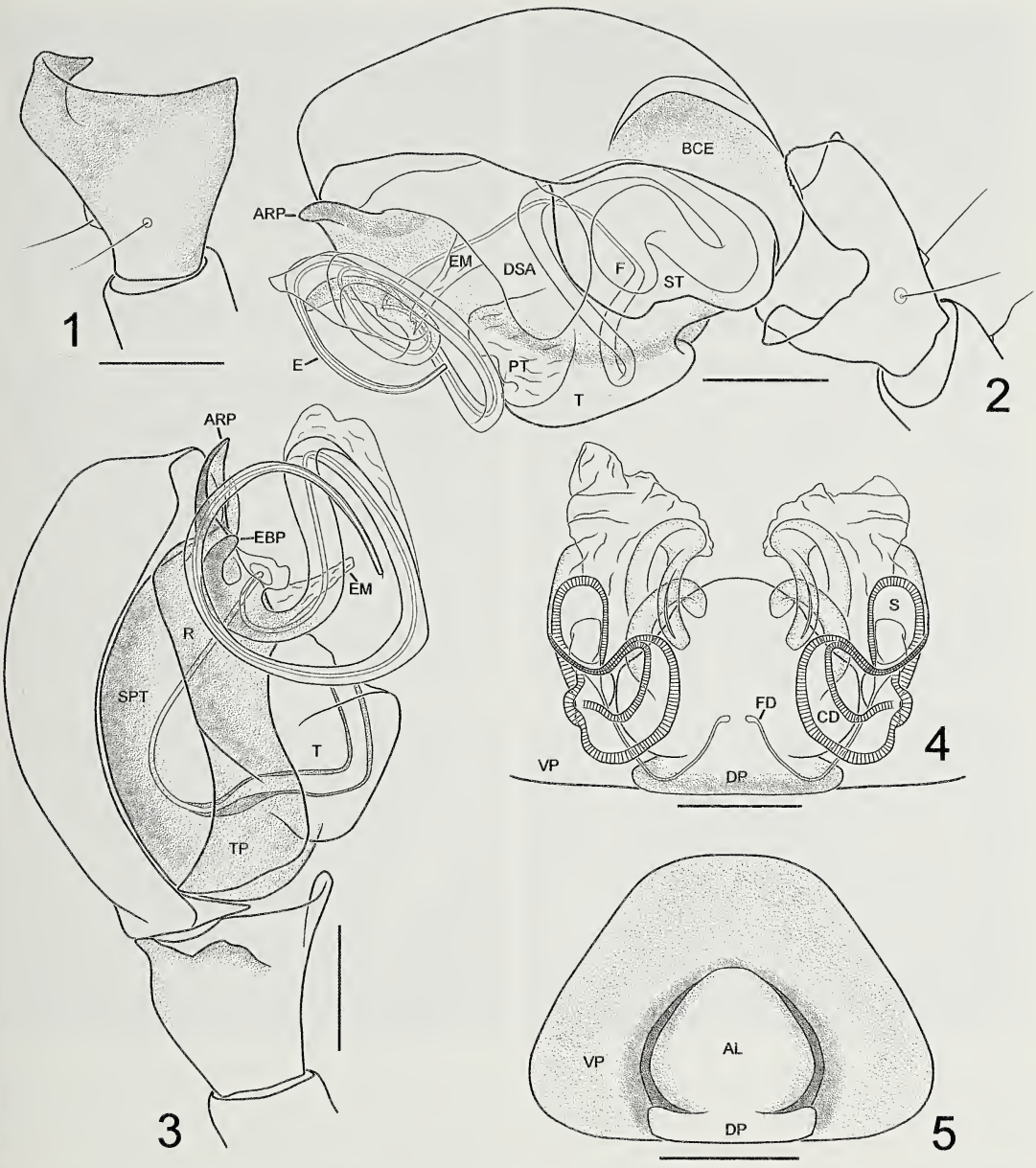
ABSTRACT. *Brattia* species (Linyphiidae) from Africa and the Philippines are not congeneric with the type species of *Brattia*. The type species of the genus, *Brattia spadicaria* Simon, and other Neotropical *Brattia* species were recently transferred to *Sphecozone* O. Pickard-Cambridge; Old World *Brattia* species were explicitly excluded from *Sphecozone*. *Sphecozone spadicaria* and Old World *Brattia* species are redescribed and illustrated. *Brattia africana* Simon is transferred to *Pachydelphus* Jocqué & Bosmans; *B. scutilla* is transferred to *Apobrata* new genus; *B. dubia* is transferred to the theridiid genus *Anelosimus* Simon.

Keywords: *Sphecozone*, *Pachydelphus*, *Apobrata*, *Anelosimus*, taxonomy, Asia, Africa

Simon (1894) established the genus *Brattia* to accommodate three species: *B. spadicaria* Simon 1894, the type species from Venezuela and nearby countries, *B. africana* Simon 1894 from Gabon and Sierra Leone, and *B. scutilla* Simon 1894 from the Philippines. Simon provided no illustrations for any of these three species. Tullgren (1910) added a fourth species, *B. dubia* from Mt. Kilimanjaro, Tanzania, providing the first illustrations of a *Brattia* species. *Brattia spadicaria* was illustrated by Baert (1987) and later by Millidge (1991), both of whom described additional *Brattia* species from the Neotropics. To date, *B. africana* and *B. scutilla* have not been illustrated.

Close affinity between *B. spadicaria* and Old World *Brattia* species has been doubted by several authors. Tullgren (1910:144) placed a question mark after *Brattia* in his original description of *B. dubia* and noted the presence of some theridiid characteristics in *B. dubia*. Holm (1962:23) examined the type of *B. dubia* and noted that *B. dubia* belongs to the Theridiidae, not Linyphiidae. Since Holm did not provide a theridiid genus for *B. dubia*, catalogers have continued to list *B. dubia* in the Linyphiidae (Brignoli 1983; Platnick 1989, 1993, 1997, 2004; Scharff 1990). In addition to his published note on *B. dubia*, Holm examined the vials of *B. africana* and *B. scutilla* examined for this paper. Holm set aside specimens in microvials labeled "lectotypes," although he never published these designations. Millidge (1991:179) expressed doubt that *B. africana* and *B. scutilla* are congeneric with the Neotropical species, but did not claim to have examined the African or Philippine species.

My own research on Neotropical erigonines led to the synonymy of *Brattia* with *Sphecozone* O. Pickard-Cambridge, 1870 (Miller in press). This synonymy was based on comparisons of *Brattia spadicaria* and other Neotropical *Brattia* species with *Sphecozone*. Old World *Brattia* species were explicitly excluded from *Sphecozone*, rendering them orphan species without a proper genus. Males of *Sphecozone* are diagnosed in part by the absence of a paracymbium and the presence of a basal cymbial excavation (Figs. 2, 7, 9); females are diagnosed in part by the presence of a dorsal plate that is exposed as a wide plate with an anterior lobe in ventral view, and by copulatory openings that usually take the form of narrow crescent to round paired atria (Figs. 5, 10; further details in Miller in press). Males of *B. africana* and *B. scutilla* both have a well-developed paracymbium and lack a basal cymbial excavation, and so require assignment to some other genus; females of *B. africana* and *B. scutilla* both lack an exposed anterior lobe of the dorsal plate, and paired atria. Holm (1962:23) correctly indicated that *B. dubia* is a theridiid, and should be associated with some theridiid genus.

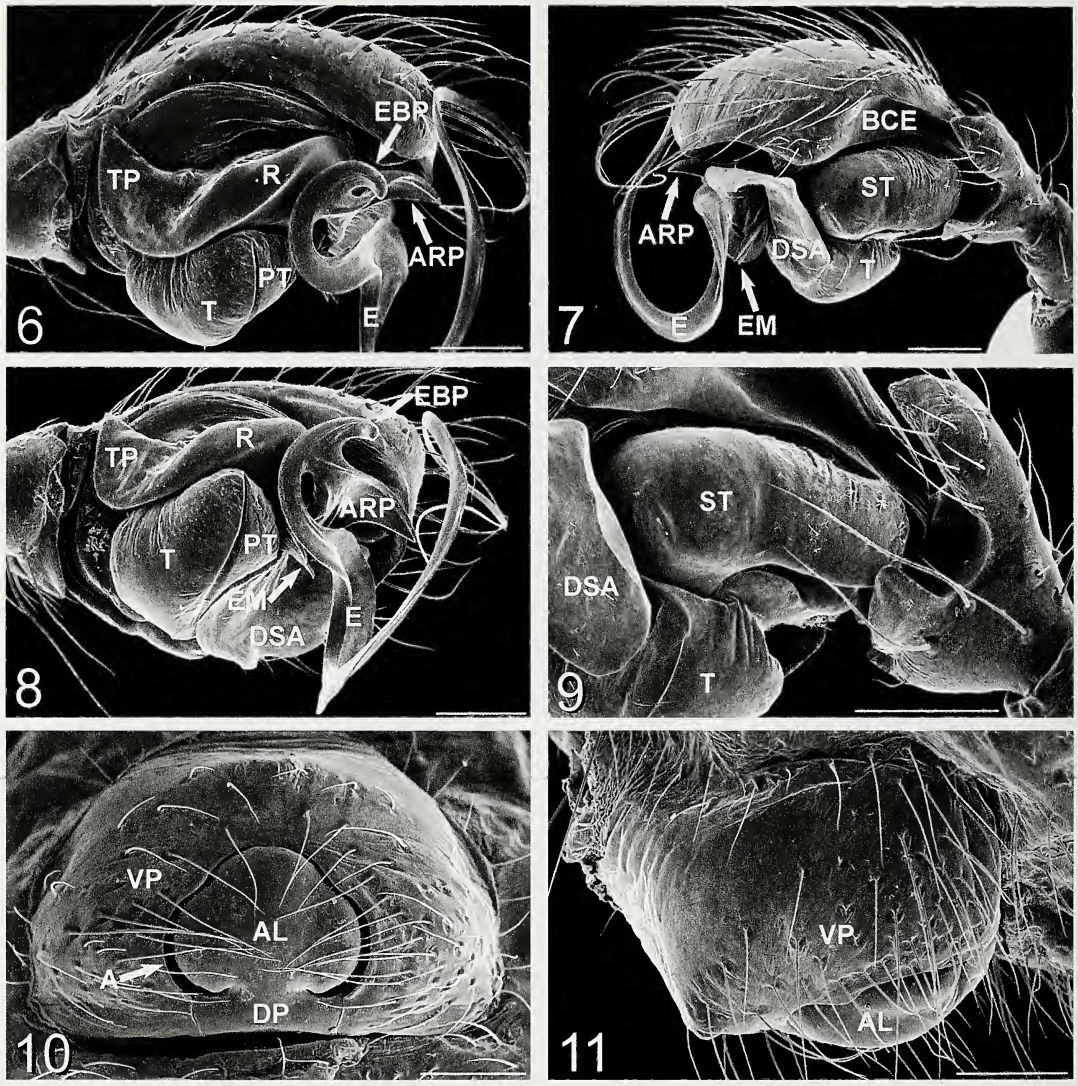


Figures 1–5.—*Sphecozone spadicaria* (Simon): 1–3, left palp of male from Arima, Trinidad; 1, palpal tibia; 2, retrolateral view; 3, prolateral view; 4, 5, epigynum of female from Alto Tolu, Colombia; 4, cleared, dorsal view; 5, ventral view. Scale bars = 0.1 mm. See text for abbreviations.

METHODS

Specimens were examined and illustrated using an Olympus BH-2 compound microscope and a Leica MZ APO dissecting microscope, fitted with drawing tubes. Palpi (and the epigynum of *Sphecozone spadicaria* only) were examined using methyl salicylate as a temporary clearing agent (Holm 1979), then positioned for illustration on a temporary slide using the method described in Coddington (1983). Illustrations of epigyna in ventral view were based on photographs taken using a Nikon DXM 1200 digital camera mounted on a Wild M10; multiple images were combined using Auto-Montage by Syncroscopy (version 4.01).

SEM images were taken using the AMRAY 1800 at the National Museum of Natural His-



Figures 6–11.—*Sphecozone spadicaria* (Simon) from Finca Bella Vista, Colombia, scanning electron micrographs: 6–9, male palp; 6, prolateral view; 7, retrolateral view; 8, ventral view; 9, palpal tibia, retrolateral view; 10, 11, epigynum; 10, ventral view; 11, lateral view. Images 6–9 taken from right palp, reversed to appear as left palp. Scale bars = 0.1 mm. See text for abbreviations.

tory Scanning Electron Microscope Facility. Specimens for SEM examination were air dried and sputter coated with gold-palladium. Specimens were attached to round-headed rivets using polyvinyl resin dissolved in acetone (polyvinyl acetate).

All measurements are in millimeters taken using a reticle in the dissecting microscope. Eye measurements were based on the lens at its widest point. Total length measurements (front of clypeus to posterior of abdomen) are approximate and may be influenced by the angle the abdomen is held at and changes in the size of the abdomen due to preservation artifacts (Hormiga 1994, 2000). Carapace measurements were made in dorsal view. Leg articles were measured in lateral view along the dorsal margin. The position of the first metatarsal trichobothrium (TmI) is expressed as the ratio of the distance between the proximal margin of the metatarsus and the root of the trichobothrium divided by the total length of the metatarsus (Denis 1949; Locket & Millidge 1953).

Abbreviations and conventions.—References to figures published elsewhere are listed

in lowercase type (fig. or pl.); references to figures in this paper are listed with an initial capital (Fig.). In the synonymy section, references to descriptions are differentiated from catalog listings by the presence of male (♂) and/or female (♀) symbols, as appropriate, following the citation. When data labels did not include geographic coordinates, I attempted to determine the approximate location using maps and gazetteers. Once the location was inferred, the coordinates were included in [square brackets]; coordinates taken directly from the data label are given in (parentheses). The following anatomical abbreviations are used in the text and figures: A = atrium; AL = anterior lobe of dorsal epigynal plate; ALE = anterior lateral eye; AME = anterior median eye; ARP = anterior radical process; BCE = basal cymbial excavation; CD = copulatory duct; CL = column; DP = dorsal plate of epigynum; DSA = distal suprategular apophysis; E = embolus; EBP = embolic basal process; EM = embolic membrane; F = fundus; FD = fertilization duct; PC = paracymbium; PLE = posterior lateral eye; PME = posterior median eye; PT = protegulum; R = radix; S = spermatheca; SPT = suprategulum; ST = subtegulum; T = tegulum; TmI = position of first metatarsal trichobothrium; TmIV = fourth metatarsal trichobothrium; TP = tailpiece of radix; VP = ventral plate of epigynum.

Material used in this study was borrowed from the following institutions: California Academy of Sciences, San Francisco, USA (CAS), Instituto de Ciencias Naturales, Bogotá, Colombia (ICN), Naturhistoriska Riksmuseet, Stockholm, Sweden (NHRM), Muséum National d'Histoire Naturelle, Paris, France (MNHN); one specimen collected by the author has been deposited in the National Museum of Natural History, Smithsonian Institution, Washington, D.C., USA (USNM).

TAXONOMY

Family Linyphiidae Blackwall 1859

Genus *Sphecozone* O. Pickard-Cambridge 1870

Sphecozone O. Pickard-Cambridge 1870:733; Simon 1894:673; Petrunkevitch 1928:132; Bonnet 1958:4117; van Helsdingen 1979:410–412; Millidge 1985:66–68, 1991:165–166; Wunderlich 1987:170 (in part). Type species by monotypy *Sphecozone rubescens* O. Pickard-Cambridge 1870.

Clitolyna Simon 1894:673; Bonnet 1956:1101. Type species by monotypy and original designation *Erigone fastibilis* Keyserling 1886. Synonymy in Miller, in press.

Clitolina. Petrunkevitch 1928:129. *Lapsus calami*.

Brattia Simon 1894:673–674; Petrunkevitch 1928: 129; Bonnet, 1955:914; Baert 1987:261–262; Millidge 1991:179. Type species by original designation *Brattia spadicaria* Simon 1894. Synonymy in Miller in press.

Hypselistoides Tullgren 1901:202; Simon 1903: 995; Petrunkevitch 1928:131; Bonnet 1957:2266. Type species by monotypy *Hypselistoides affinis* Tullgren 1901. Synonymy in Millidge 1985:66.

Gymnocymbium Millidge 1991:184. Type species by original designation *Gymnocymbium grave* Millidge 1991. Synonymy in Miller in press.

Diagnosis.—Males of *Sphecozone* are distinguished from other linyphiid genera by the absence of a paracymbium and the presence of a basal excavation of the cymbium on the retrolateral side (Figs. 2, 7). *Tutaibo* Chamberlin 1916, the only other genus known to have this basal cymbial excavation, has a well-developed paracymbium. *Psilocymbium* Millidge 1991, *Gonatoraphis* Millidge 1991, *Dolabritor* Millidge 1991, and *Moyosi* Miller in press, all of which have the paracymbium absent or small and fused to the base of the cymbium, all lack a basal excavation of the cymbium. Among erigonines, the loss or extreme reduction of the paracymbium seems to be limited to the Neotropical genera listed above. Female *Sphecozone* can be problematic to diagnose in the absence of males. All species have a dorsal plate that is exposed as a wide plate with an anterior lobe in ventral view (Figs. 5, 10). Copulatory openings are usually narrow crescent to round paired atria. Spermathecae may be round or oblong. The epigynum itself may project out strongly from the abdomen (Fig. 11). Unassociated females may be most easily confused with *Tutaibo*, which has the origin of the copulatory ducts on the ectal side of the spermathecae (Millidge 1991, fig. 671), posterior or mesal in *Sphecozone* (Fig. 4). *Tutaibo* females also lack an atrium; *Sphecozone* usually has an atrium (Figs. 5, 10), but it can be subtle or absent. Further details in Miller in press.

Sphecozone spadicaria (Simon 1894)

Figs. 1–11

Brattia spadicaria Simon 1894:674 (♂ ♀); Petrunkevitch 1911:220, 1928:129; Roewer 1942:705;

Bonnet 1955:914; Baert 1987:262, figs. 1–6 (♂♀); Platnick 1989:223, 1993:250, 2004; Millidge 1991:179, figs. 767–772 (♂♀).

Sphecozone spadicaria. Miller in press, figs. 2C,D, 150, 151C, 160, 161, 165 (♂♀).

Types.—VENEZUELA: Caracas [10°31′N, 66°57′W], syntypes: six males, six females (MNHN, examined).

Diagnosis.—Male distinguished from other *Sphecozone* species by the membranous form of the distal suprategular apophysis (Figs. 2, 7) and the form of the palpal tibia, especially the retroventral origin of one of the two tibial apophyses (Figs. 2, 9). Female distinguished from other *Sphecozone* species except *S. melanocephala*, *S. castanea*, and *S. novaeteutoniae* by the form of the epigynum, which projects out strongly from the abdomen (Fig. 11); see Miller (in press; also Baert 1987; Millidge 1991) for diagnosis from these species.

Description.—Male (from near Sasaima, Finca Bella Vista, Cundinamarca, Colombia): Total length 2.15. Carapace 0.94 long, 0.78 wide, dusky orange. Abdomen light gray, darker around spinnerets. Clypeus 0.16 high. AME diameter 0.074, ALE 0.068, PME 0.049, PLE 0.074, AME separation 0.75 times their diameter, AME-ALE separation 0.82 times one ALE diameter, PME separation 0.50 times their diameter, PME-PLE separation 0.83 times one PLE diameter. Sternum 0.53 long, 0.56 wide, dusky orange. Coxa IV separation 1.08 times their width. Chelicerae dusky orange, with six promarginal teeth, five retromarginal teeth. Legs dusky orange, tibia I length 1.01, metatarsus I length 0.85, tarsus I length 0.62; tibia I 13.33 times longer than thick; TmI 0.21; TmIV absent. Palpal tibia with one prolateral, one retrolateral trichobothrium; tibial apophysis short, arises from retrodorsal region, second shorter apophysis arises from retrovental region (Figs. 2, 9). Protegulum without papillae; tegulum with tiny papillae (Fig. 8); distal suprategular apophysis long, membranous (Figs. 2, 7). Radix with spiral tailpiece; anterior radical process present (Figs. 2, 6); small embolic membrane present (Figs. 3, 8). Embolus membranous, very long and flexible, embolic basal process present (Figs. 6, 8).

Female (same locality as male): Total length 2.18. Carapace 0.94 long, 0.81 wide, dusky orange. Abdomen light gray, darker around spinnerets. Clypeus 0.17 high. AME diameter 0.049, ALE 0.068, PME 0.062, PLE 0.062, AME separation 0.50 times their diameter, AME-ALE separation 1.00 times one ALE diameter, PME separation 0.90 times their diameter, PME-PLE separation 1.20 times one PLE diameter. Sternum 0.52 long, 0.58 wide, dusky orange. Coxa IV separation 1.29 times their width. Chelicerae dusky orange, with six promarginal teeth, five retromarginal teeth. Legs dusky orange, tibia I length 0.95, metatarsus I length 0.80, tarsus I length 0.61; tibia I 10.71 longer than thick; TmI 0.22. Palpal tibia with one prolateral, one retrolateral trichobothrium; Epigynum projects out from abdomen (Fig. 11), with paired crescent atria (Fig. 10), oblong spermathecae (Fig. 4). Copulatory ducts weakly sclerotized. Fertilization ducts originate from posterior part of spermathecae, run posteriomesally, then anteriomesally (Fig. 4). Dorsal plate with large anterior lobe, rounded anteriorly (Fig. 5).

Distribution.—Trinidad, Venezuela, Colombia.

Additional Material Examined.—COLOMBIA: *Cundinamarca*: Cachipay Alto Tolu [5°16′N, 74°34′W], 5 December 1996, 1600 m, 1♀, E. Florez (ICN); Finca Bella Vista, nr. Sasaima [4°58′N, 74°26′W], 26 March 1965, 1♂, 1♀, P.R. and D.L. Craig (CAS). TRINIDAD AND TOBAGO: *Trinidad*: Arima (10°37′N, 61°16′W), 29 June 1999, 1♂, J. Miller (USNM).

Genus *Pachydelphus* Jocqué & Bosmans 1983

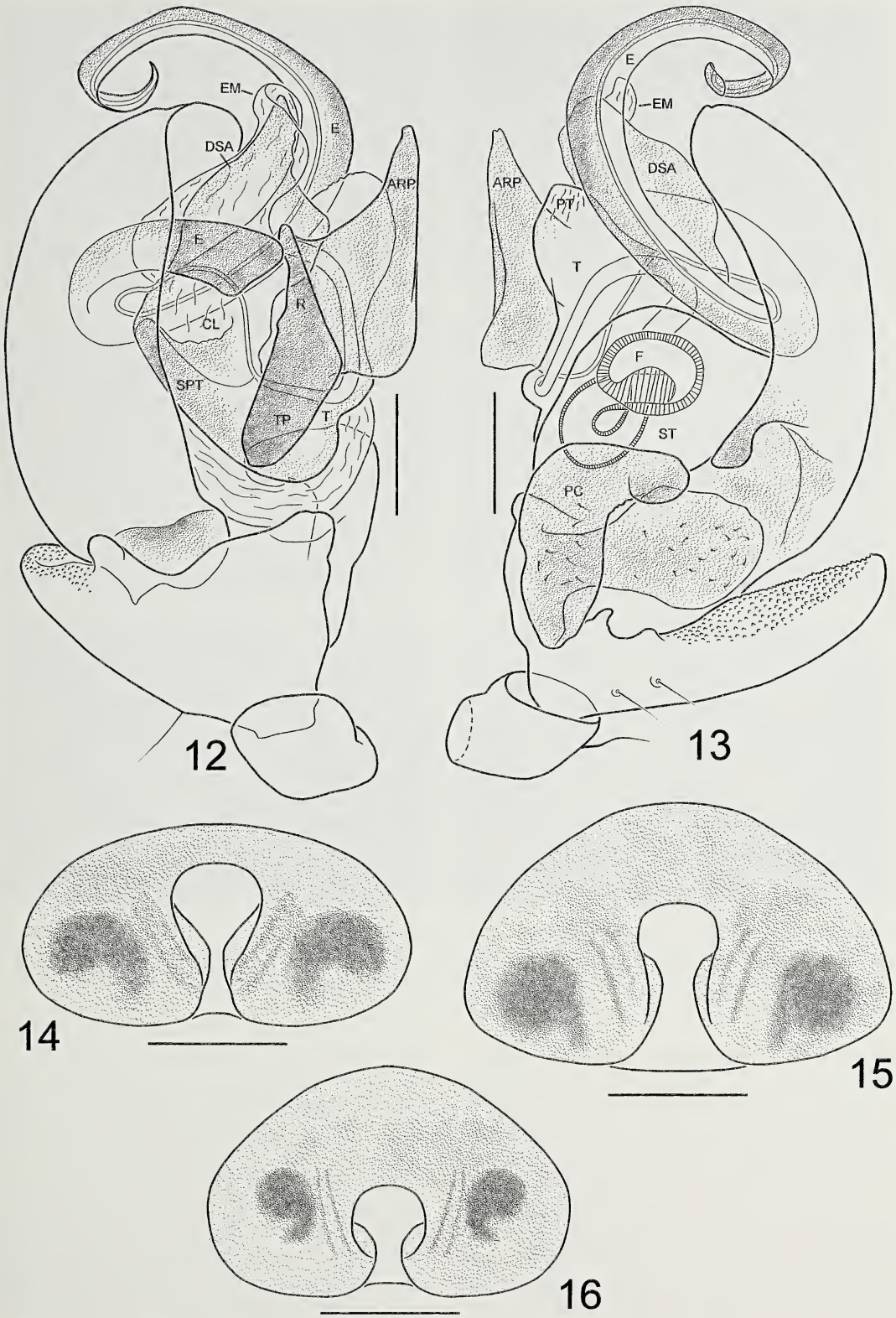
Pachydelphus Jocqué & Bosmans 1983:3. Type species by original designation *Pachydelphus banco* Jocqué & Bosmans 1983.

Pachydelphus africanus (Simon 1894) NEW COMBINATION
Figs. 12–22

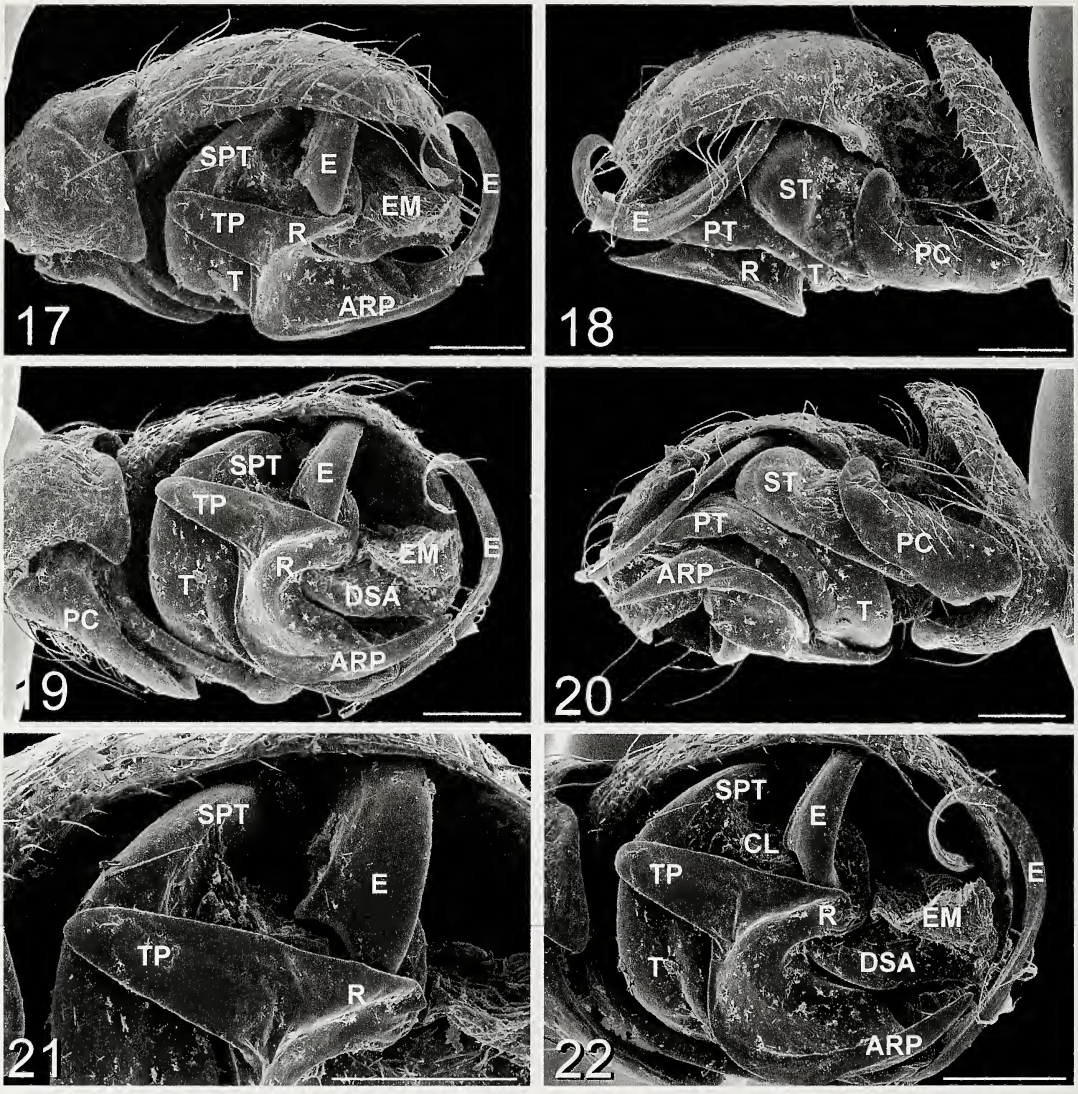
Brattia africana Simon 1894:674 (♂♀); Roewer 1942:705; Bonnet 1955:914; Platnick 2004.

Types.—GABON: lectotype male, six paralectotype males, eight paralectotype females, two paralectotype juveniles (NMHN, 11683, examined). Holm indicated the male lectotype by placing it in a labeled microvial. Simon (1894) indicated that additional specimens were known from Sierra Leone, but these could not be located.

Justification of transfer.—*Pachydelphus*



Figures 12–16.—*Pachydelphus africanus* (Simon), paralectotypes: 12, 13, left palp of male; 12, prolateral view; 13, retrolateral view; 14–16 female epigyna, ventral view, three individuals. Scale bars = 0.1 mm. See text for abbreviations.



Figures 17–22.—*Pachydelphus africanus* (Simon), paralectotype, scanning electron micrographs of male palp: 17, prolateral view; 18, retrolateral view; 19, proventral view; 20, retroventral view; 21, detail, base of embolus; 22, detail, embolic division. Scale bars = 0.1 mm. See text for abbreviations.

Jocqué & Bosmans 1983 is known from three species, but only *P. banco* Jocqué & Bosmans 1983 has the male described. Unlike *P. africanus*, the male of *P. banco* has a cephalic lobe bearing the PME (Jocqué & Bosmans 1983, fig. 1). The structure of the male palp is quite similar in *P. banco* and *P. africanus*, both having the first coil of the embolus running under the cymbium (Figs. 12, 17; Jocqué & Bosmans 1983, fig. 6), a similarly-shaped radix (Fig. 22; "L" in Jocqué & Bosmans 1983, fig. 6), and a field of seta-bearing tubercles on the distal margin of the palpal tibia (Fig. 18; Jocqué & Bosmans 1983, fig. 3). Females of *Pachydelphus* have a protruding epigynum with a deeply invaginated ventral plate. *Pachydelphus africanus* is the second member of the genus from Gabon; the remaining species are known from Ivory Coast. The chaetotaxy of *Pachydelphus africanus* is consistent with descriptions of other *Pachydelphus* species: dorsal tibial macrosetae 2-2-1-1, TmI located near the middle of the segment, TmIV present, one prolateral, two retrolateral trichobothria on palpal tibia. *Parasisis amurensis* Eskov 1984, the sole species

in a genus from northeastern Asia, probably also belongs to *Pachydelphus*.

Diagnosis.—Males of *P. africanus* differ from *P. banco* by the presence of a PME cephalic lobe in *P. banco* (Jocqué & Bosmans 1983, fig. 1), absent in *P. africanus*, by the length of the distal suprategular apophysis, which is much longer in *P. banco* (Jocqué & Bosmans 1983, figs. 4, 6) than *P. africanus* (Figs. 13, 22), and by the shape of the paracymbium, which has a proximodorsally projecting apophysis in *P. banco* (Jocqué & Bosmans 1983, fig. 4), no such apophysis in *P. africanus* (Figs. 13, 18). Females of *P. africanus* distinguished from those of other *Pachydelphus* species by the shape of the ventral plate invagination, which is narrowest anteriorly in *P. banco*, 1983, *P. tonqui* Jocqué & Bosmans, 1983 (Jocqué & Bosmans 1983, figs. 8, 12), and *P. coiffaiti* Jocqué, 1983 (Jocqué 1983, fig. 17), keyhole-shaped in *P. africanus* with a narrow part medially and wider anteriorly (Figs. 14–16). Note that *Parasisis amurensis* shares with *P. africanus* a keyhole-shaped invagination (Eskov 1984, fig. 5, Saito 1987, fig. 17).

Description.—Male (lectotype): Total length 1.88. Carapace 0.78 long, 0.66 wide, pale yellow. Abdomen white. Clypeus 0.15 high. AME diameter 0.040, ALE 0.074, PME 0.065, PLE 0.065, AME separation 0.85 times their diameter, AME-ALE separation 0.46 times one ALE diameter, PME separation 0.88 times their diameter, PME-PLE separation 0.57 times one PLE diameter. Sternum 0.43 long, 0.46 wide, dusky yellow. Coxa IV separation 0.91 times their width. Chelicerae yellow, dorsal spur absent, fang furrow tapered, with five promarginal teeth, four retromarginal teeth. Legs pale yellow, dorsal tibial macrosetae 2-2-1-1, tibia I length 0.84, metatarsus I length 0.80, tarsus I length 0.58; tibia I 11.33 times longer than wide; TmI 0.50; TmIV present. Palpal coxae without tubercles. Palpal tibia with one prolateral, two retrolateral trichobothria; distal margin with field of small tubercles bearing setae; tibial apophysis broad, projects dorsodistally. Cymbium somewhat excavated retrobasally near origin of paracymbium, with small process along cymbial margin anterior to excavation (Fig. 18). Paracymbium robust, spiral, with several short setae basally, ventrally, and on ectal face (Figs. 13, 18, 20). Subtegulum robust, ectal to tegulum; fundus nearly perpendicular to axis of palpal bulb (Fig. 13). Protegulum pointed, without papillae (Figs. 18, 20); junction between tegulum and suprategulum continuous (Fig. 12). Radix with flat, tapered tailpiece projecting posteriorly (Fig. 17); anterior radical process robust, tapered, arises from ectal part of radix, curves distally (Fig. 22); embolic membrane present (Fig. 22). Embolus arises from column, not fused to radix, passes under cymbium emerging on retrolateral side (Figs. 12, 21).

Female (paralectotype): Total length 1.95. Carapace 0.78 long, 0.61 wide, pale yellow. Abdomen white, darker dorsally. Clypeus 0.14 high. AME diameter 0.037, ALE 0.068, PME 0.059, PLE 0.068, AME separation 0.83 times their diameter, AME-ALE separation 0.45 times one ALE diameter, PME separation 0.91 times their diameter, PME-PLE separation 0.59 times one PLE diameter. Sternum 0.51 long, 0.44 wide, dusky yellow. Coxa IV separation 1.32 times their width. Chelicerae yellow, with five promarginal teeth, four retromarginal teeth. Legs pale yellow, dorsal tibial macrosetae 1-1-1-1, tibia I length 0.83, metatarsus I length 0.76, tarsus I length 0.54; tibia I 10.50 times longer than wide; TmI 0.43; TmIV present. Epigynum slightly protruding. Ventral plate with keyhole-shaped invagination revealing dorsal plate above (Figs. 14–16). Spermathecae widely spaced.

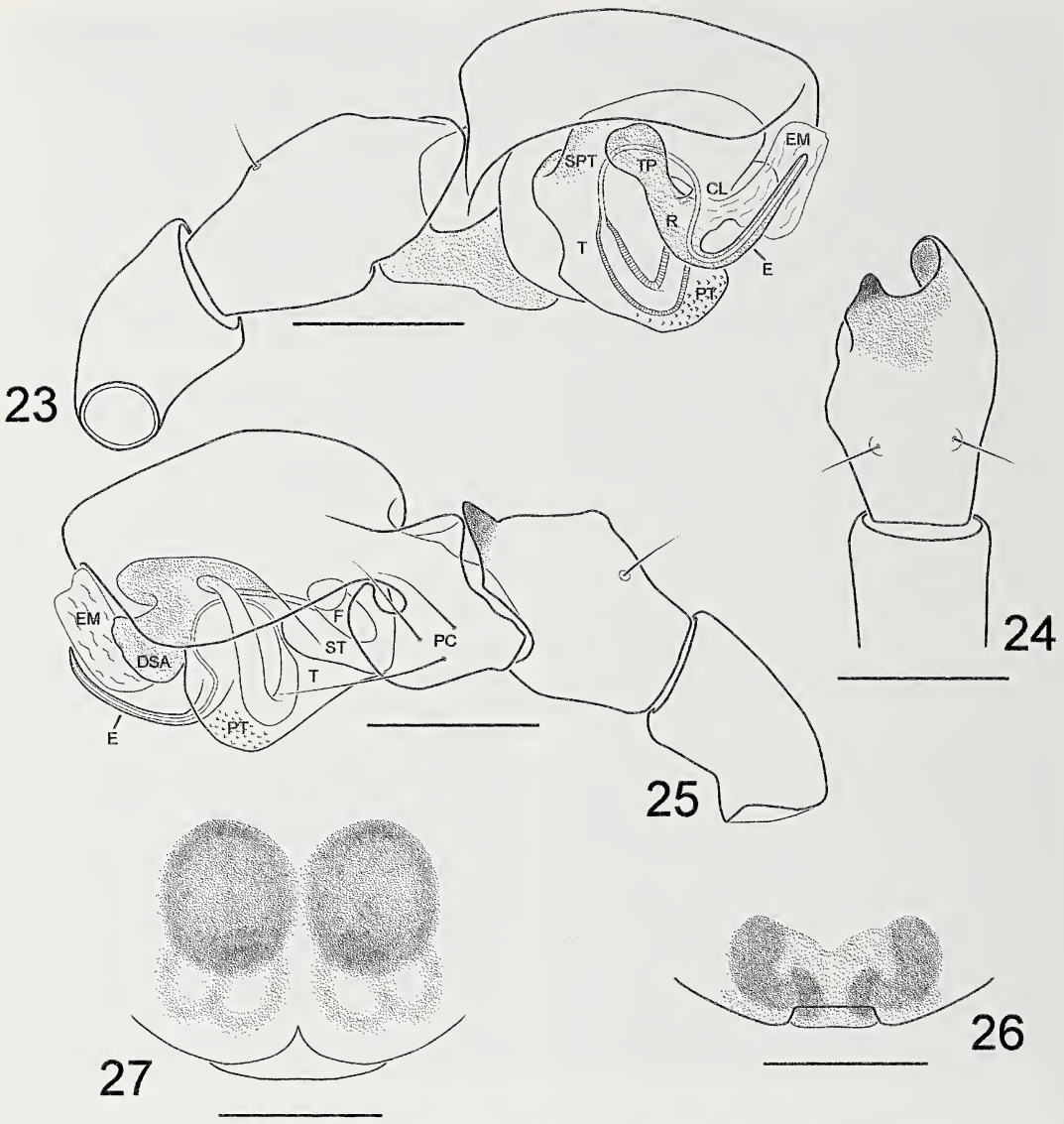
Variation.—The shape of the epigynum is quite variable among the paralectotypes. The invagination of the ventral plate may be deep, projecting nearly to the anterior margin of the epigynum, or shallow, not reaching the anterior margin of the spermathecae (Figs. 14–16).

Apobrata NEW GENUS

Type species.—*Brattia scutilla* Simon 1894.

Etymology.—From the Greek prefix *apo,* meaning from or separate, and a contraction of the genus name *Brattia* Simon 1894. The gender is feminine.

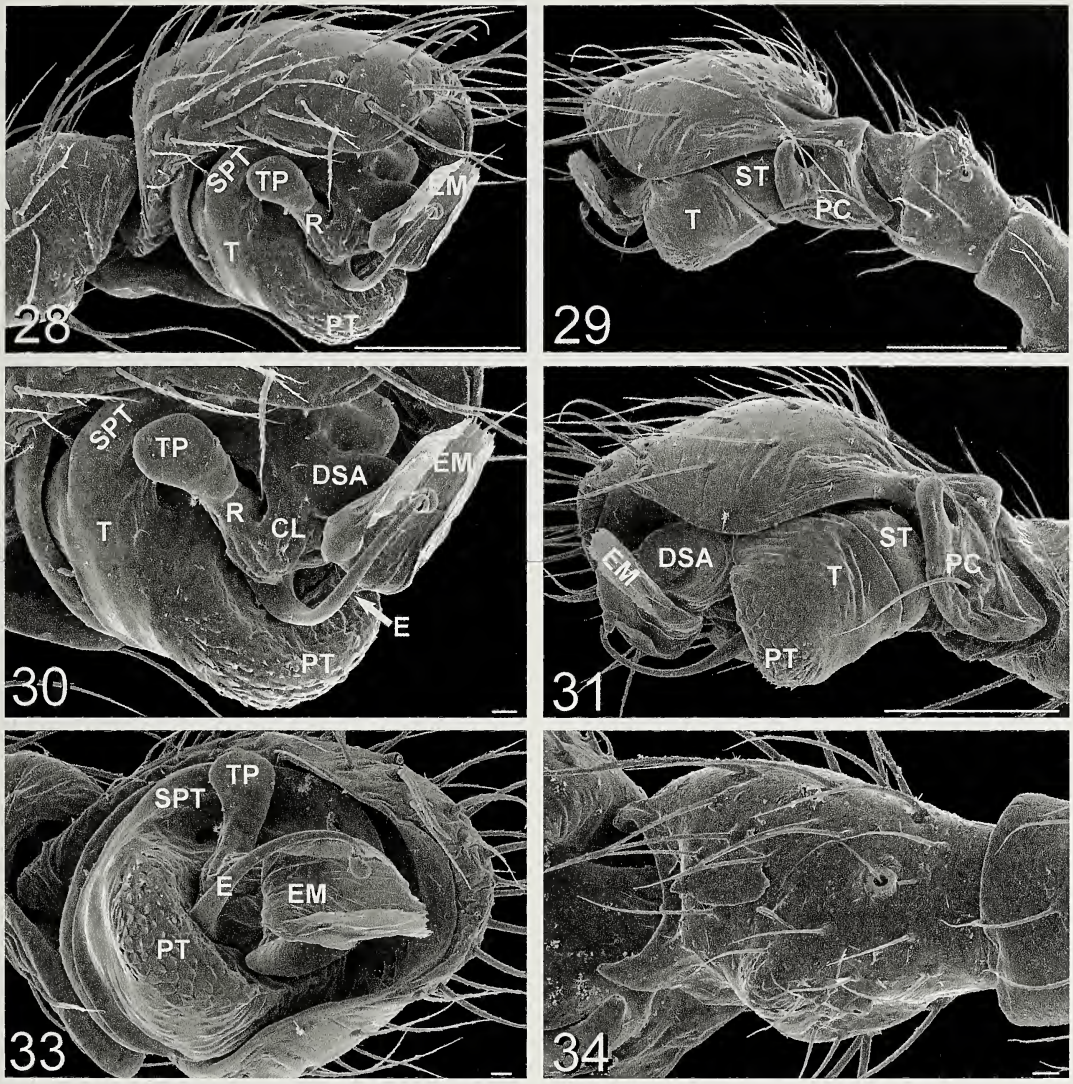
Diagnosis.—*Apobrata* is distinguished from all other erigonine genera by the following combination of characters in the male palp: paracymbium in the form of a flat hook with a strong groove at the junction with the cymbium (Figs. 25, 29), radical tailpiece teardrop shaped, continuous with a moderately



Figures 23–26.—*Apobrata scutilla* (Simon), paralectotypes; 27, *Anelosimus dubius* (Tullgren), syntype. 23–25, left palp of male; 26, 27, epigynum, ventral view. 23, prolateral view; 24, palpal tibia; 25, retrolateral view. Scale bars = 0.1 mm. See text for abbreviations.

long curved embolus (Figs. 23, 30), and palpal tibia with two short apophyses (Figs. 24, 34). Confirmatory characteristics include the presence of a single dorsal macroseta on all tibiae, the absence of a TmIV, and the absence of any cephalic lobes in the male.

The embolic division, the well-developed protegulum, and the form of the epigynum in *Apobrata* are similar to those of *Abacoproeces* (Wiehle 1960, figs. 168, 169; Millidge 1977, fig. 98), some *Tapinocyba* (Millidge 1977, fig. 45; Hormiga 2000, fig. 27), and some *Mecynargus* (Millidge 1977, fig. 47; Roberts 1993, fig. 49a, b). Of these, only *Apobrata* has a groove at the dorsal margin of the paracymbium. The male prosoma of *Abacoproeces* species (Wiehle 1960, figs. 170—172; Thaler 1973, figs. 1, 2), some *Mecynargus* species (Heimer & Nentwig 1991, fig. 646.5), and most or all *Tapinocyba* species (Wiehle 1960, figs. 978, 986, 993; Roberts 1993, fig. 74c–f) is modified with lobes and/or lateral sulci. The



Figures 28–34.—*Apobrata scutilla* (Simon), paralectotype, scanning electron micrographs of male palp: 28, prolateral view; 29, retrolateral view with palpal tibia; 30, detail, embolic division; 31, retrolateral view; 33, ventral view; 34, palpal tibia. Images taken from right palp, reversed to appear as left palp. Scale bars = 0.1 mm in 28, 29, 31; 0.01 mm in 30, 33, 34. See text for abbreviations.

chaetotaxy of *Apobrata* and *Tapinocyba* (1-1-1-1, TmIV absent) differs from that reported for *Abacoproeces* (2-2-1-1, Tm IV present) and *Mecynargus* (2-2-2-2, 2-2-2-1, 2-2-2-0, or 2-2-1-1, TmIV present or absent) (Millidge 1977, Roberts 1993).

Justification of monotypy.—Few erigonine spiders are described from the islands off Southeast Asia. *Apobrata* shares characteristics with *Abacoproeces* Simon 1884 (two species, Palearctic), *Tapinocyba* Simon 1884 (41 species, Holarctic), and *Mecynargus* Kulczyn'ski 1894 (14 species, Holarctic); it is unclear which if any of these genera is the closest relative of *Apobrata*. A new phylogenetic analysis, which could determine the placement of *Apobrata* within the Erigoninae, is beyond the scope of this paper. The examination of additional material from the Philippines and vicinity may reveal new *Apobrata* species.

Distribution.—Philippines.

Species included.—*Apobrata scutilla* (Simon 1894), new combination.

Apobrata scutilla (Simon 1894) NEW COMBINATION
Figs. 23–26, 28–34

Brattia scutilla Simon 1894:674 (♂♀); Roewer 1942:705; Bonnet 1955:914; Murphy & Murphy 2000:512; Platnick 2004.

Types.—PHILIPPINES: Manila [14°35′N, 120°59′E]: lectotype male, 11 paralectotype males, 26 paralectotype females, E. Simon (NMHN, 11275, examined). Holm indicated the male lectotype by placing it in a labeled microvial with a female paralectotype.

Diagnosis.—Monotypic genus; see genus diagnosis.

Description.—Male (paralectotype): Total length 1.63. Carapace 0.71 long, 0.66 wide, yellow. Abdomen white, darker around spinnerets. Clypeus 0.20 high. AME diameter 0.049, ALE 0.069, PME 0.062, PLE 0.056, AME separation 0.50 times their diameter, AME-ALE separation 0.63 times one ALE diameter, PME separation 0.75 times their diameter, PME-PLE separation 1.11 times one PLE diameter. Sternum 0.43 long, 0.49 wide, dusky yellow. Coxa IV separation 1.40 times their width. Chelicerae pale yellow, dorsal spur absent, fang furrow tapered, with three promarginal teeth. Legs yellow, dorsal tibial macrosetae 1-1-1-1, tibia I length 0.94, metatarsus I length 0.97, tarsus I length 0.66; tibia I 13.19 times longer than wide; TmI 0.30; TmIV absent. Palpal coxae without tubercles. Palpal tibia with one prolateral, one retrolateral trichobothrium; with short, pointed prolateral and retrolateral apophyses (Figs. 24, 34). Cymbium with groove above connection to paracymbium (Figs. 25, 29). Paracymbium a flat hook with three long setae on ectal face (Figs. 25, 29). Subtegulum small, proximal to tegulum; fundus nearly perpendicular to axis of palpal bulb (Fig. 25). Protegulum with scale-like papillae (Fig. 30); junction between tegulum and suprategulum with membranous articulation (Figs. 23, 30); distal suprategular apophysis a short spiral (Fig. 31). Radix with bulbus tailpiece projecting posteriorly; embolic membrane present (Figs. 23, 30). Embolus continuous with radix, curved, projecting dorsodistally (Figs. 23, 30).

Female (paralectotype): Total length 2.25. Carapace 0.81 long, 0.75 wide, orange. Abdomen white, darker around spinnerets. Clypeus 0.17 high. AME diameter 0.049, ALE 0.074, PME 0.069, PLE 0.068, AME separation 0.65 times their diameter, AME-ALE separation 0.60 times one ALE diameter, PME separation 0.71 times their diameter, PME-PLE separation 0.82 times one PLE diameter. Sternum 0.44 long, 0.53 wide, orange. Coxa IV separation 1.67 times their width. Chelicerae orange, with four promarginal teeth. Legs dusky orange, dorsal tibial macrosetae 1-1-1-1, tibia I length 1.10, metatarsus I length 1.13, tarsus I length 0.67; tibia I 13.88 times longer than wide; TmI 0.59; TmIV absent. Ventral plate of epigynum with shallow invagination (Fig. 26). Spermathecae reniform, widely spaced.

Family Theridiidae Sundevall 1833
Genus *Anelosimus* Simon 1891

Anelosimus Simon 1891:11; Bonnet 1955:322; Levi 1956:412; Levi & Levi 1962:16, 51; Levi 1963: 32. Type species *Anelosimus socialis* Simon 1897 [= *Anelosimus eximius* (Keyserling 1884)], by monotypy.

Anelosimus dubius (Tullgren 1910) NEW COMBINATION
Fig. 27

Brattia (?) *dubia* Tullgren 1910:144, pl. 3, fig. 62 (♀); Roewer 1942:705; Bonnet 1955:914; Denis 1962:170; Scharff 1990:122; Platnick 2004.

Types.—TANZANIA: Mt. Kilimanjaro, Kibonoto, Kulturzone, [3°4′S, 37°21′E], 2 syntype females, Colleg. Yngve Sjöstedt (NHRM, examined). Both syntypes in poor condition, coloration faded. One syntype missing some distal leg segments on left legs I and IV and right leg I; second syntype disarticulated at pedicel, prosoma partially flattened, most legs disarticulated and lost.

Justification of transfer.—Tullgren (1910) indicated that he was hesitant about placing this species in *Brattia*. Tullgren even suggested that this species resembles a theridiid, but he was unable to see the comb on tarsus IV. Tullgren also noted that the abdominal pattern reminded him of "*Theridium*" (= *Theridion* Walckenaer 1805); the abdominal pattern is hardly visible in the degraded syntypes. Holm (1962:23) also indicated that *B. dubia* belongs to Theridiidae. *Anelosimus dubius* is similar to other *Anelosimus* species recently recognized from Africa (Agnarsson 2004). Although the form of the colulus cannot be determined from the syntypes, *Anelosimus*

species including other African species lack a colulus but retain two setae (Agnarsson 2004). Also, *Anelosimus* species usually have denticles on the retromargin of the chelicerae; no denticles are visible on the syntypes, but the apparent absence of retromarginal denticles may be due to the condition of the specimens.

Description.—Female (syntype): Total length 2.13. Carapace 0.94 long, 0.72 wide, orange, head region covered in even patch of setae. Abdomen pale, dorsal folium faded, originally reported as whitish with a series of brown transverse chevron markings (Tullgren 1910). Clypeus 0.16 high. AME diameter 0.068, ALE 0.074, PME 0.074, PLE 0.078, AME separation 0.68 times their diameter, AME-ALE separation 0.38 times one ALE diameter, PME separation 0.83 times their diameter, PME-PLE separation 0.48 times one PLE diameter. Sternum 0.51 long, 0.44 wide, dusky yellow, labium-sternum separated. Coxa IV separation 1.32 times their width. Chelicerae pale orange, with three promarginal teeth. Femur I strong, orange dorsally, otherwise pale yellow, leg lengths I-IV-II-III, tibia I length 0.93, metatarsus I length 0.85, tarsus I length 0.47; tibia I 7.83 times longer than wide; tibia IV length 0.60, metatarsus IV length 0.58, tarsus IV length 0.40; tibia IV 5.00 times longer than wide. Ventral plate with notch-like posterior invagination (Fig. 27). Spermathecae large, closely spaced.

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A NEW SPECIES OF THE GENUS *VAEJOVIS* (SCORPIONES, VAEJOVIDAE) ENDEMIC TO THE BALSAS BASIN OF MICHOACAN, MEXICO

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ABSTRACT. A unique new species of the genus *Vaejovis* is described: *V. cisnerosi* from deciduous scrub forest in the Balsas Basin in Michoacan state, Mexico. Morphological characters, including the hemispermatophore of the holotype male, are illustrated. The closest relative of *V. cisnerosi* within the genus is unknown, but hemispermatophore morphology, tarsal setation, and trichobothrial patterns suggest close ties with the *V. eusthenura*, *V. intrepidus* and *V. punctipalpi* groups.

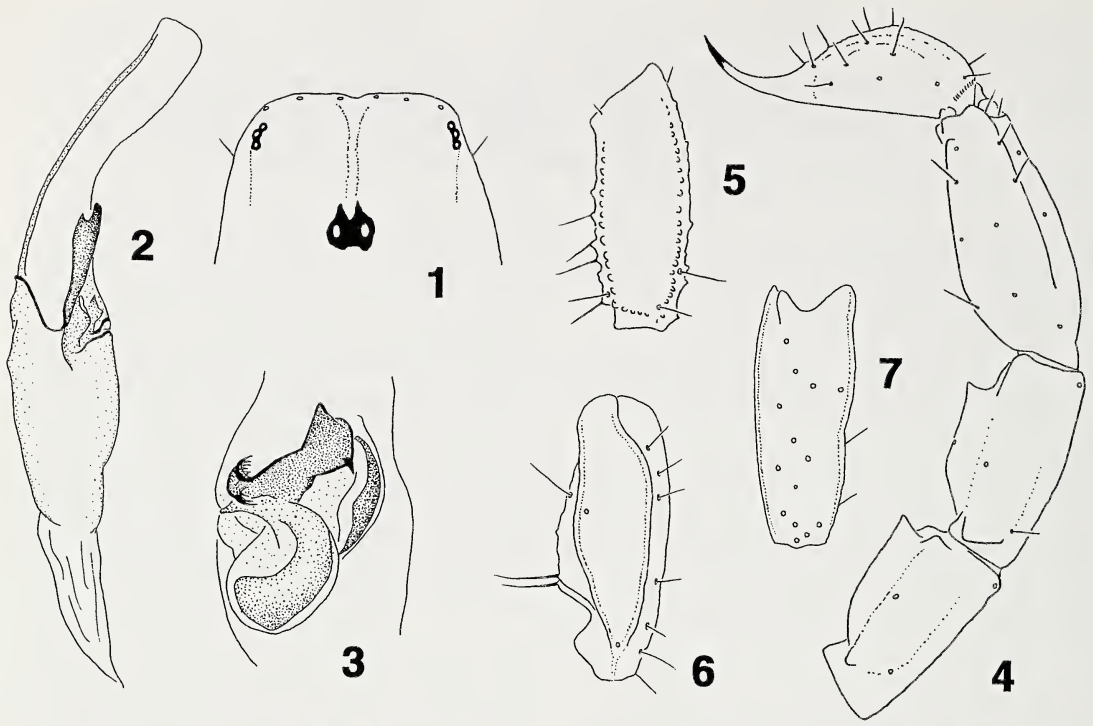
Keywords: Scorpion, *Vaejovis*, taxonomy, Mexico

The Balsas-Tepalcatepec Basin is a distinct structural depression in southern Mexico that extends in a west-northwest to east-southeast direction. Comprising the lower parts of the Balsas river basin, it occupies a large area inside Michoacan and small portions of adjacent Guerrero and Jalisco. In Guerrero it lies near the boundaries with Oaxaca, Puebla and Morelos, and in Michoacan it is a large valley in which the elevation ranges from 200–700 m (Toledo 1982). The Balsas-Tepalcatepec region has experienced a complex geological history and exhibits high levels of endemism in both plants and animals. Among insects, 11 endemic species of butterflies of the family Papilionidae are known (Llorente-Bousquets & Luis-Martínez 1993), and the bee genus *Loxoptilus* is endemic to this region and the coast of Nayarit (Ayala et al. 1993). In birds, although the deciduous scrub forest is not especially rich in diversity, there are many endemic species (Challenger 1998). In arachnids (including scorpions), Robles Gil et al. (1993) recorded 311 species from the subhumid forests of the Pacific, representing fairly high diversity. Scorpions, because of their antiquity and poor vagility, can be considered excellent indicators of the presence of true biogeographical barriers and can be used to help delimit boundaries of biogeographical areas.

Vaejovis is the most diverse genus of scorpions in North America. Sissom (2000) listed 66 described species in a recent world catalog. Six additional species have been described since the appearance of the catalog (Capes 2001; Hendrixson 2001; Hendrixson & Sissom 2001; Armas & Martín Frías 2001), and herein we report on a new species from the Balsas Basin of Michoacan. Seven other species of *Vaejovis* have previously been recorded from the state of Michoacan (Beutelspacher 2000; Ponce & Beutelspacher 2001).

METHODS

Terminology for general morphology conforms to Stahnke (1970), except for trichobothrial patterns (following Vachon 1974), carinal nomenclature (following Francke 1977), and hemispermatophore morphology (following Lamoral 1979 and Sissom 1991). Hemispermatophores from a specimen were dissected by means of an incision in the pleura of the right side of the mesosoma. The hemispermatophores were cut at their connection with the genital opercula, allowing both hemispermatophores (with their paraxial organs intact) to remain united during removal. The right hemispermatophore was subsequently detached and prepared for further study in clove oil as described by Sissom (1990); both hemispermatophores were preserved in 80



Figs. 1–7.—Morphology of the holotype male of *Vaejovis cisnerosi*: 1. Dorsal view of carapace; 2. Dorsal view of right hemispermatophore; 3. Ventral view of right hemispermatophore, showing capsular region; 4. Lateral view of metasomal segments III-V and telson; 5. Dorsal view of pedipalp femur; 6. Dorsal view of pedipalp patella; 7. External view of pedipalp patella.

percent ethyl alcohol and stored in shell vials with the specimen.

Family Vaejovidae Thorell 1876
Genus *Vaejovis* C. L. Koch 1836
Vaejovis cisnerosi new species
(Figs. 1–14)

Type material.—Holotype male taken from Churumuco, Michoacan, Mexico (18°40′15″N, 101°38′39″W), 7 January 2000, J. Ponce (deposited in the Colección Nacional de Arácnidos del Instituto de Biología de la Universidad Nacional Autónoma de México). Paratypes: 1 male, same data as holotype; 1 female, Churumuco, 11 November 2000, R. Moreno; 1 subadult male, 1 juvenile male, Churumuco, 9 September 2000, J. Ponce; 1 male, 1 female, Cerro de Turitzio (18°31′41″N, 100°55′27″W), Arúa, Mpio. de Huetamo, Michoacan, 9 September 2000, R. Moreno, R. Cancino; 1 female, El Carrizal, Mpio. de Carácuaro (19°09′00″N, 101°06′19″ W), July 2000, E. Miranda; all paratypes deposited in the Universidad de Michoacán, Morelia.

Etymology.—The specific name is a patronym honoring the memory of Sócrates Cisneros Paz, biologist and ecologist at Michoacan University, who dedicated a great part of his life to the training of biologists and entomologists and founded the university's laboratory of entomology.

Diagnosis.—*Vaejovis cisnerosi* is very unique in morphology, rendering its placement in an established species group within the genus difficult. *Vaejovis cisnerosi* is unlike all other species of *Vaejovis* in that the carinae of the dorsal and lateral surfaces of the metasoma are greatly reduced in strength (mostly obsolete) and completely smooth. In addition, the metasomal setation is highly reduced (see description below), giving it the lowest setal counts of any species in the genus. These features are autapomorphic.

The hemispermatophore of *V. cisnerosi* is quite similar to those of the species of the *V.*

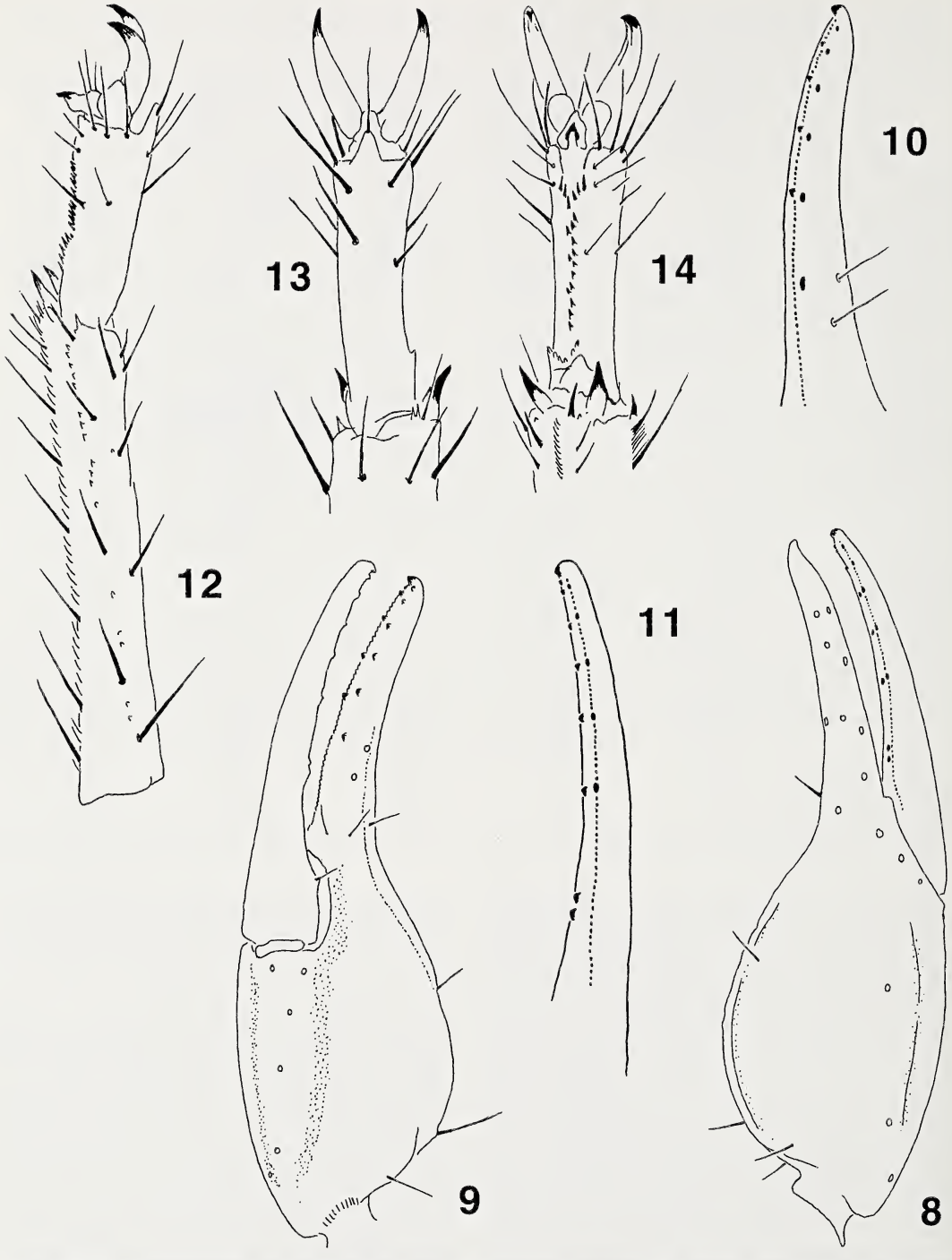
Table 1.—Measurements (in mm) of the type series of *Vaejovis cisnerosi*, new species. L = length, W = width, D = depth, L-R = left-right.

	Churumuco Holotype Male	Churumuco Paratype Female	Churumuco Paratype Male	Turitzio Paratype Female	Carrizal Medida Paratype Female
Total L	57.35	65.15	44.30	65.00	49.10
Carapace L	6.05	7.45	5.05	7.05	5.65
Mesosoma L	19.45	20.10	12.05	19.40	14.05
Metasoma L	31.85	37.60	27.20	38.55	29.40
Metasoma I L/W	3.65/3.70	4.35/4.55	3.20/3.25	4.65/4.85	3.45/3.70
Metasoma II L/W	4.35/3.65	5.30/4.45	3.65/3.15	5.15/4.60	3.50/3/65
Metasoma III L/W	4.40/3.60	5.30/4.30	4.00/3.10	5.65/4.55	4.00/3.10
Metasoma IV L/W	5.55/3.50	6.40/4.20	4.90/3.05	6.80/4.35	4.90/3.05
Metasoma V L/W	7.25/3.30	8.25/3.90	5.95/2.95	8.45/4.30	5.95/3.00
Telson L	6.65	8.00	5.50	7.85	7.60
Vesicle					
L	4.00	5.40	3.55	5.25	5.55
W	2.45	3.35	2.20	3.30	2.20
D	2.10	2.85	1.70	2.70	1.75
Aculeus L	2.65	2.60	1.95	2.60	2.05
Pedipalp L	19.55	24.05	17.15	23.9	18.40
Femur L/W	4.95/1.75	6.20/2.10	4.30/1.50	6.05/2.15	4.40/1.65
Patella L/W	5.10/2.05	6.30/2.20	4.60/1.55	6.70/2.45	5.20/1.75
Chela					
L	9.50	11.55	8.25	11.15	8.80
W	2.80	3.30	2.30	3.45	2.30
D	3.60	4.05	2.95	4.10	1.85
Movable Finger L	5.80	7.30	4.95	7.25	5.30
Fixed Finger L	4.15	5.35	3.65	5.40	4.05
Pectinal Teeth (L-R)	21-21	21-21	21-21	20-20	21-20

eusthenura, *V. intrepidus* and V. *punctipalpi* species groups. There is a broad flange along the ental margin of the distal lamina, and the ental process of the inner capsular lobe bears a series of hooklets (Sissom 1991). The position of trichobothria *ib* and *it* on the pedipalp chela fixed finger (displaced to near the 6th inner accessory denticle of the primary denticle row) and the possession of only five subrows of denticles on the chela fixed finger also suggest relationship with those groups. Finally, the ventromedian spinule row of the leg tarsi are flanked distally by two or more pairs of larger spinules, as in the aforementioned groups.

The reduction of the carinae of the pedipalps and the absence of ventral carinae on the metasoma place the species closer to the *eusthenura* group (e.g. in southern Mexico, this would include *Vaejovis punctatus* Karsch 1879 and its relatives); on the other hand, the reduction of the metasomal setation and the dorsoventral compression of the metasoma are similar to the conditions seen in the *intrepidus* species group.

Description.—Based on adult males; where different, characteristics of females are indicated. Total length: adult males 44.3–57.4 mm, adult females 49.1–65.2 mm. Complete measurements of two males and three females are included in Table 1. *Coloration (in alcohol):* Base color of carapace and tergites yellow. Dorsal aspect of prosoma and mesosoma with diffuse dusky markings. Legs, vesicle and ventral aspect immaculate yellowish. Chela of pedipalps yellow, with the fingers orange brown and the palm with faint lines of pigment that indicate the positions of obsolete dorsal and external carinae. *Prosoma:* Carapace (Fig. 1) with anterior margin bearing three pairs of setae; anterior margin slightly emarginate, median notch weak and shallow.



Figs. 8–14.—Morphology of the holotype male of *Vaejovis cisnerosi*: 8. Dorsal view of pedipalp chela; 9. Proventral view of pedipalp chela; 10. Pedipalp chela fixed finger, showing dentition pattern and position of trichobothria *ib* and *it*; 11. Pedipalp chela movable finger, showing dentition pattern; 12. Left leg III, retrolateral view; 13. Left leg III, superior (dorsal) view; 14. Left leg III, ventral view.

Surface almost completely smooth (a few scattered granules are present). *Mesosoma:* Median carina on all tergites weak or obsolete; all tergites smooth. Tergite VII with four weak lateral carinae on the posterior half; median carina very weak or obsolete. Pectinal tooth count 20–22 in males and 20–21 in females. Sternites I-VII acarinate, with setae along their margins. *Hemispermatophore* (Figs. 2–3): Distal lamina slightly wider at the distal end; ental margin of distal lamina with a broad flange, this partitioned at its distal edge (as viewed from ental aspect). Flange length (as measured from base of dorsal trough margin) approximately 40% of distal lamina length. Ental process of inner capsular lobe (= sperm plug, *sensu* Sissom & Stockwell 1991) with series of hooklets. *Metasoma (Fig. 4):* Segments I–IV with the dorsolateral and lateral supramedian carinae moderate and smooth, ending in an enlarged subspinoid denticle; all other keels obsolete. Intercarinal spaces smooth. Setal counts on segments I–IV: dorsolaterals, 0/0:0/0:0/0:1/1; lateral supramedians, 0/0:1/1:1/1:1/1; lateral inframedians, 0/0:0/0:0/0:0/0; ventrolaterals 0-1/0-1: 0-1/0-1:0-1/0-1:0-1/0-1; ventral submedians, 1/1:1/1:1/1:1/1. Segment V: Dorsolateral carinae moderate, smooth anteriorly, slightly granular on posterior third. Lateromedian carina obsolete. Ventrolateral and ventromedian carinae weak and smooth anteriorly, moderate with distinct granules on posterior third. Intercarinal spaces smooth. Metasoma V setal counts: dorsolaterals, 4/4; lateromedians, 2/2; ventrolaterals, 3/3; ventromedians, 3/3. The ratio of segment III length/width 1.22–1.23 in males (n = 2) and 1.24–1.29 in females (n = 3); of segment V length/width 2.12–2.20 (n = 2) in males and 1.97–2.02 in females (n = 3). *Telson* (Fig. 4): Ventral surface of the vesicle completely smooth, with 9 pairs of setae. *Pedipalp:* Trichobothrial pattern type C, orthobothriotaxic. Femur (Fig. 5): Carinae moderate and irregularly granulose. Internal face with scattered granules, these irregular in size and form. Patella (Figs. 6–7): Dorsointernal and ventrointernal carinae smooth to feebly granular; dorsoexternal and ventroexternal carinae completely smooth. Internal face of patella with an oblique, slightly crenulate keel, restricted to basal half. Dorsal and external surfaces smooth. Chela (Figs. 8–11): acarinate, hand moderately swollen. Primary denticle row of fixed finger (Fig. 10) divided into five subrows by four enlarged primary row denticles; denticle subrows flanked medially by six inner accessory granules. Movable finger (Fig. 11) with six subrows and eight inner accessory granules (basalmost usually doubled). Ratio of chela length/width 3.39–3.90 in males (n = 2), 3.23–3.83 in females (n = 3); fixed finger length/carapace length 0.69–0.72 for males (n = 2), 0.72–0.77 in females (n = 3); pedipalp femur length/carapace length 0.82–0.85 for males (n = 2), 0.78–0.86 in females (n = 3). *Legs (Figs. 12–14):* Basitarsus (Fig. 12) with well developed retrosuperior, retroventral, and ventral longitudinal spinule rows. Regularly-spaced setae interspersed along spinule rows as in Fig. 12. Telotarsus: Ventromedian spinule row terminating distally between two to three pairs of larger spinules. Setation as in Figs. 13, 14.

Variation.—In males, pectinal tooth counts were as follows: one comb with 20 teeth, five with 21 teeth, and two combs with 22 teeth. In females, the counts were: 3 combs with 20 teeth and 3 combs with 21 teeth. The dentition of the pedipalp chela fingers was consistent in the number of subrows of denticles and the number of inner accessory denticles on the fixed finger. On the movable finger, however, the number of inner accessory denticles exhibited slight variation. Unique among vaejovids (except some *Serradigitus* spp.), which normally have six or seven inner accessory denticles, this species exhibited doubling of the basalmost denticles, yielding a count of eight. On one individual, the movable finger had the basalmost inner accessory denticle tripled, giving a total count of nine. The females are larger than the males in total length and more robust.

Natural history.—*Vaejovis cisnerosi* is an uncommon species that inhabits deciduous tropical scrub forest. It is found on more or less sandy soils or other soils of smooth texture in open areas, where it digs burrows 15–20 cm deep with circular entrances. Most of the specimens were collected near their burrow entrances. *Vaejovis cisnerosi* coexists with other vaejovids, an undescribed species of *Diplocentrus* Peters 1861 (Diplocentridae) and *Centruroides limpidus* (Karsh 1879) (Buthidae); the latter is the numerically dominant species and has been observed feeding on *V. cisnerosi*.

Distribution.—*Vaejovis cisnerosi* is known from three localities of the Balsas Basin, all in the state of Michoacan.

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WHY STUDY SPIDER SEX: SPECIAL TRAITS OF SPIDERS FACILITATE STUDIES OF SPERM COMPETITION AND CRYPTIC FEMALE CHOICE

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ABSTRACT. I argue that several unusual aspects of spider sexual biology make them extremely promising subjects for future research on sperm competition and cryptic female choice, and outline promising lines for future research. The important traits include: double, bilaterally symmetrical genitalia (allowing the use of the same animal as experimental and control and thus providing unusually complete controls for experimental manipulations); isolation of male ejaculates in pure form during sperm induction (allowing experimental determination of the effects of sperm and male accessory glands on female reproductive physiology, and separation of their effects on the female from those of copulatory courtship and copulation); frequent venter-up orientation and genitalic meshes in which most of the male genitalia is outside rather than inside the female (allowing unusually complete observations of male genital behavior during copulation); immobile sperm (allowing confident deductions about male and female movement of sperm without complications from motility of the sperm themselves); a huge data set on female as well as male genitalic morphology from previous taxonomic studies (enabling, in combination with studies of the fit between male and female genitalia, studies of the details of how rapid genitalic divergence occurs). Studies of spider sex should be in the forefront of the next generation of studies of sperm competition and cryptic female choice.

Keywords: Sperm competition, cryptic female choice, sexual selection, genitalia

Ever since the path-breaking study of sperm competition by Parker (1970), it has been apparent that sexual selection can act on the abilities of males to influence reproductive processes that occur after the initiation of copulation. In Darwin's original treatment of sexual selection (1871), he only considered events leading up to copulation. Perhaps because of cultural strictures that were imposed by his own ideas or those of his wife or daughter (Birkhead 2000) of what was proper for a Victorian gentleman to discuss, he missed the possible significance of the more intimate details of male—female interactions that occur after copulation begins. Parker's attention originally focused on processes corresponding to Darwin's category of direct male-male conflict or intrasexual sexual selection ("sperm competition"), but it later became clear that processes corresponding to Darwin's other category, female choice or intersexual selection, could also occur in addition after copulation has begun ("cryptic female choice"; Thornhill 1983; Eberhard 1985, 1996). Because the crucial events occur within the female's own body, cryptic female choice may have been a more important evolutionary process than sperm competition (Eberhard 1996), but to date it has been less studied.

Recognition of the possible importance of sperm competition and cryptic female choice has forged new connections with the fields of reproductive morphology and physiology, which had developed in relative isolation from sexual selection theory (Eberhard 1985; Eberhard & Cordero 1995). It brings into focus the possible evolutionary consequences of much otherwise arcane information, such as the morphological details of how male and female genitalia function during sperm transfer, how sperm are handled within the female prior to fertilization (e.g., Burger et al. 2003), and the effects of male seminal products on female reproductive physiology, including control of ovulation, oviposition, sperm storage, and induction of resistance to further copulations (Chen 1984).

Sperm competition and cryptic female choice are currently active fields of research, as testified by recent book-length summaries

(Birkhead & Møller 1998; Simmons 2001). These summaries show that the amount of attention that has been given to spiders has, as usual, been relatively minor compared to that paid to insects. I will argue in this paper that this bias should be reduced in the next generation of studies, and that spiders should be in the vanguard of work on these topics, due to several peculiar aspects of their sexual biology which facilitate study. My aim is not to present a complete review of work on sperm competition and cryptic female choice in spiders, but rather to show why spiders are particularly well suited for studies regarding sperm competition and cryptic female choice, in the hope of encouraging further study. Because of this objective, my citations of previous work are incomplete and biased toward more recent studies so as to give entries into the published literature.

Morphology of genitalia and sperm.— The genitalic structures with which male spiders introduce sperm into the female are unique, and although studies of their functional morphology are still only fragmentary, their morphology offers many special advantages for the study of sperm competition and cryptic female choice (Table 1). The male's palpal bulb includes: a reservoir which stores sperm that have been emitted from the male's primary genital opening on his abdomen; more or less complex sclerites which brace each other and couple the palp to the female's genitalia; and sclerites which introduce the sperm into her reproductive tract. The bulb is apparently derived embryologically from the tarsal claw of the pedipalp, and, not surprisingly, is devoid of both neurons and muscles (Eberhard & Huber 1998a). Its movements during copulation are somewhat limited in scope, as they are produced by hydraulic pressure that inflates membranous sacs and causes sclerites to move in complex patterns with respect to each other and to the female (Gering 1953; von Helsdingen 1965, 1969; Grasshoff 1968, 1973; Blest & Pomeroy 1978; Huber 1993, 1995a, b). The highly sclerotized rigid nature of both male and female genitalia, the lack of sensory structures on at least the external portions of the female genitalia as well as on the male's genitalia, combined with the limited movements of male genitalia, mean that functional accommodation of male and female forms can be deduced relatively clearly (com-

Table 1.—Special traits of spiders which facilitate study of sperm competition and cryptic female choice and could make spiders leaders in future studies of these phenomena.

1. Sperm are encapsulated when transferred, so sperm displacements within female during copulation can be attributed with confidence to either male or female transport rather than sperm mobility. If sperm do not become decapsulated soon after insemination, clumping may occur in storage.
2. The more or less independent sclerites in the palpal bulb lack nervous connections, thus allowing ablation experiments in which possible sensory effects can be ignored.
3. Movement of palpal sclerites occurs via expansions of membranous sacs (haematodochae) rather than muscles. Most movements are relatively stereotyped and largely occur on the female's external surface. This allows direct observation of male genitalic movements, and precludes cryptic movements inside the female that cannot be observed directly.
4. External isolation of pure seminal products occurs during the process of charging pedipalps, thus allowing experimental separation of the effects on the female of copulation per se, and of seminal products.
5. The external female genitalia are rigid and often complex, and lack sensory structures on the external surface. The male genitalia must mesh physically with them, allowing relatively easy deductions regarding functional significance of male genitalic structures, by freezing and sectioning spiders during copulation; mechanical functions of male genitalia are especially likely to be important.
6. Paired male and female genitalic structures make it possible to experimentally modify one side of the animal and leave the other intact, giving unusually complete experimental controls.
7. The forms of both male and female genitalia are easily determined because they are generally strongly sclerotized, and there is already a huge taxonomic literature that documents genitalic structures in females as well as in males. Data is thus already available for broad comparative studies tracing coevolutionary patterns in males and females.
8. Experimental manipulation of male feeding of the female during copulation (e.g. *Argyrodes*) should be easy.

pared with many other animals) by freezing copulating pairs and then sectioning them (e.g,, Huber 1993, 1995a, b; Uhl et al. 1995; Knoflach 1998 and references therein). The general finding from these studies is that many portions of complex rigid male genitalic structures function to contact and brace against the female's rigid and sometimes structurally complex genitalia, or to brace other male sclerites so as to facilitate contact with the female (Eberhard & Huber 1998a). These are functions that are relatively easily determined directly from morphology. It appears that the male genitalia of spiders are seldom used to physically seize the female or directly stimulate her; these are probably common functions of the genitalia of some major groups of insects (Eberhard 2004).

Possibly as a consequence of the lack of neurons in the male palpal bulb that might provide feedback between palps and behavior, male spiders which have lost the entire palp or the intromittent organ (embolus) nevertheless court females and go through normal movements of copulation (Rovner 1966, 1967; Snow & Andrade in press). This makes it possible to experimentally separate the responses of the female that are triggered by stimulation from the male's genitalia and their products from her responses to all the other stimuli normally associated with copulation (pre-copulation courtship, copulatory courtship). Possible behavioral responses of female (e.g., her receptivity to further copulations, willingness to oviposit, clutch size, etc.) that have been "mated" by a modified male can be compared with those of females mated with intact males. To my knowledge this exciting possibility has only been exploited in two species, and only with respect to a single female response. Aisenberg et al. (2002) found that in the lycosid *Schizocosa malitiosa* Tullgren 1905, a recently mated female's lack of receptivity to further copulation is apparently due to the semen itself, rather than to the elaborate male courtship before and during copulation. First they sealed the tip of the male's pedipalp soon after he molted to maturity, and thus prevented uptake of semen. These males nevertheless performed apparently normal courtship and copulation behavior (although it is possible that details may not have been identical—see Costa 1998). When a female mated with a male that could not transfer semen, she was much more likely to remate than were control females that had received semen from normal males. Rovner (1966) obtained apparently normal tendencies to court in palpless males of the lycosid *Rabidosa rabida* (Walckenaer 1837), and saw at least approximately normal copulation behavior by palpless males of the linyphiid *Linyphia triangularis* (Clerck 1757); females of this species that had not received semen were more receptive than normally mated females. The conclusion from both studies is that seminal products, either the sperm itself or other products, or perhaps stimuli associated with normal intromission, lower female sexual receptivity. Similar prevention of sperm uptake (by the simpler and more powerful technique of removing the sperm droplet from his sperm web, which leaves the male's genitalia unaltered) showed that male products in the last of the several droplets which male *Theridion* take up during sperm induction were crucial to the formation of the mating plug, and also affected the male's own copulation behavior (Knoflach 1998).

The design of the female reproductive tract in many species also facilitates study. The external female genitalia are often rigid (the epigynum), as are her spermathecae and their ducts, so they offer the advantage that their forms are readily accessible for study. These traits help make comparative functional morphology and detailed studies of stages in the rapid divergent evolution of genitalia particularly feasible in spiders. The long-standing tradition in taxonomic studies of using both male and female genitalia means that there is already a huge data base on both male and female designs in closely related species. With a detailed understanding of the mesh between male and female structures in chosen species, and the phylogenetic relations within a particular group, it should be possible to trace in fine detail both how and why male and female genitalic traits have co-evolved. Even though in some groups it may be necessary to carefully examine females for cryptic complexity (Uhl & Gunnarsson 2001), tracing coevolution would be especially interesting if it were combined with studies of intraspecific variation in different male and female structures (a type of data not traditionally emphasized in taxonomic studies). Comparisons would be of even greater interest if this type of study were

coupled with attempts to correlate intraspecific variation in genital morphology with different variables that could affect copulatory success such as paternity success, female delay to oviposition, female receptivity to remating, or female attractivity to males (pheromone production). Have new male forms led to the evolution of new female forms, or vice versa? If new male forms take the lead (as expected under traditional female choice hypotheses), what are their original consequences during copulation? Have novel male forms evolved to overcome species-specific female defensive structures, as supposed by the currently popular sexually antagonistic coevolution hypothesis (Chapman et al. 2003)?

Spider genitalia are readily visible during copulation, in contrast with those of many other animals. Because many spiders hang upside down in their webs, male and female genitalia can be observed in great detail when copulating pairs are placed under a dissecting microscope (use of a mirror also allows detailed observations of species without webs). Much of the movement of the male's genitalia is observable because it occurs outside the female. The new generation of digital video cameras makes it possible to film behavior easily through a microscope, by simply holding the camera to the eyepiece and shooting. Males of different species perform quite different genitalic behavior, including groping and hammering against the female, rhythmic expansions of haematodochae, twisting, and vibrating or quivering, and repeated insertions and withdrawals of their intromittent structures (Huber 1998). To date, nearly all descriptions are only qualitative (for an exception, see Schäfer & Uhl 2002), and the few available detailed comparative analyses show that genitalic behavior is sometimes complex and species-specific (Rovner 1973, 1974; Stratton et al. 1996; Knoflach 1998). This behavior probably offers useful characters for distinguishing closely related species in some groups. Although the behavior of spiders' genitalia is relatively easy to study, research on this topic has only barely begun.

In spiders, the male's sperm are normally encapsulated when they are transferred to the female. This trait represents an advantage for study of sperm transfer, because it means that any movements within the male or the female can be confidently attributed to male and female effects, and the possibility of sperm mobility can be ignored. In the araneid *Micrathena gracilis* (Walckenaer 1805), copulation involves two separate processes, sperm release and sperm storage (Bukowski & Christenson 1997a). In groups such as *Latrodectus*, in which the male's genitalia can reach the spermatheca, it may mean that even a plug that only partially occludes the insemination duct (enough to detain a subsequent male's intromission) can nevertheless be effective in biasing paternity (Snow & Andrade pers. comm.). Sperm encapsulation may also make sperm precedence studies using irradiated males more useful in understanding natural processes, since sperm mobility is not important, at least in these early stages. The complete lack of disadvantage of sperm from irradiated males in competition with non-irradiated sperm in the pholcid *Physocyclus globosus* Taczanowski 1873 (Eberhard et al. 1993; Peretti pers. comm.) and the theridiid *Latrodectus hasselti* Thorell 1870 (Snow & Andrade pers. comm.) supports this idea. In *L. hasselti*, irradiated sperm were just as competitive in fertilizing the eggs in the female's fourth clutch following copulation as those in her first clutch (Snow & Andrade in press). At least in *Pholcus phalangioides* Fuesslin 1775, sperm activation may occur only shortly before oviposition (G. Uhl pers. comm.).

The paired nature of both male and female genitalia and the alternating use of sides allow one to use the same animal to assume the roles of experimental subject and control in the same experiment. If, for example, one modifies one of the male's palps and then checks insemination success or plug removal success, the other intact palp can serve as an unusually sophisticated control, in which all other variables (male precopulatory and copulatory courtship, male and female size, duration of pairing, etc.) are equal for both experimental and control treatments. This should make studies of experimental modifications of male and female genitalic form unusually powerful and sensitive in spiders, compared with most other animals. The conclusions would be especially interesting if the behavior of the intact palp is not affected (an interesting topic in itself). I know of only one study that has used this experimental design. In the tetragnathid *Leucauge mariana* Keyserling 1881, the effects on insemination and copulatory

plug removal are being tested by cutting off the tips of either the conductor hook, or both the hook and the conductor tip on one palp, but leaving them intact in the other (Mendez & Eberhard unpub. data). The male was then allowed to mate with either a female which had a copulatory plug in her epigynum from a previous mating, or a virgin female. Preliminary data indicate that the conductor hook is important in both plug removal and sperm transfer, while the conductor tip improves insemination. Snow & Andrade (in press, pers.comm.) exploited the female's bilateral design and interruptions of first copulations after only one side was inseminated in *Latrodectus hasselti* to determine the effects of possible plugs and of sperm in different spermathecae on paternity. They also showed that the tip of the embolus functions to facilitate intromission. Watson (1991) mentioned possible palpal damage due to use in the linyphiid *Neriene litigiosa* Keyserling 1886, but gave neither morphological details nor observations on the consequences. Clearly much further work could be done in this area; manipulative studies would be especially feasible with larger species, and with species in which the male intromits only once into each side of the female.

Other manipulations could also illuminate the dynamics of utilization of sperm from different spermathecae, by allowing one male to inseminate one side of the female, and another to inseminate the other, and then checking the paternity of the offspring. Do the contents of the paired spermathecae move simultaneously and in equal numbers into the oviduct for fertilization? Do spiders' multiple sperm storage organs result in biased use of sperm from different males, as has been hypothesized (Hellreigel & Ward 1998; Simmons 2001)? To my knowledge this experiment has been done with only one spider, *Latrodectus hasselti*. When each spermatheca contained sperm from a different male, the paternity success of the two males did not change from the female's first to fourth clutch, suggesting similar use of sperm from the two sides with each clutch (Snow & Andrade in press). When each male inseminated the same side of the female, sperm from the first male were more likely to fertilize her eggs than when each copulated with a different side (Snow & Andrade in press). Because females of this species sometimes allow a male to inseminate only one side (12.5% of observed copulations), this means that females can affect male paternity success. Males also play active roles in this species, as they show a strong tendency to inseminate the side of the female not inseminated by a previous male (Snow & Andrade in press).

Austad (1984) noted that the internal morphology of the female reproductive tract may have an influence on sperm precedence patterns when a female mates with more than one male, and may thus result in a female-determined "passive preference" (Wiley & Posten 1996) for males with certain traits. Austad contrasted groups in which there is a single duct associated with each spermatheca and in which the sperm of the last male to mate may be better placed (closer to the exit of the spermatheca) to fertilize eggs; and groups with two spermathecal ducts, in which the first male's sperm may be better positioned (near the fertilization duct). In particular, a strong first male paternity advantage of species in the second group could explain the striking and otherwise puzzling tendency for males of in many species of spiders to seek out sexually immature, penultimate instar females in preference to mature females (Jackson 1986; Eberhard et al. 1993). Some additional studies of sperm precedence and male behavior have found further cases of first male precedence in species with both insemination and fertilization ducts (Bukowski & Christenson 1997a; Snow & Andrade in press). There are also exceptions to this and several researchers have noted intermediate morphologies in some species (Uhl & Vollrath 1998; Elgar 1998; Uhl 2002). It is nevertheless possible that there may prove to be general trends. Many details, including sperm mixing (and lack of mixing) in the female, and the effects of intermediate spermatheca designs remain to be determined for many species (Elgar 1998).

Fertilization in at least one theridiid species does not occur near the mouth of the duct from the spermatheca, as often assumed, but farther up the oviduct (Suzuki 1995), and this could affect sperm usage patterns. Fertilization near the mouth of the fertilization duct apparently occurs during or just after oviposition in a different species of the same family (Berendonck & Greven in press), and also in two other families (Linyphiidae, Pholcidae),

(Uhl & Gunnarsson 2001; G. Uhl pers. comm.). These possible differences add another level of complexity in determination of paternity. The degree of sperm mixing in storage can be easily determined in species with multiple clutches by checking whether paternity values change in different clutches (lack of change would indicate complete mixing). The erratic changes in sperm precedence in successive clutches of the pholcid *Pholcus phalangioides* (Uhl 1992) strongly suggest sperm clumping rather than mixing. These spiders are unusual in storing sperm in an outpouching of the oviduct (the "bursa") rather than in discrete spermathecae (Uhl 1992), and the sperm remain encapsulated and embedded in a female secretion, details that suggest clumping. In *Latrodactus hasselti*, in contrast, lack of changes in paternity in successive clutches strongly suggests sperm mixing (Snow & Andrade in press). Decapsulation of sperm soon after copulation in *Nephila clavipes* (Linnaeus 1767) (Brown 1985) and *Leucauge mariana* (Taczanowski 1881) (Eberhard & Huber 1998b) also suggests the possibility of sperm mixing. Further studies of sperm precedence patterns in successive clutches in species with different spermathecal designs, and with different timing of decapsulation would be of great interest.

Isolation of semen.—Male spiders deposit a droplet of semen from their primary gonopore on a small silk web, and then take up the semen in their pedipalps. This means that, in contrast with other animals, obtaining precise counts of sperm at this stage is unusually simple in spiders (just place the droplet on a slide, dilute it and count). If the male removes all sperm from the web, as seems to be common, and if his palps are empty after a copulation, as is true in at least some species such as *Nephila clavipes* (Christenson 1990) (but not in others such as *Anyphaena accentuata* (Walckenaer 1802) (Huber 1995b), and *Lycosa malitiosa* Tullgren 1905 (Costa 1998); then sperm counts in semen droplets may give unusually precise estimates of ejaculate size. Clearly, this will need to be checked in other species. Do males modulate ejaculate size according to male or female size, to previous sexual experience of the male or female, or according to the likelihood that the female will remate, as occurs in some other groups (e.g., Gage 1995)? Do ejaculate sizes often vary among related species, as seems to be the case in some species of *Theridion* (Knoflach 1998)? If so, then why? Does the fraction of the ejaculate that is stored by the female vary according to differences between males? There is an entirely unexplored field of study, comparative ejaculate sizes and usage, for which spiders are ideal subjects.

A further possible type of experiment, in which seminal products are injected directly into the female, has apparently never been attempted in a spider. Such experiments have been performed with many species of insects and ticks using relatively crude techniques such as injecting or implanting entire glands or their extracts into females. Deductions from similar experiments with spiders should be much more convincing, because they can be done without any contamination of the male's seminal products. Such experiments in spiders will presumably also permit separation of the possible physiological effects on the female of seminal substances that reach her body cavity from the possible effects of sperm in her storage organs (unless injected sperm are able to migrate through her body to the spermathecae). They could thus contribute to answering questions regarding the possibility that spider seminal substances affect sperm usage by the female (e.g., Snow & Andrade 2004). The high frequency with which seminal products have been found to influence female remating and oviposition rates in insects and ticks (Chen 1984; Eberhard 1996; Simmons 2001) makes experiments of this sort with spiders especially promising.

Function of males feeding females during copulation.—Male feeding of the female during copulation has arisen in several families, including Linyphiidae, Theridiidae, Pholcidae, and Pisauridae (summaries in Lopez 1987; Elgar 1998; Vanacker et al. 2003), and is associated in some groups with elaborate male morphology (Lopez 1987). In at least some species, the small amounts of material transferred by the male suggest that the male gains from influencing cryptic female choice, rather than from benefiting the female nutritionally (Elgar 1998), a trend also found in the seminal products of many insect groups (Vahed 1998). Experimental manipulation of the male's ability to transfer material to the female (for example, by sealing the openings of the ducts on his cephalothorax, or altering the amount that

he can transfer by manipulating his previous copulatory history) should be especially easy in the spiders which transfer small amounts (e.g., *Argyrodes* spp.); to my knowledge this has never been attempted.

Function of copulatory plugs.—Masses of material (copulatory plugs) at or near the entrance of the insemination ducts are probably very common in spiders (Jackson 1980; Suhm et al. 1996). In some species, the material is apparently deposited entirely by the male, as in the salticid *Phidippus johnsoni* Peckham & Peckham 1883 (Jackson 1980), the agelenid *Agelena limbata* Thorell 1897(Masumoto 1993), and the linyphiid *Dubiarana* sp. (Eberhard 1996). In some others the plug is a combination of male and female products, as in the theridiid *Theridion varians* Hahn 1833 (Knoflach 1998) and some plugs of the tetragnathid *Leucauge mariana* (Mendez 2002). In still others it is apparently produced only by the female (some plugs of *L. mariana* Mendez 2002). Male copulatory plug material comes from glands in his abdomen (Knoflach 1998), his palps (Suhm et al. 1996), or his mouthparts (Braun 1963), and is sometimes composed of more than one type of material (Suhm et al. 1996).

Some copulatory plugs clearly impede subsequent attempts at intromission (Masumoto 1993; Knoflach 1998; Mendez 2002). But females can influence the effectiveness of a plug in preventing intromission in at least three different ways. In *Theridion* spp. and *L. mariana* female products are necessary for the formation of a functional plug (Knoflach 1998; Eberhard & Huber 1998b; Mendez 2002). In *L. mariana* the female sometimes (often, when she is young) fails to add her part, causing the male's attempts to form a plug to fail. Female *L. mariana* also sometimes physically impede a male's attempt to remove a plug by pushing his palp away from the epigynum with her legs. To my knowledge, no one has ever checked for possible differences between males which might correlate with such female decisions to facilitate or impede plug deposition or removal.

A more subtle way in which the female's own morphology can influence whether a plug is effective was illustrated in *A. limbata* by Masumoto (1993). The epigynum of this species has a cavity (the atrium) where both insemination ducts open. When a male mates, he first inseminates the female, then deposits a brown liquid in her atrium which soon hardens into a plug. Some plugs fill the atrium and cover the openings of both insemination ducts completely ("complete plugs"); others cover only a portion of the atrium ("incomplete plugs"). Incomplete plugs were common (38% of 50 lab matings involving virgin males and females). Smaller males more often made incomplete plugs, and when the ratio of male's size compared with that of the female was larger, complete plugs were more frequent. After depositing a plug, males in the field usually left the female within a day, presumably to search for other mates.

If a second male *A. limbata* subsequently attempted to mate with a plugged female, he first used his palp in attempts to hook the plug and remove it. Complete plugs were not removable, but incomplete plugs were often dislodged (11 of 15), in which case the male then inseminated the female and deposited a plug of his own. In these pairs, the second male fertilized on average 62.9% of the female's eggs. Masumoto concluded that the design of the female's epigynum (and in particular, of the atrium) enables her to bias the fertilization of her eggs in favor of larger males. If the atria of larger females are larger (this has never, to my knowledge, been investigated), the effects of this bias on male reproduction could be magnified because larger spider females tend to lay a larger numbers of eggs (e.g. Turnbull 1973).

While copulatory plugs in some species thus appear to function in sperm competition and cryptic female choice, important mysteries still remain. Some plugs in spiders are deep within the female (A. Danielson-François pers. comm. on *Tetragnatha*) and so large that they appear difficult to remove, but others do not impede intromission by subsequent males (e.g., *Phidippus johnsoni* (Jackson 1980)). Some especially flimsy plugs are apparently produced by the female, not the male in *L. marina* (Mendez 2002). Perhaps plug material is produced by the spermathecal glands, which are widespread, and which vary in number, location, and cell types; their function or functions need further study (Danielson-François 2002; Uhl & Gunnarsson 2001). Experimental removal of a plug in *L. mariana* is sometimes immediately followed by the female exuding a liquid from inside the insem-

ination ducts; a crust quickly hardens into a thin, weak, scab-like plug on the surface, and the liquid is then withdrawn (W. Eberhard, unpub. data). Todd Bukowski (pers.comm.) has proposed the intriguing idea that some plugs may function to prevent genitalic infections in females; another possibility is avoidance of desiccation (Huber 1995a). Both these ideas fit with the unusual genitalic design of many spiders, in which the openings of the female insemination ducts are embedded in a rigid sclerite (the epigynum), and are thus, unless plugged, permanently open and exposed externally. Predictions of both the infection and desiccation hypotheses that could be easily checked are that plugs should be more common in species with shorter, more direct insemination ducts, relatively larger entrances, or (in the case of desiccation avoidance) that live in drier habitats.

Breakage of the male genitalia within the female occurs in several groups of spiders, and in some cases male sclerites have distinct lines of weakness and seem clearly designed to break. In some araneoids the morphology of the male structure (part of the embolus) suggests that it acts as a plug that probably prevents subsequent intromissions (Levi 1972, 1975 on the araneid genera *Araneus* and *Singa*; Knoflach & van Harten 2002; Berendonck & Greven in press on the theridiid genus *Latrodectus*). However, direct observations of mating and determination of paternity showed that in another species, *Nephila plumipes* (Latreille 1804), the broken male structure (the conductor tip) did not preclude subsequent inseminations (Schneider et al. 2001), and multiple embolus tips in some other *Latrodectus* females also testify to both multiple intromissions and multiple penetrations reaching the spermathecae (Abalos & Baez 1966; Knoflach & van Harten 2002; summary of evidence Uhl 2002). Some female *Latrodectus* may control breakage using a muscle attached to the copulatory duct (Berendonck & Greven in press), although further work is needed to clarify this point (B. Berendonck pers. comm.). Experimental manipulation of male palps in *Latrodectus hasselti* showed that breaking off the embolus tip prior to copulation did not reduce the male's ability to transfer sperm, but breakage within the female did reduce access of subsequent males to her spermathecae (Snow & Andrade pers. comm.). The suggestion is that in other species of this genus in which the male is not sterile after his first mating (as occurs in *L. hasselti*) breakage does not entail elimination of insemination ability. Perhaps broken embolus tips serve as partially effective plugs that only sometimes exclude subsequent males in this genus. Perhaps their incomplete effectiveness is due to male inability to always leave the tip in the most effective site within the female, or variation in the success of subsequent males to overcome this barrier (possible consequences of the lack of innervation of male genitalia?). The significance of palpal breakage in *N. plumipes*, which may occur only if the female performs certain types of rejection behavior, is not yet clear (Schneider et al. 2000).

Progress in techniques.—Recent advances in techniques also contribute to making spiders an attractive group for future studies. Technical problems with counting sperm should be substantially reduced by the techniques recently worked out by G. Uhl (pers. comm.), and Bukowski & Christenson (1997a). It is possible to stain the sperm in a plug while leaving the rest of the plug nearly transparent, using the nuclear stain acetocarmine (Mendez 2002). Another technical problem—combining freeze-fixed specimens with embedding and sectioning of strongly sclerotized genitalia—has been solved by Huber (1993). Huber's discoveries have also laid to rest the mistaken idea that one can understand the functional relations of pedipalpal sclerites by using another technique, simply expanding the male's pedipalp in isolation from the female.

Further mysteries and suggestions for future studies.—One phenomenon which seems simple on the surface but becomes more difficult to understand on closer examination is sperm "dumping" by the female. Sperm masses often emerge from females of the pholcids *P. phalangioides* and *P. globosus* during or immediately following copulation (Uhl et al. 1995; Huber & Eberhard 1997; Peretti unpubl. data). In *P. globosus* sperm masses sometimes emerge during copulation when the female has not mated previously. The mystery is that size and presence of dumping seems to have no effect on paternity patterns when the female is mated to two males, at least in *P. globosus* (Peretti unpubl. data). Perhaps sometimes the first male's sperm are emitted, and

perhaps sometimes it those of the second male. Sperm are also emitted immediately following copulation in the distantly related *Pachygnatha clerki* Sundevall 1823. (Tetragnathidae), and are then eaten by the female (Gerhardt 1923). The structure of the female genitalia of the oonopid *Opopaea fosuma* Burger 2002 also suggests the possibility of sperm dumping (Burger et al. 2003). Careful observation of other species to check for sperm dumping, and the circumstances in which it occurs (male smaller, less elaborate courtship, more female resistance, etc.) is likely to be interesting.

Another recently discovered and even more mysterious trait is the correlation in the linyphiid *Pityohyphantes phrygianus* (C.L. Koch 1836) between the angle at which a female rests with respect to gravity and the sex ratio in her offspring (Gunnarsson & Andersson 1996; Uhl & Gunnarsson 2001; Gunnarasson et al. 2004) . The mechanism by which this is accomplished in this species may be related to the extraordinarily complex female sperm storage organs, which have three chambers and three valves on each side, and different types of gland cells associated with different chambers. The reproductive significance for this species of biasing sex ratios in nature is not clear.

One vast area of study which is as yet nearly completely unexplored in spiders (as well as in other animals) concerns the effects of male copulatory courtship on the female. Copulatory courtship behavior is quite common in spiders (Eberhard 1994; Huber 1998), but its effects have hardly been studied (but see Schäfer & Uhl 2002). I predict that observation of pairs in which male copulatory courtship varies (or can be altered experimentally), combined with measurements of female reproductive responses such as numbers of sperm transferred to storage sites, fertilization of eggs by different males, numbers of eggs laid, rapidity with which eggs are laid, and readiness to mate with an additional male, will yield further insights. Manipulations of males so as to change their morphological and behavioral abilities to perform different types of copulatory courtship could be especially useful in this context. The apparently widespread nature of copulatory courtship among spiders suggests that there will be a variety of results of such studies.

A fascinating recent discovery by Alfredo Peretti (pers. comm.) of active female participation in copulatory courtship opens still further major research questions. Females of *Physocyslus globosus* (Pholcidae) respond to powerful rhythmic squeezes by the male's palps by stridulating, rubbing ridges on their pedipalps across stridulatory files on their chelicerae. Females produce bursts of squeaky sounds that can be made audible when a microphone is held nearby. Female squeaking occurs more frequently when the male is squeezing her tightly with his powerful palps, and the male appears to relax his squeeze more quickly when she squeaks, so the female message may be "Ouch, stop that!" Males that were more "obedient", and responded more consistently by relaxing their squeezes when the female squeaked obtained more offspring than less obedient males that mated with the same females. Female stridulatory structures are widespread in some pholcid taxa (B. Huber, pers. comm.), so copulatory dialogues of this sort may be widespread in this family.

Does copulatory communication of this sort occur in other families? In the araneid *Micrathena gracilis*, the female strokes the male on his venter with her legs I and II, apparently to induce him to flip his body over to assume the venter to venter copulation position (Bukowski & Christenson 1997b). Female movements also occur during copulation in species in other groups, such as *Leucauge mariana* (W. Eberhard, unpubl. data), but it is not clear whether they are communicatory in function. As a general rule, female behavior during copulation is very poorly studied (Peretti pers. comm.), and the field is wide open.

Conclusion.—In conclusion, spider sexual biology is of special interest for documenting phenomena related to sperm competition and cryptic female choice. Several properties of spiders make experimental manipulations especially feasible and powerful. Several mysteries have already been discovered, and there are literally thousands of species in different major taxonomic groups whose sexual behavior is almost completely unknown. The opportunities for future studies are legion.

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Figures 1-4.— *A-us x-us*, male from Timbuktu: 1. Left leg; 2. Right chelicera; 3. Dorsal aspect of genitalia; 4. Ventral aspect of abdomen.

Figures 27-34.—Right chelicerae of species of *A-us* from Timbuktu: 27, 29, 31, 33. Dorsal views; 28, 30, 32, 34. Prolateral views of moveable finger; 27, 28. *A-us x-us*, holotype male; 33, 34. *A-us y-us*, male. Scale = 1.0 mm.

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