Pacific Insects 15 (1): 163-180 20 May 1973

THE CAVERNICOLOUS FAUNA OF HAWAIIAN LAVA TUBES, 3. ARANEAE (Spiders)[1]

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Abstract: This paper is a systematic report and analysis of an important collection of spiders from Hawaiian caves. Of the 20 species represented, 11 are introduced taxa as follows: eight cosmopolitan and tropicopolitan species mostly from the Eastern Hemisphere; one species (*Corinna cetrata* Simon) thought to be Polynesian; one species (*Nesticus mogera* Yaginuma) from the Japanese Islands; and one species (*Nesticus pallidus* Emerton) from North America. A species of uncertain status and two based on immature material are held for future consideration. The remaining six species are eyeless or have the eyes reduced to vestiges, are classified as obligative cavernicoles (troglobites) exclusive to Hawaiian caves, and descriptions and illustrations of five of these are presented. Most important are two new wolf spiders (Lycosidae), one with vestigial eyes and the other a completely eyeless species of this family of big-eyed hunting spiders.

Introduction

Although the spider fauna of the Hawaiian Islands is still imperfectly known, some generalizations can be made of its composition and origins. It is a relatively small fauna of ancient and recent immigrants that by various means managed to reach the islands from remote peripheral land areas, and this invasion is still continuing. Most interesting are older arrivals that early reached and spread through the islands to produce the unique elements we call endemic. Well established immigrants are species called cosmopolitan or tropicopolitan, which now monopolize habitats around buildings and in disturbed areas. Many recent immigrants have been derived from Oriental sources but, not surprisingly, many more now come from the Americas. At least 14 species are common elements in the United States. In 1900 Simon claimed endemism for the 71 of the 101 species then available to him; in 1964 Suman concluded that only 55 % of the 150 species were endemic. This recent and continuing invasion poses great difficulty to the arachnologist who cannot exclude from consideration any fauna no matter how remote in his efforts to properly name the Hawaiian taxa.

The presence in the Hawaiian Islands of an important fauna of cavernicoles was recently reported by F. G. Howarth (1972) of the Bishop Museum in Honolulu, to whom I am indebted for this opportunity to study the spiders. Any cave fauna consists of local surface forms that penetrate the recesses to varying distances and, sometimes, cave adapted elements that can survive only in such restrictive habitats. So far 20 spider

1. Contribution No. 18, ISLAND ECOSYSTEMS IRP/IBP HAWAII, National Science Foundation grant no. GB 23075.

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species have been collected from caves on several of the Hawaiian islands. Two of these are rejected for analysis because of immaturity and a species of *Meioneta* is at present of uncertain status. Of the remaining 17 species, 11 are known to have been brought into the islands by trade or other means. Most of these are now common species around the world and were derived from the Eastern Hemisphere. The 2 nesticids come from the Japanese Islands (*Nesticus mogera* Yaginuma) and from North America (*Nesticus pallidus* Emerton). The remaining 6 species are exclusive to Hawaiian caves and are classified as troglobites. Four of these are completely eyeless and 2 have the eyes reduced to vestiges. The 2 eyeless linyphiids belong to genera heretofore without blind representatives. Most interesting of all are 2 wolf spiders (Lycosidae) representing a family of normally big-eyed hunting types that put prime reliance on sight. One of these has its eyes reduced to vestiges and the other, completely eyeless, has strangely modified its body shape and other features far from the norm of its family. All the holotypes and most of the material on which this paper is based are deposited in the Bernice P. Bishop Museum, Honolulu, Hawaii.

Order ARANEAE

Suborder Araneomorphae

Family Dysderidae

Dysdera crocata Koch

Dysdera crocata Koch, 1839: 81. — Simon, 1900: 444. — Fage, 1931: 134. — Suman, 1964: 669.

DISTRIBUTION: A species of Mediterranean region origin, now widely distributed in the world, nearly cosmopolitan; introduced into Hawaiian Islands.

Cave Records: KAUAI: Koloa: Knudsen Cave # 2, 45 m, 23.VI.1972, 3 ♂♂, 1 ♀, 2 immatures from dark zone under rocks on dry floor. Koloa Cave # 1, 39 m, 24.VI. 1972, 1 immature; Koloa Cave # 2, 37 m, 24.VI.1972, fragments of ♀, food of *Adelocosa anops;* Koloa Cave # 3, 25 m, 24.VI.1972, ♀, immature, all F. G. Howarth, W. C. Gagné.

Family Oonopidae

The oonopids are small spiders that shun the light and mostly live underneath stones or in ground detritus. An eyeless species from a cave in Yucatan, Mexico, *Wanops coecus* Chamberlin & Ivie, is thought to be a troglobite. Other eyeless species, presumed to be edaphobites, have been found in termite galleries in Africa and in ground detritus in Mexico and the West Indies. The presence of an eyeless species in a Hawaiian cave is a notable record. Unfortunately, the only specimen so far found is immature and not assignable to genus. The family Oonopidae is represented in the Hawaiian Islands by 8 well marked species assigned to 6 genera (Suman, 1965) and previous records for the islands are so incomplete that they properly have been discarded. All of these are thought to be endemic species and, until information to the contrary is available, the blind species recorded below is also presumed to be endemic.

Oonops (?) species

Cave Record: HAWAII: Volcano: Hongo Store Cave, 1130 m, 3.X.1971, F. G. Howarth,

J. Jacobii ; 1 immature of uncertain sex without trace of eyes, presumed to be a troglobite.

Family Scytodidae

Scytodes longipes Lucas

Scytodes longipes Lucas, 1844: 72. — Suman, 1964: 675.
Scytodes marmorata: Simon, 1900: 444.

DISTRIBUTION: Widespread, tropicopolitan species common in both hemispheres, introduced into Hawaiian Islands. Often found around and on buildings and in cave entrances.

Cave Records: HAWAII: Kaumana Cave, Kaumana, 290 m, 2.X.1971, F. G. Howarth, 2 ♂♂ from 180 m in dark zone on tree roots. OAHU: Burial Cave # 1, Niu Valley, 33 m, 17.VII.1971, F. G. Howarth, F. Stone, 1 immature at end of cave. KAUAI: Koloa Cave # 3, 25 m, Koloa, 24.VI.1972, F. G. Howarth, W. C. Gagné, 1 ♂.

Family Ochyroceratidae

This family of minute, lucifugous spiders is found only in tropical and subtropical regions. Most species live in deep ground detritus and a few have been reported from caves. An essentially blind species from a cave in Jamaica may be a troglobite and the species described below, the first record of the family in the Hawaiian Islands, may also belong in this category.

Theotima makua Gertsch, new species Fig. 1–3.

Diagnosis: Essentially blind troglobite similar to *Theotima microphthalma* Simon from caves in Luzon, Philippine Islands, distinguished by following features: eye group without trace of dark pigment, occupying half width of head, all eyes subequal in size, subcontiguous, in recurved row; legs longer, with comparison of fourth leg lengths 1.88 mm/1.7 mm.

Etymology: Named for Makua Cave, used in apposition with feminine generic name.

Female: Total length, 1.1 mm.

	Carapace	Sternum	Labium	Endite	Abdomen
Length	0.46	0.30	0.05	0.14	0.62
Width	0.34	0.28	0.10	0.07	0.45

Coloration: Cephalothorax and appendages whitish with faint yellow tinge; abdomen whitish.

Structure: Carapace longer than broad, suboval; pars cephalica narrowed at eyes, equal to about 3/4 carapace width. Eyes evanescent, faintly visible as silvery flecks, with anterior median eyes about their diameter from indistinct lateral eyes. Clypeus 2/3 as high as eye group. Chelicerae parallel; promargin with series of 6 or 7 contiguous dark teeth; retromargin without evident denticles.

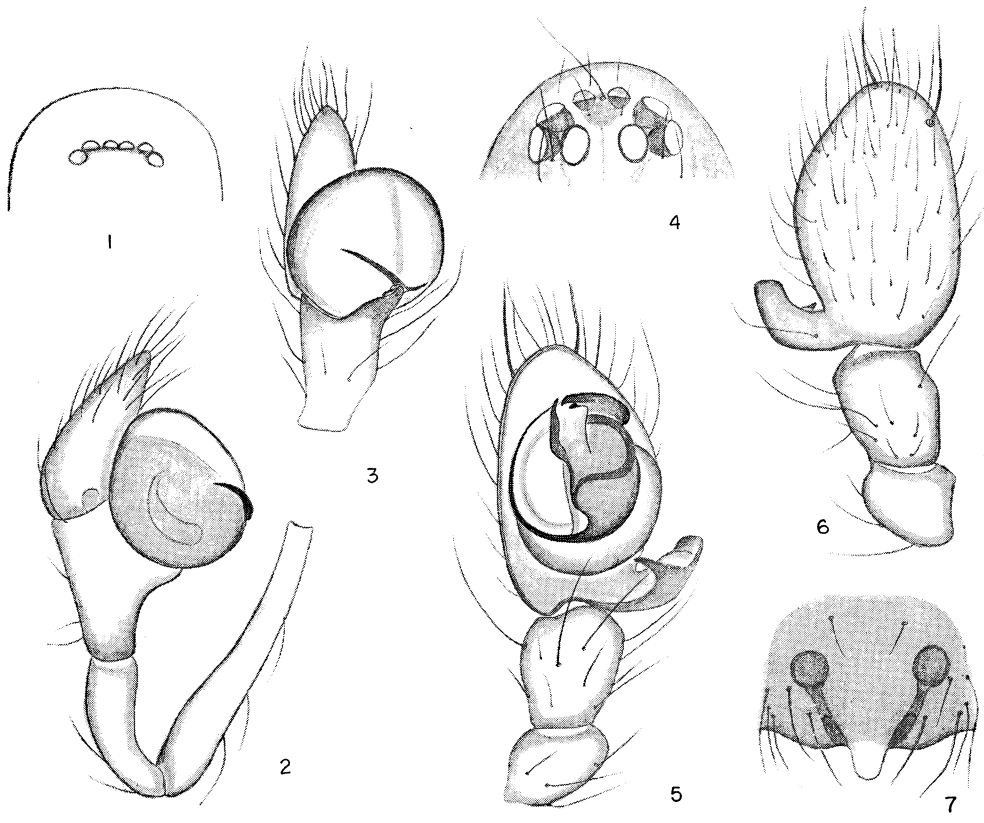

Fig. 1-7. *Theotima makua*, n. sp., ♂: 1, eyes, dorsal view; 2, left male palpus, prolateral view; 3, left male palpus, subventral view of tibia and tarsus. Fig. 4-7. *Nesticus mogera* Yaginuma: 4, eyes of ♀, dorsal view; 5, left male palpus, ventral view; 6, left male palpus, dorsal view; 7, epigynum, ventral view.

	I	II	III	IV	Palp
Femur	0. 52	0. 46	0. 42	0. 55	0. 15
Patella	0. 12	0. 11	0. 10	0. 11	0. 06
Tibia	0. 50	0. 46	0. 34	0. 52	0. 11
Metatarsus	0. 32	0. 31	0. 24	0. 42	—
Tarsus	0. 26	0. 24	0. 21	0. 28	0. 11
Total	1. 72	1. 58	1. 31	1. 88	0. 42

Leg formula 4123. First leg 3.7 times, fourth leg 4 times and first femur slightly longer than carapace. Tarsus and metatarsus of fourth leg longer than tibia and patella. Femur and patella of palpus slightly shorter than tibia and tarsus.

Abdomen probably suboval and about as high as wide, now mutilated. Receptacles of epigynum median in position but position of tubules and lateral openings uncertain.

Male holotype: Total length, 1.1 mm.

	Carapace	Sternum	Labium	Endite	Abdomen
Length	0.46	0.30	0.05	0.14	0.60
Width	0.36	0.30	0.10	0.07	0.42

Coloration and structure like those of ♀ except as noted. Anterior eye row straight as seen from in front, weakly recurved from above; eyes of anterior row subequal, contiguous; posterior lateral equal to and contiguous with anterior lateral eyes. Eyes as shown in fig. 1.

	I	II	III	IV	Palp
Femur	0.56	0.52	0.40	0.60	0.32
Patella	0.14	0.12	0.13	0.15	0.13
Tibia	0.53	0.43	0.40	0.57	0.14
Metatarsus	0.37	0.35	0.32	0.46	—
Tarsus	0.25	0.26	0.25	0.30	0.17
Total	1.85	1.68	1.50	2.08	0.76

Male palpus (fig. 2-3) typical of genus; tarsal process bearing at end asymmetrically T-shaped spur; femur slightly incrassated near base.

Type Data: ♂ holotype (BISHOP 9876), and ♀ allotype from Makua Cave, OAHU, 5 m, 21.X.1971, F. G. Howarth, from damp wall in deep twilight.

DISTRIBUTION: Caves of Oahu and Kauai.

Other Records: KAUAI: Koloa: Knudsen Cave # 1, 45 m, 23.VI.1972, F. G. Howarth, W. C. Gagné, ♂. Koloa Cave # 1, 39 m, 24.VI.1972, F. G. Howarth, W. C. Gagné, 2 ♀♀.

Family Pholcidae

The family Pholcidae seems not to be represented in the Hawaiian Islands by endemic species but 5 well known species, most credited with being tropicopolitan or cosmopolitan, have been acquired by introduction. Cave pholcids were infrequently mentioned in the world literature until recent work on the Mexican fauna revealed numerous troglobites and troglophiles in the extensive cave systems of that country.

Smeringopus elongatus (Vinson)

Pholcus elongatus Vinson, 1863: 135.
Smeringopus elongatus: Simon, 1900: 446. — Suman, 1964: 673.

DISTRIBUTION: Widespread, tropicopolitan species; introduced into Hawaiian Islands.

Cave Records: OAHU: Burial Cave # 1, Niu Valley, 33 m, 17.VII.1971, F. G. Howarth, F. Stone, immature ♀ in end room. KAUAI: Koloa: Koloa Cave # 3, 25 m, 24.VI. 1972, F. G. Howarth, W. C. Gagné, ♀, 4 immature. Knudsen Cave # 2, 45 m. 23.VI. 1972, F. G. Howarth, W. C. Gagné, 1 immature from dark zone under rock on dry floor.

Family Nesticidae

A high percentage of nesticids live in caves, mines, cellars, and dark epigean situa-

tions, and many from cave habitats are to varying degrees cave adapted types. Two obviously introduced species are now known from the Hawaiian Islands, where they live inside caves as troglophiles and in suitable outside stations. The first of these is *Nesticus pallidus* Emerton (given separate generic recognition by some as *Eidmanella pallida*) which is widespread in the Americas and has been introduced into such relatively remote areas as the British Isles. The first Hawaiian record (Oahu: Kawaihapai, on the north base of the Waianae Range) was identified by me many years ago (see Suman 1964: 671, family Linyphiidae) and was presumed to be an introduction from the United States. The present collection contains cave records of *pallidus* from the island of Kauai. The second species, *Nesticus mogera* Yaginuma, is widespread in the Japanese Islands, where it is said to be commonest under dead leaves or in burrows of moles, and not too often found in caves. Hawaiian examples from epigean stations were seen by me many years ago from Kawaihapai on Oahu and Akaka Falls on Hawaii, and the present collection has many specimens from caves on Maui, Kauai and Hawaii. The species is undoubtedly an introduced one in the Hawaiian Islands.

Nesticus pallidus Emerton

Nesticus pallidus Emerton, 1875: 275, fig. 22-27. — Suman, 1964: 671.

DISTRIBUTION: Widespread in North and Central America and West Indies; now known from several stations in South America; introduced into Hawaiian Islands and British Isles.

Cave Records: KAUAI: Koloa: Koloa Cave # 1, 37 m, 24.VI.1972, ♀, egg sac; Koloa Cave # 3, 25 m, 24.VI.1972, ♂, 2 immature; Koloa Cave # 4, 20 m, 24.VI.1972, 2 ♀♀, penultimate ♂ in deep twilight zone; Knudsen Cave # 2, 45 m, 23.VI.1972, 2 ♂♂, 4 ♀♀, egg sac from dark zone under rocks on dry floor; all F. G. Howarth, W. C. Gagné.

Nesticus mogera Yaginuma Fig. 4-7.

Nesticus terrestris Yaginuma, 1970: 390, fig. 3-8. (Name preoccupied by *Theridion terrestre* Emerton=*Nesticus cellulanus* Clerck); *N. mogera* Yaginuma, 1972: 621.

Female from Kualoa Point, Oahu: Total length, 2.65 mm.

	Carapace	Sternum	Labium	Endite	Abdomen
Length	1.10	0.68	0.10	0.30	1.62
Width	0.97	0.60	0.25	0.20	1.50

Coloration: Base color of carapace and appendages dusky yellow. Carapace dusky with faint lines of darker color outlining pars cephalica and radiating from cervical groove. Eye tubercles and area inside eyes blackish. Carapace with sparse hair covering, with usual erect bristles on midline and in ocular region. Sternum dusky. Legs paler than carapace and paler apically, without rings or makings; femora dusky. Abdomen grayish, without pattern. Specimens from caves whitish to pale yellow.

Structure: Carapace longer than broad, evenly convex, with only slight indication of cephalic grooves; cervical groove a broad, inconspicuous depression. Pars cephalica of medium height, highest just behind eyes, broadly rounded in front. Clypeus 0.18 mm long, inclined forward, equal to about 3 diameters of anterior median eye. Ratio of eyes: ALE: AME: PLE: PME= 12 : 9 : 12 : 12. Front eye row faintly procurved, essentially straight; anterior median eyes

separated by radius, half as far from lateral eyes. Posterior eye row (fig. 4) weakly procurved; oval median eyes separated by short diameter, half as from lateral eyes. Median ocular quadrangle broader than long (31/24), narrowed in front (31/22). Chelicera typical; promargin with 3 subequal teeth; retromargin with series of trivial denticles.

	I	II	III	IV	Palp
Femur	1.40	1.10	0.96	1.32	0.50
Patella	0.50	0.42	0.34	0.45	0.20
Tibia	1.33	0.90	0.65	1.14	0.27
Metatarsus	1.22	0.84	0.79	1.10	—
Tarsus	0.70	0.53	0.31	0.55	0.60
Total	5.15	3.89	3.10	4.56	1.57

Leg formula 1423. First leg 4.7 times, first femur 1.27 times as long as carapace. Third metatarsus 7/10 length of carapace. Tarsal comb with 8 toothed setae.

Abdomen suboval, as high as broad.

Epigynum (fig. 7) small, subtriangular, with small median lobe projecting behind and dark tubules leading to small receptacles.

Male from Kualoa Point, Oahu: Total length, 2 mm.

	Carapace	Sternum	Labium	Endite	Abdomen
Length	1.00	0.63	0.10	0.24	1.20
Width	0.90	0.60	0.20	0.19	0.78

Coloration and structure like those of ♀ except as noted below. Clypeus 0.15 mm, equal to little more than 2 diameters of anterior median eye. Ratio of eyes: ALE: AME: PLE: PME=13 : 10 : 13 : 13. Eyes like those of ♀ but closer together; posterior row clearly procurved, with oval median eyes separated by narrow radius.

Male palpus (fig. 5-6) with following features: paracymbium an excavated lamina with prominent thin spine lying across ventral aspect; median apophysis a thin apically directed spine; conductor with 2 short spurs at apex; embolus a fine tube margining bulb and at apex strongly spiraled ventrad to meet conductor.

	I	II	III	IV	Palp
Femur	1.30	1.10	0.92	1.05	0.43
Patella	0.43	0.36	0.33	0.39	0.14
Tibia	1.27	0.85	0.68	1.10	0.15
Metatarsus	1.20	0.85	0.70	1.00	—
Tarsus	0.60	0.56	0.50	0.60	0.30
Total	4.80	3.72	3.13	4.14	1.10

Leg formula 1423. First leg 4.8 ×, first femur 1.3 × as long as carapace. Third metatarsus shorter than carapace. Legs proportionately longer but tarsal comb and claws like those of ♀.

DISTRIBUTION: Japanese Islands; introduced into Hawaiian Islands.

Cave Records: HAWAII: Kazumura Cave, 400 m, Mountain View, 25.VII.1971, W. C. Gagné, ♀ from dark zone 50 m inside cave: 25.VII.1971, F. G. Howarth, ♀; 15. VII.1972, F. G. Howarth, ♀, young, 900 m from entrance; 15.VII.1972, F. G. Howarth, J. Jacobi, ♂, ♀, 1200 m from entrance. Hamakua Forest Reserve Caves, 600 m, 24. IV. 1972, F. G. Howarth, ♀, immature, egg sac from twilight zone. KAUAI: Haena:

Waikanaloa Cave, 5 m, 13.VIII.1971, F. G. Howarth, 2 ♀♀, 1 juvenile. Koloa: Knudsen Cave # 1, 45 m, 23.VI.1972, F. G. Howarth, W. C. Gagné, ♀, immature. Knudsen Cave # 2, 45 m, 23.VI.1972, F. G. Howarth, W. C. Gagné, ♂ ♀, 2 immature from dark zone under rocks on dry floor. Koloa Cave # 1, 37 m, 24.VI.1972, F. G. Howarth, W. C. Gagné, 1 immature; 25.VI.1972, F. G. Howarth, W. C. Gagné, 2 ♀♀ from upper section. Limestone Quarry Cave, 5 m, 21.VI.1972, F. G. Howarth, 1 immature from berlese debris in deep twilight. Limestone Quarry Cave, 5 m, 21.VI.1972, F. G. Howarth, W. C. Gagné, ♀, 2 immature from dark zone. MAUI: Hana: Lower Waihoi Valley Cave, 300 m, 19.VII.1972, F. G. Howarth, ♂. Trench Cave, 450 m, 19. VII.1972, F. G. Howarth, W. C. Gagné, 1 immature. Offal Cave, 90 m, 12, 13.XII.1971, W. C. Gagné, 2 immature; 15.XII.1971, W. C. Gagné, 5 ♂♂, 8 ♀♀, 1 with egg sac; 13. XII.1971, F. G. Howarth, S. Montgomery, ♀, immatures ; 15.XII.1971, F. G. Howarth, 1 juvenile.

Family Linyphiidae

This family of small sheet weavers, partial to ground debris in dark situations, is most strongly developed in northern latitudes. Many species live in caves as troglophiles and others with eyes greatly reduced in size or completely lacking are thought to be obligative cavernicoles. A notable example is the blind *Antrobia mammouthia* Tellkampf of Mammoth Cave in Kentucky.

Suman (1964: 669, 671) recorded 12 linyphiids under the family names Erigonidae and Linyphiidae from several of the Hawaiian Islands. The 5 described by Simon (1900) may be endemics but all but 1 of these were assigned with doubt or some qualification to their respective genera. The other 7 records were based on specimens identified by me while in the American Museum of Natural History. The 3 distinctive American *Erigone* and *Eperigone*, none of which came into Simon's hands for consideration in 1900, were probably recently introduced by trade from the United States.

Two completely eyeless linyphiids from Hawaiian caves are represented in the present collection, each by a single female. Assignment of these to genera without benefit of males, often difficult in this family is made easy by distinctive genitalic features that make placement reasonably certain. No species of *Erigone* has so far been reported as being cave adapted so this record is of special interest. An eyeless species is assigned to *Meioneta*, a difficult genus with many American and European representatives. This genus is frequently taken in American caves and a few of the species show cave adaptations. It seems likely that both of the eyeless species described below can claim an ancient American derivation.

Subfamily Erigoninae

Erigone stygius Gertsch, new species Fig. 10-11.

Diagnosis: Pale yellowish troglobite without trace of eyes, in sharp contrast with mostly black epigean types of this genus, with longer, thinner legs and distinctive epigynum.

Etymology: Specific name from Latin *stygius*, stygean, infernal.

Female Holotype: Total length, 2.2 mm.

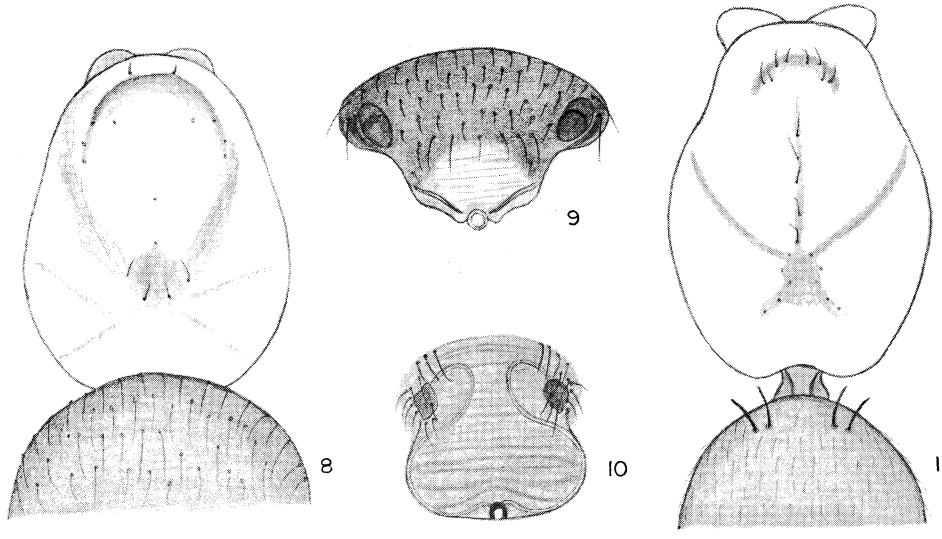

Fig. 8-11. *Meioneta gagnei*, n. sp., ♀ : 8, carapace and base of abdomen, dorsal view; 9, epigynum, ventral view. Fig. 10-11. *Erigone stygius*, n. sp., ♀ : 10, epigynum, ventral view; 11, carapace and base of abdomen, dorsal view.

	Carapace	Sternum	Labium	Endite	Abdomen
Length	0. 91	0. 50	0. 10	0. 27	1. 26
Width	0. 70	0. 53	0. 18	0. 17	0. 88

Coloration: Carapace and appendages pale amber yellow; chelicerae, labium and endites pale yellowish brown; abdomen whitish; hairs inconspicuous, whitish to dusky.

Structure: Carapace (fig. 11) much longer than broad, of medium height, widest between third coxae, smooth, shiny, with row of 6 weak setae on midline and few others in eye region; pars cephalica well elevated, highest between coxae of pedipalps, rounded in front, without trace of eyes. Sternum, labium and endites sparsely set with erect dusky setae. Chelicerae slender, with fang of medium length: promargin with 2 tiny denticles at base and 5 strong teeth; retromargin with 2 denticles and 4 small teeth.

	I	II	III	IV	Palp
Femur	1. 30	1. 22	0. 90	1. 25	0. 38
Patella	0. 28	0. 27	0. 23	0. 25	0. 12
Tibia	1. 10	1. 00	0. 80	1. 03	0. 23
Metatarsus	1. 00	0. 95	0. 78	0. 93	—
Tarsus	0. 56	0. 57	0. 47	0. 60	0. 42
Total	4. 24	4. 01	3. 18	4. 06	1. 15

Leg formula 1423. First leg 4.6 times, first femur 1.4 times as long as carapace. Legs long, thin, set evenly with rows of pale setae and with trivial spines on tibiae; fourth metatarsus without trichobothrium.

Abdomen suboval, of medium height, covered evenly with erect dusky hairs, with a few stouter setae at base over exposed pedicel. Spinnerets short; laterals with short apical segment; colulus a short, flat plate with six small setae on ventral side.

Epigynum (fig. 10) typical of genus, a pale rounded, laterally grooved lobe with small, sclerotized median elevation behind, below which lie atriobursal orifices leading through slender tubules to rounded receptacles.

Type Data: ♀ holotype (BISHOP 9877), from final room 90 m inside Bird Park Cave # 1, 1250 m, Kipuka Puaulu, Hawaii Volcanoes National Park, HAWAII, 20.VII.1971, F. G. Howarth.

Subfamily Linyphiinae

Meioneta gagnei Gertsch, new species Fig. 8–9.

Diagnosis: Pale yellowish troglobite without trace of eyes; carapace broad, widely rounded in front; legs long and thin with first pair seven times as long as carapace; epigynum an elevated lobe of distinctive form.

Etymology: Named for W. C. Gagné, who has been an active collector of Hawaiian cave spiders.

Female Holotype: Total length, 2.2 mm.

	Carapace	Sternum	Labium	Endite	Abdomen
Length	0. 87	0. 52	0. 08	0. 25	1. 30
Width	0. 70	0. 50	0. 20	0. 20	0. 85

Coloration: Cephalothorax and appendages bright amber yellow; chelicerae and epigynum yellowish brown; abdomen dusky white, without pattern.

Structure: Carapace (fig. 8) longer than broad, suboval, broadly rounded, smooth, shiny, with few weak setae; pars cephalica suboval, convex, nearly as broad as long, highest between coxae of pedipalps, without trace of eyes, with middle and lateral rows of tiny setae. Sternum, labium and endites with sparse covering of dusky hairs. Chelicerae of medium size; promargin with 4, retromargin with 3 teeth.

	I	II	III	IV	Palp
Femur	1. 75	1. 63	1. 35	1. 60	0. 40
Patella	0. 25	0. 26	0. 22	0. 24	0. 13
Tibia	1. 80	1. 48	1. 05	1. 37	0. 22
Metatarsus	1. 63	1. 40	1. 03	1. 35	—
Tarsus	0. 90	0. 82	0. 60	0. 67	0. 45
Total	6. 33	5. 59	4. 25	5. 23	1. 30

Leg formula 1243. First leg 7.3 times, first femur twice as long as carapace. Legs long, thin, set with rows of pale hairs, fewer on femora, with thin dorsal spines as follows: one at apex of all patellae, one subdorsal and subapical on all tibiae; metatarsi without trichobothria.

Abdomen suboval, as high as broad, slightly overlapping base of carapace, with covering of hairs mostly rubbed off. Spinnerets short, with conical apical segment; colulus short, flattened lobe with 8 tiny setae on ventral surface.

Epigynum (fig. 9) typical of genus, a prominent transversely rounded elevation with tiny central lobe behind and pattern of thin tubules as shown.

Type Data: ♀ holotype (BISHOP 9878) from dark zone 80 m inside Kalua O Lapa Cave, 120 m, Keoneoio, MAUI, 4.XII.1971, F. G. Howarth, W. C. Gagné.

Meioneta species

Cave Records: KAUAI: Koloa: Knudsen Cave # 2, 45 m, 23.VI.1972, F. G. Howarth, W. C. Gagné, ♂ from dark zone under rocks on dry floor. Koloa Limestone Quarry, Cave 5 m, 21.VI.1972, F. G. Howarth, W. C. Gagné, ♂ from dark zone.

The above small, gray species with large eyes, a troglophile, is given only generic identification. Three well marked species of *Meioneta* were listed by me in 1953 and all reported under a single name by Suman 1964: 671. The status of these and others now known, as endemics or introduced elements, cannot be clarified without intensive study.

Family Theridiidae

Achaearanea tepidariorum (Koch)

Theridion tepidariorum Koch, 1841: 75. — Simon, 1900: 449. — Suman, 1964: 678.
Achaearanea tepidariorum: Levi, 1955: 32.

DISTRIBUTION: Cosmopolitan species known from most temperate and tropical regions of the world; introduced into Hawaiian Islands.

Cave Records: HAWAII I.: Puu Waawaa Lava Tube # 1, 1250 m, 30.IX.1971, F. G. Howarth, J. Jacobi, immature ♀. Hamakua Forest Reserve Caves, 600 m, Honokaa, 24. IV.1972, F. G. Howarth, ♂ and immature from upper section, dark zone. KAUAI: Koloa Cave # 3, 25 m, Koloa, 24.VI.1972, F. G. Howarth, ♀.

Argyrodes argyrodes (Walckenaer)

Linyphia argyrodes Walckenaer, 1841: 282.
Argyrodes argyrodes: Simon, 1900: 446.— Suman, 1964: 676.

DISTRIBUTION: Mediterranean region; not cosmopolitan as formerly reported; introduced into Hawaiian Islands.

Cave Record: KAUAI: Koloa Cave # 3, Koloa, 25 m, 24.VI.1972, F. G. Howarth, ♀.

Family Argiopidae

Cyclosa albisternis Simon?

Cyclosa albisternis Simon, 1887: 1; 1900: 478. — Suman, 1964: 667.

DISTRIBUTION: Andaman Islands, southern India, Hawaiian Islands. An introduced species.

Cave Record: KAUAI: Kokee Water Tunnel, 1000 m, 16.VIII.1971, F. G. Howarth, ♂ 3 ♀♀, egg sacs.

Family Lycosidae

Simon (1900) found in the endemic Hawaiian lycosid fauna several remarkable and

perplexing elements and even a new genus, *Syroloma*, with features suggesting relation to certain ctenids and clubionids. Thus, it is not surprising that wolf spiders from caves should further emphasize the uniqueness of the Hawaiian Lycosidae.

Wolf spiders are noted for large eyes and good eyesight and for the presence of reflective tapeta in the eyes that may aid in night hunting. Many lycosids use sight as vagrant day hunters but others stay hidden in burrows and ground retreats during daylight and come out at night to hunt. There is little evidence that sight plays a large role for such night hunters which seem to rely on their keen chemotactic senses as do most spiders. So far no wolf spider has been closely identified with the cave habitat except as a temporary refuge, and few show any significant reduction in eye size as a result of habitat preference. In his large work on European cave spiders Fage (1931, p. 248) listed only a single *Lycosa* sp. ? from a cave in France. In North America there are a few published and numerous unpublished records of lycosids and pisaurids from caves in the United States and Mexico. These typical lycosids came mainly from cave entrances and are classified as trogloxenes. In short, it is axiomatic that no lycosid, or any big-eyed diurnal spider, can become cave adapted since its innate qualities seemingly would preclude such a happening. This principle is refuted in part below.

One of the small wolf spiders of the southeastern United States, *Sosilaus spiniger* Simon, has long been considered a rare species. The few specimens studied by me show normal eye size development typical of the genus *Pirata*, of which *Sosilaus* seems only to be a subgenus. In Florida (personal communication of Dr. H. K. Wallace of the University of Florida) specimens of *spiniger* have been found in the burrows of pocket gophers (*Geomys*) and these exhibit features usually attributed to cave animals: striking reduction of eyes to vestiges, loss of body pigment, and lengthening of the legs. Such eye and body modifications, seemingly a consequence of specific edaphic habit at preference, is well known for various short-sighted haplogyne spiders and seemingly is possible even in the big-eyed wolf spiders.

Two remarkable lycosids are represented in the material from Hawaiian caves and at present they are presumed to be troglobites. The first of these is a species with vestigial eyes known only from caves on the island of Hawaii. The second species, known only from Koloa Cave on Kauai, is completely eyeless, has the appearance of an amaurobiid or clubionid, and features a broadly rounded, low pars cephalica and more numerous spines beneath the tibiae of the front legs. Although closely related to *Lycosa* as shown by the standard epigynum, separate generic status is proposed for it.

The above examples demonstrate the ability of big-eyed spiders with seeming fixed qualities to seize and exploit a habitat opportunity even though its results, essential or total eyelessness, seem antagonistic to their nature.

Lycosa howarthi Gertsch, new species Fig. 12-14.

Diagnosis: Pale yellowish, blind species probably a troglobite, with eyes (very large in typical members of the genus) reduced to small vestiges: posterior eye row twice as wide as middle one.

Etymology: Named for F. G. Howarth, who discoverd this unusual wolf spider in caves in Hawaii.

Male holotype: Total length, 11 mm.

	Carapace	Sternum	Labium	Endite	Abdomen
Length	6.0	2.7	1.0	1.8	5.0
Width	4.7	2.3	0.9	0.8	3.0

Coloration: Dorsal view of carapace and abdomen as shown in fig. 12. Carapace dull orange, without contrasting pattern except faint dusky shadings demarking pars cephalica and others radiating toward side margins from cervical groove, covered evenly with thin coat of pale procumbent hairs and similar dusky ones and with few erect black setae limited to ocular region and on midline to median groove; eyes pale, outlined by narrow dusky rings. Chelicerae dark reddish brown, with numerous long dark setae above and band of dusky hairs below. Sternum and coxae yellowish, endites yellowish brown and labium dark reddish brown, all set with erect black hairs. Legs dull orange above, more yellowish below, some brown pigment at ends of segments, clothed thinly with mixed pale and dusky hairs and set with strong black spines; scopulae on front pairs silky gray. Abdomen gray to dull yellow; dorsum with quite thick covering of pale procumbent hairs, set with erect blackish bristles forming quite conspicuous brush above pedicel; venter covered with short dark hairs.

Structure: Dorsal outline of carapace and abdomen as shown in fig. 12; basic features in

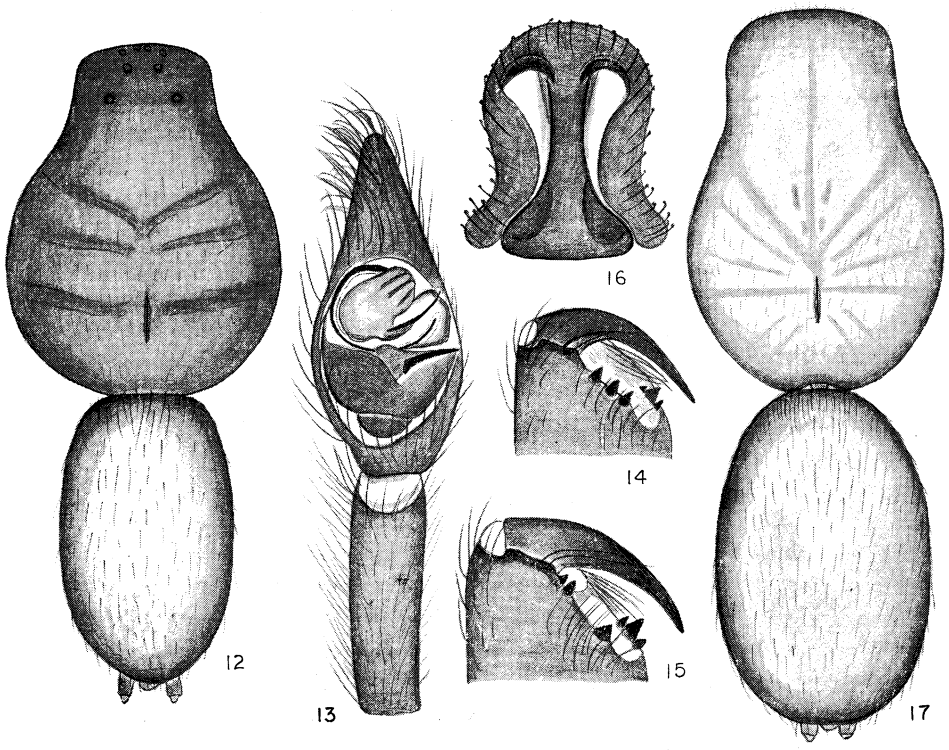

Fig. 12-17. *Lycosa howarthi*, n. sp., ♂: 12, carapace and abdomen, dorsal view; 13, left male palpus, ventral view; 14, tip of right chelicera of male, ventral view. Fig. 15-17. *Adelocosa anops*, n. sp., ♀: 15, tip of right chelicera, ventral view; 16, epigynum, ventral view; 17, carapace and abdomen, dorsal view.

general agreement with typical *Lycosa*. Carapace about half as high as wide, convex, highest at cervical groove, gradually declining forward and rounded downward over eyes to clypeal margin. Pars cephalica 2.3 mm wide in front, about half width of carapace. Ratio of eyes, in millimeters: ALE : AME : PLE : PME=0.09 mm : 0.13 mm : 0.13 mm : 0.13 mm. Clypeus narrow, equal to diameter of small anterior lateral eye. First eye row broader than second (0.09 mm/0.78 mm), slightly procurved; median eyes separated by their diameter, about as far from smaller lateral eyes. Eyes of second row (posterior median) separated by nearly 4 diameters (13/50). Eyes of posterior row (posterior lateral) very widely separated by about 8 diameters (13/103). Chelicerae (fig. 14) stout; promargin with 2 stout contiguous teeth (compounded on left chelicera); retromargin with 3 subcontiguous teeth (1 on left chelicera with 2 cusps).

	I	II	III	IV	Palp
Femur	6.0	5.8	5.2	6.9	2.7
Patella	3.0	2.8	2.4	2.7	1.3
Tibia	5.7	5.2	4.6	6.3	1.6
Metatarsus	5.3	5.2	5.6	8.8	—
Tarsus	2.7	2.5	2.6	3.3	2.2
Total	22.7	21.5	20.4	27.9	7.8

Leg formula 4123. First leg 3.78 times, fourth 4.65 times as long as carapace. Spination of first and second legs as follows: femur, prolateral 1 or 2 near apex; dorsal 1-1-1 but apical 1 weak; patella 0; tibia, prolateral 1 in apical third nearly ventral in position; metatarsus, ventral 2-2-1, apical 1 small. Posterior legs more strongly spinose as usual in the genus with dorsal, lateral and ventral spines on some of the segments; third and fourth tibiae with basal and subdistal spine above. Paired tarsal claws with comb of 10 to 13 fine teeth; unpaired claw simple, without basal teeth.

Male palpus (fig. 13) standard in design for genus, with thin transverse median apophysis and embolus a fine spine.

Male paratype: Total length, 9.3 mm. Structure like that of holotype except as follows: presence of single apical spines below tibia of first and second legs and absence of 1 of basal pairs below second right tibia.

Immature female paratype: Total length, 13.5 mm. Carapace 5.8 mm long, 4.5 mm wide, 2.7 mm wide in front. Color paler than that of ♂, with legs and abdomen paler yellow, less hairy and with fewer coarse bristles. Structure like that of ♂♂ except as follows: pars cephalica broader in front, equal to about 3/5 of carapace width. Eyes slightly more prominent but not significantly larger. Legs proportionately shorter and stouter; first leg spination like that of ♂ but lacking single distal spine on metatarsi and all spines shorter; first leg: femur 5.5 mm, patella 2.9 mm, tibia 4.7 mm, metatarsus 3.8 mm, tarsus 2.5 mm, total length 19.5 mm, 3.36 times as long as carapace.

Type Data: ♂ holotype (BISHOP 9879) from Hongo Store Cave, 1130 m, Volcano, HAWAII, 3.X.1971, F. G. Howarth, J. Jacobi.

DISTRIBUTION: Caves of Hawaii Island.

Other Records: HAWAII: Kazumura Cave, 400 m, 25.VII.1971, ♂, penultimate ♂, subadult ♀ and immature from dark zone; 25.VII.1971, 1 immature from dark zone 60 m inside; 22.VII.1971, 1 immature from dark zone 200 m inside; Bird Park Cave # 1, 1250 m, Kupuka Puaulu, 20.VII.1971, penultimate ♂ from final room 100 m in; 3.VII. 1971, 1 immature (all collected by F. G. Howarth).

Adelocosa Gertsch, new genus

Lycosine genus with basic features of subfamily and derived from *Lycosa*, with following special characters: carapace low and broad in front, without trace of eyes; legs of medium length and stoutness, with 4 pairs of ventral spines beneath tibiae of first and second pairs; promargin of chelicera with 3 large teeth, 2 near base of fang and third far removed from basal pair; ♀ genitalia typical of subfamily.

Type-species: *Adelocosa anops*, new species.

Etymology: Of genus from Greek *adelos*, unseen, and *lycos*, wolf; of species from Greek *a*, without, and *ops*, eyes; an eyeless wolf spider.

Although sharing the prime characters of the genus *Lycosa*, this eyeless species has diverged in striking fashion from the norm of that genus. The complete lack of eyes is not matched by any species of this family and reduction of the eyes is found in few. The presence of 4 pairs of ventral spines on the front tibiae is unusual for the entire range of genera of the Lycosinae, exceeded only by 5 pairs in *Pirata spiniger* (Simon), which Simon placed in a separate genus *Sosilaus*. The retromargin of the chelicera is tridentate but the basal pair has migrated to a point near the base of the fang, leaving the third tooth far separated from the pair. The ♂ and ♀ genitalia of the lycosine genera are quite stereotyped and most genera are based on such subsidiary characters as eye position, height of the pars cephalica, presence or absence of the third tooth on the retromargin of the chelicera, situation of various spines on the legs or their absence, and other trivial differences. Most spider genera based on eyelessness alone are proving to be invalid. Final evaluation of the special features of *Adelocosa* can be realized only by study of the generic make-up of the world fauna.

Adelocosa anops Gertsch, new species Fig. 15–17.

Diagnosis: Completely eyeless lycosid, probable troglobite or edaphobite, with features readily separating it from other lycosines as noted in generic description.

Female holotype: Total length, 14 mm.

	Carapace	Sternum	Labium	Endite	Abdomen
Length	7.3	3.0	1.3		6.7
Width	5.4	2.3	1.1		4.7

Coloration: Dorsal view of carapace and abdomen as shown in fig. 17. Carapace orange to reddish brown, shiny, darkest in front, with some duskiness along side margins, faint dark linear streak from front to cervical groove and similar thin streaks radiating from this groove; entire surface covered with thin layer of fine procumbent whitish hairs and pars cephalica with few weak dusky hairs and setae. Chelicerae dark reddish brown, with numerous fine whitish hairs above and inconspicuous band of hairs below. Sternum and coxae yellow, labium and endites dark reddish brown, all set sparsely with erect blackish hairs. Legs quite bright orange above, darkest apically, paler below, with trivial brown flecks and streaks at ends of segments, clothed thinly with mixed pale and dusky hairs and set with stout black spines; scopulae on front pairs silky gray. Abdomen whitish, with coating of pale inconspicuous hairs and scattered suberect short black setae forming thin brush above pedicel.

Structure: Dorsal outline of carapace and abomen as shown in fig. 17; basic features of *Lycosa* unless otherwise noted. Carapace longer than broad, less than half as high as broad,

highest just in front of cervical groove; pars cephalica 3.8 mm across front, about 2/3 of carapace width, with cephalic sutures little evident, low and slightly curved along clypeal margin; front smooth, without trace of eyes. Cervical groove a deep linear depression situated on posterior third of carapace. Chelicerae (fig. 15) stout; promargin with 3 teeth, middle 1 much larger; retromargin with 3 teeth, a pair near base of fang and single large tooth remote from basal pair, opposite large tooth of upper margin.

	I	II	III	IV	Palp
Femur	5.9	5.7	5.5	6.7	2.7
Patella	3.2	3.2	2.7	2.9	1.0
Tibia	5.6	5.4	4.7	6.3	1.4
Metatarsus	5.1	5.3	5.5	8.1	—
Tarsus	2.3	2.3	2.2	2.9	2.5
Total	22.1	21.9	20.6	26.9	7.6

Leg formula 4123. First leg 3 times, fourth leg about 3.7 times as long as carapace. Spination of first leg as follows: femur, prolateral 2 near apex, dorsal 1-1-0; patella 0; tibia, ventral 2-2-2-2; metatarsus, prolateral 1 and retrolateral 1, and ventral 2-2—; second leg like first but with additional prolateral at middle of femur and 1 near apex of tibia. Posterior legs with dorsal, lateral and ventral spines on some segments; third and fourth tibiae with basal and subapical spine. Paired claws of 3 front legs with 6 or 7, fourth legs with 9 teeth; unpaired claws without teeth. Trichobothria of tarsi and metatarsi of legs long and willowy, twice as long as those of surface lycosines.

Epigynum (fig. 16) of typical *Lycosa* design.

Type Data: ♀ holotype (BISHOP 9880) from Koloa Cave # 2, 37 m, Koloa, KAUAI, 11. VIII.1971, F. G. Howarth, from floor in dark zone 100 m inside cave.

DISTRIBUTION: Known only from above cave.

Other Records: KAUAI: Koloa Cave # 2, 11.VIII.1971: same data as holotype, 2 ♀ paratypes; from 75 m inside dark zone, ♀ paratype with egg sac containing 14 spiderlings; from rotting wood 50 m inside dark zone, 1 immature (all collected by F. G. Howarth).

Family Agelenidae

Tegenaria domestica (Clerck)

Tegenaria domestica: Simon, 1900: 505. — Suman, 1964: 666.

DISTRIBUTION: Widespread in temperate and tropical areas of world, cosmopolitan, presumably of Mediterranean origin, introduced into Hawaiian Islands.

Cave Record: HAWAII: Pigeon Cave, 670 m. Puu Waawaa Ranch, Kona, 29.IV. 1972, F. G. Howarth, ♀, 4 immature from webs in twilight zone.

Family Clubionidae

Corinna cetrata (Simon)

Creugas cetratus Simon, 1889: 243.
Corinna cetrata: Suman, 1964: 669.

DISTRIBUTION: Polynesia; introduced into Hawaiian Islands.

Cave Records: OAHU: Burial Cave # 1, Niu Valley, 33 m, 17.VII.1971, F. G. Howarth, F. Stone penultimate ♂, immature from end room. KAUAI: Koloa: Koloa Cave # 1, 37 m, 25.VI.1972, F. G. Howarth, ♂; Koloa Cave # 3, 25 m, 24.VI.1972, F. G. Howarth, W. C. Gagné, ♀, shed skin from twilight and transition zones; Koloa Cave # 4, 20 m, 24.VI.1972, F. G. Howarth, W. C. Gagné, immature ♀♀ from deep twilight zone. Knudsen Cave # 2, 45 m, 23.VI.1972, F. G. Howarth, W. C. Gagné, 2 ♀♀ from 50 m inside; 1 immature from dark zone under rocks on dry floor.

Clubionid of uncertain genus

Cave Record: OAHU: Burial Cave # 1, Niu Valley, 33 m, 17.VII.1971, F. G. Howarth, F. Stone, 1 immature from end room.

Family Gnaphosidae

Gnaphosid of uncertain genus

Cave Record: OAHU: Burial Cave # 1, Niu Valley, 33 m, 17.VII.1971, F. G. Howarth, F. Stone, 1 immature from end room.

Family Salticidae

Bavia aericeps Simon

Bavia aericeps Simon, 1877: 61. — Suman, 1964: 673.

DISTRIBUTION: Oriental region and Pacific Islands; introduced into Hawaiian Islands.

Cave Record: HAWAII: Kazumura Cave, Mt. View, 400 m, 30.IV.1972, F. G. Howarth, immature ♀, twilight zone below upper entrance.

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