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INTRODUCTION

California is known among orthopterists as a reservoir of camel cricket species. Many endemic genera are found throughout the state, some widely distributed, others more restricted to a particular combination of environmental factors. Farallonophilus cavernicolus Rentz, new genus and species, is apparently confined to the Farallon Islands where it dwells in uplifted sea caves and possibly in sea bird burrows. The species is the only known orthopteran from the islands and is believed to be among the most primitive members of its tribe, the Ceuthophilini. Because of the unique historical and faunistic contributions of the islands, a brief résumé is presented below.

GEOLOGY

The Farallon Islands, officially part of San Francisco County, include seven islets lying approximately 32 miles northwest of the Golden Gate of San Francisco in the Pacific Ocean. The largest, South Farallon (fig. 1), which is the type locality of the cricket herein described, covers approximately 90 acres with the main peak ascending some 375 feet. The other islands are much smaller, some so small and treacherous that man has probably never set foot on them.

The Farallons consist of granitic rock which is deeply weathered and broken. It is much darker in color and more obviously fractured than the granite of the Sierra Nevada of California.

Sea terraces are very conspicuous on South Farallon, indicating either uplifting or a change in sea level or both. These terraces are marked by relict sea caves. It was in one of these caves (fig. 1), approximately 50 feet above sea level, that the camel crickets were found in greatest abundance. Other sea caves located away from tidal influences were not visited and are either unsafe to enter or are currently undergoing excavation by wave action, as on the northeastern shoreline, and are apparently too salty to be suitable for the crickets.

The Farallons are geologically similar to the granitic outcrops of the tip of the Point Reyes Peninsula, about 20 miles to the northeast. Similar sea caves occur on the western shore of Tomales Bay but were not found to harbor any camel crickets on the single collecting trip the author took to the area during May, 1970. However, a more intensive search of these caves is necessary, especially at night, before it can be said that the Farallon camel cricket does not occur on the mainland. Collecting along the adjacent coast in Marin County in suitable habitats has yielded other camel crickets such as Pristoceuthophilus pacificus Scudder and Tropidischia xanthostoma Scudder. The deserted copper mines on Bolinas ridge, not far from the southern end of Tomales Bay, present a habitat superficially similar to the sea cave of South Farallon. The largest tunnel of those mines is dark, damp, and occupied by the two species mentioned above, as well as by other insects. It differs geologically in that it is primarily hard gray sandstone or dark shale (Bowen and Crippen, 1951, p. 168). Either such a substrate is unsuitable for Farallonophilus cavernicolus Rentz, new species, or the species has not been successful in competition with the other species.

BRIEF HISTORY OF MAN ON FARALLONS

Few localities as remote to the present-day human population of central California, yet so well known, have had as much written about them as the Farallon Islands. Evidence from artifacts indicates that Sir Frances Drake stopped on the islands in 1578 (Hanna, 1951, p. 302). Subsequently economic exploitation of various sorts has plagued the fauna and flora of the islands. Russian furriers virtually eliminated one or more species of fur seals from the islands during the early 1800's. With the California gold-rush boom of the mid and late 1800's, the islands were raided by "egggers" who harvested annually 25,000 dozen sea bird eggs from approximately 1850 to 1903. Eggs from the islands commanded a high price, sometimes \$1.00 per dozen, and rivalry among egg collectors culminated in an egg war.

Because of the importance of the islands to navigation,

and the predominance of fog-shrouded days, a lighthouse was established about 1872 and has been maintained and improved to this day. Many buildings exist on the island including one housing an electric generator. At one time a considerable number of Coast Guard maintenance men and their families occupied South Farallon. Today a skeleton crew maintains the automatic beacon and fog horn; supplies and fresh water are brought on a regular basis. The Point Reyes Bird Observatory coordinates the scientific investigations through a research contract with the Bureau of Sport Fisheries and Wildlife and maintains vigilance over the bird rookeries. Presently, interested parties can participate in scientific investigations under the aegis of PRBO and utilize the room and board facilities on South Farallon. Transportation is provided by the Coast Guard during regular supply missions or by private boat.

CLIMATE

The climate of the Farallons is similar to that of the adjacent coast. Temperature remains rather constant throughout the year with an average maximum near 55°F. in winter. Yearly rainfall averages 25 inches, mostly in winter or early spring. Fog prevails in summer months, but there is considerable wind throughout the entire year and the annual plant growth matures and dries sooner than that of the adjacent coast.

VEGETATION

The main vegetation of South Farallon consists of large expanses of the composite Farallon weed, Lasthenia minor (DC) Ornduff subspecies maritima (Gray), which grows in mats where the soil is soft and loose. Fewer than 50 species of plants are known from the islands and two tree species, both introduced, are present. One species, Monterey Cypress, Cupressus macrocarpa Hartwood, is represented by two plants over twenty feet in height; the other species, Monterey pine, Pinus radiata Don, is represented by a single sprawling tree less than 10 feet in height. The number of introduced species greatly outnumbers the native plants. Many of the former residents of the island cultivated gardens which probably account for a good portion of the plants now present.

INSECT FAUNA

Several insect collections have been made on the Farallon Islands and descriptions of species or subspecies have appeared from time to time. No comprehensive work has been published listing the insects of the islands. In general, the pattern in species studied to date shows little endemism with almost all species represented along coastal California. A

notable exception is the genus described herein. As might be anticipated, the entomofauna is dominated by beetles and flies, especially those species of marine or littoral habitats. The Orthoptera are represented by the single species described in this paper.

FARALLONOPHILUS Rentz, new genus

GENERIC DIAGNOSIS.

1. Fastigium concial, not sulcate, the protuberance barely attaining 1/4 the length of first antennal segment.
2. Sensory portion of distal segment of maxillary palpus occupying entire ventral portion of distal half of segment; segment slightly swollen, without any visible indication of ventral cleft or groove, a minute sulcus detectable only under high magnification.
3. Only metathoracic notum marginate.
4. Caudal metatarsus unarmed dorsally.
5. Fore coxa without spine.
6. Dorsal surface of hind tibia without movable spurs, larger teeth separated by smaller serrations.
7. All femora unarmed.
8. All tarsi four segmented; tarsal claws with ventro-proximal sensory setae.
9. Dorsal valves of ovipositor unarmed; ventral valves with low, weak crenulations.
10. Pseudosternite present; subgenital plate of male with styles.

TYPE OF THE GENUS. Farallonophilus cavernicolus Rentz, new species, by monotypy.

GENERIC RELATIONSHIPS. Hubbell (1936, p. 35) presented a table illustrating the distribution of ten selected fundamental characteristics among the genera of the Ceuthophilini. Using this scheme, Farallonophilus falls somewhere between Pristoceuthophilus Rehn and Ceuthophilus Scudder. The ten characters which were used by Hubbell are almost all included above in the generic diagnosis. Farallonophilus most closely resembles Pristoceuthophilus, but differs in having only the metathoracic notum marginate (Pristoceuthophilus has all the thoracic nota marginate), the dorsum of the male's abdomen and cerci unspecialized, the ventral carinae of the femora without spines, and the tibial margins without movable spines. From the more widespread and commonly collected genus Ceuthophilus, Farallonophilus may be distinguished by possessing the ventroproximal sensory seta of the tarsal claws, and not having the subgenital plate of the male divided into halves by a cleft. Females of Ceuthophilus species often have aciculate teeth on the ventral ovipositor valves rather than low crenulations as in Farallonophilus.

The presence of claw setae, styles of the subgenital plate, and crenulate ovipositor render Farallonophilus among the most primitive of the tribe Ceuthophilini which is

confined to North and Central America. Only Argytes, Pristoceuthophilus, and Phoberopus possess styles on the subgenital plate of the male, and Pristoceuthophilus is the only other genus in the tribe known to possess claw setae, a character believed by Hubbell to be primitive.

Farallonophilus cavernicolus Rentz, new species.
(Figures 1-8.)

HOLOTYPE. Male. Head slightly less than 2.67 times as long as broad; interocular distance at base of eye 5.4 times width of eye at ventral margin. Antennae 3.2 times as long as body. Eye triangular, slightly longer than dorsal width. First antennal segment 2.3 times longer than second; third segment 1.67 times longer than second. Maxillary palpi elongate, distal segment 1.5 times as long as dorsointerocular distance, 1.23 times length of cephalic metatarsus. Fastigium of vertex weakly produced as a small, smooth protuberance barely surpassing fossa of antenna. Thorax: Pronotum in dorsal aspect extremely sellate, lateral lobes well produced, declivent on anterior ventral margin; ventral margin slightly angulate at midlength; surface more or less smooth, setose, foveolae well indicated; caudal margin of mesonotum in dorsal aspect broadly arcuate, of metanotum truncate. Meta and mesosternum each with small, densely setose, ovate area on each side. Legs: Fore femur distinctly more robust than middle femur, 1.74 times dorsal length of pronotum; ventral carinae of fore and middle femora without spines; fore coxa weakly produced as a low, blunt protuberance; middle coxa smooth, not at all produced; hind femur elongate, distal 1/4 barely surpassing abdominal apex, 3.22 times longer than dorsal length of pronotum, ventral surface carinate, without teeth. Hind tibia 1.20 times length of hind femur, weakly concave; dorsal carinae with many attingent short spines laterally compressed, longer spines separated by 3-5 shorter spines; ventral surface linearly setose. Apex of hind tibia armed dorsally with 4 apical calcars, dorsal pair long, more than 3/4 as long as adjacent tarsal segment; ventral surface with a pair of short apical calcars. All femora spineless, though linearly setose. Fore and middle tibiae of nearly equal length with femur; fore tibia armed ventrally with a pair of short spines mesad, a pair apicad; dorsal surface armed with a single, short, triangular spine on inner and outer margins. All tarsi 4-segmented; fore and middle tarsus subequal to respective tibiae, armed on inner and outer ventral margins with many short, stout setae, linearly placed; tarsal claw with sensory seta. Abdomen: Dorsal aspect of each abdominal segment feebly convex; 9th segment truncate. Epiproct large, feebly convex, triangular distad; paraprocts plate-like, triangular, not concealed by epiproct. Cercus elongate curled laterad, hirsute. Pseudosternite (fig. 7) broad, shallow, not appreciably adpressed to abdomen, poorly sclerotized, distal margins concave mesad; styles present, longer than length of one side of median incision; external surface of plate sparsely hirsute.

ALLOTYPE. Female. Similar to holotype but slightly smaller, form more robust. Differs in following features: interocular distance 1.7 width of eye; fore femur less robust than middle femur, 1.6 times longer than dorsal length of pronotum; lateral and ventral portion of metathoracic tergite with a number of low rugae; cercus 1.2 times longer than dorsal length of pronotum; surface of abdomen pilose and setose, the latter emerging from tuberculae; subgenital plate simple, four times broader than long, distal margin broadly arcuate, weakly truncate to apex; ovipositor (figs. 3, 4) elongate, slender, 1.8 times longer than dorsal length of pronotum, straight, apical 1/4 weakly upturned, dorsal valves very obliquely concave; ventral valves in distal 2/9 with 13 low crenulations, the apicodorsal tooth hooked.

COLORATION OF ADULTS. Uniform, characteristic, head pallid yellow, dorsum accentuated by network of dark brown stripes, the confluence of fastigium and vertex emphasized by a dark brown blotch. Eye light grey, basal antennal segment light brown, distal segments darker but segments 8, 22, 31, 50, 73, and 101 light brown, swollen; all segments densely setose, the setae dark brown. Pronotum dark brown with many light brown-white blotches. Meso and metathorax basically yellow brown with darker blotches. Abdominal tergites similarly colored, the yellow forming an indistinct medial dorsal longitudinal stripe. Thorax and abdominal tergites uniformly moderately setose, the setae short, brown. Fore and middle femora and all tibiae uniformly yellow-brown, densely setose, the setae darker brown. Hind femur with characteristic pattern (fig. 2) setal arrangement following the darker coloration. Spines of hind tibia light yellow-brown in basal 1/2-2/3, apex dark brown. Cercus grey brown, the tuberculation somewhat darker. Subgenital plate and ventral surface light grey brown. Ovipositor yellow brown, polished, dorsal and ventral apical margins darker; lateral surfaces of distal 1/4-1/5 with scattered setae or tubercles, these contrastingly darker brown.

COLORATION OF NYMPHS. As in many Ceuthophilus species, especially in the smaller specimens, this is different from that of the adults. Young instars were found to be uniform slate grey, the palpi and legs somewhat lighter. Older nymphs assume some of the color pattern of the adult insect.

TYPE DATA. "California: Farallon Islands, S. Farallon Isd., 4-6-II-70, David C. Rentz." The type and type series were preserved in the fixative described by Williams (1968) and the holotype and allotype dried and pinned as described by Rentz (1962). Much of the paratypic series remains in alcohol.

TYPE LOCALITY. The exact type locality is the sea cave (fig. 1) located on the southwest face of South Farallon Island near the generator housing.

DERIVATION OF NAME. The generic name is in reference to the type locality: the trivial name refers to the cave-dwelling habit of the species.

DEPOSITION OF TYPES. The holotype and allotype are deposited in the California Academy of Sciences. Paratypes

will be deposited in the Academy of Natural Sciences of Philadelphia, U. S. National Museum, University of Michigan, Museum of Zoology, and British Museum (Natural History).

RECORDS. Numerous specimens of all instars were collected on both 4-6 February 1970 and 12 April 1970 at the type locality. All are designated as paratypes and the bulk of the collection is in the California Academy of Sciences.

BIONOMICS

Farallonphilus cavernicolus is apparently closely restricted to its cave-dwelling habit. An hypothesis to suggest the sequence of events leading to such a habit might be found with the burrowing Cassin's auklets, Ptychoramphus aleutica (Pallas), which are oceanic birds abundant on the islands. Uvardy (personal communication) estimates the current population to exceed 100,000 birds on South Farallon. These birds tunnel underground for considerable distances honeycombing the island with their burrows. The tunnels are of considerable length and probably parts of them remain intact for several years when no longer in use by the birds. Such unused burrows would seemingly provide a suitable habitat for the cricket and the abundance of feathers, fecal material, and food remnants would probably be utilized by the insects. The biology of the adult nesting birds is such that they are away from the burrows and out at sea from approximately 4:00 A.M. (P.S.T.) until 8:00 A.M. (P.S.T.) when they return. This would provide crickets living within active burrows potential time for feeding and other activity without much disturbance. However, as indicated below, this would necessitate a change in the activity period of the insect, an event which is not very likely. Uvardy (personal communication) has dug out many auklet burrows in his studies and informs me that he has never found a cricket within them. The high population of crickets within the cave indicates that if bird burrows were a suitable habitat, they should probably have been detected therein by now. Of interest is the collection of a single cricket, a female, more than 100 yards from the entrance of the cave under a rock in the general vicinity of the auklet nesting area. This single observation lends credence to the possibility of the above hypothesis. Repeated turning of rocks, large and small, many covering auklet burrows, failed to yield other crickets, although the burrows themselves were not excavated by the author because of current studies of the nesting behavior of the birds. Whatever factors may have contributed to the presence of this cricket in a distinctly monotypic genus, on this small island close to coastal California, are still in conjecture. California is rich in genera of camel crickets and central and southern California, including some of the Channel Islands, claim the aberrant, monotypic Cnemotetix pulvilifer Caudell, a very interesting camel cricket though it was placed in the Henicinae by Hubbell (1936). Tropidischia xanthostoma Scudder, another unusual monotypic camel

cricket, occurs along the Pacific Coast following the present and past distribution of the redwood, Sequoia sempervirens.

BIOLOGY

One of the most distinctive behavioral characteristics of F. cavernicolus is its gregarious habit. Groups of up to 15 individuals of all instars could be found gathered closely together in mutual antennal contact. Upon disturbance, individuals would disperse and either establish new groups or enter other such groups. Individuals could be seen entering and leaving the clusters of crickets. In addition, scattered isolated individuals were frequently encountered within the cave, but those present in groups far exceeded the number of isolated individuals. Mating was not observed within groups of crickets.

The resting posture of the Farallon cricket is also unique among the camel crickets with which I am familiar. A resting individual will most likely be encountered with the hind tibia closely adpressed against the femur and both drawn forward so that the "knee" (tibial-femoral attachment) is over the pronotum. The function of this behavior is not understood. It does not seem to aid in the jumping activity of the cricket because when disturbed, most crickets seemed to crawl into cracks or run away rather than jump.

Feeding crickets were not observed within the cave which was supplied with much organic matter. Apparently detritus and nesting material from auklets and rabbits have accumulated over a considerable period of time. This contributes to the distinctly "birdy" atmosphere of the air and very rich, black color of the soil. The walls of the cave were very moist on both of my visits (February and April) and the temperature was warmer than that of the ambient air outside.

The Farallon camel cricket was successfully maintained alive in the laboratory only by providing them a humid atmosphere. As with other camel crickets such as Tropidischia, this species soon perishes at room temperature and humidity conditions. A small group was maintained alive by placing the specimens in a wire cage around the inside of which a washcloth was hung. The bottom of the cloth was allowed to drape into a vessel of water. Capillary action kept the cloth moist and the crickets exhibited a marked nocturnal-diurnal cycle. During the day they all clustered together (8-10 individuals) at the top of the cage in the darkest corner close to the moist washcloth. Individuals isolated from the group and maintained in similar cages, but singly, failed to survive lending some credence to the idea that the gregarious habit may have a beneficial effect, the mode of action of which is not yet known. The captive crickets were fed oatmeal and dry dog biscuits which were readily eaten.

Mating was observed among the caged individuals on a single occasion. A copulating pair was discovered at 12:30 A.M. (P.D.T.) on 20 June 1970. There is no indication how

long the two had been together but at 12:50 A.M. (P.D.T.) the pair separated, the penis of the male extruded and remaining so for some minutes. No spermatophore was evident on the female. Attempts at interesting the female in oviposition were unsuccessful even though soil from the cave was provided and a selection of varying degrees of dampness of the soil was available. Perhaps females lay their eggs between the fractures of rocks within the cave.

ACKNOWLEDGMENTS

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TABLE I. Measurements (in millimeters) of Farallonophilus cavernicolus

	Pronotum					
	Total length	Dorsal length	Width lateral lobe	Length hind femur	Length hind tibia	Length ovipositor
Holotype	12.20	3.00	2.50	9.60	12.10	
Allotype	11.90	2.75	2.50	9.20	11.20	4.70
Paratypes						
Male	9.50	2.95	2.40	9.70	11.60	
Male	10.50	2.80	2.40	9.60	10.90	
Male	8.50	2.70	2.30	8.20	10.90	
Male	10.00	2.60	2.30	8.40	10.60	
Male	10.00	2.70	2.20	8.70	10.80	
Male	9.90	3.00	2.55	10.40	11.50	
Male	8.50	2.90	2.40	8.70	10.50	
Female	9.50	3.10	2.60	9.10	11.10	4.96
Female	9.20	3.20	2.50	10.20	12.50	4.91
Female	12.40	3.20	2.80	9.80	11.90	4.90

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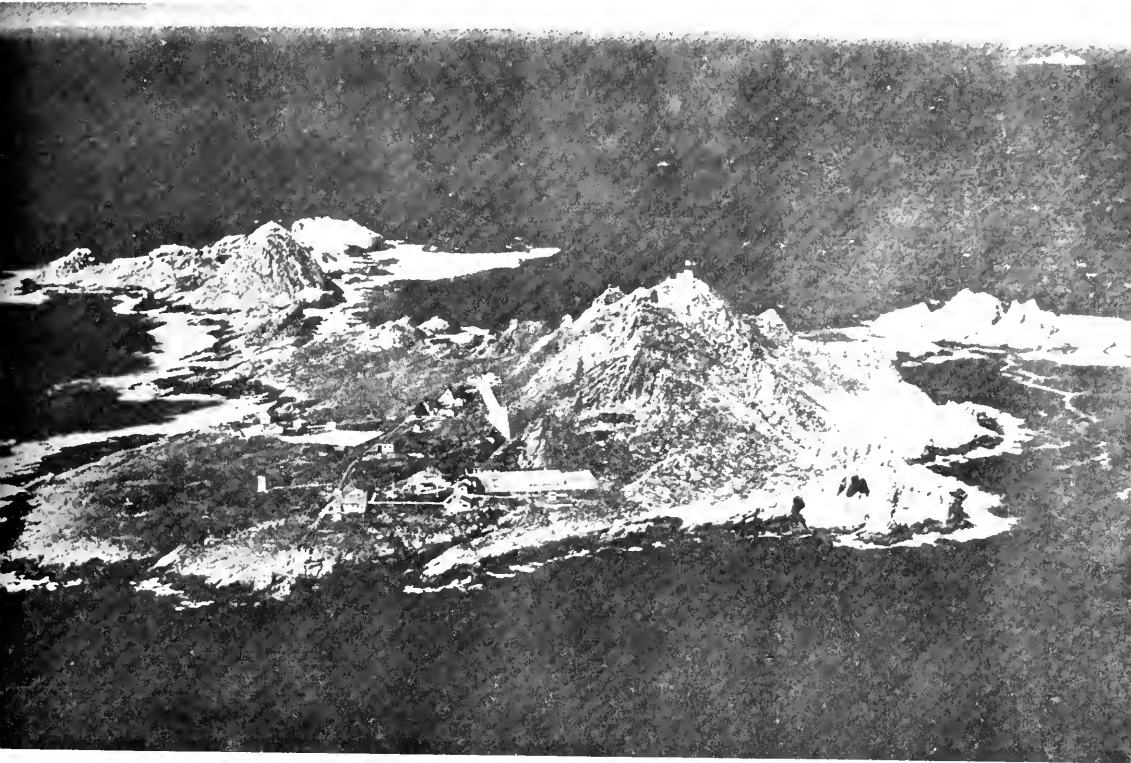


FIGURE 1. Aerial photo of South Farallon Island. Arrow indicates site of type locality of Farallon camel cricket. U. S. Coast Guard photo.

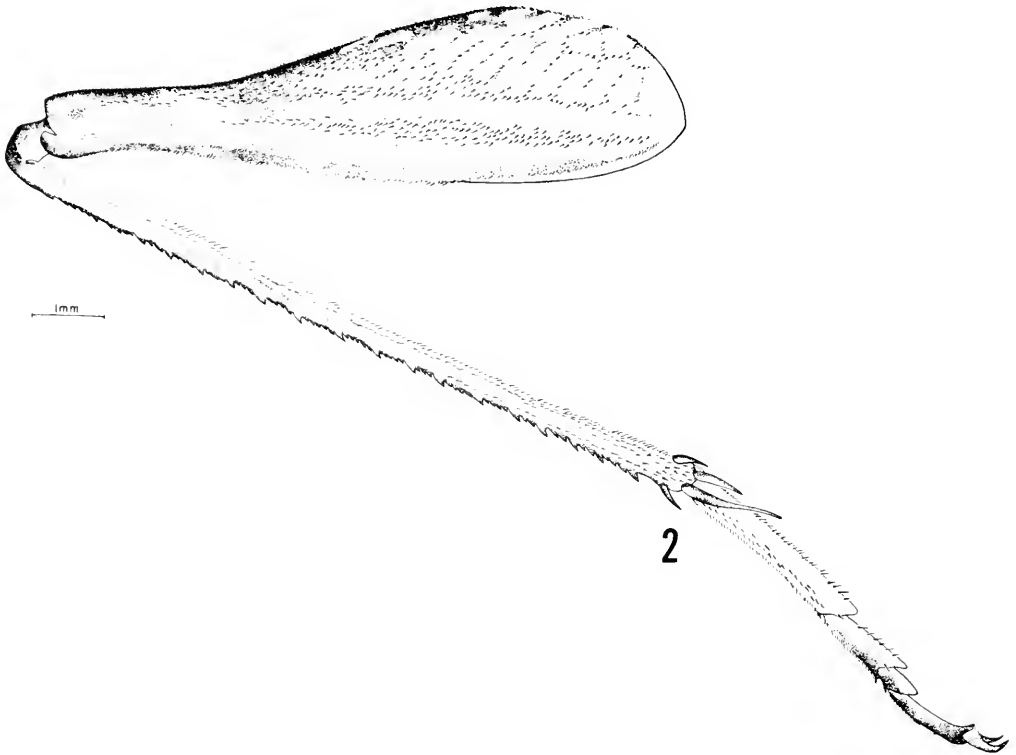
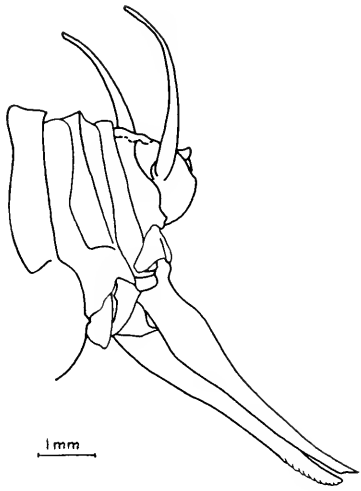


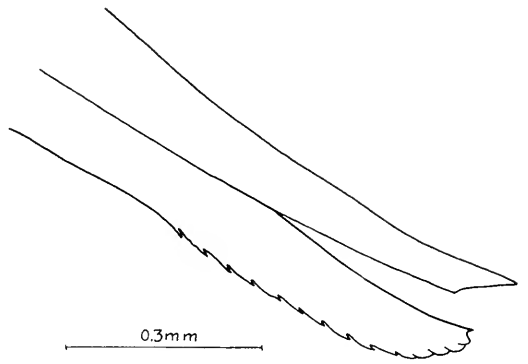
FIGURE 2. Farallonphilus cavernicolus Rentz, new genus and species. Right hind femur of adult female. Note color pattern emphasized by arrangement of setae.

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FIGURES 3 - 8. Farallonphilus cavernicolus Rentz, new genus and species. Figures 3-4. Allotype: figure 3, lateral view of distal abdominal segments; figure 4, ovipositor. Figures 5-7. Holotype: figure 5, ventral view of subgenital plate; figure 6, genitalia; figure 7, pseudosclerite. Figure 8. Adult female: maxillary palpus; note white sensory portion, groove not present.



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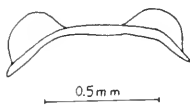
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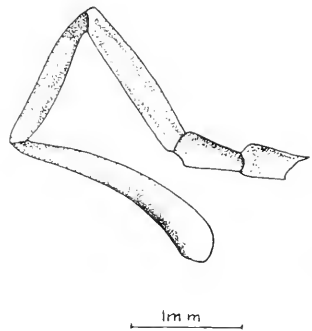
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