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GENERIC PLACEMENT OF THE EMPIRE CAVE PSEUDOSCORPION, *MICROCREAGRIS IMPERIALIS* (NEOBISIIDAE), A POTENTIALLY ENDANGERED ARACHNID

William B. Muchmore: Department of Biology, University of Rochester, Rochester, New York 14627 USA

James C. Cokendolpher: Adjunct Professor, Department of Biology, Midwestern State University, Wichita Falls, Texas 76308 USA

ABSTRACT. Types, topotypes, and some other material of the pseudoscorpion *Microcreagris imperialis* Muchmore have been studied, and the species is transferred to the genus *Fissilicreagris* Ćurčić. Supplemental description and illustrations are presented, including the first information about females. This species is known only from three caves in Cave Gulch, Santa Cruz County, California. The cave habitat for *F. imperialis* is threatened by vandalism, development, and closure; and the U. S. Fish and Wildlife Service has proposed this pseudoscorpion as a candidate for listing as an endangered or threatened species.

More than 1500 species and subspecies of animals in the United States are proposed by the U. S. Fish and Wildlife Service for listing as endangered or threatened (Drewry 1994). In most instances, these taxa have been submitted for consideration in the absence of any validation of taxonomic status. One of the candidate species of pseudoscorpions being reviewed for possible addition to the List of Endangered and Threatened Wildlife under the Endangered Species Act of 1973, as emended, is *Microcreagris imperialis* Muchmore, from Empire Cave, Santa Cruz County, California.

As Mahnert (1979) and Ćurčić (1983) have demonstrated, the genus *Microcreagris* Balzan is restricted to two species in China and Afghanistan, and the numerous American species which had been placed in that genus are improperly assigned. Ćurčić (1978–1989) created quite a few new genera and placed many of the American species in them; he was, however, unable to make definite generic assignments for some species, including *M. imperialis* (1984:165).

The purpose of this paper is to clarify the taxonomic position of *M. imperialis* so that this potentially endangered species can be identified properly in the literature. Furthermore, we wish to provide sufficient identification characteristics so that field biologists might more easily recognize this species in its native habitat.

METHODS

Specimens have been borrowed from the American Museum of Natural History, New York, New York (AMNH); California Academy of Sciences, San Francisco, California (CAS); D. Ubick personal collection, San Francisco, California (CDU); and the Florida State Collection of Arthropods, Gainesville, Florida (FSCA).

Unless otherwise stated, the specimens have been dissected, cleared, and mounted in Canada balsam on microscope slides.

Fissilicreagris imperialis (Muchmore), new combination
Empire Cave Pseudoscorpion
Figs. 1–9

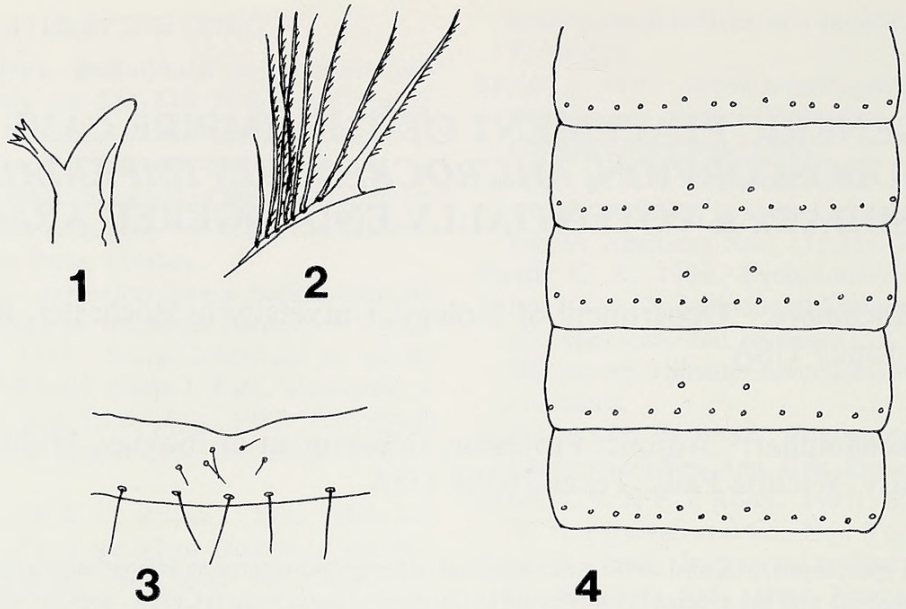
Microcreagris imperialis Muchmore 1969:13–15, 21, fig. 10; Arnett 1984:21666; Briggs & Ubick 1988:44; Drewry 1989:566; Coddington, Larcher & Cokendolpher 1990:11; Drewry 1991:58833; Harvey 1991: 342; Drewry 1994:59025.

'Microcreagris' imperialis: Ćurčić 1984:164, 165, figs. 20, 41.

Pseudoscorpion: Briggs 1990:180.

Type locality.—Empire Cave, in Cave Gulch, one mile NW of Santa Cruz, Santa Cruz County, California.

Material examined.—Holotype male and one paratype male from Empire Cave, 26 August

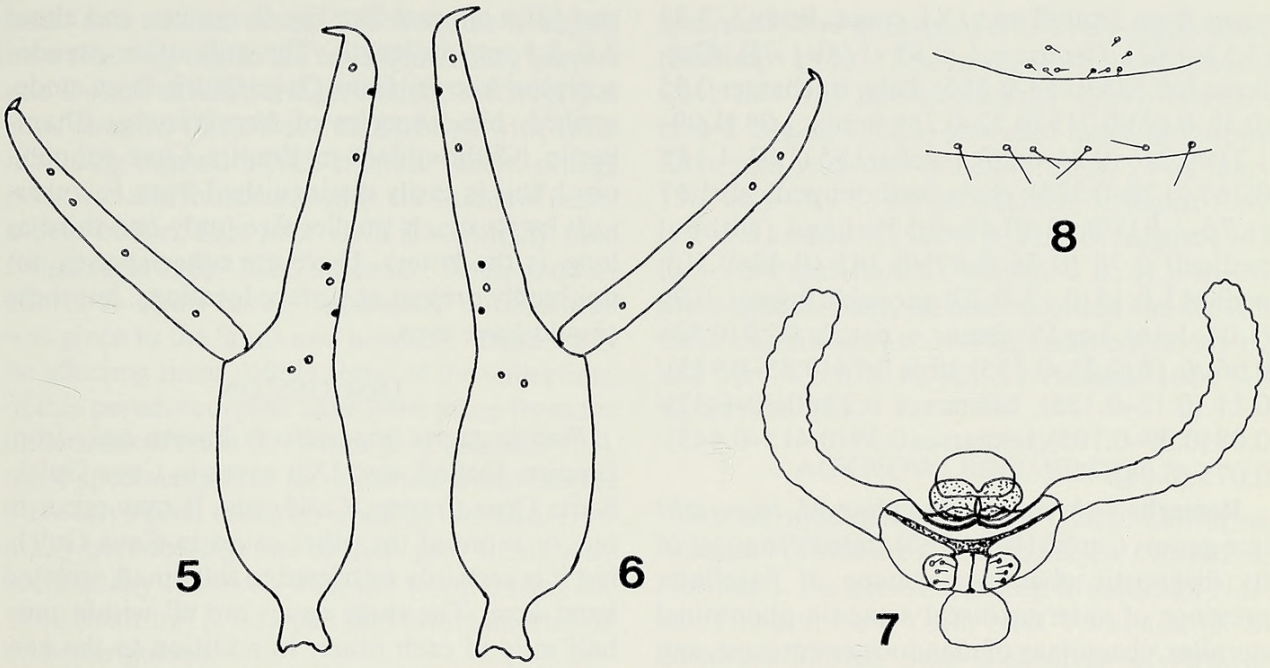


Figures 1–4.—*Fissilicreagris imperialis* (Muchmore), male holotype. 1, Tip of movable finger of chelicera, with galea; 2, Cheliceral flagellum; 3, Central part of sternite 3; 4, Sternites 5–9, showing chaetotaxy (setae omitted).

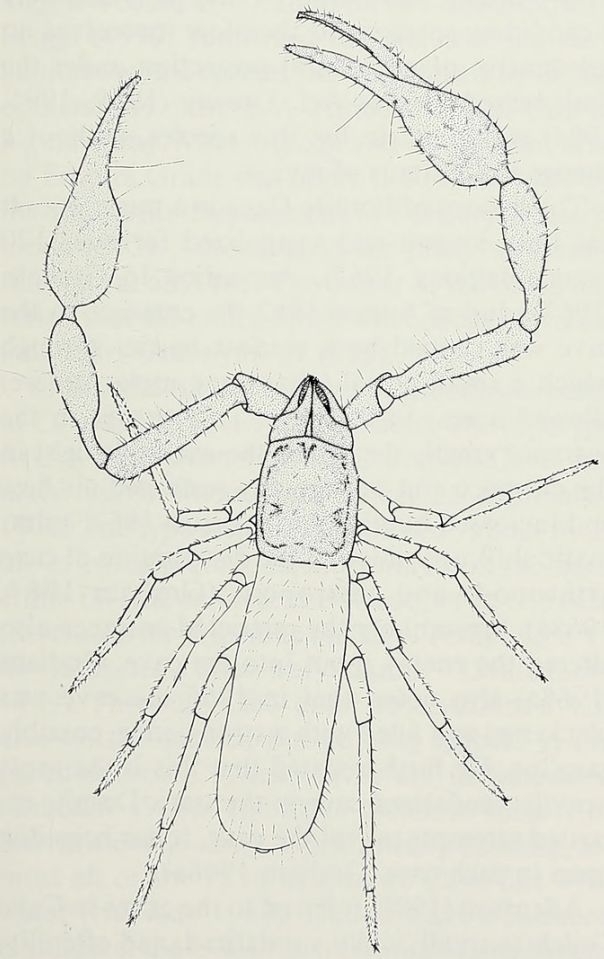
1963, R. E. Graham, mounted on slides (AMNH); one paratype male, same data (FSCA); one topotype female from Empire Cave, September 1972, R. Lem, mounted on slide (CAS); one topotype male from Empire Cave, 8 July 1989, D. Ubick, et al., in alcohol (CDU); two topotype males from Empire Cave, 8 September 1991, D. Ubick and S. Fend, mounted on slides (CAS); one female from Dolloff Cave, across Cave Gulch from Empire Cave, 22 April 1979, D. C. Rudolph et al., mounted on slide (CAS); three females from IXL Cave, in Cave Gulch one-half mile S of Dolloff Cave, 21 April 1979, D. C. Rudolph et al., two mounted, one in alcohol (CAS).

Supplementary description.—The topotypes and specimens from Dolloff and IXL caves are generally similar to the holotype and paratypes. Dimensions, proportions, and chaetotaxies of body and appendages vary slightly from the values given in the original description, but all appear conspecific with the types. A few features of the additional specimens are, however, worth mentioning.

Apex of palpal coxa (manducatory process) bears three setae in all specimens, as in types. Cheliceral galea short and twice bifid (Fig. 1); galeae of types also like this, not just "with four or five terminal spinules" as characterized in original description (Muchmore 1969:15). Cheliceral flagellum composed of 7–8 serrate setae (Fig. 2). Sternites 6, 7, and 8 with two setae on face near middle (discal setae) as in types (one topotype with two setae on face of sternite 5); sternites 9 and 10 with two corresponding setae slightly anterior to the marginal row (Fig. 4). Trichobothria on palpal chela of holotype as shown in Fig. 5 (and Ćurčić 1984: fig. 41); there is a little variation in position of trichobothria on fixed fingers of other specimens (Fig. 6). Genital opercula (sternites 2 and 3) of male about as illustrated for holotype (Ćurčić 1984: fig. 20); sternite 3 of holotype with 22 setae scattered broadly (paratypes and topotypes with 18–22 setae); sternite 3 of holotype with five small setae near middle and 11 larger setae along posterior margin (paratypes and topotypes with 5–9 small setae near middle and 12–13 along margin); anterior margin of sternite 3 slightly concave at middle (Fig. 3), but not as distinctly indented as in *Fissilicreagris chamberlini* (Beier) (see Ćurčić 1984: fig. 3). Genital opercula of female as shown in Fig. 8, similar to those of *F. chamberlini* (see Ćurčić 1984: fig. 4); sternite 2 with 8–11 small setae in two groups, on either side of midline; sternite 3 with 11–14 setae along posterior margin. In both sexes, on sternites 3 and 4, there are 4–7 small setae on each spiracular plate. Internal genitalia of holotype male shown in Fig. 7; generally similar to those of *Saetigerocreagris phyllisae* (Chamberlin) (see Chamberlin 1962: fig. 12), *Tartarocreagris texana* (Muchmore) (see Muchmore 1992: fig. 4), and *Fissilicreagris macilenta* (Simon) (see Muchmore 1994: fig. 4); the dorsal sacs are thin-walled and not as clearly separate



Figures 5–8.—*Fissilicreagris imperialis* (Muchmore). 5, Left palpal chela of holotype (male), lateral view, showing positions of trichobothria (darkened areoles are underneath); 6, Right palpal chela of paratype (male), lateral view; 7, Internal genitalia of holotype (male), ventral view (dorsal genital sacs stippled); 8, Central parts of sternites 2 and 3 of female (IXL Cave).



as in the three species mentioned; lateral sacs long and narrow. Internal genitalia of female not distinguished.

Measurements (mm).—*Male:* Figures given first for holotype, followed in parentheses by ranges for the two paratypes and two topotypes. Body L 3.50 (2.50–3.45). Carapace L 0.935 (0.89–0.96). Chelicera L 0.52 (0.495–0.56). Palp: trochanter 0.58 (0.56-0.63)/0.215 (0.205–0.23); femur 1.12 (1.08–1.19)/0.23 (0.215–0.24); patella 1.07 (1.00–1.11)/0.29 (0.28–0.305); chela (without pedicel) 1.73 (1.69–1.86)/0.435 (0.43–0.47); hand (without pedicel) 0.73 (0.70–0.815)/0.385 (0.38–0.43); pedicel L 0.16 (0.16–0.18); movable finger L 1.05 (1.03–1.15). Leg IV: femur + patella 0.89 (0.81–0.92)/0.215 (0.205–0.23); tibia 0.835 (0.79–0.89)/0.115 (0.11–0.125); basitarsus 0.29 (0.295–0.31)/0.095 (0.08–0.095); telotarsus 0.43 (0.40–0.445)/0.07 (0.07–0.075).

Female: Figures given first for topotype, followed in parentheses by ranges for three speci-

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Figure 9.—*Fissilicreagris imperialis* (Muchmore), female (IXL Cave). Dorsal view (setae are transparent and can only been seen with a microscope, not visible in field examinations).

mens from Dolloff and IXL caves. Body L 3.33 (3.52–3.62). Carapace L 0.89 (1.00–1.05). Chelicera L 0.525 (0.53–0.585). Palp: trochanter 0.55 (0.59–0.63)/0.215 (0.22–0.26); femur 1.03 (1.09–1.21)/0.215 (0.24–0.26); patella 0.95 (1.03–1.14)/0.265 (0.29–0.325); chela (without pedicel) 1.67 (1.76–1.91)/0.43 (0.48–0.55); hand (without pedicel) 0.70 (0.76–0.87)/0.385 (0.43–0.50); pedicel L 0.15 (0.17–0.20); movable finger L 0.96 (1.04–1.16). Leg IV: femur + patella 0.79 (0.87–0.96)/0.18 (0.21–0.235); tibia 0.74 (0.85–0.925)/0.11 (0.12–0.125); basitarsus 0.27 (0.30–0.32)/0.08 (0.09–0.105); telotarsus 0.39 (0.415–0.445)/0.075 (0.08).

Remarks.—Attempting to place *M. imperialis* in a genus, Ćurčić (1984:165) stated "In most of its diagnostic characters (shape of flagellum, presence of anterior discal setae on abdominal sternites, chaetotaxy of manducatory process, and trichobothriotaxy), it is closest to the genus *Australinocreagris* Ćurčić 1984]." This is generally correct, but it is also true that in these same characters *M. imperialis* is very similar to representatives of the genus *Fissilicreagris*, which are found in the same general area of California (see Ćurčić 1984:154–156; Muchmore 1994:63–64). In addition, the internal genitalia of male *M. imperialis* are more like those of *F. macilenta* (see Muchmore 1994) and *F. chamberlini* than those of *Australinocreagris grahami* (Muchmore) (unpubl. obs.); in particular, the dorsal genital sac of the latter species is entire and round in outline, while that of the first two species and *M. imperialis* is bilobed or divided into two separate round sacs. *Microcreagris imperialis* is also similar to the two species of the genus *Saetigerocreagris* Ćurčić in respect to the male genitalia, but it differs from them in proportions of body and appendages and in the chaetotaxies of various parts. Its relation to the genus *Tartarocreagris*, which also has similar male genitalia, but is presently known only from Texas, is uncertain.

It is concluded that *Microcreagris imperialis* Muchmore is most similar to *Fissilicreagris macilenta* and *F. chamberlini* and should be considered congeneric with them. Its major difference from them is its lack of eyes, a condition which is presumably an adaptation to life in caves.

Field recognition.—Although preserved material is required for positive identification, persons conducting a census of cave faunas or other work associated with protection of this species can be fairly certain that they have *Fissilicreagris imperialis* if: (1) it is in a cave in Cave Gulch, and (2) it appears like Fig. 9, eyeless, and about 3.0–3.5 mm in length. The only other pseudoscorpion known from Cave Gulch is an undescribed, blind species of *Neochthonius* Chamberlin (Chthoniidae) in Empire Cave (unpubl. obs.); this is easily distinguished from *F. imperialis* by its much smaller size (only one-third as long as the latter). There are other species undoubtedly present at surface locations, but these should have eyes.

DISCUSSION

Fissilicreagris imperialis is known only from Empire, Dolloff, and IXL caves in Cave Gulch, Santa Cruz County, California. It may occur in one or more of the other caves in Cave Gulch, but it is certainly restricted to this small, isolated karst area. The three caves are all within one-half mile of each other. In addition to the new records listed under specimens examined, it is important to note that D. Ubick (pers. comm. 1995) observed but did not collect more than six specimens in Empire Cave on 3 July 1993.

Microcreagris imperialis was first listed by the U.S. Fish and Wildlife Service as a candidate for review as an endangered or threatened species over a decade ago (Arnett 1984). It is still only a candidate species and therefore it receives no substantive or procedural protection under the Endangered Species Act. Drewry (1989, 1991, 1994) continued to list this species, without a change in its status of review.

The history of Empire Cave is a tragic one. It has been known and vandalized for over 120 years (Halliday 1962). According to Graham (1967), during August 1962 the entrance to the cave was capped by a cement barrier through which a small portal (about one meter square) allowed access to the cave. This change in the entrance greatly decreased the available light in the entrance and presumably restricted air flow and increased humidity. By August 1963, a dramatic shift was noted in the distribution of cave arthropods and gastropods (Graham 1967, 1968a). Presumably the restricted entrance also altered the energy input into the cave. Graham (1968a) also noted that in 1966 the cave was blackened and filled with a strong odor, possibly gasoline. He further stated that this is the most heavily vandalized cave in the state. Despite repeated attempts to seal the cave, it has been dug open in each case (Graham 1968a).

Adamson (1982) referred to the caves in Cave Gulch as small, badly vandalized, and often lit-

tered and trashed caves. She went on to report on a clean-up trip to the caves (including Empire and Dolloff caves) during March of 1982. At that time Empire Cave was "really filled with trash including papers, wood, cigarette butts, orange peels, etc. and most dangerous, the shards of many a beer bottle. This poor cave is reputedly used for parties etc. by UCSC students." As in so many efforts to clean caves, apparently no attention was given to the fauna and how this "trash" may be affecting them. While some of the collections of this pseudoscorpion have been taken from the undersides of rocks (D. Ubick pers. comm. 1995), most specimens thus far reported from Empire Cave have been taken on wood in the cave. How many pseudoscorpions or their prey items were accidentally removed with the wood during the 1982 clean-up? It is hoped that future efforts will be better guided.

Briggs & Ubick (1988) stated that Cave Gulch on the Gray Whale Ranch and nearby Empire Cave were in danger. At that time there were plans to log the area. Those authors felt that this activity could collapse caves and disturb root systems on which primary consumers feed, alter drainage, and block entrances. If the areas were logged it could also lead to further development. Briggs (1990) continued to state that the cave habitat for this species was threatened by development and closure. A Timber Harvest Plan to log the Gray Whale Ranch and an adjacent area on Empire Grade was approved in late 1994 by the California Department of Forestry (Anonymous 1995). According to the plan, harvesting can start at anytime. The owner of the ranch has stated that the entire ranch will be logged within four years (Anonymous 1995).

Little data on the biology of pseudoscorpions in Cave Gulch caves are available. The topotype female reported herein from Empire Cave was taken under wood at 20 °C on 25 September 1972. The type series was collected "about middle of twilight zone. Each captured on the floor either on side or bottom of wood, or in one case traveling over dripstone on floor. Temp. 53.5 °F, air saturated, floor very damp." (Muchmore 1969). There are a few other observations available on the habitat, but nothing specific to the pseudoscorpion. These caves are in limestone (Graham 1966). The Cave Gulch is subject to intermittent flooding. During heavy flooding, almost all of the 75 m of Empire Cave fills with water (Halliday 1962). Dolloff Cave's entrance is almost at the level of an intermittent side stream and must be re-excavated after every major flood (Halliday 1962). The lower portion of Empire Cave has clay floors (Graham 1967). Graham (1967, 1968a, 1968b) provided maps to Empire Cave and recorded the conditions: 29 January 1960 (6.9–7.3 °C, 94–99% R. H.), 7 August 1962 (9.0–9.3 and 12 °C, 100% R. H.), 26 August 1963 (9.3–10.9 and 12.8 °C, 96–100% R. H.). In the same publications, he also recorded the Dolloff Cave conditions as: 28 August 1963 (8.6–10.2 and 12.6 °C, 90% R. H.), 16 October 1966 (16 °C, 85% R. H.).

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