

Two new cavernicolous species of the pseudoscorpion genus *Cryptocreagris* from Colorado (Pseudoscorpiones: Neobisiidae)

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ABSTRACT

Two new cavernicolous species of the neobisiid genus *Cryptocreagris* are described from small caves situated in Colorado, western U.S.A.: *C. steinmanni* from Glenwood Caverns and Historic Fairy Caves and *C. destica* from Squeak Cave. These species are larger than other species of the genus, with elongated pedipalps and legs. The eyes, although not entirely absent, are reduced in size. Despite the caves being only 14 km apart, there are sufficient morphological differences between the two populations to justify the naming of two species.

Key words: taxonomy, Nearctic, troglobitic, morphology, caves

INTRODUCTION

The pseudoscorpion family Neobisiidae is mostly restricted to the Holarctic region, with representatives occurring in Europe, northern Africa, Asia and North America (see Harvey 2009). The only neobisiids recorded from outside of this area are a few species of *Microbisium* Chamberlin 1930 found in tropical eastern Africa (Beier 1955a; 1955b; 1964; Harvey 2009; Mahnert 1981) and a single record of *Neobisium carcinoides* (Hermann, 1804) from Kenya (Mahnert 1981). Many members of this family possess troglomorphic features resulting from isolation and evolution in cavernicolous environments. The world neobisiid fauna consists of 32 genera and 555 species (Harvey 2009), of which 18 genera and 63 species are currently known from North America. The genus *Cryptocreagris* Čurčić, 1984 presently contains only three species which are found in western North America (Čurčić 1984; 1993; Harvey 2009). The type species, *C. laudabilis* (Hoff, 1956) has only been found at Mt Taylor, Valencia County, New Mexico (Čurčić 1984; Hoff 1956). *Cryptocreagris magna* (Banks, 1909) was originally described from Mount Shasta, Siskiyou County, California (Banks 1909), and later recorded from Napa County and Del Norte County (Čurčić 1984). *Cryptocreagris tibialis* (Banks, 1909) is known from Florissant, Teller County, Colorado (Banks 1909; Čurčić 1993).

The present study commenced after specimens of *Cryptocreagris* collected in two Colorado caves were submitted to WBM for study. The presence of long appendages, large bodies and reduced eyes suggested long isolation in cavernicolous habitats and were worthy of description to better understand the subterranean pseudoscorpion fauna of the Rocky Mountains. After the

retirement of WBM, the specimens were dispatched to MSH for further study, illustration and completion of the manuscript. In a complementary paper currently in preparation by Steven J. Taylor and MSH, the systematic position of *M. grandis* Muchmore, 1962 from Nevada, U.S.A. (Muchmore 1962) - which appears to be similar to the new species described here - will be examined.

MATERIAL AND METHODS

The specimens used in this study are lodged in the Denver Museum of Nature and Science, Denver (DMNS) and the Western Australian Museum, Perth (WAM), and were studied using three techniques. Temporary slide mounts were prepared by immersion of specimens in concentrated lactic acid at room temperature for several days, and mounting them on microscope slides with 10 or 12 mm coverslips supported by small sections of 0.25, 0.35 or 0.50 mm diameter nylon fishing line. After study the specimens were returned to 75% ethanol with the dissected portions placed in 12 x 3 mm glass genitalia microvials (BioQuip Products, Inc.). Some of the specimens treated here were cleared and mounted on slides by WBM for microscopic examination, generally following the procedure outlined by Hoff (1949) but using clove oil instead of beechwood creosote for clearing. All specimens were studied by MSH using an Olympus BH-2 or a Leica DM2500 compound microscopes and illustrated with the aid of a drawing tube. Measurements were taken at the highest possible magnification using an ocular graticule. Terminology and mensuration mostly follows Chamberlin (1931), with the exception of the nomenclature of the male genitalia (Legg 1975), chelicera (Judson 2007), pedipalps, legs and with some mi-

nor modifications to the terminology of the trichobothria (Harvey 1992). Measurements were taken to the nearest 0.005 mm.

The GPS coordinates of Squeak Cave have been rounded to the nearest minute to provide protection for the cave (D. Steinmann, in litt., October 2009).

TAXONOMY

Family Neobisiidae Chamberlin, 1930
Subfamily Microcreagrinae Balzan, 1892

Diagnosis

Microcreagrinae differ from Neobisiinae solely in the presence of a distinct galea on the movable finger of the chelicera.

Remarks

The North American neobisiid fauna includes 16 genera of which four (*Novobisium* Muchmore, 1967, *Parobisium* Chamberlin, 1930, *Roncus* L. Koch 1873 and *Trisetobisium*, Čurčić 1982) are assignable to Neobisiinae, and 12 (*Alabamocreagris* Čurčić, 1984, *Americocreagris* Čurčić, 1982, *Australinocreagris* Čurčić, 1984, *Cryptocreagris* Čurčić, 1984, *Fissilicreagris* Čurčić, 1984, *Globocreagris* Čurčić, 1984, *Halobisium* Chamberlin, 1930, *Lissocreagris* Čurčić, 1981, *Minicreagris* Čurčić, 1989, *Saetigerocreagris* Čurčić, 1984, *Tartarocreagris* Čurčić, 1984, and *Tuberoocreagris* Čurčić, 1978) to Microcreagrinae. The distinctions between some of these microcreagrine genera are very slight and the entire North American fauna requires extensive review to understand their evolutionary relationships and generic classification. Indeed, it is doubtful that Microcreagrinae represent a monophyletic taxon, as they are defined by a single feature, the presence of a cheliceral galea, which is an obvious plesiomorphy (Murienne et al 2008). The other neobisiid subfamily, Neobisiinae, is defined by the reduction of the galea to a sclerotic process (e.g. Beier 1932; Chamberlin 1930).

The current generic system for North American Microcreagrinae was developed in a series of papers that primarily used abdominal setal patterns, mainly in the genital area to define the genera (Čurčić 1978; 1981; 1982a; 1982b; 1984; 1989; 1993). Muchmore (1994; 2001) and Muchmore and Cokendolpher (1995) noted considerable difficulties in interpreting some of these morphological features and in assigning newly discovered species into the generic classification. Similar problems were found in assessing the systematic position of the cave-dwelling species from Colorado examined for this study. Despite these uncertainties we here include the new species within *Cryptocreagris* as it shows obvious similarities to the type species, *C. laudabilis* from New Mexico. The relationship of these species to other neobisiid genera, and their generic placement, will require an extensive review of the North American neobisiid fauna which is beyond the scope of the present study.

Genus *Cryptocreagris* Čurčić, 1984

Cryptocreagris Čurčić, 1984: 158-160; Čurčić, 1989: 354; Harvey, 1991: 334; Čurčić, 1993: 69; Harvey, 2009: [unpaginated].

Type species

Microcreagris laudabilis Hoff, 1956, by original designation.

Diagnosis

Cryptocreagris is a member of Microcreagrinae with the following combination of characters: fixed finger of chela with trichobothria *et*, *it* and *est* in distal half, and *eb*, *esb*, *ist*, *isb* and *ib* in proximal half; male genitalia without paired dorsal sac; sternites VI and VII each with a pair of anteriorly placed setae.

Description

Chelicera: large, about 0.5-0.6 as long as carapace; hand usually with 7 setae, occasionally with 6 or 8 setae; rallum usually with 7-8 blades, but occasionally 10 blades, each blade with anterior serrations; galea deeply subdivided with each ramus further divided into 2 smaller rami.

Pedipalps: manducatory process of coxa with 5 (occasionally 4 or 6) long, apical setae. Chelal fingers with numerous contiguous marginal teeth. Fixed finger of chela with trichobothria *et*, *it* and *est* in distal half, and *eb*, *esb*, *ist*, *isb* and *ib* in proximal half. Venom apparatus present only in fixed finger.

Cephalothorax: carapace longer than broad; epistome small to absent; 2 pairs of eyes, although these are greatly reduced in cavernicolous forms; usually with 24 setae, but occasionally with 23-29 setae, with 4 near anterior margin, and with 6 (occasionally 5 or 7) near posterior margin.

Legs: legs I and II with femur much longer than patella, and tarsus longer than metatarsus; legs III and IV with the suture between femur and patella nearly perpendicular to the long axis and a little proximad of the middle of the combined segment; subterminal tarsal setae prominently bifurcate and with small spinules along each branch; arolia shorter than claws.

Abdomen: tergites uniseriate; most sternites uniseriate, but sternites VI and VII with 2 anteriorly placed setae; sternite III with marginal row of setae of moderate size.

Genitalia: male genitalia with conspicuous round ventral sac, 1 smaller, round or ovoid dorsal sacs, and 2 wrinkled lateral sacs. Female genitalia with small gonosac which is covered with scattered pores.

Remarks

The diagnostic feature of *Cryptocreagris* cited by Čurčić (1984; 1989) is the presence of a pair of setae situated near the mid-line on abdominal sternites VI and VII, but not on sternite VIII. Čurčić (1993) later modified the generic diagnosis and noted that similar setae

are indeed present on sternite VIII, although these setae are not situated anterior to the regular setae on the sternite as they are on sternites VI and VII. Paired setae that are situated anterior to the main setal row on the medial sternites have been reported from a variety of different neobisioid pseudoscorpions, but are apparently absent from all species of Hyidae, Gymnobisiidae, Ideoroncidae, Parahyidae and Syarinidae (e.g. Harvey and Volschenk 2007; Judson 1992).

Ćurčić (1993) failed to indicate how *Cryptocreagris* could be satisfactorily distinguished from other North American or Palearctic microcreagrine neobisiids with anteriorly displaced setae on sternites VI and VII, especially as the other characters cited by Ćurčić (1984) to distinguish these genera (e.g. disposition of setae on the female genital sternites, and the number of setae on the distal margin of the manducatory process) can vary within neobisiid genera. Muchmore (1994) noted

that species of *Globocreagris* and *Fissilicreagris* actually possess such sternal setae, claimed to be absent by Ćurčić (1984; 1989), but as in species of *Cryptocreagris*, they are poorly differentiated from the regular setae on the median sternites.

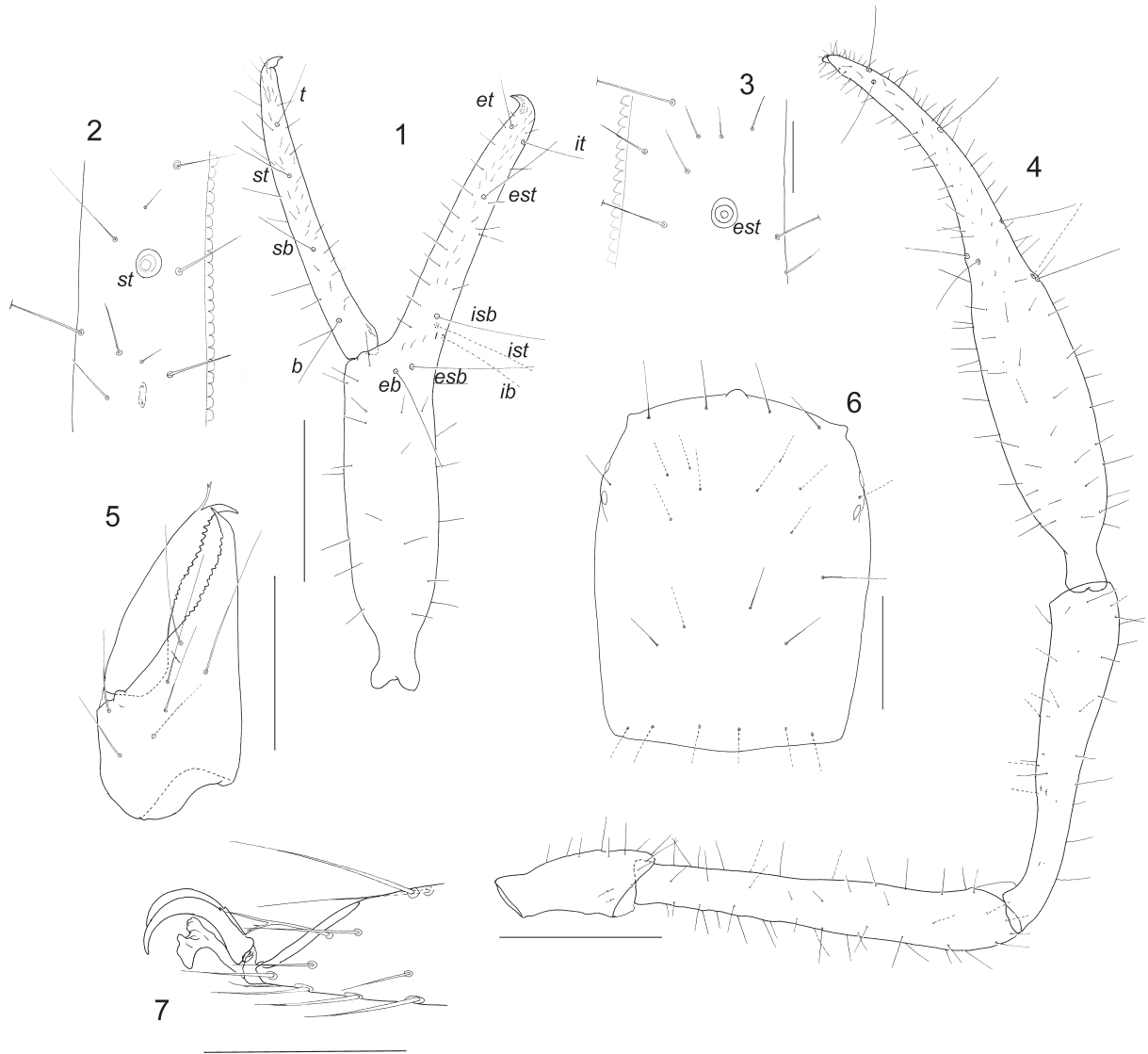
In the absence of a robust phylogenetic system for microcreagrine neobisiids, we here retain the genus *Cryptocreagris* for those microcreagrines with the combination of characters listed above in the diagnosis.

Cryptocreagris steinmanni, sp. nov.

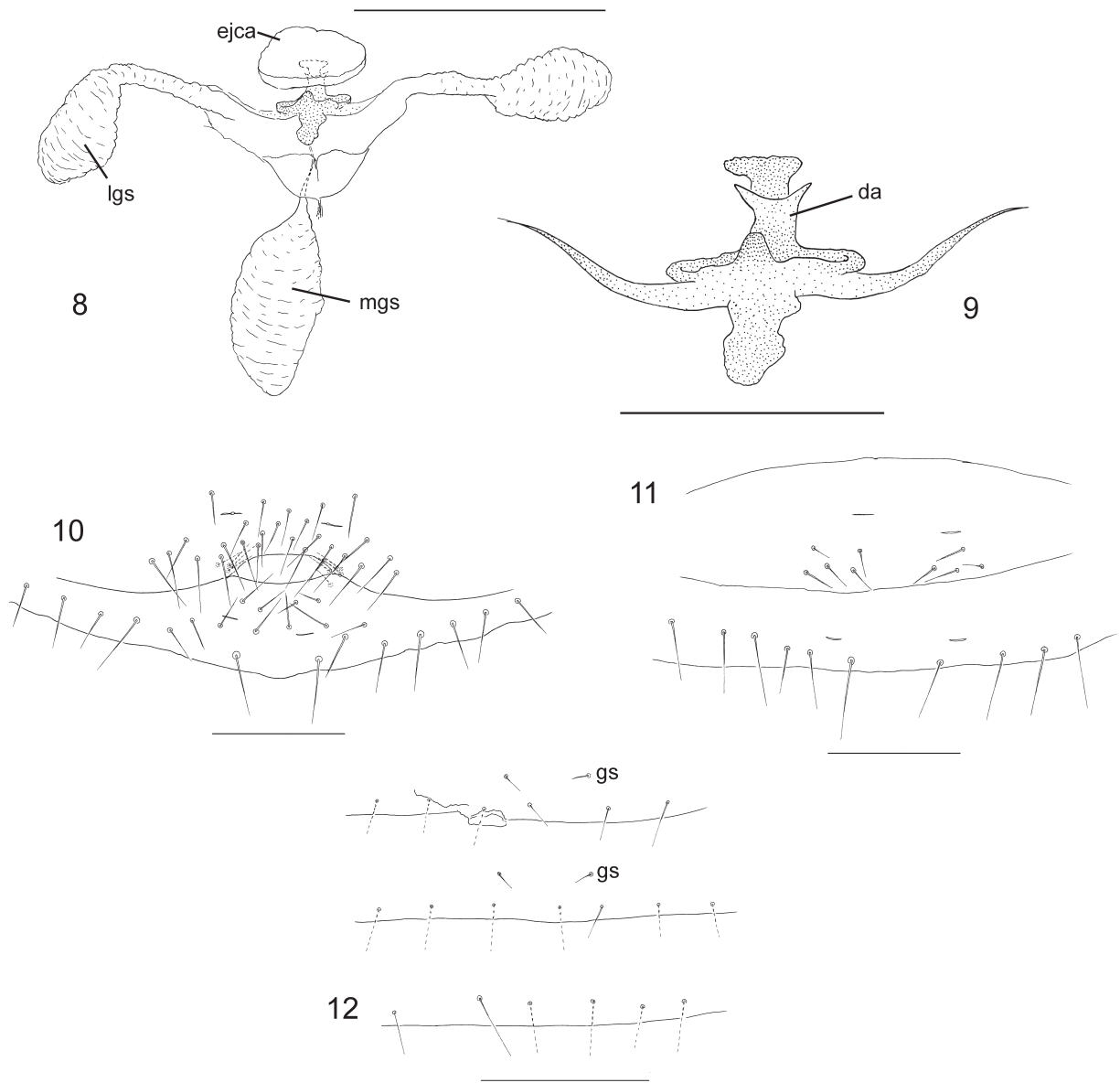
Figs 1-12

Material examined

Types: U.S.A.: Colorado: holotype male, Glenwood Caverns and Historic Fairy Caves, Garfield County, 39°33'53"N, 107°19'45"W, 2 000 m elevation, in



Figs 1-7 - *Cryptocreagris steinmanni*, sp. nov., holotype male unless stated otherwise: 1, left chela, lateral aspect; 2, teeth of movable chelal finger, lateral aspect; 3, teeth of fixed chelal finger, lateral aspect; 4, right pedipalp, dorsal aspect; 5, left chelicera, dorsal aspect; 6, carapace, dorsal aspect; 7, tip of right leg IV, lateral aspect. Scale lines = 1.0 mm (Figs 1, 4), 0.5 mm (Figs 5—7), 0.1 mm (Figs 2, 3).



Figs 8-12 - *Cryptocreagris steinmanni*, sp. nov.: 8, genitalia, ventral aspect, holotype male; 9, detail of genitalia, ventral aspect, holotype male; 10, sternites II and III (genital sternites), holotype male; 11, sternites II and III (genital sternites), paratype female (WM8347.01002); 12, sternites VI—VII, ventral aspect holotype male. Abbreviations: da, dorsal apodeme; ejca, ejaculatory canal atrium; gs, glandular seta; lgs, lateral genital sac; mgs, median genital sac. Scale lines = 0.5 mm (Figs 8, 12), 0.2 mm (Figs 9—11).

dark zone, 15 April 2000, D.B. Steinmann (DMNS, WM8347.01001, slide). Paratypes: 2 females, collected with holotype (DMNS, WM8347.01002- 3, slides); 1 male, same data except in from side passage off Bright Angel Halls, dark zone under a rock, 7 August 2008, D. Steinmann (WAM T81128, ethanol).

Etymology

This species is named for David Steinmann, collector of the type specimens.

Diagnosis

Cryptocreagris steinmanni differs from *C. destica*

in the presence of only 2-4 microsetae on the internal face of the male patella (Fig. 1), and in being larger and with slightly thinner pedipalps, e.g. pedipalpal femur 2.50- 2.55 (♂), 2.32-2.42 (♀) mm in length, 7.25-7.50 (♂), 6.03-6.49 (♀) x longer than broad, and chela (with pedicel) 3.68-4.03 (♂), 3.71-3.79 (♀) mm in length, 6.30-6.55 (♂), 5.49-5.50 (♀) x longer than broad.

Description

Adult: colour generally light red-brown, pedipalps and carapace darker than remaining body. Setae generally long, straight and acicular.

Chelicera (Fig. 5): large and robust; with 7 setae on

hand; movable finger with 1 subdistal seta; galea prominent, deeply subdivided with each ramus further divided into 2 smaller rami; fixed finger with 16- 17 (δ , φ) small teeth; movable finger with 16- 17 (δ , φ) small teeth; serula exterior with 35 (δ , φ) blades; rallum of 7 blades, each with numerous serrations; dorsal face with 2 lyrifissures, exterior lyrifissure situated near seta *is*, exterior condylar lyrifissure situated near exterior condyle, ventral face with 1 lyrifissure, interior lyrifissure situated near rallum; lamina exterior and velum absent.

Pedipalp (Fig. 4): all segments extremely elongated; trochanter 2.42-2.44 (δ), 2.40-2.44 (φ), femur 7.25-7.50 (δ), 6.03-6.49 (φ), patella 5.70-5.89 (δ), 4.91-5.03 (φ), chela (with pedicel) 6.30-6.55 (δ), 5.49-5.50 (φ), chela (without pedicel) 5.91-6.18 (δ), 5.16-5.18 (φ), hand (without pedicel) 2.90-3.14 (δ), 2.50-2.61 (φ) x longer than broad, movable finger 1.06-1.10 (δ), 1.02-1.17 (φ) x longer than hand. Trochanter, femur and patella smooth; chela smooth except for light granulations on internal face. Patella with pronounced interno-distal excavation, and long, slender pedicel; internal face of male with 2- 4 microsetae (Fig. 1), females lack these microsetae; with 1 basal and 2 sub-basal lyrifissures. Fixed chelal finger with 8 trichobothria, movable chelal finger with 4 trichobothria (Fig. 1): *eb* and *esb* at base of finger; *isb* on external face of fixed finger; *est* situated closer to *et* than to *isb*; *ist* sub-basal, situated near *ib*; *et* slightly distal to *it*; *b* situated closer to basal end of finger than to *sb*; *t* slightly closer to *st* than to end of finger; *t* long and acuminate. Diploid sensillum situated on movable chelal finger slightly basal to *st* (Fig. 2). Venom apparatus present only in fixed chelal finger, venom duct terminating in nodus ramosus almost immediately. Chelal hand with rounded externo-distal condyle. Chelal teeth small and contiguous: fixed finger (Fig. 3) with ca. 99 (δ), 95-112 (φ) teeth, slightly pointed, especially the distal teeth; movable finger (Fig. 2) with ca. 109 (δ), 96-110 (φ) mostly truncated teeth.

Cephalothorax: carapace (Fig. 6) 1.32-1.41 (δ), 1.11-1.26 (φ) x longer than broad; lateral margins evenly convex; with 4 very small eyes, with barely distinguished lenses, each very flat; with prominent epistome; δ with 23 setae, arranged 4: 6: 3: 4: 6, φ with 27-29 setae, arranged 4: 9-10: 3-4: 4-6: 6; without furrows or any regions of rugosity. Coxae narrow, coxa IV not much wider than coxa I; pedipalpal coxa with 11 (δ , φ) setae plus 5 pairs of apical setae on manducatory process, apex rounded; median maxillary lyrifissure U-shaped, situated sub-medially, posterior maxillary lyrifissure semi-circular; chaetotaxy of coxa I- IV: holotype δ , 7: 8: 7: 11; paratype φ (WM8347.01002), 8: 7: 6: 10; coxa I with rounded antero-lateral process near foramen of leg I; antero-medial area without process but with minute denticles.

Abdomen: somewhat narrowly ovate, much longer than broad. Pleural membrane densely granulate. Tergites: segments not divided; all setae acuminate and arranged in uniseriate rows; tergite XII with several small papillae; chaetotaxy: holotype δ , 6: 6: 7: 7: 8: 8: 10: 11: 11: 9: 7: 2; paratype φ (WM8347.01002), 6: 6: 8: 9: 11:

9: 9: 10: 12: 9: 6: 2. Sternites: segments not divided, except for sternite IV of δ ; all setae acuminate and mostly arranged in uniseriate rows, except for sternites VI and VII which bear a pair of medial setae slightly anterior to other setae (Fig. 12); chaetotaxy: holotype δ , 28: (5) 23 [4 + 4] (5): (4) 12 (4): 13: 13 + 2: 12 + 2: 12: 12: 11: 8: 2; paratype φ (WM8347.01002), 9: (6) 8 (5): (5) 8 (4): 12: 13 + 2: 13 + 2: 14: 14: 12: 8: 2; setae of genital sternites (sternites II and III) of δ densely situated (Fig. 10); setae of anterior genital sternite (sternite II) of φ small, and in two groups either side of mid-line (Fig. 11); posterior genital sternite of δ without anterior notch (Fig. 10). Tergite XII and sternite XII slightly more sclerotized than segment XI.

Genitalia: male genitalia (Figs 8, 9) with prominent T-shaped dorsal apodeme; without paired dorsal sac; median genital sac ovoid, not bifurcate; lateral genital sacs ovoid. Female genitalia with small gonosac which is covered with scattered pores.

Legs: long and slender; femur I and II longer than patella I and II, respectively; femur I and II with 2 small sub-basal slit sensilla, and a larger, sub-distal longitudinally directed slit sensillum; femur + patella IV 4.92-5.24 (δ), 4.75-4.80 (φ) x longer than broad; metatarsi III and IV with 1 tactile seta, situated sub-basally; tarsi III and IV with 1 tactile seta, situated sub-medially; subterminal tarsal setae deeply bifurcate, each branch denticulate (Fig. 7); arolium shorter than claws (Fig. 7); arolia not divided; claws slender.

Dimensions (mm)

Holotype male, followed by WAM T81128 in parentheses: Body length 4.56 (3.60). Pedipalps: trochanter 1.005/0.415, femur 2.50/0.345 (2.55/0.34), patella 2.25/0.395 (2.385/0.405), chela (with pedicel) 3.68/0.585 (4.03/0.615), chela (without pedicel) 3.455 (3.80), hand (without pedicel) length 1.695 (1.93), movable finger length 1.865 (2.055). Chelicera 0.92/0.63. Carapace 1.58/1.20 (1.64/1.16); anterior eye diameter 0.065; posterior eye diameter 0.07. Leg I: femur 1.025/0.21, patella 0.735/0.19, tibia 1.055/0.165, metatarsus 0.50/0.115, tarsus 0.68/0.11. Leg IV: femur + patella 1.78/0.34, tibia 1.83/0.205, metatarsus 0.60/0.155, tarsus 0.815/0.135.

Paratype female (WM8347.01002) followed by other paratype (WM8347.01003) in parentheses (where applicable): Body length 4.77 (4.41). Pedipalps: trochanter 0.985/0.41 (1.025/0.42), femur 2.42/0.37 (2.32/0.385), patella 2.185/0.445 (2.165/0.43), chela (with pedicel) 3.79/0.69 (3.71/0.675), chela (without pedicel) 3.56 (3.495), hand (without pedicel) length 1.80 (1.685), movable finger length 1.83 (1.97). Chelicera 0.96/0.455; movable finger length 0.67. Carapace 1.605/1.275 (1.60/1.445); anterior eye diameter 0.105; posterior eye diameter 0.09. Leg I: femur 1.04/0.225, patella 0.72/0.20, tibia 1.03/0.155, metatarsus 0.455/0.12, tarsus 0.665/0.12. Leg IV: femur + patella 1.745/0.365 (1.78/0.375), tibia 1.825/0.215, metatarsus 0.61/0.16, tarsus 0.81/0.145.

Cryptocreagris destica, sp. nov.
Figs 13—18

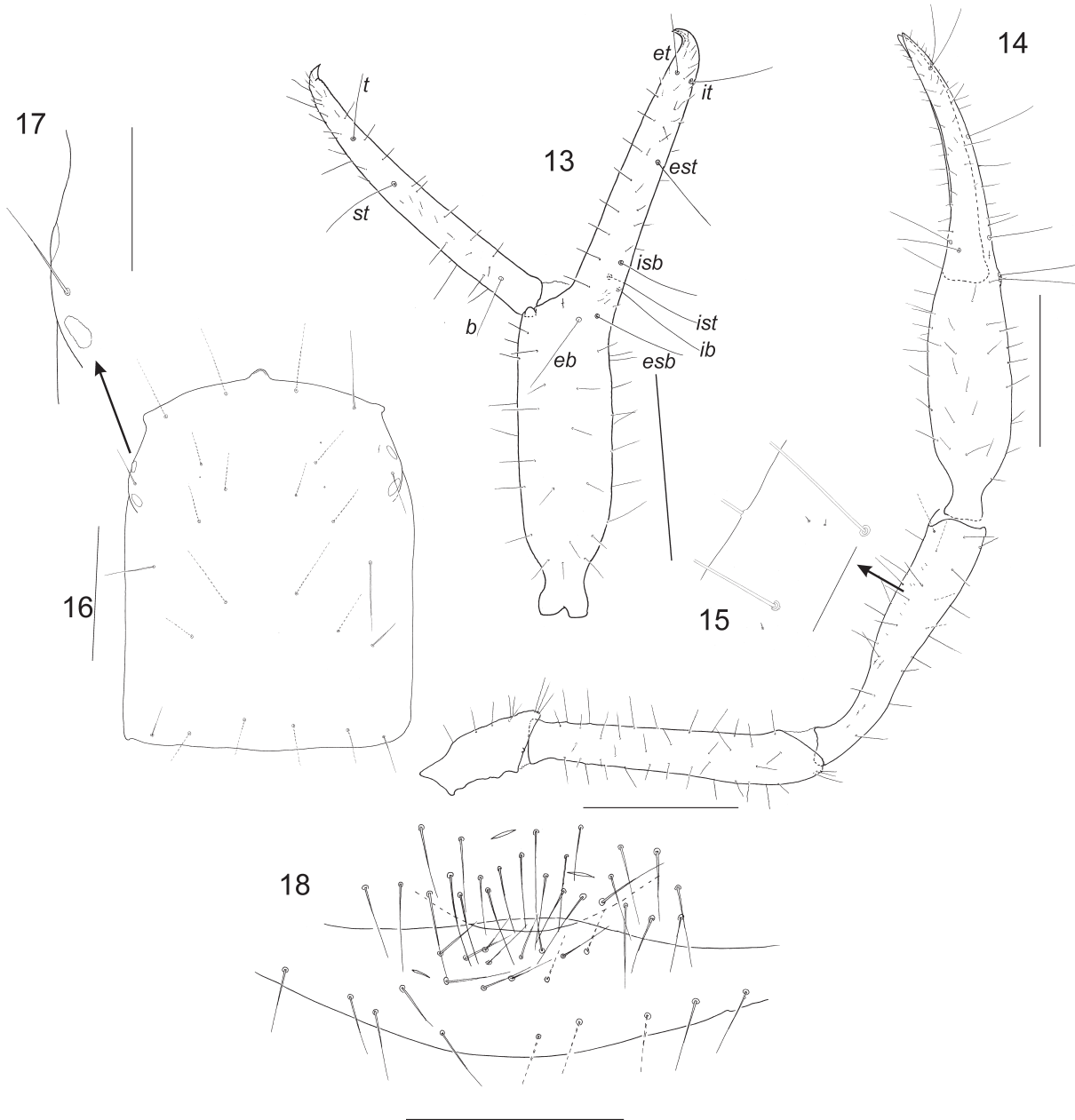
Material examined

Types: U.S.A.: Colorado: holotype male, Squeak Cave No. 1, Garfield County, ca. 39°38'N, 107°14'W, 2 990 m elevation, under rock in dark zone, 8 June 2000, D.B. Steinmann (DMNS, WM8349.01001, slide). Paratypes: 1 male, 1 female, same data except 12 September 2004, one under a rock, one on a rock (DMNS, ethanol);

1 female, same location, 2 October 2009, in dark zone 25 feet from entrance, under rock, D. and D.B. Steinmann (DMNS, 2009-44, ethanol).

Etymology

The species epithet is based upon the type locality, Squeak Cave (*desticus*, Latin, squeak like a mouse) (Brown 1956). The cave is often a home for marmots, which make a loud whistle/squeak noise when alarmed, hence the name “Squeak Cave” (D. Steinmann, in litt. October 2009).



Figs 13-18 - *Cryptocreagris destica*, sp. nov., holotype male: 13, left chela, lateral aspect; 14, right pedipalp, dorsal aspect; 15, detail of pedipalpal patella; 16, carapace, dorsal aspect; 17, left eyes; 18, sternites II and III, ventral aspect. Scale lines = 1.0 mm (Figs 13, 14), 0.5 mm (Fig. 16), 0.2 mm (Figs 17, 18), 0.1 mm (Fig. 15).

Diagnosis

Cryptocreagris destica differs from *C. steinmanni* by the presence of 7 microsetae on the internal face of the male patella (Fig. 15), and in being smaller and with slightly thicker pedipalps, e.g. pedipalpal femur 1.95-2.07 (♂), 2.115-2.27 (♀) mm in length, 5.91-6.57 (♂), 5.82- 5.96 (♀) x longer than broad, and chela (with pedicel) 3.21-3.285 (♂), 3.445 (♀) mm in length, 6.08- 6.11 (♂), 4.99-5.07 (♀) x longer than broad.

Description

Adult: colour generally light red-brown, pedipalps and carapace darker than remaining body. Setae generally long, straight and acicular.

Chelicera: large and robust; with 7 setae on hand; movable finger with 1 subdistal seta; galea prominent, deeply subdivided with each ramus further divided into 2 smaller rami; fixed finger with 16 (♂, ♀) small teeth; movable finger with 17 (♂), 15 (♀) small teeth; serrula exterior with 36 (♂, ♀) blades; rallum of 7 blades, each with numerous serrations; dorsal face with 2 lyrifissures, exterior lyrifissure situated near seta *is*, exterior condylar lyrifissure situated near exterior condyle, ventral face with 1 lyrifissure, interior lyrifissure situated near rallum; lamina exterior and velum absent.

Pedipalp (Fig. 14): all segments extremely elongated; trochanter 2.51-2.55 (♂), 2.27 (♀), femur 5.91-6.57 (♂), 5.82-5.96 (♀), patella 4.99-5.24 (♂), 4.60-4.66 (♀), chela (with pedicel) 6.08-6.11 (♂), 4.99-5.07 (♀), chela (without pedicel) 5.67-5.69 (♂), 4.71-4.75 (♀), hand (without pedicel) 2.57-2.81 (♂), 2.28-2.46 (♀) x longer than broad, movable finger 1.08-1.24 (♂), 1.10-1.13 (♀) x longer than hand. Trochanter, femur and patella smooth; chela smooth except for light granulations on internal face. Patella with pronounced interno-distal excavation, and long, slender pedicel; internal face of male with 7 microsetae (Fig. 13); with 3 basal and 2 sub-basal lyrifissures. Fixed chelal finger with 8 trichobothria, movable chelal finger with 4 trichobothria (only 3 trichobothria on left chela of holotype, *sb* absent) (Fig. 13): *eb* and *esb* at base of finger; *isb* on external face of fixed finger; *est* situated closer to *et* than to *isb*; *ist* sub-basal, situated near *ib*; *et* slightly distal to *it*; *b* situated closer to basal end of finger than to *sb*; *t* slightly closer to *st* than to end of finger; *t* long and acuminate. Diploid sensillum situated on movable chelal finger slightly basal to *st*. Venom apparatus present only in fixed chelal finger, venom duct terminating in nodus ramosus almost immediately. Chelal hand with rounded externo-distal condyle. Chelal teeth small and contiguous: fixed finger with 106 (♂), 101 (♀) slightly pointed teeth; movable finger with 106 (♂), 97 (♀) truncate teeth.

Cephalothorax: carapace (Fig. 16) 1.31-1.38 (♂), 1.44-1.49 (♀) x longer than broad; lateral margins evenly convex; with 4 very small eyes, with barely distinguished lenses, each very flat (Fig. 17); with prominent rounded epistome; ♂ with 23 or 24 setae, arranged 4: 6: 4: 3: 6 (holotype) and 4: 5: 5: 4: 6 (paratype), both ♀ with 23 se-

tae, arranged 4: 6: 3: 4: 6; without furrows or any regions of rugosity. Coxae narrow, coxa IV not much wider than coxa I; pedipalpal coxa with 10-12 (♂), 11-13 (♀) setae plus 4-6 (♂), 4-5 (♀) pairs of apical setae on manducatory process, apex rounded; median maxillary lyrifissure U-shaped, situated sub-medially, posterior maxillary lyrifissure semi-circular; chaetotaxy of coxa I- IV: holotype ♂, 9: 7: 7: 13; paratype ♀, 8: 7: 6: 12; coxa I with rounded antero-lateral process near foramen of leg I; antero-medial area without process but with minute denticles.

Abdomen: somewhat narrowly ovate, much longer than broad. Pleural membrane densely granulate. Tergites: segments not divided; all setae acuminate and arranged in uniseriate rows; tergite XII with several small papillae; chaetotaxy: holotype ♂, 6: 6: 8: 8: 8: 9: 12: 12: 10: 12: 6: 2; paratype ♀, 6: 6: 8: 8: 8: 9: 10: 10: 9: 9: 4: 2. Sternites: segments not divided, except for sternite IV of ♂; all setae acuminate and mostly arranged in uniseriate rows, except for sternites VI and VII which bear a pair of medial setae slightly anterior to other setae; chaetotaxy: holotype ♂, 26: (5) 24 [2 + 2] (4): (5) 8 (5): 13: 12 + 2: 11 + 2: 11: 11: 11: 8: 2; paratype ♀, 9: (5) 8 (5): (4) 6 (4): 10: 10 + 2: 10 + 2: 8: 8: 8: 9: 2; setae of genital sternites (sternites II and III) of ♂ densely situated (Fig. 18); setae of anterior genital sternite (sternite II) of ♂ small, and in two groups either side of mid-line; posterior genital sternite of ♂ without anterior notch (Fig. 18). Tergite XII and sternite XII slightly more sclerotized than other abdominal segments.

Genitalia: male genitalia with prominent T-shaped dorsal apodeme; without paired dorsal sac; median genital sac ovoid, not bifurcate; lateral genital sacs ovoid. Female genitalia not observable.

Legs: long and slender; femur I and II longer than patella I and II, respectively; femur I and II with 3 small dorsal slit sensilla basally, and 1 large dorsal slit sensillum distally; femur + patella IV 5.03-5.17 (♂), 4.70-4.84 (♀) x longer than broad; metatarsi III and IV with 1 tactile seta, situated sub-basally; tarsi III and IV with 1 tactile seta, situated sub-medially; subterminal tarsal setae deeply bifurcate, each branch denticulate; arolium shorter than claws, not divided; arolia not divided; claws slender.

Dimensions (mm)

Holotype male, followed by paratype male in parentheses (where applicable): Body length 4.42 (ca. 4.51). Pedipalps: trochanter 0.89/0.355 (0.905/0.355), femur 1.95/0.33 (2.07/0.315), patella 1.885/0.36 (1.82/0.365), chela (with pedicel) 3.21/0.525 (3.285/0.54), chela (without pedicel) 2.975 (3.075), hand (without pedicel) length 1.35 (1.515), movable finger length 1.68 (1.64). Chelicera 0.815/0.405; movable finger length 0.565. Carapace 1.41/1.075 (1.421/1.030); anterior eye diameter 0.065; posterior eye diameter 0.075. Leg I: femur 0.895/0.195, patella 0.66/0.18, tibia 0.855/0.145, metatarsus 0.43/0.125, tarsus 0.635/0.125. Leg IV: femur + patella 1.585/0.315 (1.655/0.32), tibia 1.04/0.205, metatarsus 0.555/0.16, tarsus 0.775/0.145.

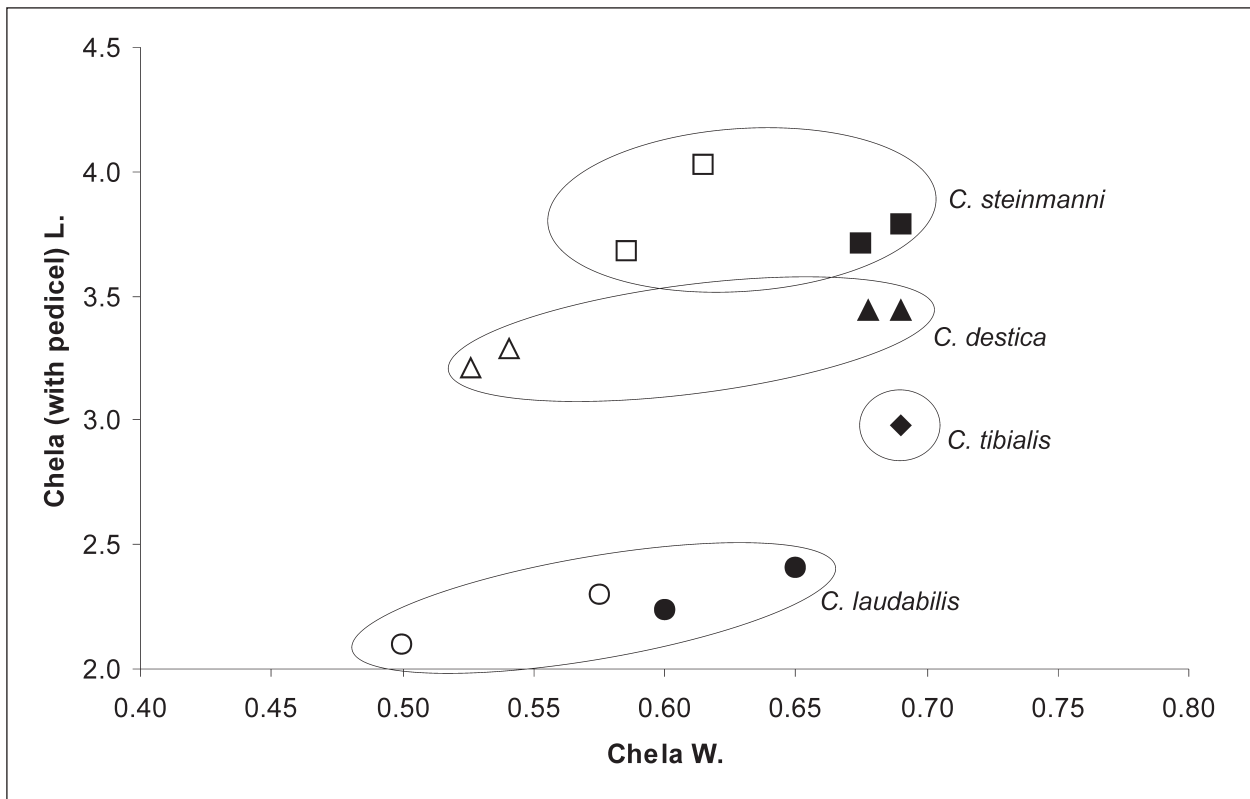


Fig. 19 - Graph of chela (with pedicel) length versus width of *Cryptocreagris steinmanni*, *C. destica*, *C. tibialis* and *C. laudabilis*. The data for *C. tibialis* was taken from Ćurčić (1993), and those of *C. laudabilis* represent the minima and maxima reported by Hoff (1956).

Paratype female, followed by paratype female in parentheses (where applicable): Body length 5.99 (3.92). Pedipalps: trochanter 0.93/0.41, femur 2.115/0.355 (2.27/0.39), patella 1.91/0.415 (1.98/0.425), chela (with pedicel) 3.445/0.68 (3.445/0.69), chela (without pedicel) 3.23 (3.25), hand (without pedicel) length 1.55 (1.695), movable finger length 1.755 (1.865). Chelicera 0.905/0.465; movable finger 0.625. Carapace 1.67/1.16 (1.635/1.10); anterior eye diameter 0.08; posterior eye diameter 0.055. Leg I: femur 1.01/0.21, patella 0.68/0.195, tibia 0.905/0.16, metatarsus 0.44/0.135, tarsus 0.625/0.135. Leg IV: femur + patella 1.50/0.31 (1.715/0.365), tibia 1.345/0.185, metatarsus 0.505/0.165, tarsus 0.73/0.15.

DISCUSSION

The two species of *Cryptocreagris* described here occur in caves located in Garfield County, northwestern Colorado. *Cryptocreagris steinmanni* is currently known only from Glenwood Caverns and Historic Fairy Caves, and *C. destica* from Squeak Cave No. 1. Glenwood Caverns and Historic Fairy Caves is a commercial cave with over 3 miles of surveyed passage whereas Squeak Cave consists of a single linear passage about 20 m long by 2–3 m wide with an average height of about 1 m (D. Steinmann, in litt., October 2009). The collector of the

specimens, David Steinmann, informs us that he has “never found a single pseudoscorpion in a much larger cave with similar habitat located only 100 yards from Squeak Cave, despite having visited both caves over a dozen times.” The entrances to the two caves are situated only 14 km apart but the two sites are separated by several deep canyons (D. Steinmann in litt., October 2009) which may have acted as an isolating mechanism restricting genetic exchange between the pseudoscorpions.

Although all eight specimens of *Cryptocreagris* from the two Colorado caves are extremely similar to each other, two consistent differences were detected that are here interpreted that each population represents a different species. Firstly, the males of both species possess several microsetae on the interno-dorsal face of the pedipalpal patella, with the males of *C. steinmanni* with only 2–4 microsetae and those of *C. destica* with 7 microsetae (Fig. 15). Such setae have not been previously reported in neobisiids and it is not known how widespread the feature is amongst microceagrines. Secondly, specimens of *C. steinmanni* are consistently larger than those of *C. destica*, and both are larger than the other members of the genus that occur in the Rocky Mountains, *C. tibialis* and *C. laudabilis* (Fig. 19). The data for *C. tibialis* and *C. laudabilis* were taken from Ćurčić (1993) and Hoff (1956), respectively, and those of *C. laudabilis* represent the minima and maxima reported by Hoff (1956). The size differences reported between the cavernicolous

species may diminish when if further specimens are collected and studied, which may necessitate changes to the species-level taxonomy of the group.

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