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Three new species of *Branchinecta* (Crustacea: Branchiopoda: Anostraca) from the Nearctic

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Abstract

Branchinecta lateralis, *B. constricta* and *B. serrata*, three new species of fairy shrimp, are described from central North American temporary pools. *Branchinecta campestris* Lynch, 1960 has been thought to occur on both sides of the Rocky Mountains in Canada and the United States. However, material from east of the North American Continental Divide were found to represent an undescribed species, morphologically distinct from *B. campestris*, and is described here as *Branchinecta lateralis* n. sp. *Branchinecta constricta* n. sp. has affinities with *B. coloradensis*, and *B. packardi*, yet is distinguished in that the male second antenna has a proximal constriction. *Branchinecta serrata* n. sp. is closely related to *Branchinecta paludosa* and *B. kaibabensis*, but differs in the shape of the distal segment of the male second antenna and in the female pattern of dorsolateral projections.

Key words: *Branchinecta*, new species, *Branchinecta lateralis*, *Branchinecta campestris*, *Branchinecta constricta*, *Branchinecta serrata*, Montana, Wyoming, Texas, Alberta, fairy shrimp

Introduction

The Branchinectidae is monogeneric with approximately 50 described species. The genus *Branchinecta* has been reported from all continents except Africa and Australia. Six taxa occur in Eurasia, one species is circumpolar and another ranges into Antarctica, however the genus reaches its greatest diversity is in the Americas with more than 20 species for each of the continents (Belk & Brtek 1995).

Brtek and Mura (2000) provided a very confused diagnosis of the Branchinectidae and divided the genus *Branchinecta* into five species groups, the geographic distribution of each was depicted on a map. These species groups were justified by the sentence: “One genus only: *Branchinecta* Verrill, 1869 which can be divided (according to the morphology of the male antenna, among other features) into five distinct species groups at

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least . . .". The remainder of the sentence names the species groups and gives their generalized distributions. Nothing more is said by the authors about the Branchinectidae in the remainder of the paper. Since no data, analysis or any reasoning, let alone quantitative definitions following modern taxonomic standards was provided, these species groups cannot be accepted.

The genus *Branchinecta* is in need of revision from a morphological and molecular perspective. The majority of species are well defined, but their relationships within the genus are not. Furthermore, numerous species remain to be described.

In this paper I describe three new species, *Branchinecta lateralis*, *B. constricta* and *B. serrata*. *Branchinecta lateralis* has been previously misidentified as *Branchinecta campestris* Lynch, 1960. Both *B. constricta* and *B. serrata* were found in the collections of D. Belk after he passed away in 2001 (Rogers 2001). *B. constricta*, was labeled in Belk's collections as "*Branchinecta* n. sp."; *B. serrata*, was misidentified as *B. paludosa* (Müller, 1788).

Methods

Specimens were loaned from Mary Belk from the late Denton Belk's collections. The material was examined using a Wild M8 dissection stereomicroscope and was sketched freehand. The specimens were compared with other taxa that are similar in form. G. Langstaff, who originally sent the material to Belk for identification, collected these new species, as well as many other anostracans and spinicaudatans in the 1980's and early 1990's from Wyoming.

Results

***Branchinecta lateralis* n. sp.**
Figures 1, 3

Synonymy: *Branchinecta campestris* Lynch, 1960; Sublette and Sublette, 1967; Horne, 1974;
Types: Holotype, male, data: USA: WYOMING; Sweetwater Co.: East Cyclone Rim, Big Bend Lost Creek Pond #1, 42º 12' 41"N, 108º 07' 01"W, 8 June 1987, G. D. Langstaff, deposited: National Museum of Natural History, Washington D.C. USNM 1014987. Paratypes: same data as holotype, 5 females, 5 males, National Museum of Natural History, Washington D.C. USNM 1014988.

Material examined: USA: COLORADO: Alamosa County: San Luis Lakes State Wildlife Area, site 115, 7 July 2003, Collector unknown, Det. D. C. Rogers. MONTANA: Teton Co.: Saline pools in the vicinity of Pishkun Reservoir, 4 July 1997, D. L. Gustafson, det. D. C. Rogers, DCR-552. WYOMING: Albany Co.: Laramie Basin, Pond XIV (Horne), 41º 07'32"N, 105º 43'15"W, 4 June 1988,G. D. Langstaff, (DB [Denton Belk's collection number]-865). Carbon Co.: Long Pond,

3 June 1993, G. D. Langstaff, (DB-1237). Screeching Avocets Pond, 3 June 1993, G. D. Langstaff, (DB-1239). Yellow Pond, 3 June 1993, G. D. Langstaff, (DB-1240). Freemont Co.: Sweetwater Valley, Soda Lakes Far Eastern Pond, 13 km ENE of Jefferey City, 42º 32' 25"N, 107º 40' 21"W, 9 June 1989, G. D. Langstaff, (DB-950). Natrona Co.: Sweetwater Valley, Steamboat Lake Oxbow Pond, 2.7 km ESE of junction WY220 and Dry Creek Road, 42º 32' 15"N, 107º 03' 32"W, 7 June 1989, G. D. Langstaff, (DB-944). Sweetwater Valley, Steamboat Lake, 30 km W of Alcova and 1.2 km E of WY220 and Dry Creek Road junction, 42º 32' 44"N, 107º 04' 23"W, 7 June 1989, G. D. Langstaff, (DB-945). Sweetwater Co.: East Cyclone Rim, Big Bend Lost Creek Pond #1, 42º 12' 41"N, 108º 07' 01"W, 8 June 1987, G. D. Langstaff, (DB-810). East Cyclone Rim, Big Bend Lost Creek Pond #1, 42º 12' 41"N, 108º 07' 01"W, 5 June 1988, G. D. Langstaff, (DB-866).

Type Locality. Big Bend Lost Creek Pond #1, is on the south side of the East Cyclone Rim of Great Divide Basin in Sweetwater County, Wyoming, (42º 12' 41"N, 108º 07' 01"W). This basin literally is in the middle of the Continental Divide. The type locality pool is at an elevation of 2069 meters, and is a clay bottomed, desert playa pool. The pool is 300 meters across, and less than 5 meters deep, with whitish, turbid water.

Etymology. The specific epithet is from the Latin word for side "lateral", and refers to the lateral projections of the female's brood pouch, and the laterally directed apices of the distal segments of the male second antennae. The gender is feminine.

Description. *Male*. (Figure 1B) Average length of preserved material 22 mm. Head rounded, anteriolateral corners projecting slightly over compound eye peduncles. First antenna twice as long as stalked compound eye, with apex truncated, bearing four to six setae. Second antennae extending posteriorly to ninth thoracic segment.

Second antenna proximal antennomere subcylindrical, approximately five times as long as broad. Medial surface with small, scattered spines and fine chitinized papillae. Proximal antennomere with a posteriomedial proximal apophysis. Apophysis sub-cylindrical, tapering distally, with apex truncated. Pulvillus absent.

Second antennal distal antennomere subequal in length to proximal antennomere, laterally flattened, curving nearly 90° medially at the proximal fourth. Anterior and posterior margins expanded slightly in distal two-thirds, truncating towards apex. Posterior margin distal half, except apex, covered in chitinized papillae. Apex thickened, constricted, and abruptly bent 90° laterally, with tip curving slightly posteriad, tapering to a point (Figure 3).

Labrum with chitinized papillae on ventral surface. Distal lobe smooth, rounded, and directed ventrally.

Mandibles and maxilla 2 typical for the genus. Maxilla 1 with an apical transverse row of hooked aciculate spines, palp with an apical transverse row of digitiform spines each with a hook shaped setaform distal portion.

Praeepipodites and epipodites typical for genus. Thoracopod I with exopodite and endopodite triangular. Endopodite bearing stout, curved, pectinate setae. Endite 1 + 2 and endite 3 with numerous long plumose setae. Endite 4 with anterior plumose setae and stout posterior setae. Endite 5 with plumose anterior setae and posterior pectinate setae. Endite

six with anterior proximal setae plumose, distal setae pectinate, and posterior setae plumose. The setae of endites 1 + 2, 3, and 4, and the non-pectinate setae of endites 5 and 6, with distal 60% filiform with paired lateral spinules along their lengths.

Thoracopod V with exopodite with lateral margin straight, curving apically towards the rounded apex. Endopodite triangular, bearing stout, curved, pectinate setae. Endite 1 + 2 and endite 3 as in thoracopod I. Endite 4 with anterior and posterior setae plumose. Endite 5 with anterior plumose setae and posterior pectinate setae. Endite 6 with pectinate setae, the proximal four being half the length of the remaining distal setae. All plumose setae as described for thoracopod I.

Thoracopod XI with exopodite oval. Endopodite subtriangular bearing stout, curved, pectinate setae. Endite 1 + 2 as in thoracopod I. Endite 3 with two short, digitiform anterior setae, the posterior setae plumose. Endites 4 and 5 with anterior and posterior setae plumose. Endite 6 with all setae plumose.

Genital segments smooth. Penes each with basal portion bearing a large ventral subconical, ventroposteriorly directed lobe, and a ventromedial digitiform spur. Everted penes short, just reaching the first abdominal segment. Apices of everted penes bearing one lateral and one medial "wart"- like mounds. Medial mound round, bearing ten to fifteen recurved spinules about one fourth as long as "wart"- like mound. Lateral mound in the form of a longitudinal ridge, directed anteriorly, with 35 to 40 recurved spinules.

Cercopods as typical for the genus.

Female. (Figure 1A) Average length of preserved material 17 mm. Head without dorsal protuberances. First antennae sub-equal to second antennae. Second antennae smooth, with or without a small lateral protrusion. Distal fourth before apex bearing scattered setae. Apex subcylindrical, curving anteromedially, and tapering to a point. Anterior surface of head and labrum with fine spinules. Labrum, mandibles and maxillae as in male.

Thorax with rounded, dorsolateral bosses on all segments. Genital segments and first two abdominal segments with paired, angular dorsolateral bosses. Third abdominal segment with unpaired, angular, dorsolateral bosses. Thoracic and abdominal bosses are transverse, nearly bilobed in more posterior thoracic pairs, and densely papillose.

Thoracopods similar to male, save that the endopodites and epipodites ovate. Setation is similar to the male.

Brood pouch fusiform with short, subconical, papillose lateral out-pocketings in 64% of females. Brood pouch extending to post-genital abdominal segment five or six. Ovaries extend anteriorly into thoracic segment 10 or 9, and posteriorly into abdominal segment 4 or 5.

Cercopods as typical for the genus.

Cyst. Approximately 300 µm in diameter, with dense, small, shallow depressions 10 µm in diameter or less.

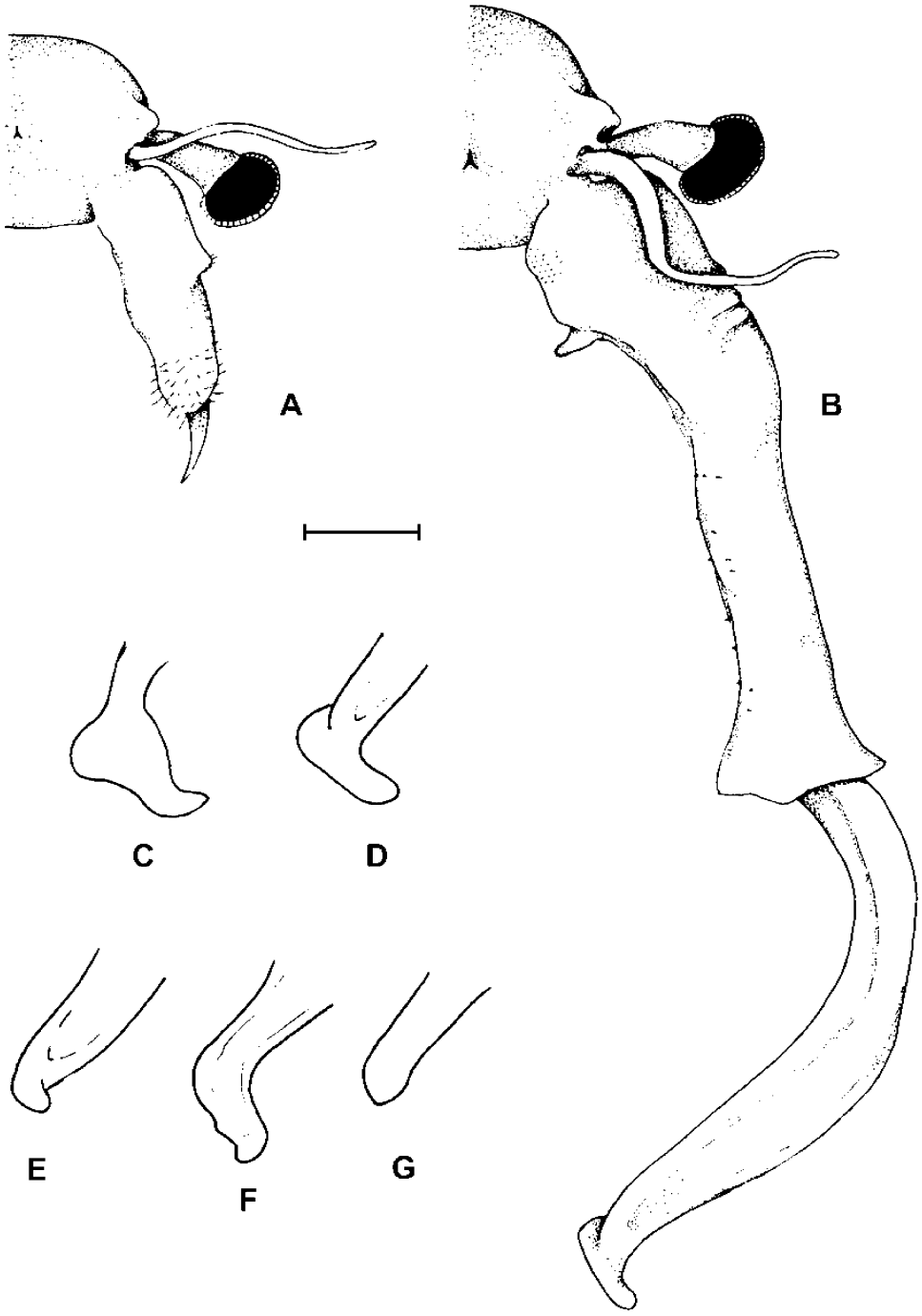

FIGURE 1. A) *Branchinecta lateralis* n. sp. female, anterior view of left side of head; B) *Branchinecta lateralis* n. sp. male, anterior view of left side of head. C–G) Branchinecta male left second antennal apices: C) *B. potassa*; D) *B. lateralis* n. sp.; E) *B. campestris*; F) *B. readingi*; G) *B. mackini*. Scale bar for: A and B = 1.0mm, C–G = 2.4mm.

Differential diagnosis. Male *Branchinecta lateralis* are separated from all other reported *Branchinecta* species by the distal antennomere of the second antennae, which has the apex bent laterally (90º) and tapers to a posteriorly directed point (Figure 1B and D, 3).

Male *B. lateralis* most closely resemble *Branchinecta campestris* Lynch, 1960 and *Branchinecta potassa* Belk, 1979; however, the distal antennomeres of the second antenna of *B. campestris* males curve medially 30º at the basal third, and have the apices truncated and bent laterally 60º (Figure 1E, also see Figure 2D in Lynch 1960). In *B. lateralis* the distal antennomere curves nearly 90º in its proximal fourth, and the apex of the second antennomere is more produced, and arcs posteriorly in ventral view, which is never found in *B. campestris*.

B. potassa are separated from *B. lateralis* primarily by the lack apophyses, and have the distal antennomere of the second antenna with the apex bent laterally 60º, apically acute, and with a medial "swelling" at the base giving the apex a "foot-like" shape in anterior view (Figure 1C).

Branchinecta readingi Belk, 2001, males have the apex of the distal antennomere of the second antennae bent laterally approximately 75º (Figure 1F) and *Branchinecta mackini* Dexter, 1956 have the second antennal apices rounded (Figure 1G).

Furthermore, the penes of *B. lateralis* have a lateral and a medial "wart"- like mound, whereas in *B. campestris* the penes sport a lateral and a dorsolateral "wart"- like mound.

Branchinecta lateralis and *B. campestris* females share the lateral out-pocketings of the brood pouch. However in *B. lateralis* the out-pocketings (when present) are much smaller, and are never armed with one or more subtending spines as in some *B. campestris* (see Figure 5 in Lynch 1960). Furthermore, the brood pouch in *B. lateralis* extends to the fifth or sixth abdominal segment, whereas in *B. campestris*, the brood pouch extends to the fourth or fifth abdominal segment.

Mature female *B. lateralis* are separated from *B. campestris* and *B. potassa* by the dorsolateral, transverse, angular bosses on the thoracic (including genital) and first few abdominal segments. Female *B. campestris* and *B. potassa* have oval dorsolateral lobes on the pre-genital thoracic segments only. These structures are present only in mature animals. The first antennae of female *B. potassa* and *B. mackini* Dexter, 1956 are longer than the second antennae, whereas in *B. lateralis* and *B. campestris* the first and second antennae are sub-equal or shorter. Female *B. lateralis* are separated from all other reported *Branchinecta* species by the presence of lateral out-pocketings of the brood pouch.

Distribution and Habitat. B. lateralis has been collected from Colorado, Montana, Wyoming and Texas. Collection sites tend to be saline or clay playa type desert and grassland pools with clear to highly turbid water. *B. lateralis* often co-occurrs with the brine shrimp *Artemia franciscana* Kellogg, 1906 in similar situations as *B. campestris* (Lynch 1960; Sublette & Sublette 1967; Horne 1974). Collections made by Sublette and Sublette (1967) and Horne (1974) of *B. campestris* from saline pools in Lynn County,

Texas on the Llano Estacado were probably *B. lateralis* (Lynch, 1960), as were Broch's (1969) and Hartland-Rowe's (1966) Canadian collections. Unfortunately their material is not available for comparison. This species could potentially occur in eastern New Mexico and Colorado.

Comments. Lynch (1960) first commented on *B. lateralis* as a ëformí of *B. campestris* in the original description, but did not investigate the differences between the eastern and western forms further. Lynch mentions the defining characters for *B. lateralis* in material from Wyoming and Texas, however his material was limited and that which I examined at the Smithsonian and appears to have been not fully mature.

Branchinecta mackini, *B. readingi*, *B. campestris*, *B. lateralis*, and *B. potassa* are all closely related to each other based upon molecular analysis (Fugate 1992), bear strong morphological similarity (Belk 1979, 2000; this work), and all occur in temporary waters high in dissolved sodium salts (Belk 1979; Broch 1969, 1989; Daborn 1977; Hartland-Rowe 1966; Lynch 1960; McCarraher 1970). The species pairs with the greatest morphological similarity are *B. mackini* and *B. readingi* (Belk 2000), and *B. campestris* and *B. lateralis* (this work) with each species in each of the pairs separated geographically; *B. mackini* and *B. readingi* are separated by the continental divide (Belk & Fugate 2000). *B. campestris* occurs west of the continental divide in Washington and Oregon, and west of the Sierra Nevada Mountains in California, whereas *B. lateralis* ranges east of the continental divide in Canada, Montana, Wyoming and Texas, and east of the Great Basin Desert in Utah and Colorado. *B. potassa* also occurs east of the continental divide in Nebraska, shares affinities with both species pairs (Belk 1979; Fugate 1992).

The discovery of this new species represents another instance where more than one species of North American *Branchinecta* was being treated under a single name. In 1993, Fugate recognized that well-known *Branchinecta* populations in southern California, USA and Baja California, Mexico were not *B. lindahli* Packard, 1883 but a new species, *B. sandiegonensis* Fugate, 1993.

Belk recognized *B. readingi* Belk, 2000, as a distinct species, separate from *B. mackini* Dexter, 1956. *B. readingi* had been studied intensively for years under the name of *B. mackini* (Belk 2000). Belk and Rogers (2002) found that a form of *B. coloradensis* Packard, 1874 with small apophyses, and the then undescribed *B. oriena* Rogers and Belk, 2002, had been reported as *B. dissimilis* Lynch, 1972.

IUCN Red List Status. This species is widespread, and does not appear to be in any immediate danger, and therefore is categorized as "Least Concern" (IUCN 2000). However, *B. campestris* is more restricted. Originally reported from several localities in Washington State, most of these populations, including the type locality are now under Grand Coulee Reservoir. Outside of Washington, this taxon is only reported from Lake Abert, Oregon (Fugate 1992) and from Soda Lake, California (Belk & Serpa 1992). Therefore *B. campestris* meets the International Union for the Conservation of Nature and Natural Resources (IUCN) red list criteria for designation as a VU D2 species (IUCN

2000). That is to say, *B. campestris* is vulnerable due to the population being very small and restricted, that may be prone to the effects of human activities or stochastic events within a short period of time.

***Branchinecta constricta* n. sp.**
Figures 2, 3.

Types: Holotype, male, data: USA: WYOMING; Sweetwater Co.: Antelope Pocket Overlook Rock Pool (42º 40'26"N, 107º 54'39"W), 15 June 1989, G. D. Langstaff, deposited: National Museum of Natural History, Washington D.C. USNM 1014985. Paratypes: same data as holotype, 3 females, 4 males, deposited: National Museum of Natural History, Washington D.C. USNM 1014986.

Material Examined: USA. WYOMING: Albany County: Todd's Rock Pool I, Laramie Range, Veedauwoo Area, 2597m elevation, 41º 09'44"N, 105º 22'32"W, 20 May 1989, G. D. Langstaff. Todd's Rock Pool II, 30m northwest of Pool I, Veedauwoo Area, 2597m elevation, 41º 09'44"N, 105º 22'32"W, 20 May 1989, G. D. Langstaff. Todd's Rock Pool III, 50m east-northeast of Pool I, Veedauwoo Area, 2597m elevation, 41º 09'44"N, 105º 22'32"W, 17 May 1992, G. D. Langstaff. Todd's Rock Pool IV, 20m west of Pool I, Veedauwoo Area, 2597m elevation, 41º 09'44"N, 105º 22'32"W, 17 May 1992, G. D. Langstaff. Fremont County: Antelope Pocket Overlook Rock Pool, Western Granite Mountains, 2178 m elevation, 2 km southeast of Wildhorse Rock Pool, 42º 40'26"N, 107º 54'39"W, 15 June 1989, G. D. Langstaff. Antelope Pocket Overlook Rock Pool, 2178 m elevation, 42º 40'26"N, 107º 54'39"W, 8 May 1989, G. D. Langstaff. Antelope Pocket Overlook Rock Pool, 2178 m elevation, 42º 40'26"N, 107º 54'39"W, 19 August 1987, G. D. Langstaff. Lankin Dome Summit Pool #1, 42º 31'50"N, 107º 33'40"W, 2316 m elevation, 4 June 1990, G. D. Langstaff. Lankin Dome Summit Pool #2, 42º 31'50"N, 107º 33'40"W, 2316 m elevation, 4 June 1990, G. D. Langstaff. Dead Antelope Rock Pool, 2181 m elevation, 42º 39'26"N, 107º 53'30"W, 8 May 1992, G. D. Langstaff.

Type Locality. Antelope Pocket Overlook Rock Pool (42º 40'26"N, 107º 54'39"W) is in the Western Granite Mountains, on the south side of the Beaver Divide, at 2178 m elevation, in Fremont County, Wyoming. The pool is in Sagebrush steppe, is roughly 1.5 meters in length, and is only a few centimeters deep. The water is clear to slightly turbid.

Etymology. The specific epithet describes the characteristic constriction of the male and female second antennae. The gender is feminine.

Description. Male. Average length of preserved material 16 mm. Head smooth, anterior-lateral corners projecting over eye peduncles. First antenna 1.5 to 2 times as long as eye plus stalk. First antenna 0.25 to 0.5 times as long as second antenna proximal antennomere. Second antennae extending posteriorly to sixth or seventh thoracic segment.

Second antenna stout, 2–2.5 times as long as broad. Proximal antennomere sub-cylindrical, pulvillus present, and with an anteriolateral tubercle in the proximal fourth (Figure 2D). Apophyses absent. Proximal antennomere bearing a transverse groove just distad of the pulvillus, giving the segment a "constricted" appearance. Transverse groove

diminishes with age. Pulvillus and lateral tubercle with large, cylindrical, evenly spaced spines that may continue across the anterior surface of the proximal segment, as well as distally into the transverse groove in older males. Medial surface bearing a stout tubercle covered with fine denticles.

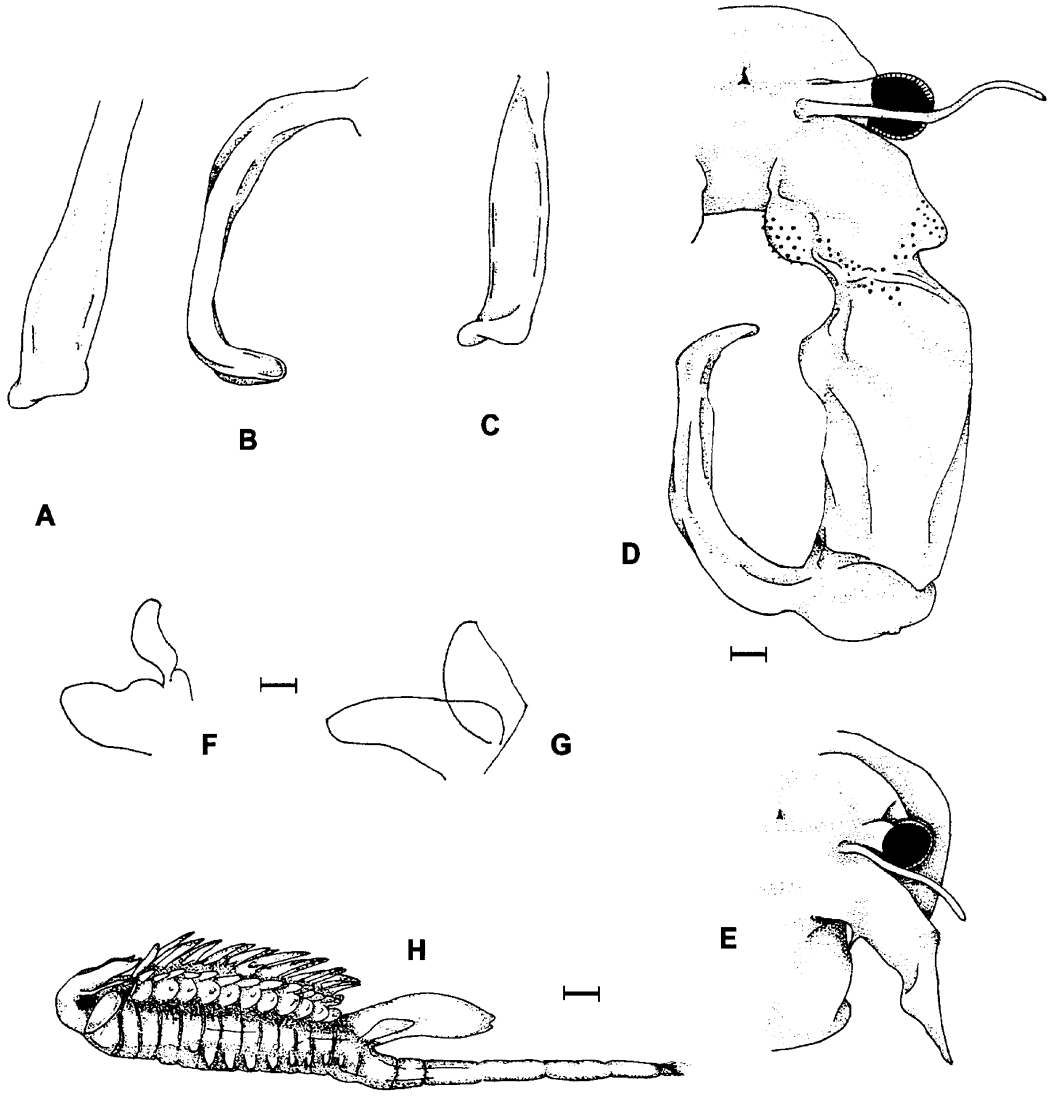

FIGURE 2. *Branchinecta constricta* n. sp.; A–C) male left second antennal distal segment: A) lateral view; B) posterior view; C) medial view. D) Male, anterior view of left side of head; E) female, anterioventral view of left side of head; F) outline of exopodite and endopodite of female fifth thoracopod; G) outline of exopodite and endopodite of male fifth thoracopod; H) female, lateral view. Scale bar for: A–E = 0.3mm, F and G = 1.0mm, H = 5mm.

Second antennal distal antennomere 0.75 times the length of the proximal antennomere; robust basally at point of articulation. Antennomere flattened laterally

(twice as broad as thick), basal half arcuate medially and parallel sided; distal half straight, margins explanate, with widest point just prior to apex; apex bent medially 90°, directed anteriorly, sub-truncate distally (Figure 2A–C, 3).

Labrum smooth, distal lobe projecting ventrally, rounded posteriorly. Mandibles with molar surface covered with fine denticles, posterior spine reduced and blunt. Maxilla 1 and 2 typical for the genus.

Praepipodites and epipodites typical for the genus. Thoracopod I with exopodite ovate, with apex slightly directed ventrally, and margined with fine setae. Endopodite margined with stout setae, subtriangular, with apex slightly directed ventrally. Endite 1 + 2 and 3 margined with long plumose setae. Endite 4 with stout anterior setae and stout posterior pectinate seta. Endite 5 with stout anterior and posterior. Endite six with stout posteriorly directed pectinate setae.

Thoracopod V with exopodite oval in outline, endopodite elongate triangular. (Figure 2G). Exopodite margined with fine plumose setae. Endopodite margined with stout setae, with distal most setae pectinate, becoming short and medially curved on the medioventral margin. Endite 1 + 2 and 3 margined with long filiform setae bearing short, fine setules. Endite 3, 4 and 5 with setae similar to endites 1 +2. Endite 6 with pectinate setae.

Thoracopod XI with exopodite rounded, blunt, and endopodite oval. Exopodite and endopodite margined with fine setae. Endites margined with sparse stout setae.

Penes extending to base of abdominal segment 2. Medial spur arcuate, 3 times as long as broad, bending posteriorly. Penes with distoapical “wart-like” mounds on lateral surface, directed posteriorly with 5 to 10 apical spines.

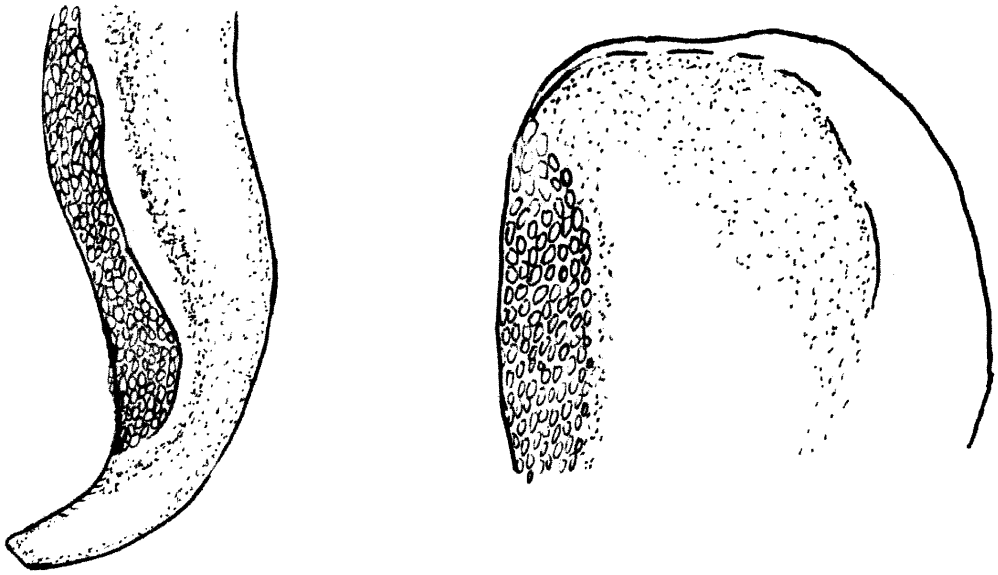

FIGURE 3. Apex of male right second antennae, distal antennomere, ventral view: left *Branchinecta lateralis*; right, *Branchinecta constricta*. The anterior side of the antennomeres is to the right.

Female. Average length of preserved material 14 mm. Head smooth, without projections. Maxillary glands large, typically asymmetrical. First antenna twice as long as eye plus stalk, and half as long as second antenna. Second antenna 2.5–3 times as long as broad, apex sub-acute. Six percent of females with second antenna proximal-medial surface bearing a small, slender spine. Second antenna lateral surface with a small tubercle bearing fine spines. (Figure 2 E, H).

Thoracic segments IV–XII with dorsal-lateral sub-conical projections, the largest on segments V–VIII. Endopodite ovate, exopodite falcate to ovate (Figure 2F). Thoracopod setal arrangement similar to male.

Ovaries extend anteriorly to the eighth or ninth thoracic segment, and posteriorly to abdominal segment 4 or 5. Brood pouch sub-cylindrical, extending to abdominal segment four or five.

Cercopods in less than 10% of females (64) may be extremely short; only one fourth or less the length of the telson. Otherwise the cercopods are as in the male.

Cyst. Approximately 320 µm in diameter and typical for the genus. Surface with shallow polygons 10 to 15 µm across bordered by low rounded ridges.

Differential diagnosis. Male *B. constricta* are separated from all other *Branchinecta* species by the second antennal proximal segmentís transverse invagination, appearing as a "constriction". *B. constricta* most closely resembles *B. coloradensis* Packard, 1874 and *B. packardi* Pearse, 1912 (see Lynch, 1964). All three species share a bulge or projection on the second antennal medial surface; however in *B. coloradensis* the bulge is spinose, and in *B. packardi* the medial projection is directed anteriorly. In *B. constricta* the medial projection is blunt and directed medially. *B. coloradensis* and *B. packardi* are also both readily separated from *B. constricta* by the presence of proximal posteriomedial apophyses on the second antennae.

Female *B. constricta* can be separated from all other female *Branchinecta* species by the dorsal thoracic ornamentation. Female *B. constricta* are most similar to *B. packardi* females. Both taxa share the large maxillary glands, and have similar brood pouch morphology and similar dorsolateral projections. However, in *B. packardi* the projections are angular and directed posteriorly, and are present only on thoracic segments nine through twelve.

Distribution and Habitat. *B. constricta* is apparently endemic to Wyoming, but may occur in northern Colorado. To date all of the locations for this species have been small pools, under 2.5 meters across, and only a few centimeters deep. It is possible that this species is opportunistic, surviving in shallow peripheral pools. Nearby larger habitats are typically occupied by *B. lateralis*, *B. readingi*, or *B. serrata*.

IUCN Red List Status. This species is currently known only from eight locations in south-central and southeastern Wyoming. Therefore this species meets the International Union for the Conservation of Nature and Natural Resources (IUCN) red list criteria for designation as a VU D2 species (IUCN, 2000). That is to say, this taxon is vulnerable due

to the population being very small and restricted, that may be prone to the effects of human activities or stochastic events within a short period of time.

***Branchinecta serrata* n. sp.**
Figure 4

Types. Holotype, male, data: USA:WYOMING: Fremont County: Bull Canyon Pond, 42º 26'24"N, 108º 11'25"W, 15 May 1987, G. D. Langstaff, deposited: National Museum of Natural History, Washington D.C. USNM 1014989. Paratypes: same data as holotype, 4 females, 4 males, deposited: National Museum of Natural History, Washington D.C. USNM 1014990.

Material Examined. USA:WYOMING: Fremont County: Bull Canyon Pond, West Crooks Mountain Range, 15 May 1987, G. D. Langstaff. Bull Canyon Pond, West Crooks Mountain Range, 6 June 1987, G. D. Langstaff. Bull Canyon Pond, West Crooks Mountain Range, 25 June 1995, G. D. Langstaff.

Type Locality. The type locality is Bull Canyon Pond (42º 26'24"N, 108º 11'25"W), in the West Crooks Mountain Range, at 2192m elevation. The pool is in sagebrush uplands, on lands currently owned by the Bureau of Land Management. The land is used for livestock grazing and recreation.

Etymology. The specific epithet is from the Latin word "serra", literally "a saw". The gender is feminine.

Description. Male. (Figure 4B) Average length of preserved material 22mm. Head smooth, anterior-lateral corners not or slightly projecting over eyestalks. First antenna twice as long as eye plus stalk. First antenna 0.5–0.6 times the length of the second antenna proximal antennomere. Second antennae extending posteriorly to thoracic segment five or six.

Second antenna proximal antennomere sub-cylindrical, smooth, 2.5–3 times as long as broad. Lateral surface may bear a few small setae. Second antenna medial surface with distal half with a longitudinal ridge bearing a longitudinal row of flat, "saw-tooth" like spines; each spine is apically curved dorsally. Second antenna proximal antennomere lateral surface with small tubercle bearing two or less small spines. Second antenna distal antennomere 0.7–0.9 times the length of the proximal antennomere; distal antennomere flattened laterally, slightly arcuate medially, bearing a slight twist with the distal-medial surface directed anteriorly; distal antennomere tapering to a narrowly truncate apex.

Labrum smooth, truncated. Distal lobe smooth. Mandibles and maxilla 2 typical as for the genus. Maxilla 1 with endite bearing a transverse row of 25 to 30 long setae each with fine lateral setules all intermeshed. Setal apices curving anteriorly.

Thorax smooth. Praepipodites and exopodites typical for the genus. Thoracopod I with exopodite suboval, margined with fine setae. Endopodite broad, arcuate medially, with spines on anterior surface of apex (Figure 3C, D). Endites 1+2 and 3 with numerous long plumose setae, bearing numerous fine setules. Endite 4 and 5 with anterior and posterior

setae stout. Endite 6 with stout setae.

Thoracopod V with Exopodite oval, margined with long fine setae with fine setules all along lateral margins. Endopodite elongated, slightly arcuate, curving toward the ventral surface of the animal. Lateral margin with stout, straight setae, medial margin with short medially curved setae. Endopodite apex with stout submarginal setae on anterior surface. Endites 1+2 and 3 with numerous long filiform setae, bearing numerous fine setules. Endite 4 with anterior long filiform setae, and posterior long filiform setae. Endite 5 with anterior and posterior long filiform setae. Endite 6 with long filiform setae.

Thoracopod XI with exopodite and endopodite oval, subequal in size and shape, margined in filiform setae. Endites 1+2 and 3 with spaced filiform setae. Endite 4, 5, and 6 with three long filiform setae each.

Genital segments slightly expanded; everted penes extending to middle of first abdominal segment; medial spurs truncated, blunt, curving posteriorly (Figure 3E); penile apices each with two "wart-like" mounds, one medial and one lateral; medial mound with 4–7 spines, lateral mound with 10–17 spines (Figure 4F).

Cercopods as typical for the genus.

Female. (Figure 4A) Average length of preserved material 20mm. Head smooth without projections. First antenna1.5 times as long as eye plus stalk. First antenna 0.5–0.6 times as long as second antenna. Second antenna 2.5 times as long as broad, sub-cylindrical, with apex produced acutely. Second antenna with a lateral tubercle bearing short hair-like spines, and a sub-apical anterior-medial tubercle bearing short hair-like spines.

Labrum, mandibles, and maxillae as in male.

Thoracic segments III–VII with dorsolateral sub-conical bosses (Figure 4G). Thoracopods as in male, except that the endopodites are blunt and triangular.

Brood pouch fusiform, extending up to telson (Figure 4G). Ovaries extending anteriorly to thoracic segment IX, posteriorly to abdominal segment IV or V.

Cercopods typical for the genus.

Comparisons. B. serrata most closely resembles *B. paludosa* (Müller, 1788), and *B. kaibabensis* Belk and Fugate, 2000. Male *B. serrata* are separated from *B. paludosa* by the slight laterally directed twist of the distal antennomere of the second antennae, versus a straight distal second antennal antennomere in *B. paludosa* (Figure 5A, B). *B. serrata* is readily separated from *B. kaibabensis* by the serrate ridge on the male second antennal medial surface (versus a row of spines in *B. kaibabensis*), and the lack of a conical process topped by a pulvillus on the basomedial surface of the proximal antennomere of the second antenna. The everted penes of *B.* serrata have denticulate "wart-like" mounds on opposite sides of the penis, whereas in *B. paludosa* the "wart-like" mounds are both on the penal lateral surface (Figure 5C). Female *B. serrata* are separated from the other two species by the dorsal-lateral ornamentation of the female (*B. paludosa* and *B. kaibabensis* females are smooth dorsally).

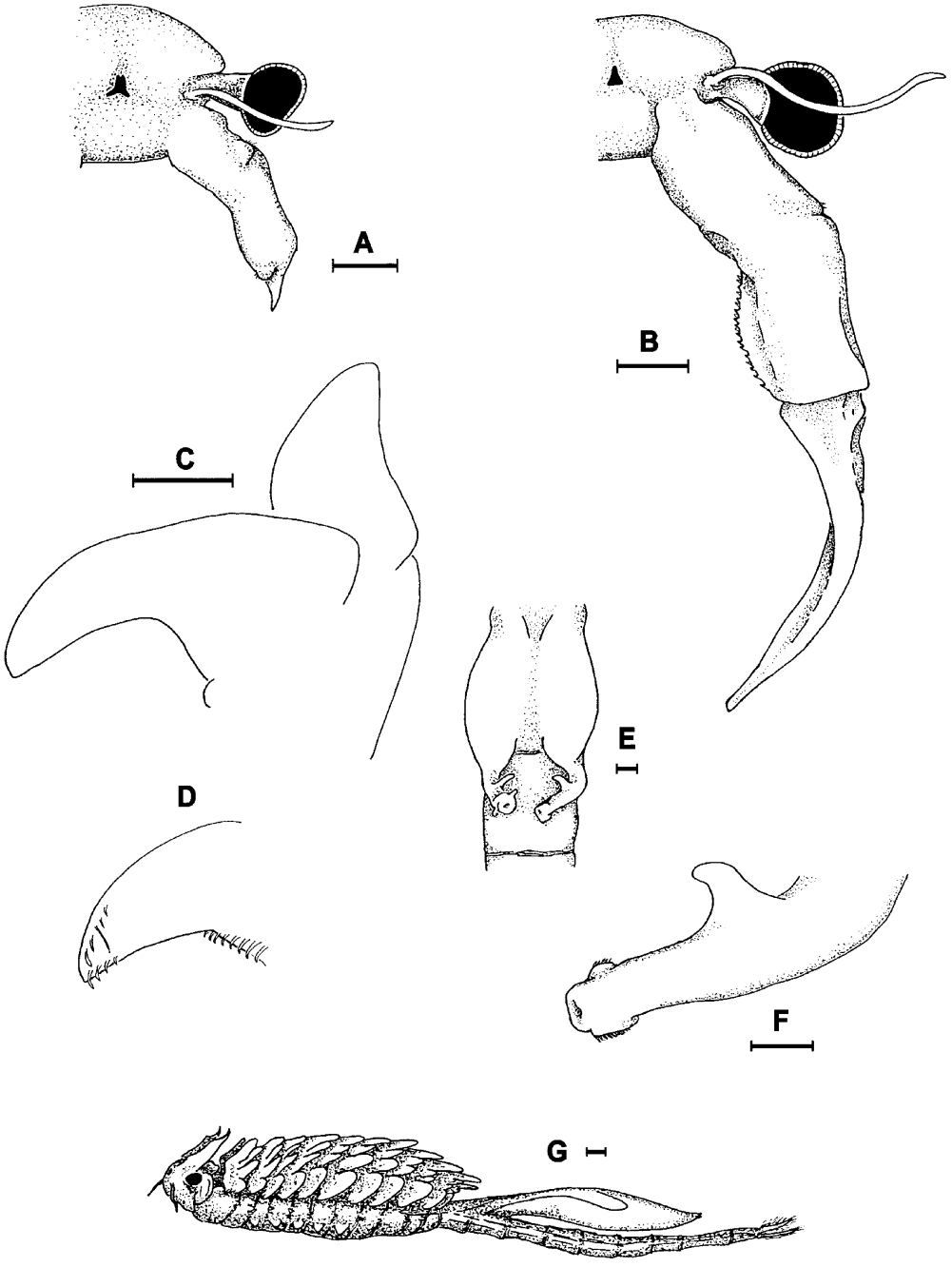

FIGURE 4. *Branchinecta serrata* n. sp.; A) female, anterior view of left side of head; B) male, anterior view of left side of head; C) outline of exopodite and endopodite of male fifth thoracopod; D) detail of spines on anterior surface of endopodite of male fifth thoracopod; E) male genitalia ventral view; F) left pene, ventral view; G) female, lateral view. Scale bar for: A – D and F = 1.0mm; E = 0.5mm; G = 2.0mm.

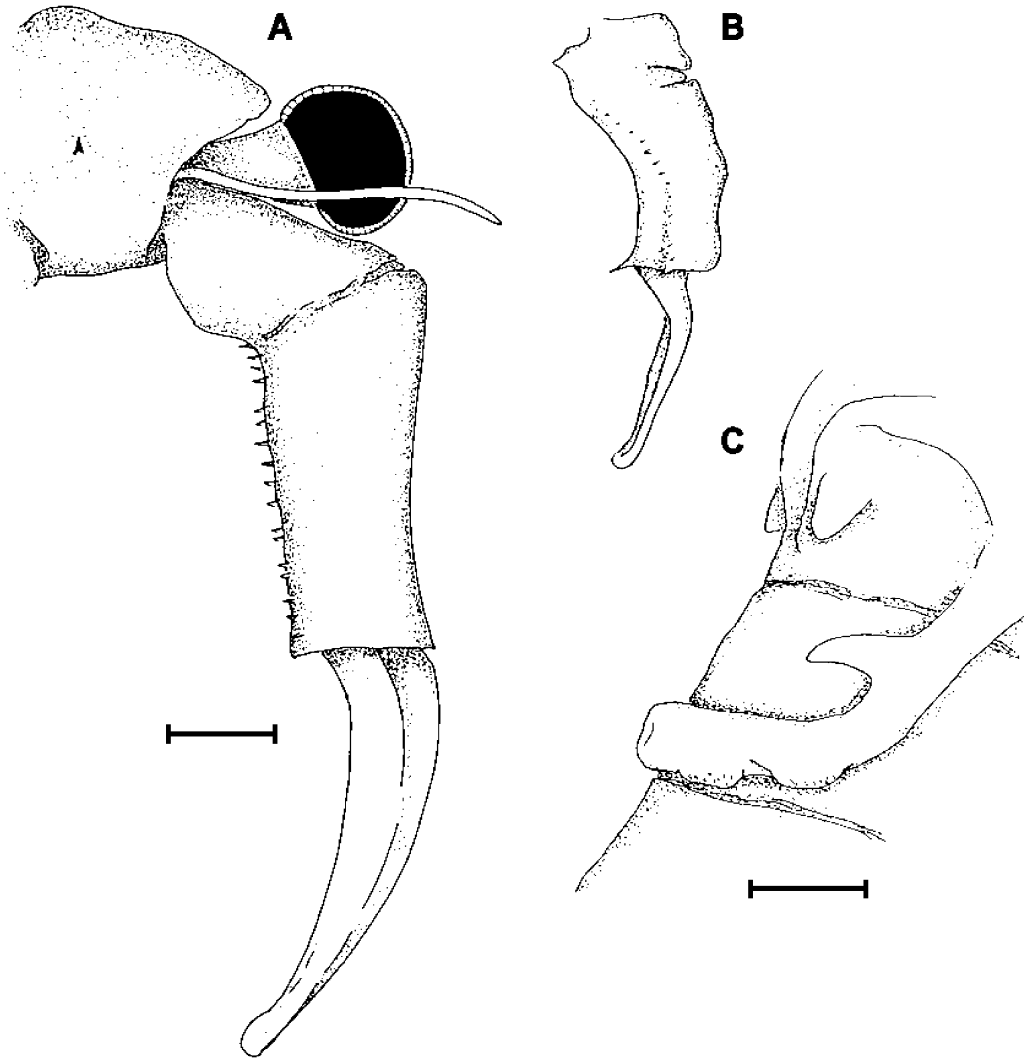

FIGURE 5. *Branchinecta paludosa* male. A) anterior view of left side of head; B) anteriomedial view of left second antenna; C) lateral view of everted pene. Scale bars for: A = 0.8mm; B = 3.2mm; C = 0.1mm.

Distribution and Habitat. *B. serrata* is known only from the type locality in the Crookís Mountains, on the north side of the Great Divide Basin. The type locality is a high altitude, alpine pool.

Comments. Co-occurs with *B. coloradensis*. *Branchinecta paludosa* collections from Wyoming and adjacent Utah, Colorado and Montana (Linder 1941; Horne 1967; Saunders et al. 1993; Stern and Belk 1999) in the collections of D. Belk and the USNM were examined and were verified to be *B. paludosa*.

IUCN Red List Status. *B. serrata* is so far only known to occur at the type locality. This

species meets the IUCN red list criteria for designation as a CR B2ab species (IUCN 2000). That is to say, this taxon is critically endangered due to the population being limited to a single population that may be prone to the effects of human activities or stochastic events within a short period of time.

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Literature Cited

Belk, D. (1979) *Branchinecta potassa* new species (Crustacea: Anostraca), a new fairy shrimp from Nebraska, U.S.A. *The Southwestern Naturalist*, 24, 93–96.

Belk, D. (2000) *Branchinecta readingi*, new species name for a well-known fairy shrimp from east of the North American Continental Divide. *Journal of Crustacean Biology*, 20, 566–570.

Belk, D. & Brtek, J. (1995) Checklist of the Anostraca. *Hydrobiologia*, 298, 315–354.

Belk, D. & Rogers, D.C. (2002). A confusing trio of *Branchinecta* (Crustacea: Anostraca) from the western North America with a description of a new species. *Hydrobiologia*, 486, 49–55.

Belk, D. & Serpa, L. (1992) First record of *Branchinecta campestris* (Anostraca) from California and casual observations of males of *Artemia* clasping females of *Branchinecta*. *Journal of Crustacean Biology*, 12, 511–513.

Broch, E.S. (1969) The osmotic adaptation of the fairy shrimp Branchin*ecta campestris* Lynch to saline astatic waters. *Limnology and Oceanography*, 14, 485–492.

Broch, E.S. (1989) Osmoregulatrory patterns of adaptation to inland astatic waters by two species of fairy shrimps, *Branchinecta gigas* Lynch and *Branchinecta mackini* Dexter. *Journal of Crustacean Biology*, 8, 383–391.

Brtek, J. & Mura, G. (2000) Revised key to families and genera of the Anostraca of the world with notes on their geographical distribution. *Crustaceana*, 73, 1037 – 1088.

Daborn, G.R. (1977) The life history of *Branchinecta mackini* Dexter (Crustacea: Anostraca) in an argillotrophic lake of Alberta. *Canadian Journal of Zoology*, 54, 161–168.

Fugate, M.L. (1992) Speciation in the fairy shrimp genus *Branchinecta* (Crustacea: Anostraca) from North America. Ph.D. thesis, University of California at Riverside. Riverside, California, 188 pages.

Fugate, M. (1993) *Branchinecta sandiegonensis*, a new species of fairy shrimp (Crustacea: Anostraca) from western North America. *Proceedings of the Biological Society of Washington*, 106, 296–304.

Hartland-Rowe, R. (1966) The fauna and ecology of temporary ponds in Western Canada. *Verhandlungen der Internationalen Vereinigung für theoretische und angewandte Limnologie*, 16, 577–584.

Horne, F.R. (1967) Effects of physical-chemical factors on the distribution and occurrence of some southeastern Wyoming phyllopods. *Ecology*, 48, 472–477.

Horne, F.R. (1974) Phyllopods of some southern high plains saline playas. *The Southwestern Naturalist*, 18, 475–479.

International Union of Conservation of Nature and Natural Resources. (2000) 2000 IUCN Red List of Threatened Species, compiled by Craig Hilton-Taylor. IUCN- The World Conservation Union Species Survival Commission.

Linder, F. (1941) Contributions to the morphology and the taxonomy of the Branchiopoda Anostraca. *Zoologiska Bidrag från Uppsala*, 20, 101–303.

Lynch, J.E. (1960) The fairy shrimp *Branchinecta campestris* from northwestern United States (Crustacea; Phyllopoda). *Proceedings of the United States National Museum*, 112, 549–561.

Lynch, J.E. (1964) Packard's and Pearse's species of *Branchinecta*: analysis of a nomenclatural involvement. *American Midland Naturalist*, 71, 466–488.

McCarraher, D.B. (1970) Some ecological relationships of fairy shrimp in alkaline habitats of Nebraska. *American Midland Naturalist*, 84, 59–68.

Saunders III, J.F., Belk, D. & Dufford, R. (1993) Persistence of *Branchinecta paludosa* (Anostraca) in southern Wyoming, with notes on zoogeography. *Journal of Crustacean Biology*, 13, 184–189.

Stern, S., & Belk, D. (1999) Confirmation of *Branchinecta paludosa* (Crustacea: Anostraca) in Utah. *The Southwestern Naturalist*, 44, 212–213.

Sublette, J.E. & Sublette, M.S. (1967) The limnology of playalakes on the Llano Estacado, New Mexico and Texas. *The Southwestern Naturalist*, 12, 364–406.