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THE FAIRY SHRIMP BRANCHINECTA CAMPESTRIS FROM NORTHWESTERN UNITED STATES (CRUSTACEA: PHYLLOPODA)

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The following description of a fairy shrimp belonging to the genus *Branchinecta* is the result of the study of 33 collections from 9 different localities, made between 1937 and 1958. The data contained in the specific diagnosis are based on observation and measurements of 20 mature specimens of each sex.

***Branchinecta campestris*, new species**

Figures 1–5

Specific diagnosis: Male: Length from front to end of cercopods 22.2 (15.9–28.5) mm. Ratio of length of head and thorax to that of genital segments, abdomen, and cercopods 1:1.3 (1:1.13–1:1.5). Antennule 2.3 (1.25–2.75) mm. long, length about 60 percent of that of basal article of antenna, with 3 setae and 9 to 12 aesthetases at the tip. Antenna biarticulate, 7.14 (5.25–9) mm. long. In straight, uncontracted specimens, the antennae, bent backwards, reach to thoracic segment 8, rarely to 7 or 9. Free part of proximal article of antenna 4 (2.75–4.75) mm. long, bearing an inconspicuous apophysis on its median side near its proximal end, distal to which is a file of from 7 to 15 small, conical sensory papillae 30–50 microns high, each with 1 or 2 sensory bristles. Distal article of antenna arcuate, its length across the arc 3.9 (2.75–4.75) mm.; nearly cylin-

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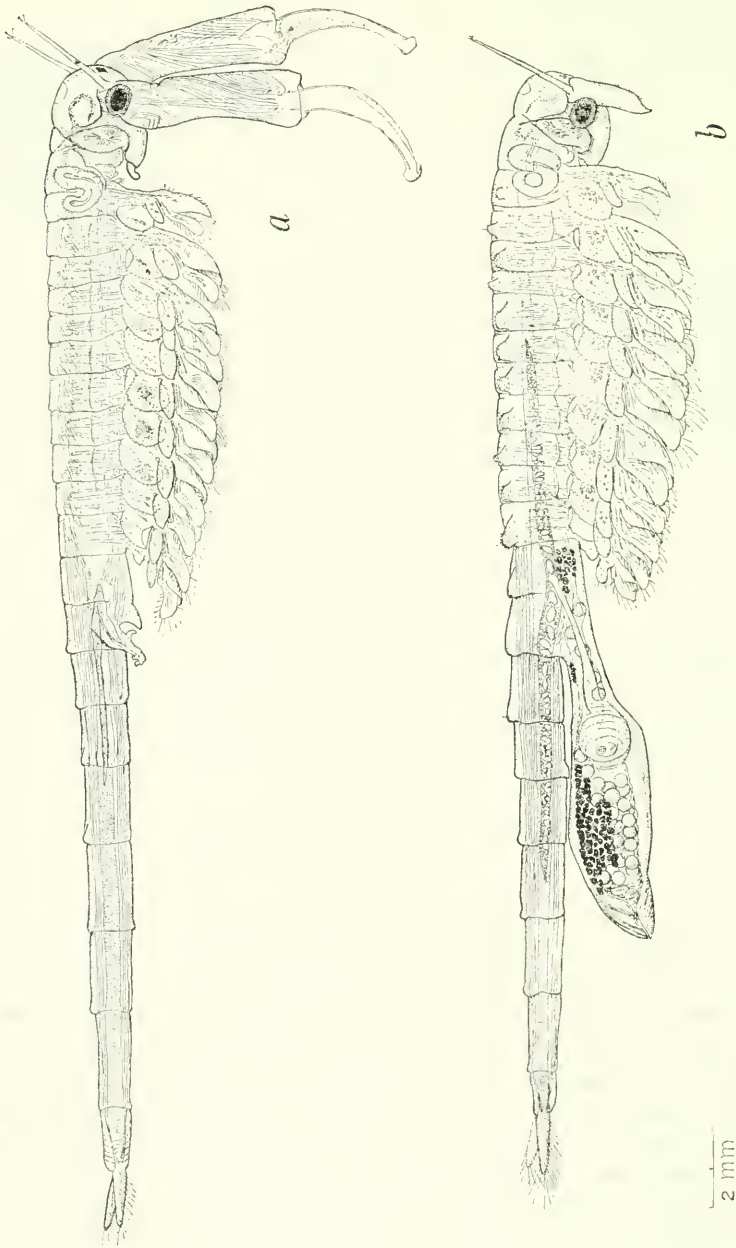

FIGURE 1.—*Branchinecta campestris*, new species: *a*, Male, × 5. *b*, Female, × 5.

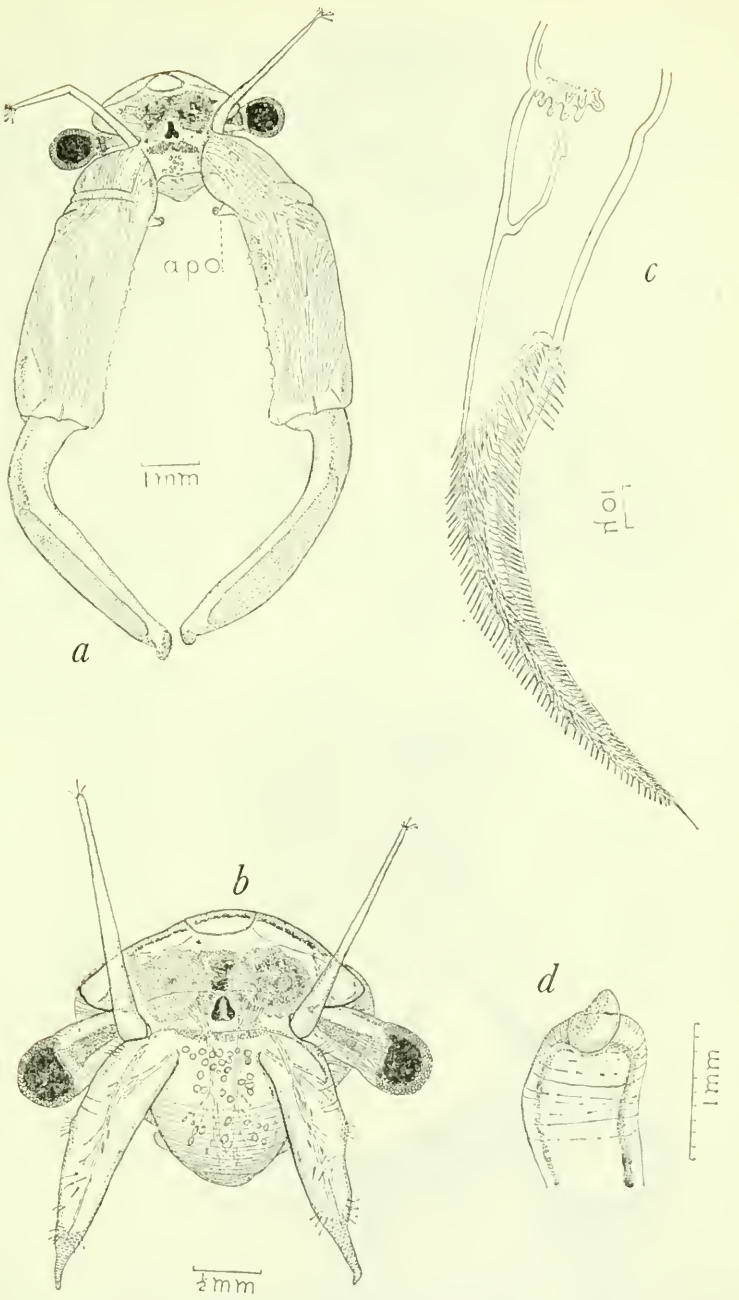

FIGURE 2.—*B. campestris: a*, Anterior view of head of male, × 7.5; *apo*, apophysis. *b*, Anterior view of head of female, × 17.5. *c*, Spine from distal median border of endopodite of sixth thoracic appendage of a male, × 540. *d*, End view of distal end of second antenna of a male to show the footlike expansion and its orientation, × 17.5. The concave lateral surface of the flattened part of the article is on the side opposite the observer.

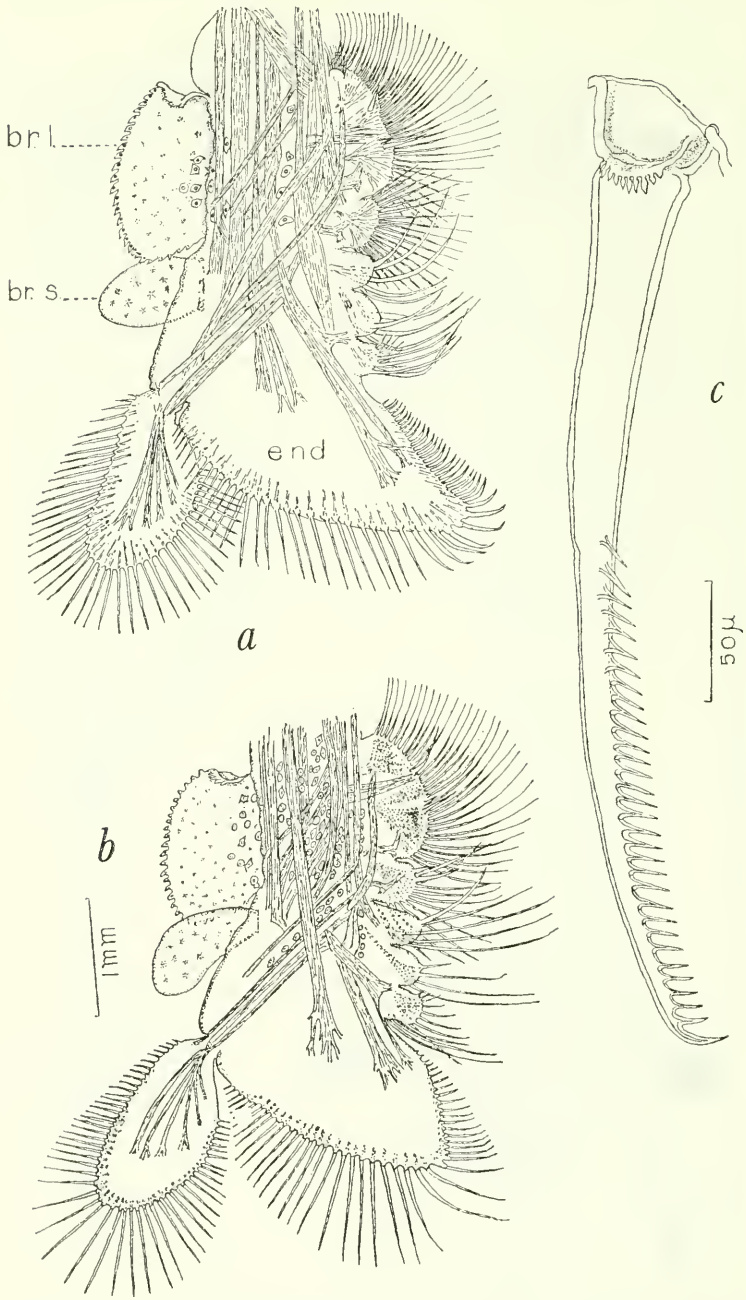

FIGURE 3.—*B. campestris: a*, Right sixth thoracic appendage of a male 26 mm. long, × 13.5. *br. l.*, branchial lamina; *br. s.*, branchial sac; *end.*, endopodite. Setules of the setae and spinules of the spines have been omitted. *b*, Right sixth thoracic appendage of a female 27 mm. long, × 13.5. *c*, Spine from distal median border of endopodite of sixth thoracic appendage of a female, × 280.

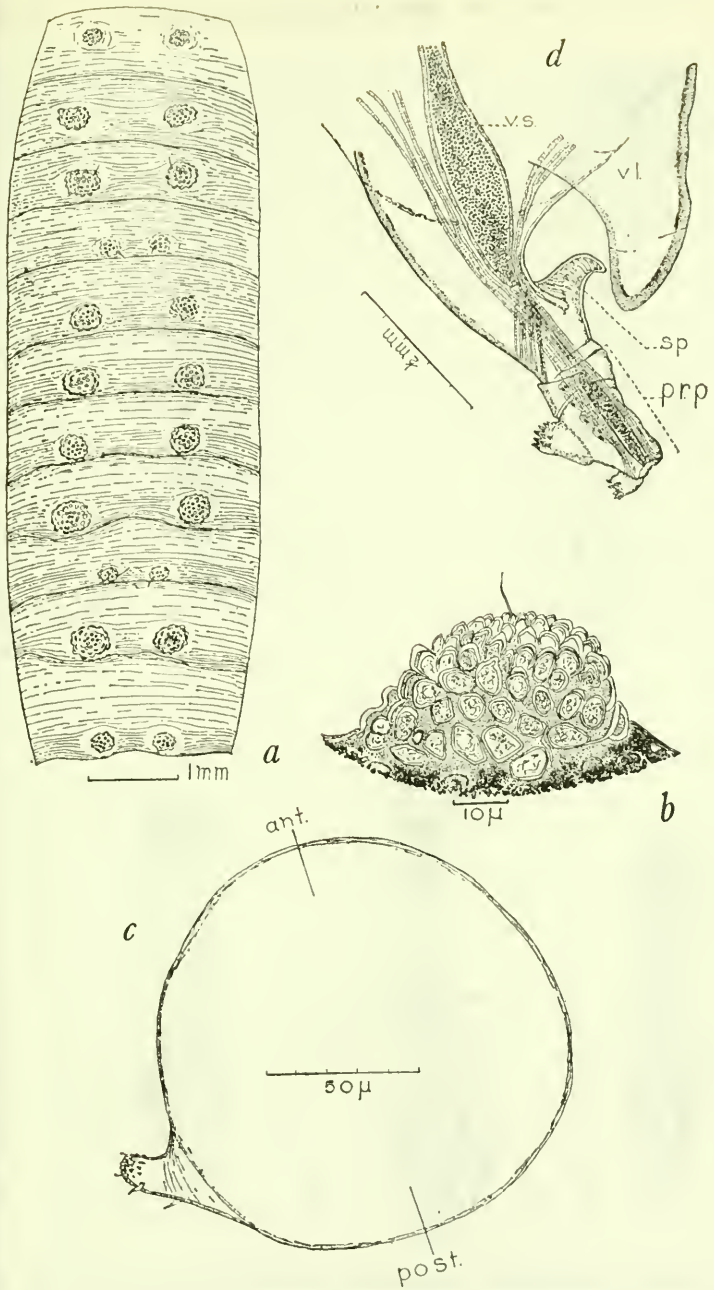

FIGURE 4.—*B. campestris: a*, Cuticle from dorsal side of thoracic segments of a female to show relative size and positions of thoracic bosses, × 12.5. *b*, Left bosse and sensory bristle from eighth thoracic segment of a female, lateral aspect, × 660. *c*, Outline of cross-section of basal article of right antenna of a male to show relative size of apophysis, × 30. *ant.* and *post.*, anteroposterior diameter of the article. *d*, Right penis and adjacent part of second genital segment of a male, × 44. *v. l.*, right ventral lobe of genital segments; *v.s.*, vesicula seminalis; *pr. p.*, retractile part of penis; *sp.*, chitinized spur on rigid part of penis.

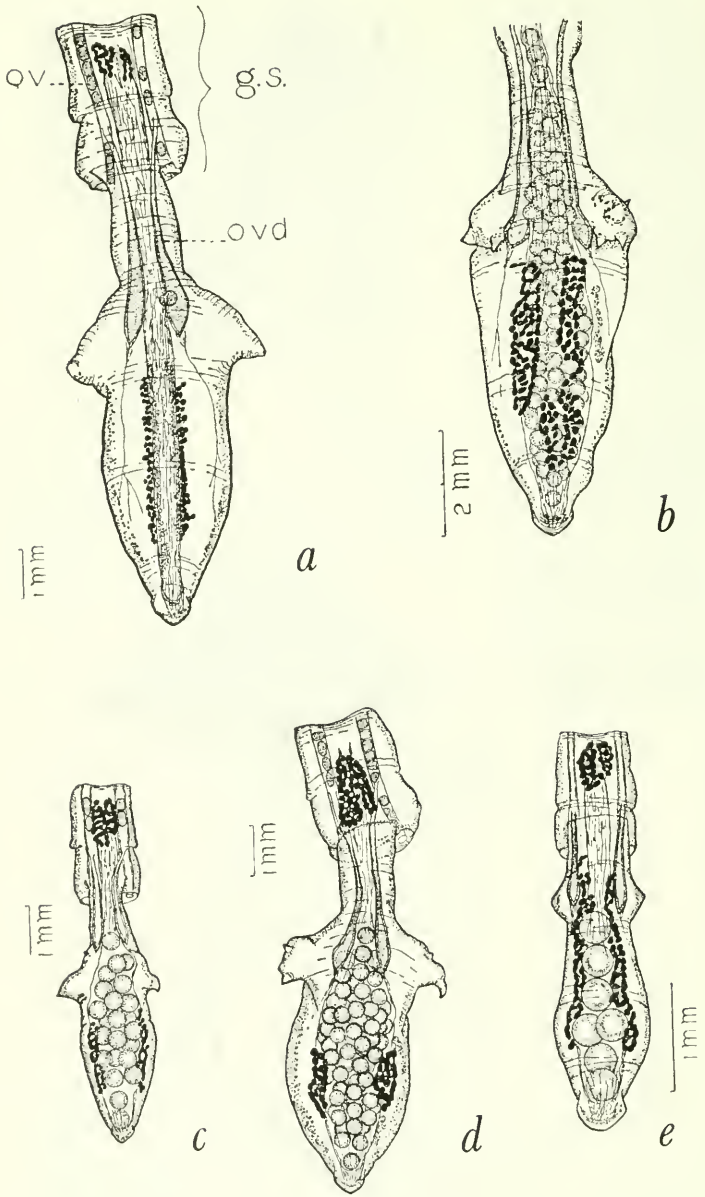

FIGURE 5.—Variations in development and conformation of the lateral outpocketings of the ovisac of female *B. campestris: a*, Ventral aspect of ovisac of a female 26 mm. long, × 6.6. *b*, Dorsal aspect of ovisac of a female 26 mm. long, × 6.6. *c*, Ventral aspect of ovisac of a female 20 mm. long, × 6.6. *d*, Ventral aspect of ovisac of a female 24 mm. long, × 6.6. *e*, Ventral aspect of ovisac of a female 14 mm. long, × 14.5. *g.s.*, genital segments; *o.v.*, ovary; *ovd.*, oviduct. Cement glands are depicted in solid black.

drical proximally, but expanding to a widened distal part which extends about 60 percent of its length, and which is approximately 4 times as wide as thick, slightly concave on its lateral side, with the narrower borders anterior and posterior. Near the apex the article contracts a little, then expands into a tip flattened nearly at right angles to the preceding part. In end view, the tip appears like a heel and toe, the more pointed toe being median. A rasplike area of low-flat-topped, chitinized papillae on the posterolateral side of the tip extends about halfway up the lateral border. Thoracic appendages typical of the genus; branchial lamina entire with serrated margin; the endopodite tapering to a slightly inturned end, with characteristic spines on its median border. Genital segments and copulatory appendages typical of the genus. Cercopods 1.5 (0.85–2.5) mm. long, distinctly articulated with the telson, with long, plumose setae on lateral and median borders.

Female: Length from front to end of cercopods 23 (18.75–30.0) mm. Ratio of length of head-thorax to that of genital segments, abdomen, and cercopods 1 : 1.33 (1 : 1.2–1 : 1.5). Antennule 1.9 (1.75–2.25) mm. long, about the same length as the antenna. Antenna 1.97 (1.4–3.5) mm. long, uniarticulate, the distal fifth narrowing to a tapering point. The 11 thoracic segments each bear a pair of dorsal verrucose bosses of conspicuous size, which may or may not bear sensory bristles; those of segments 4 and 9 nearer the middorsal line than the others. Thoracic appendages typical of the genus, the endopodite more obtuse than that of the male, with food-trapping spines of simpler spinulescence. Ovisac narrow anteriorly, expanding at the level of the second abdominal segment to from 2¼ to 4 times its anterior width to form right and left conical outpocketings, then contracting to about 65 percent of its maximum width to continue to a bluntly conical posterior end located under abdominal segment 4 or 5. Eggs of preserved specimens 295–345 microns in diameter. Cement glands composed of right and left, closely apposed, masses of large cells at the anterior end of the ovisac and on the dorsolateral sides of the posterior half of the uterus. Cercopods 1.36 (1.0–1.75) mm. long, with long, plumose setae on median and lateral borders.

The smallest mature female encountered was 12 mm. long, with 2 eggs in the ovisac, which extended only as far as the middle of the third abdominal segment.

Type data: One female holotype, USNM 104128, and 12 male and 12 female paratypes, USNM 104129, have been deposited in the U.S. National Museum. The type locality is an alkaline pond 12 miles south of the town of Moses Lake, Grant County, Washington.

Differentiating characters: The males are morphologically very close to *B. mackini* Dexter (1956). The most obvious differences

are the conspicuously flattened distal article of the second antenna and the footlike expansion at the terminal end thereof in *B. campestris* (fig. 2,*a*,*d*).

Other noticeable differences are: (1) The antennule is relatively shorter than in *B. mackini*. It is about 60 percent of the length of the basal article of the antenna, whereas in *mackini* it averages 85 percent of the length of the basal article. (2) The apophysis is smaller and is about half the size of that of *mackini*. (3) The proximal article of the antenna of *mackini* presents on the median side of the distal one-fourth a small swollen area or projection bearing 3 to 7 sensory cones, whereas in *campestris* such an eminence is lacking. (4) The food-gathering spines on the median border of the endopodite in *mackini* are relatively shorter, with heavier spinules, than those of *campestris*. (5) The telson in both males and females of *campestris* is about one-half the length of abdominal segment 6; in *mackini* it is only about one-third as long.

The females differ from any species previously described in the lateral outpocketings of the ovisac (fig. 5,*a*, *e*), and in the large size of the dorsal bosses of the thorax (figs. 1*b*, 4*b*).

Linder (1941) called attention to the arrangement of the paired dorsal sensory bristles on the thoracic segments of *B. gaini* and *B. coloradensis*, where those of thoracic segments 4 and 9 are nearer the middorsal line than the others. This arrangement occurs also in *B. mackini* and in *B. campestris*. Linder also mentions "granulated knobs" and "bulges," mostly lateral to the sensory bristles.

In many species of *Branchinecta* a pair of delicate sensory bristles occurs on the dorsum of each segment from the first thoracic to the sixth abdominal. Each bristle is typically surrounded by a circular area of low cuticular granules or verrucae. The bosses of *B. campestris* correspond to these granular areas, which in this species are remarkably developed, more or less hemispherical, and covered with coarse cuticular verrucae. The conspicuousness of the bosses is augmented by their being placed, especially those of segments 6, 7, 8, 10, and 11, on a bulge or welt of the body wall. The sensory bristle persists in many; in some it appears to be absent, or at least is undemonstrable. Very rarely one of the anterior bosses is paired, but nothing corresponding to the more lateral and ventral thoracic lobes, such as are found in *B. packardi* or in *B. lindahli* has ever been found.

The thoracic bosses of the female of *B. mackini* have the same arrangement, but are much less conspicuous because they are relatively smaller and rise much less above the surface.

It is difficult to give brief and satisfactory measurements for the bosses, since they vary in size from segment to segment and from specimen to specimen, and since the height on each side is different

(lateral side is usually highest) and the transverse diameter is usually greater than the anteroposterior diameter. On the largest bosses the verrucose part may be 450 microns high on the lateral side, and the entire eminence 530 microns high. Length and breadth are usually somewhat greater than the height. Less elevated above the surface, the bosses of the genital segments are large, but less prominent than those of the thorax. Equivalent structures occur on abdominal segments 1 to 6, but are small, scarcely rise above the surface, and are normally distinguishable only by the use of the compound microscope.

The females of *B. campestris* also differ from those of *B. mackini* in the following minor characteristics: (1) The spines on the distal median border of the endopodite of the female *B. campestris* are of the same type as those of *B. mackini*, but are relatively longer. In individuals of the same size, those of *campestris* are twice as long as those of *mackini*. (2) The antennule is usually from 85 percent to 100 percent of the length of the antenna, sometimes slightly longer. In *B. mackini* it is always longer than the antenna, averaging 185 percent as long. (3) In *B. campestris* 70 percent of the specimens have no connecting cells between the anterior and posterior groups of cement-gland cells, and the remainder have only a few, separated cells. In *B. mackini* 85 percent of the females have a continuous strand of juxtaposed cells on the dorsal side of the uterus connecting the anterior and posterior masses of cement-gland cells, and the remainder have scattered cells. (4) The ovisac is relatively shorter in *campestris*, where it terminates under abdominal segment 4 in 59 percent of the females and never extends posteriorly to segment 5. In *B. mackini*, the length of the ovisac is more variable but on the average is longer since it terminates under abdominal segment 5 in 69 percent and under segment 6 in 11.5 percent of the females.

Other American species in which the distal article of the antenna of the male is compressed and turned in at the tip can be distinguished from *B. campestris* by a number of features, of which the following are most easily recognized:

B. packardi Pearse, 1912: The males have both an apophysis and a large, proximally inclined protuberance on the median side of the proximal article of the antenna. The female has conspicuous conical lobes on the lateral side of the thorax, those of segments 9–11 and the first genital segment being the largest.

B. lindahli Packard, 1883, revised by Shantz 1905: The males have no apophysis or other protuberance on the median side of the basal article of the antenna. Full-grown females have lateral conical lobes on thoracic segments 4–11, those of segments 4–7 being the largest.

B. coloradensis Packard, 1874, revised by Shantz 1905. The male

has a large, thick apopysis, plus a large swollen verrucose area near the middle of the proximal article of the antenna. Females usually have conical lobes on the lateral sides of the thoracic segments.

Color of living specimens: The males have no distinctive color pattern. To the unaided eye they usually appear a translucent white or yellowish white, rarely pinkish.

Under low magnification the head is usually colorless, except for the yellow hepatic caeca, which are visible through the integument, but in some it is suffused with a faint green or bluish tinge. The eyes are black. The antennule is colorless or faint yellow. The proximal article of the antenna is white or yellow, usually more intensely yellow on the median side; rarely it may be faint brown, blue green, or yellowish pink. The distal article of the antenna is faint yellow and becomes darker toward the tip and on the narrow borders. The ventral side of the head and labrum ranges from pale yellow to pale blue, with a faint stippling of minute green or blue dots. Internally, the labrum contains large orange or brownish cells, visible through the integument.

The thorax is typically colorless and lacking in colored cells or oil globules. The corm and endopodite of the thoracic appendages are dingy yellow, the other endites and exites colorless.

The abdomen and cercopods are colorless, except for the posterior half of the intestine, which appears as a greenish-brown or black streak because of food residues. The genital segments are colorless, except for the heavily chitinized spur and adjacent sinus on the median side of the penes, which are yellow (fig. 4*d*).

The females, to the unaided eye, appear nearly colorless except for the dark yellow eggs in the ovisac, the brownish spots of the cement glands, and the black intestine in the abdomen.

The antennule is colorless. The antenna is usually colorless, but sometimes is faintly yellow or orange on the anterior side. The head is usually colorless except for the internal hepatic caeca, although the dorsal side is sometimes a faint blue. The eyes are black. The labrum may have a greenish or blue wash, and contains large, brownish cells, discernible through the translucent integument.

The dorsal and lateral sides of the thorax are colorless, except for the dorsal bosses, which vary from yellow to brilliant orange. Internally, large blue cells may accompany the intestine for the length of the thorax, or may be present only in the posterior half. These cells also occur along the ventral portions of the intersegmental sutures of the thorax in some individuals. The thoracic appendages are nearly colorless, although the corm is often a faint yellow.

The wall of the ovisac is colorless or glassy, except for the lateral outpocketings and adjacent area, which range from yellow to orange, and in some individuals the colored areas merge on the ventral side

of the ovisac. The cement glands vary from light yellow to dark brown but in most adult females are some shade of brown. The eggs within the uterus are usually an ochraceous yellow. The ovary, which extends from abdominal segment 4 or 3 to thoracic segment 8 to 4, often contains large oöcytes of white, greenish white, or pale blue-green tint.

The abdomen is colorless except for the intestine, which appears blackish regardless of food content since the dark blue cells mentioned above accompany the intestine along its dorsal side from some part of the thorax to the fourth or fifth abdominal segment and in some individuals completely encircle the abdominal intestine. The cercopods are colorless.

The females are unique among North American species of *Branchinecta* in the yellow or orange spots on the outpocketings of the ovisac, and in the similarly colored thoracic bosses.

Distribution and habitat. *B. campestris* has been collected in the State of Washington from the following localities: Three ephemeral ponds in the Lower Grand Coulee, Grant County, Washington, and five ponds scattered over an area of rough "scab land," 10 to 17 miles south of the town of Moses Lake, in southern Grant County and western Adams County. Most, or more likely all, of these ponds in Grant and Adams Counties have been destroyed in recent years by the construction of gigantic reservoirs filled with water from the Columbia River. These reservoirs have covered and annihilated some of the largest and most interesting "dry lakes" in North America. In addition, most of the ponds for miles below the dams have been converted, by continuous seepage, from ephemeral alkaline ponds into permanent fresh-water ponds in which none of the original unique and scarcely explored fauna of alkali-tolerant organisms has survived.

One collection came from a pond in Okanogan County, Washington, about 10 miles north of LaFleur. Dr. G. C. Anderson (1958) reported an unknown *Branchinecta* from Hot Lake, Okanogan County. Specimens that he kindly donated to the writer proved to be *B. campestris*. Two separate collections came from a pond situated at the eastern border of the town of Rawlins, Carbon County, Wyoming. The specimens from Rawlins differ slightly from those from Washington in that the females have somewhat smaller thoracic bosses, and the males have somewhat larger expansions at the tip of the antenna.

B. campestris has always been found in water of extremely alkaline reaction, or at least with a high content of dissolved salts. The pH of water carried back to Seattle and determined a day or two later by a Beckman pH Meter, Model G, has ranged from 9.5 to 10. On the two occasions when the density of the water was ascertained, it was 1.020 and 1.012 at 60° F. Usually, the new species has been found

in clear water, as contrasted with *B. mackini* and *B. gigas*, common in the same area, which are usually in opaque water. The temperature of the water at the time that collections were made ranged from 48° to 69° F. All collections in the State of Washington were made from late March to mid-June. The collections from near Rawlins, Wyoming were made on August 5, 1937, and June 20, 1958.

The elevation above sea level of the ponds in which *B. campestris* has been found ranges from about 1,100 feet in Adams County, Washington, to 6,750 feet near Rawlins, Wyoming.

In 60 percent of the collections, *B. campestris* is the only phyllopod present. *Artemia salina* was, however, regularly present in three of the ponds in Grant County, and often the two species occurred simultaneously; at times only one or the other species was present. In three other ponds in Grant County, *B. mackini* in small numbers was associated with *B. campestris*.

In spite of the scanty data on physical conditions in the ponds, it seems evident that *B. campestris* is adapted to living in water with so high a content of dissolved salts that only *Artemia salina* can develop abundantly in the same habitat. This may account for its scarcity in Grant County, Washington (known from seven ponds) where, before the construction of enormous dams and the permanent inundation of approximately 67 square miles of land with water from the Columbia River, there were literally hundreds of ponds that annually produced teeming populations of *B. mackini*. This circumstance provoked the thought that *campestris* might be only a variety of *mackini* developing in water of greater alkalinity and density than its more usual habitat. This conjecture seems most unlikely, however, in view of the relatively large number of specific differences, and my failure to find unmistakable intergradations between the two species.

Remarks. Including the subject of this paper there are now eight species of *Branchinecta* reported from western North America, and several undescribed species that await the attention of systematists. In addition, redescriptions of several species and a study of the variability of others are in order before an adequate revision of, and keys to, the species of the genus in North America can be made.

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