

THE CALIFORNIA MAYFLIES OF THE GENUS
RHITHROGENA
(Ephemeroptera)

W. C. DAY

1021 Hubert Road, Oakland, California

Since its description as *Heptagenia brunnea* in 1875 by Hagen, *Rhithrogena brunnea* has been known by but one adult female and one adult male specimen, the penes of the latter being figured in a general way by Eaton in his revisional monograph. The type locality of the species was given as "Nevada, Truckee, in Sierra Nevada Range," which can probably be taken to mean some location on the Truckee River between its headwaters and Reno, Nevada.

Collecting in each of four years on the Truckee River and its tributaries, my wife, Helen L. Day, and I have reared and taken by aerial net about 150 male adults of *R. brunnea*, and have reared 35 additional male adults in Shasta County and Mono County. We have found both nymphs and adults of this species to be highly variable in size, color and maculation. In our earlier collecting we noted that the positioning and the appearance of the penes of the male adult was also extremely variable.

Variation of appearance of the penes in this species makes classification most difficult as at least five *Rhithrogena* species of the *brunnea* group are so closely allied as to be separable only by the form and details of this feature. The basic separation of *R. doddsi* and *R. petulans* on one hand, and *R. brunnea*, *R. morrisoni* and *R. futilis* on the other, has traditionally been made on the erectness or the divergence of the two arms of the penes, the width and form of the tips of the penes, and the relative size of the ventral and apical spines of the penes.

For the two species of the above that we have collected in quantities, namely *R. brunnea* and *R. morrisoni*, I have found that the degree of stability in the form and positioning of the penes of collected adult specimens depends almost wholly on the method of killing. When a male adult is taken from the net and

dropped directly into 70% alcohol, the specimen ordinarily clamps the forceps across one another. At the same time, the arms of the penes may be brought together with ends folded into narrow, pointed tips; or the arms of the penes may be held straight out in parallel, with tips narrowly rounded; or the arms of the penes may be curved outward in wide divergence, with fully rounded tips in *R. brunnea* or more narrowly rounded tips in *R. morrisoni*. Any combination of these appearances and positions may be assumed.

Variation in the prominence of ventral, dorsal and distal spines of the penes depends considerably on the freshness or dryness of the specimens when placed in alcohol for preservation. After the male adult is dry-killed, excessive drying of the penes causes the integument to shrink away from the bases of the spines so that these spines appear to be larger than normal in size.

After several experiments, I believe that adults of these species should be placed, immediately after capture, in loose tissue in a dry killing jar charged with ethyl acetate (ether acetic), and kept there for about one and one-half hours before immersion in 70% alcohol. This treatment provides museum specimens of uniform and life-like appearance and avoids distortion and variation in the positioning and appearance of the penes.

On each of the four evenings of July 2-5, 1954, we found a small swarm of *R. brunnea* at 5:30 p.m., P.S.T., at a point some 50 yards from the Upper Truckee River near Highway 50. Placing alternate male adults in (1) 70% alcohol and (2) in the dry killing jar charged with ethyl acetate, we totaled 59 specimens in alcohol and 60 in the dry jar.

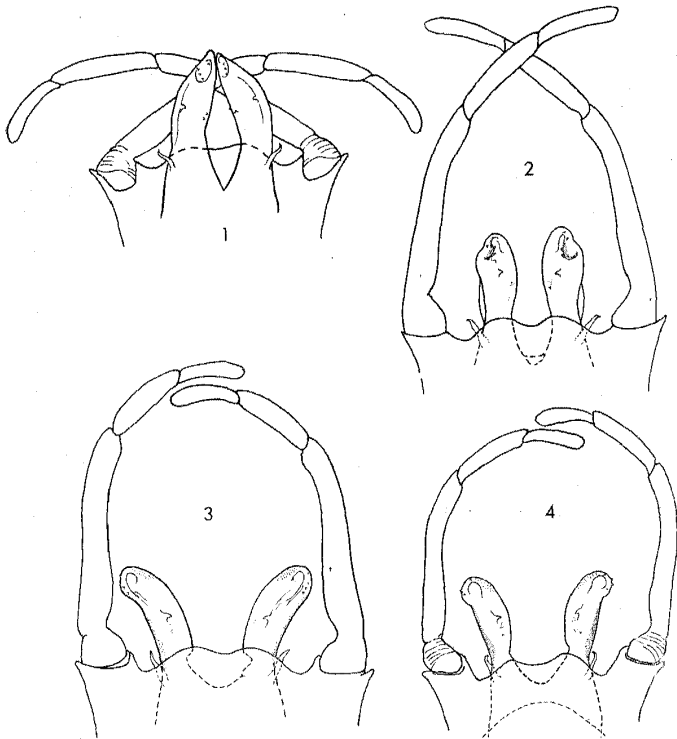
Of the 59 specimens placed directly in alcohol, 55 showed tightly clamped forceps and great variation in the appearance of the penes, the accompanying figures 1, 2 and 3 presenting examples of this variation.

The 60 specimens taken through the ethyl acetate killing jar before immersion in alcohol produced not a single specimen with clamped forceps, and provided 60 specimens with penes of life-like appearance showing little distortion or variation in divergence. In figure 4, forceps and penes are shown in the form that I regard as the true appearance of these parts in *R. brunnea*.

The centrally placed ventral spines of the penes are usually quite strong in *R. brunnea* but, as in *R. morrisoni*, there is con-

siderable variation in both the size of these spines and their number. Occasionally the ventral spine of *R. brunnea* is lacking on one arm of the penes and, in other cases, two ventral spines appear on one arm.

The apical spines of the penes of *R. brunnea* belong to the outer lateral margin but are sometimes also partly dorsal; they are always short, sometimes heavy and well-formed and again little more than blunt and shapeless protuberances. They are identical in form, variation and placement with the similar spines I have seen in *R. doddsi* from Utah. Another feature shared alike by *R. brunnea* and *R. doddsi*, and not previously reported for either, is the existence of from one to four tiny spines on the dorsal surface of each arm of the penes. These spines are centrally



EXPLANATION OF FIGURES

1-4, genitalia of *Rhithrogena brunnea*: 1-3, various distortions of penes; 4, natural appearance of penes.

located and usually somewhat basad of the position of the opposite, heavier ventral spines.

The structure of the penes of *R. brunnea* and *R. doddsi* is identical. The ends are smoothly rounded and expanded, the openings of seminal ducts are large and surrounded by a darkened area, and the lightly chitinized strip along the basal lateral surfaces is identical in size, form and placement. Both nymphs and adults of *R. brunnea* and *R. doddsi* seem identical in detail except for difference of divergence of the arms of the penes of the adult male after death. Occasional specimens from Utah and New Mexico show slight distortions of the penes that exactly match the distorted form of these parts shown for the California specimen in figure 2. On the eastern slope of the Sierra Nevada we find many Rocky Mountain species from numerous orders of insects and it seems quite possible that *R. brunnea* and *R. doddsi* represent populations that are simply geographic races of the same polytypic species.

Collecting *R. brunnea* in Nevada, Placer, El Dorado, Mono and Shasta Counties, we have noted considerable variation in coloration of the adults, often among those taken simultaneously. The body shades from light to very dark brown, wingveins and mesonotum vary from pale, yellowish brown to fuscous, and the bodies of numerous adults are bright ruddy in color.

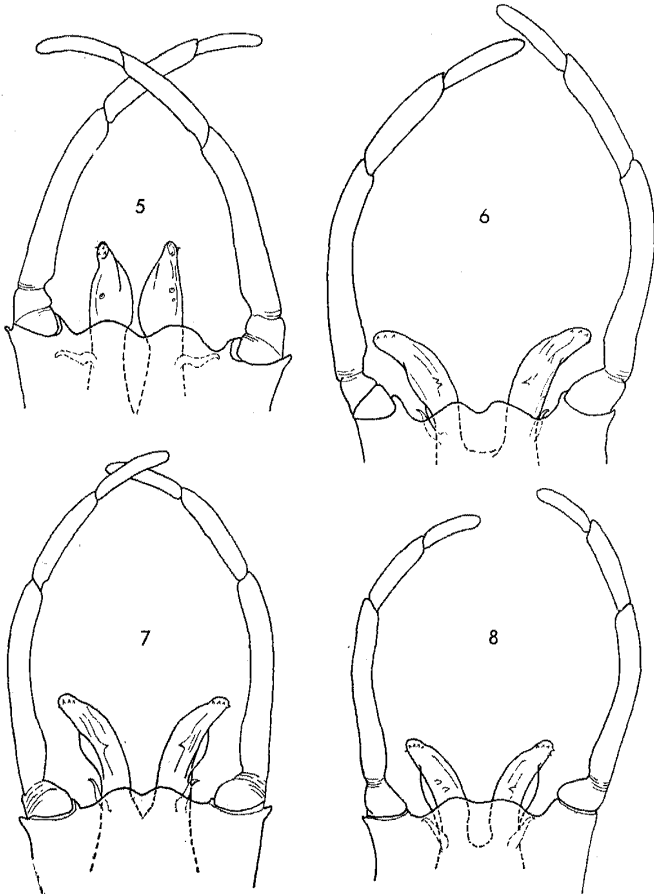
Nymphs of *R. brunnea* are highly variable in color and fall into three basic groups, (1) concolorous brown, from pale to very dark, gills white, (2) brown, with tergites 7 and 8 almost entirely white, gills white, and (3) body pale pinkish brown, gills bright red. In this latter phase, both lamellae and fibrillae of the gills are bright crimson, the legs are often bright red, and the abdomen has a pinkish cast; these nymphs rear to adults broadly and sometimes strongly marked with dark red. In four situations I have attempted to roughly establish the proportions of the three color phases of these nymphs coexisting in a short stretch of stream; of 273 nymphs collected, 42 (15%) had at least red gills, 101 (37%) were brown with tergites 7 and 8 white, and 130 (48%) were concolorous brown.

RHITHROGENA MORRISONI

Precautions in killing the adults of *R. morrisoni* apply with equal force as with *R. brunnea*, as killing directly in alcohol leads to variation and distortion of the penes as shown in figures 5 and

6. A drawing of the natural position of the genitalia of *R. morrisoni* as observed in California is given in figure 7.

Intermixed with brown nymphs, we frequently find nymphs of *R. morrisoni* that have bright crimson gills, legs and abdomen, with touches of red on head and pronotum. When reared, the red nymphs usually produce adults with bright red legs and abdomen, the tails and wingveins being a pale yellow brown. Because the tails and wingveins of the red adults are much lighter



EXPLANATION OF FIGURES

5-8, genitalia of *Rhithrogena morrisoni*; 5-6, distortions of penes; 7, natural appearance of penes; 8, genitalia of red adult reared from red nymph.

in color than those of the adults reared from brown nymphs, I suspect that the redness of the nymph is due to the subtraction of some color substance from the total color pigment of the brown nymph. The normal appearance of the genitalia of the red male adult is identical with that of the brown adult, and is shown in figure 8.

As a rough guide to the ratio of red to brown nymphs of *R. morrisoni*, a count was kept for several collections in Yolo and Napa County. In these collections 272 nymphs were taken, of which 49 (18%) were red, and 223 (82%) were brown.

Ventral spines of the penes of the male adult vary in size from very large, as in the largest similar spines of *R. brunnea*, to smallness that makes them difficult to see with the stereoscopic microscope. Variation in number of these ventral spines goes from no spines on either arm of the penes to three spines on each arm. In 68 male adults reared from nymphs taken from Cache Creek, Yolo County, California on April 19, 1952, the following breakdown was made:

No. specimens	VENTRAL SPINES ON PENES	
	Left arm	Right arm
1	0	0
3	0	1
41	1	1
18	1	2
4	2	2
1	2	3

We have collected specimens of *R. morrisoni* in the following California counties: Alpine, Amador, Sonoma, Napa, Yolo and Marin, and have received male adult specimens from Los Angeles and San Bernardino Counties. From this distribution it may be seen that *R. morrisoni* inhabits five differing life zones in California, namely, the eastern slope of the Sierra Nevada, the western slope of same, the barren areas of the eastern slope of the Coast Range, the Redwood Coastal strip, and the San Gabriel mountains.

Rhithrogena petulans was described by Seeman (1927) as *Iron petulans* from Cucamonga Canyon, San Bernardino County, California, and I have examined the four penes on micro slides and one male adult from Cucamonga Canyon placed in the Cornell University collection as the type material. Also, through the kindness of Dr. Henry Dietrich I have examined material from nearby Icehouse Canyon, San Bernardino County, collected by

Michener and identified by Traver as *R. petulans*. Additional specimens from the same area have been supplied me by Dr. Fred S. Truxal, same having been collected in San Gabriel Canyon, Los Angeles County and Adahi, San Bernardino County.

R. petulans was separated from *R. brunnea* and *R. morrisoni* by the erectness of the penes of the former. Only one specimen from Cucamonga Canyon shows this erectness, one specimen has penes slightly divergent, two are widely divergent and the other is badly mounted. The Michener collections show two specimens with erect penes and one divergent. If collected in alcohol, the diversity of appearance of the Seeman and Michener material is explained but, in any case, the type material does not bear out the original description.

The four male adults from Truxal taken from San Gabriel Canyon and Adahi were pinned and I restored and mounted the genitalia on slides, finding them to be very good normal examples of *R. morrisoni*. Thus, in eleven good specimens including the type material, and all from the same area, seven are quite positively normal specimens of *R. morrisoni*. I therefore conclude that *R. petulans* is a synonym of *R. morrisoni*. There are but four good species of the genus *Rhithrogena* that have to date been reported from California these being as follows: *R. brunnea* Hagen, *R. decora* Day, *R. flavianula* McDunnough, *R. morrisoni* Banks.

REFERENCES

EATON, A. E.

1885. A revisional monograph of recent Ephemeridae. Trans. Linn. Soc. London Sec. Ser. Zool. 3:1-352, pls. 1-65.

HAGEN, HERMANN

1875. Rep. U.S. Geol. Survey of Terr. for 1873:571-606.

McDUNNOUGH, J.

1926. Notes on N. A. Ephemeroptera with descriptions of new species. Canad. Ent. 58:184-196.

NEEDHAM, J. G., J. R. TRAVER AND Y. HSU

1935. The Biology of Mayflies. Comstock Pub. Co., Ithaca, N.Y.

SEEMAN, T. M.

1927. Dragonflies, Mayflies and Stoneflies of Southern California. Jour. Ent. and Zool. 19:40-51, 2 text figs., pls. 2-4.