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**Observations on the Biology of *Cinygmula*  
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(Ephemeroptera: Heptageniidae)

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Mayflies of the genus *Cinygmula* are widespread and frequently abundant in the lotic waters of the western United States. The immature stages are undescribed at the species level and aside from scattered notes, no details have been published on the biology of any species (Berner, 1959). Information reported here was gathered as a background for studies of benthic communities in lotic waters.

This genus has been included in the works of Traver (1935), Burks (1953), Day (1956), and Jensen (1966). A drawing of *Cinygmula* sp. nymph is provided by Edmunds (1959, p. 909). Three of the 11 North American species were recorded from Oregon by Allen and Edmunds (1956). *Cinygmula par* (Eaton) and *C. tioga* (Mayo) have been collected in the vicinity of Mt. Hood, whereas *C. reticulata* McDunnough is widespread in western Oregon. Allen (1955) collected the latter only west of the Cascade Mountains. Jensen (1966) reported it from east-central Idaho.

TAXONOMIC CONSIDERATIONS

Jensen (1966) used the following combination of characters to distinguish *Cinygmula* nymphs from those of other genera of Heptageniidae: (1) three well developed caudal filaments present; (2) gills on abdominal segments one and seven not enlarged nor extending beneath the abdomen, and similar to those on intermediate segments, only smaller; (3) fibrilliform portion of gills absent or reduced to a few tiny filaments; (4) front of head distinctly emarginate medially.

According to Jensen (1966) *C. reticulata* is included in the *minus* group which is the most difficult section of the genus, with much variation in size and color.

The mature nymph is 6 to 8 mm in length with caudal filaments 5 to 7 mm long. The fibrilliform portion of the gill of *C. reticulata* is absent. The color of the dorsum varies from light brown to dark brown to red,

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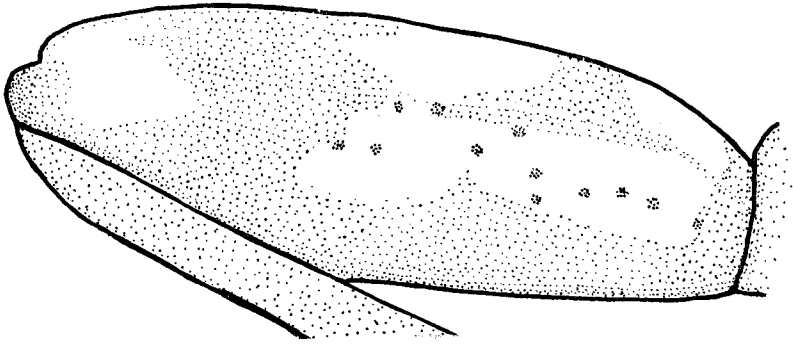


FIG. 1. Femur of *Cinygmula reticulata* illustrating color pattern.

and hence is unreliable as a taxonomic character (see below). Day (1956) used the color pattern on the femur to separate species of *Cinygmula* nymphs. We found that the femur of *C. reticulata* has a basal, central, and sometimes apical white area, with the basal and central areas usually connected by a longitudinal white patch; there are 10 to 15 brown spots in the white area of the basal half of the femur (Fig. 1). Based on the examination of a number of specimens (some of which were not *C. reticulata*) it appears that the brown spots on the femur may be useful for separating the species of nymphs. An unidentified species collected in Montana had nearly 40 of these spots.

Nymphs and adults from the same collection may vary in color (representatives are deposited in the Oregon State University insect collection). The basic color of nymphs ranges from ochreous to grayish-brown and the nymphs occasionally have a distinct dorsal stripe, or they may be marked strongly with red. In reared material, red nymphs retain the red markings from one moult to the next. Within the family Heptageniidae, this occurrence of red nymphs is not restricted to *Cinygmula* as Day (1957) commented on the occurrence of 15 to 18% of the nymphs of *Rhithrogena* with varying degrees of reddish color. Based on laboratory rearing of *C. reticulata*, adults from red nymphs do not differ morphologically from other adults.

In a single series collected in Oregon, adults varied considerably in size, and the wings varied from clear to strongly tinged with yellow. The dark markings forming the wing reticulation may be strong or entirely absent. Since some species in this genus are distinguished only by differences in size or color (Traver, 1935), a revision of the genus would likely yield many synonyms.

## SEASONAL SIZE CLASS DISTRIBUTIONS

The life cycle was studied in two streams. Samples were taken from July 1967 to June 1968; monthly in Oak Creek, Benton County, in the Willamette Valley and in alternate months in the Metolius River, Jefferson County, on the eastern side of the Cascade Range. On each sampling date, three samples were taken from each biotope described below. Benthos samples were taken by embedding the end of a length of stovepipe (6 in. dia.) into the substrate of the stream. The larger stones were removed by hand, and then the water was stirred vigorously and the contents were transferred to a pail with a fine mesh (0.2 mm openings) aquarium net.

Oak Creek is a small, densely-shaded woodland stream. The sampling station was five miles northwest of Corvallis in the foothills of the Coast Range at an elevation of 500 feet. Conditions of flow and temperature varied considerably as a result of normal seasonal changes. Stream width in the sample area varied from 3.5 to 16 feet, depending on rainfall, and water temperature varied from 1° C in December and January to 21° C in August. Benthos samples were taken from the following biotopes in Oak Creek: still backwater (protected from main current by stumps and other obstructions); glide (water up to 2 feet deep with a smooth flow, impacted silt and rubble substrate); and riffle (turbulent flow with much splashing, clean rubble substrate).

Samples from the Metolius River were taken at a site between Camp Sherman and the headwater springs at an elevation of 3,000 feet. In the sample area, volume of flow and water temperatures were fairly constant year round (water temperatures at mid-day were: March, 8° C; May, 10° C; July, 12° C; August, 10° C; September, 10° C; November, 9.5° C; and January, 9° C). The bed of the river is broad (about 100 feet), flat, and shallow, the water seldom being over 2 feet deep. Most of the gravel substrate is less than 2 inches in diameter. Dense beds of *Ranunculus aquatilis* L., islands of sedge, and growths of *Lemna* near the shore, are conspicuous features. Samples were taken from both the gravel and the plant beds.

*C. reticulata*, in Oak Creek, hatches in the fall, grows slowly during the winter and adults emerge from April to June (Fig. 2). Eggs apparently require several months to hatch. Some small nymphs occurred in the June 1968, sample but from the present data we cannot determine their significance. It is possible that these emerged from eggs deposited in early spring. Sampling was not continued after June so data are not available on the fate of this group. In the previous year, no active stages

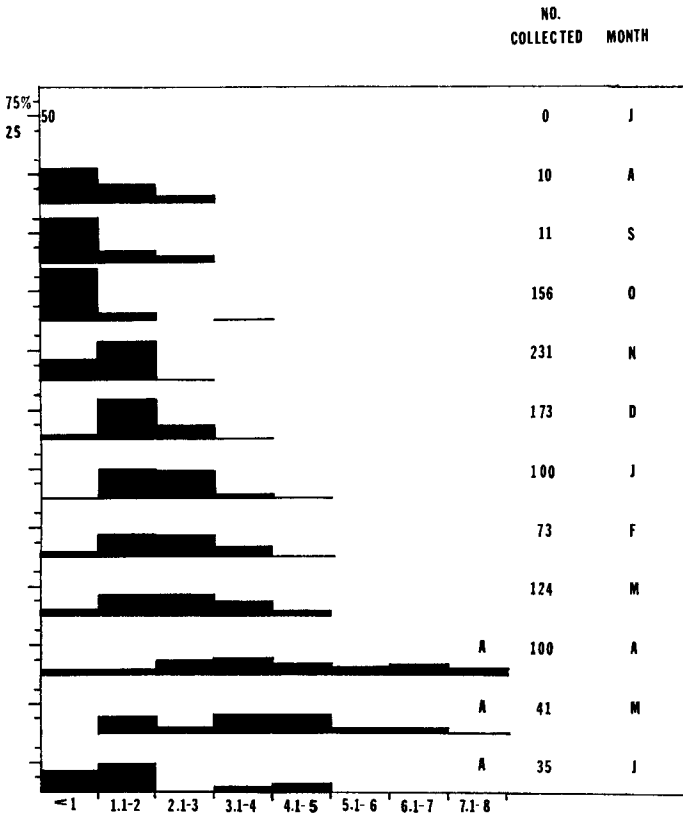


FIG. 2. Size class distribution of *Cinygmula reticulata* in monthly benthos samples, Oak Creek, Benton Co. Ore. A = adults collected. Nymphs absent in July.

of *C. reticulata* were collected during July, and the major hatching period did not start until October.

Figure 3 shows the life cycle of *C. reticulata* in the Metolius River. All size classes were present on nearly all sampling dates. Adults, or nymphs with dark wing pads, were present from April to November indicating that adults emerge during eight or more months of the year. In spite of the long hatching and emergence periods, the overlapping generations can be distinguished by noting the increase in nymphal density in the autumn, and the change in percentage of newly-hatched nymphs (from 4% to 65%) between July and September. The < 2 mm size group in September and the < 3 mm group in November represents the bulk of a new generation hatching in the fall (Fig. 3). The over-

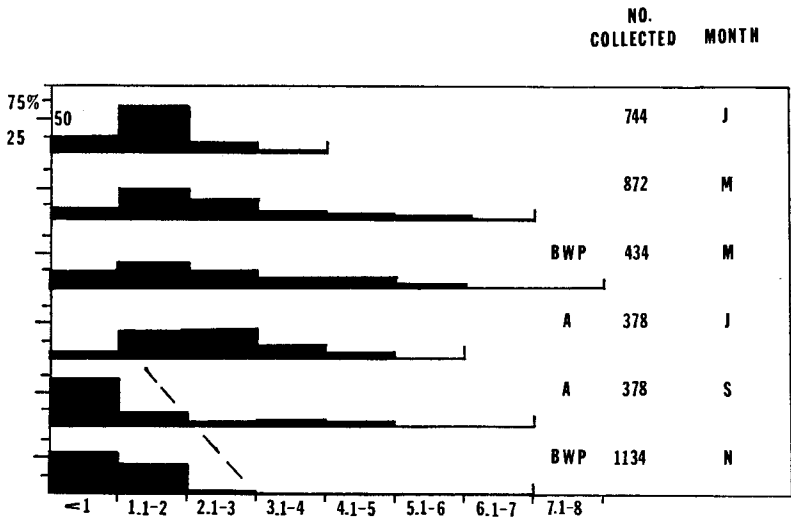


FIG. 3. Size class distribution of *Cinygmula reticulata* nymphs in benthos samples, Metolius River, Jefferson Co. Ore. BWP = mature nymphs with black wing pads. A = adults collected.

lapping generations are separated by a diagonal line, indicating a clear univoltine cycle (by adding those to the left of the diagonal line to the top of the graph).

While the streams differ in many respects, the life cycle of the species is similar in both. The duration and temporal spacing of events differ, probably as a result of differences in air and water temperature. Specimens from the Metolius River tend to be larger and darker in color than those from Oak Creek.

#### HABITAT PREFERENCES

According to Day (1956), the nymphs of *Cinygmula* spp. are often found in water only 1 to 2 inches deep at the foot of riffles, in crevices, and on the lower surfaces of small stones in small streams in California. Jensen (1966) stated that the nymphs of *C. mimus* (Eaton) are found in small to moderate streams, usually above 5,000 feet, on rocks and among gravel; nymphs of *C. ramaleyi* (Dodds) are found in small to moderate streams above elevations of 4,000 feet; and those of *C. par* occur in small, cold, swiftly flowing streams above elevations of 5,000 feet where they cling to the undersides of rocks in the swiftest portions of the current.

As is apparent from our study, *C. reticulata* occurs at considerably lower altitudes and in larger streams than Jensen reports for the other species. Nymphs of *C. reticulata* live in gravel or rubble substrates, and while they tolerate some silt and organic matter, they are usually absent from muddy areas and plant beds. Nymphs are found in moderate currents, i.e., they are absent from still water, and uncommon in extremely fast riffles. Small nymphs (presumably newly hatched) and mature nymphs (those with dark wing pads) were almost entirely restricted to riffle areas. Of 140 from Oak Creek and 1,269 from the Metolius River, 81% and 99%, respectively, of the small nymphs were from the gravel riffle area. Of the ultimate instar nymphs, 15 of 24 from Oak Creek and 37 of 40 from the Metolius River were from gravel, as opposed to plant bed areas.

We have no detailed data on food habits of the species but nymphs apparently feed both on diatoms and on detritus. Chapman and Demory (1963) carried out gut analysis of a species of *Cinygmula* (as *Cynigmula*) in western Oregon; they found that the nymphs fed heavily on diatoms in spring and early summer but turned to allochthonous detritus from late summer to mid-winter.

#### MATING AND OVIPOSITION

Adults of this species were observed in the field many times. At the Metolius River, swarms comprised of hundreds of adults were observed both in direct sunlight at midday and in the evenings. At Oak Creek, most mating flights were seen on cloudy days or in the shade. The mating flight usually occurred 5 to 8 feet above the surface of the water, and the rising and falling of individuals covered a vertical interval of less than 2 feet.

Thirteen males were collected from a swarm and kept in a cage at outside temperatures. Eight were alive after 24 hours, five after 48 hours, three after 52 hours, and all were dead at 64 hours. Thus, under artificial conditions, males live long enough to swarm more than one day.

A female was observed laying eggs at Oak Creek. She maintained a stationary position by fluttering at the height of one foot over the surface of a riffle. The female extruded a cluster of yellow eggs, dropped to the water and touched the mass to the surface. The eggs scattered in the water and the female flew back to the former position above the riffle. She fluttered there 1 to 2 minutes, more eggs appeared on the underside of the abdomen, and she again dropped to the water. This was repeated four times, after which the insect flew off to the vegetation along the stream bank.

## SUMMARY

*Cinygmula reticulata* McDunnough (Ephemeroptera: Heptageniidae) was studied in Oak Creek (yearly water temperature range 1° to 21° C) and in the spring-fed Metolius River (yearly water temperature range 8° to 13° C) in Western Oregon. In Oak Creek, eggs hatched mainly in October and adults emerged from April to June. In the Metolius River most eggs hatched from September to November and adults emerged from April to November. The species was univoltine in both, and the abbreviated period of adult emergence in Oak Creek was presumably due to high summer temperatures. Nymphs were most numerous in moderate current or silt-free substrates. The most stable character for identification of the nymphs is the color pattern on the femur.

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