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in Western Oregon**
(Ephemeroptera : Heptageniidae)

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**The Life Cycle of *Rhithrogena morrisoni* (Banks)
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Detailed biological data are lacking for the North American species of *Rhithrogena*. Some species in the genus are distinguished only by minute details of the male genitalia, and the females and nymphs are frequently undescribed. The species treated here will be referred to as *R. morrisoni*. Specimens of all stages are deposited in the Oregon State University Insect Collection, Corvallis.

Rhithrogena morrisoni was described by Banks from Nevada in 1924. It also occurs in western Canada (Bernier, 1959), California (Day, 1963), Idaho (Jensen, 1966), Oregon (Allen and Edmunds, 1956), and Utah (Edmunds, 1952). Jensen (op. cit.) described the nymphs and included both adult males and nymphs in his keys to the *Rhithrogena* of Idaho.

METHODS AND COLLECTIONS

Nymphs of *R. morrisoni* were collected from a variety of streams in the Benton County area. The description of nymphal development is

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based on intensive sampling in Oak Creek, near Corvallis, from July 1967 to June 1968. Adults were reared or collected in 1966, 1967, and 1968.

In the sample area, Oak Creek was 5–10 feet wide, 6–18 inches deep, and had a dense canopy of deciduous trees. The sample area consisted of a series of riffles and pools, the former having a rubble and gravel substrate. Other information on the stream can be found in Anderson and Lehmkuhl (1968) and Lehmkuhl (1968).

Benthos samples were taken by embedding the end of a one foot length of stovepipe 6 inches in diameter into the substrate. Contents of the sampler were removed by hand and with a fine aquarium net. Surface velocity, water depth, distance from shore, and general bottom type were recorded for each sample. Three samples were taken each month from each of the major habitats in the stream: slow deep glide, still backwater, middle of riffle, edge of riffle (12 samples per month).

Mayfly nymphs of equal maturity may vary much in size, i.e., ultimate instar nymphs (having black wing pads) may differ in length by several mm. In addition to length measurements, a system of groupings based on biologically significant characters was used, as described below:

Group	Biological Significance
I Gills poorly developed, threadlike or absent; nymphs scarcely resemble mayflies.	Newly hatched.
II Definite mayfly appearance, gills developed beyond I, no wing buds.	Young nymphs.
III Wing buds present on posterior margin of meso- and metathorax; mesothoracic wing pads do not completely cover metathoracic wing pads.	Half grow nymphs.
IV Mesothoracic wing pads cover metathoracic wing pads.	Mature nymphs.
V Wing pads black.	Ready to emerge to subimago.

To obtain adults, nymphs collected in the field were placed in small screen cages which were partly submerged in a trough in which water was circulated by a paddle wheel. Nymphs could rise to the water surface or crawl up the side of the screen to emerge.

LIFE CYCLE

Of over 100 samples taken in Oak Creek, about 15% contained large stones (4–5" dia.) and were in water over 2 ft./sec. surface velocity.

TABLE 1. Sizes and natural groups of *Rhithrogena morrisoni* (Banks) nymphs from Oak Creek bottom samples, 1967-1968.

	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.
Length (mm)	1-2	3-5	6-8	8-9	none	8-9
Natural Groups ¹	II	II-III	III	IV	—	V

¹ See text.

Nymphs of *R. morrisoni* were found only in these samples indicating that the nymphs have strict environmental requirements.

Table 1 illustrates the seasonal development of the nymphs in the 1967-1968 sample period. None was found from March to August but small nymphs may have been overlooked in August because of the presence of *Cinygmula reticulata* McDunnough nymphs which might be confused with *Rhithrogena*. Nymphs of *R. morrisoni* were 1-2 mm long in September and had increased to 9 mm in December. Severe spates in the fall and winter caused much disturbance in the stream (Anderson and Lehmkuhl 1968), and this may explain the absence of nymphs in the January sample. Nymphs increased greatly in maturity but only slightly in length from November to February (compare lengths and natural groups, Table 1). Nymphs had black wing pads (natural group V) in February, and the first adults appeared at this time.

Adults were collected between the following dates: 1966—25 March to 26 April; 1967—11 March to 21 April; 1968—29 February to 24 April. In 1968, the main emergence from Oak Creek was early and of short duration (first week of March), probably because of several days of unseasonably warm weather at this time (air temp., over 20° C; water temp., about 7° C). This explains the absence of nymphs in March and April samples (Table 1). Adults from other areas were collected as late as 24 April 1968.

Cast skins from laboratory-emerged specimens were found floating free on the surface of the water, indicating that the nymphs do not climb out of the water to transform to the winged stage. The subimago stage lasted from 4-6 days for laboratory reared specimens kept at outside temperatures of 5-15° C. Subimagos collected on buildings in Corvallis and kept indoors (21-23° C) usually required 2 days to transform to the adult stage.

A mating swarm was observed over a roadside ditch (March 2, 1968) near a stream at 3 P.M. on a misty day. The swarm consisted of a dozen males widely spaced 8-15 ft. above the ground. Jensen (1966),

reported that the adults swarm over streams and adjacent ground in mid-morning, but that the main flight occurs in the evening.

No nymphs were collected in the summer indicating that the eggs have a resting period of several months. This is similar to *R. semicolorata* in England (Macan, 1960).

DISCUSSION

Jensen (1966) reported that *R. morrisoni* had an early emergence in Idaho and Utah (May and June). This species also has an early emergence in the Corvallis area (March and April). Macan (1960) suggested that the end of the period of emergence occurs when rising water temperatures reach a point which kills the nymphs. I have shown that emergence may be correlated with temperature in some species of *Epeorus* (Lehmkühl, 1968), but that temperature alone will not explain the emergence period in all cases for a given species. In the present case it is unlikely that high water temperatures limit the period of adult emergence. Jensen (1966) found *R. morrisoni* nymphs in water up to 18° C, which is well above the temperature in Oak Creek when the last adults emerged.

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