



The benthos and drift fauna of a riffle in the Madison River, Yellowstone National Park
by John R Heaton

A thesis submitted to the Graduated Faculty in partial fulfillment of the requirements for the degree of
DOCTOR OF PHILOSOPHY in Zoology
Montana State University
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Abstract:

The benthos and drift fauna of a riffle in the Madison River, Yellow-stone National Park, were sampled during June 1963 through January 1965. Sixteen collections of benthos containing 128 samples (1/4 m²) and 10 col-lections of drift containing 531 samples were taken. Benthos standing crops ranged from 455.5 organisms/m² with a volume of 3.10 cc/m² in Sep-tember to 2,496 organisms/m² with a volume of 11.81 cc/m² in April. A total of 55 different organisms was identified from the benthos samples. Bphemeroptera, Plecoptera, Coleoptera, Odonata, Diptera, Trichoptera made up 89% of the number and 93% of the volume of all benthos. Mollusca, Turbellaria and Oligochaeta contributed the remainder. Drift animals varied from 160,997 organisms with a volume of 1,460 cc/24 hours in Nov-ember to 6,219,988 organisms with a volume of 36,378 cc/24 hours in June. Aquatic invertebrates and emerged aquatic insects made up 92.1% of the total volume of drift, while fish and fish eggs contributed 4.3% and terrestrial arthropods 3.6% Immature aquatic insects dominated the drift. Most species which appeared in the benthos were taken in the drift. Most organisms had diurnal periodicity with higher drift rates at night. Highest drift rates occurred when benthos numbers were high and lowest when benthos was low, but relations between benthos and drift were not consistent. Organisms drift from unknown distances upstream making correlations of drift with benthos difficult. Drifting plant material was present throughout the year varying from 2,084.82 g(dry weight)/24 hours in October to 94,212.29 g in June.

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JOHN R. HEATON

A thesis submitted to the Graduate Faculty in partial
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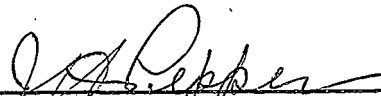
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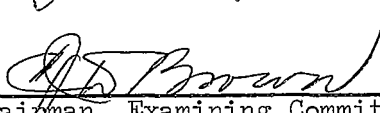
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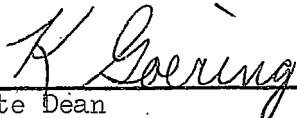
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ABSTRACT

The benthos and drift fauna of a riffle in the Madison River, Yellowstone National Park, were sampled during June 1963 through January 1965. Sixteen collections of benthos containing 128 samples ($\frac{1}{4}$ m²) and 10 collections of drift containing 531 samples were taken. Benthos standing crops ranged from 455.5 organisms/m² with a volume of 3.10 cc/m² in September to 2,496 organisms/m² with a volume of 11.81 cc/m² in April. A total of 55 different organisms was identified from the benthos samples. Ephemeroptera, Plecoptera, Coleoptera, Odonata, Diptera, Trichoptera made up 89% of the number and 93% of the volume of all benthos. Mollusca, Turbellaria and Oligochaeta contributed the remainder. Drift animals varied from 160,997 organisms with a volume of 1,460 cc/24 hours in November to 6,219,988 organisms with a volume of 36,378 cc/24 hours in June. Aquatic invertebrates and emerged aquatic insects made up 92.1% of the total volume of drift, while fish and fish eggs contributed 4.3% and terrestrial arthropods 3.6%. Immature aquatic insects dominated the drift. Most species which appeared in the benthos were taken in the drift. Most organisms had diurnal periodicity with higher drift rates at night. Highest drift rates occurred when benthos numbers were high and lowest when benthos was low, but relations between benthos and drift were not consistent. Organisms drift from unknown distances upstream making correlations of drift with benthos difficult. Drifting plant material was present throughout the year varying from 2,084.82 g (dry weight)/24 hours in October to 94,212.29 g in June.

INTRODUCTION

The benthos and the associated drift of a riffle in the upper Madison River were studied to provide information on numbers and volumes, species composition, and distribution of organisms throughout the year.

Benthos in Yellowstone National Park was investigated by Armitage (1958, 1961) on the Firehole River (a tributary of the Madison River) and four other streams and by Muttkowski (1925, 1929) and Muttkowski and Smith (1929) who reported on benthos of several other park streams. Several workers have investigated stream benthos in other areas of the Rocky Mountains. In Montana, Linduska (1942) described mayfly distribution in relation to bottom type, Brown et al. (1953) and Logan (1963) observed the effects of winter conditions on benthos and drift while Graham and Scott (1958, 1959) and Schoenthal (1963) studied the effect of DDT on benthos. In Utah, Moffett (1936) investigated the effect of flooding and measured repopulation due to drift while Gaufin (1959) studied benthos production. In Colorado, Dodds and Hisaw (1924a, 1924b, 1925a, 1925b) investigated the adaptations of stream insects to altitude and velocity while Pennak and Van Gerpen (1947) studied their relationship to the substrate. Tarzwell (1937, 1938b) observed benthos in relation to substrate and other physical conditions in several southwestern streams.

A variety of studies on benthos of coldwater streams has been made in other areas. These include: trout food relationships by Needham (1928, 1933, 1934, 1938), Moore et al. (1934), Surber (1937), Mottley et al. (1939), Allen (1940, 1942, 1951), Leonard (1941), Hess and Swartz (1941),

Smith and Moyle (1944), Horton (1961) and Tebo and Hassler (1961); relation to physical and chemical conditions by Percival and Whitehead (1929), Ide (1935, 1940), Tarzweil (1936, 1938), Sprules (1940, 1947), Briggs (1948), Jones (1948, 1951), Harker (1953), Badcock (1954a, 1954b), Needham and Usinger (1956), Scott (1958), Morgan and Egglisshaw (1965); the effects of ice by O'Donnell and Churchill (1954), Maciolek and Needham (1952), and Benson (1955); colonization and repopulation from drift by Müller (1954), Kennedy (1955), and Waters (1964).

Several investigators have been concerned primarily with drift organisms originating from benthos. Needham (1928, 1933, 1938) first described the production of benthos on riffles and drift into pools. Denham (1938) found benthos organisms (benthoplankton) in the drift during normal flows with increased numbers during floods. Lennon (1941) reported increased drift with higher flows and temperatures. Dendy (1944) found that most species of benthos organisms present in a stream appeared in the drift. Müller (1954) described a "colonization cycle" which involved downstream drift of immature stages and upstream flights by adults. Waters (1961, 1962a, 1965) studied relationships of drift to benthos standing crops and made productivity estimates from drift. Tanaka (1960), Waters (1962b), Müller (1963a, 1963b, 1965), Klyuchareva (1963), and Elliot (1965) reported on diurnal periodicity of drift.

A variety of benthos studies in warm water streams has also been made. Among these are fish food relationships by Richardson (1921, 1928), Surber (1939, 1940) and Berner (1951); various physical and chemical conditions

by Gersbacher (1937), Stehr and Branson (1938), Denham (1938), Murray (1938), Shockley (1949), Slack (1955) and Minckley (1963); and pre-impoundment studies by Lyman (1942), Lyman and Dendy (1943), O'Connell and Campbell (1953).

Some investigators have studied benthos in relation to pollutants. Invertebrates as indicators of pollution have been described by Gaufin and Tarzwell (1956). Cordon and Kelly (1961) reviewed the literature concerning the effects of sediment on stream benthos.

Description of the Study Area

The present study was restricted to a riffle in the Madison River at Riverside Station (elevation 2,026.9 m) located 4 km upstream from the west boundary of Yellowstone National Park. The drainage area above the study riffle is predominantly a high forested plateau of about 121,730 hectares. Air temperature in this area ranged from 51 C below to 33 C above zero during 1963 and from 47 C below to 32 C above zero during 1964. Annual precipitation was 72.5 cm in 1963 and 72.6 cm in 1964 (48 year mean 53.9 cm) with the lowest amount during July and the highest during June (U. S. Weather Bureau 1963, 1964). Deep snow made access difficult throughout the winter and early spring months.

The study area was 70 m in length and comprised the lower portion of a riffle about 10 km in total length (Fig. 1). This area had a mean width of 54.4 m and mean depth of 29.3 cm (maximum 51.8 cm). Discharge during the study period ranged from 9.35 to 39.65 m³/sec with the lowest flows during December and the highest following the melting snow pack in June

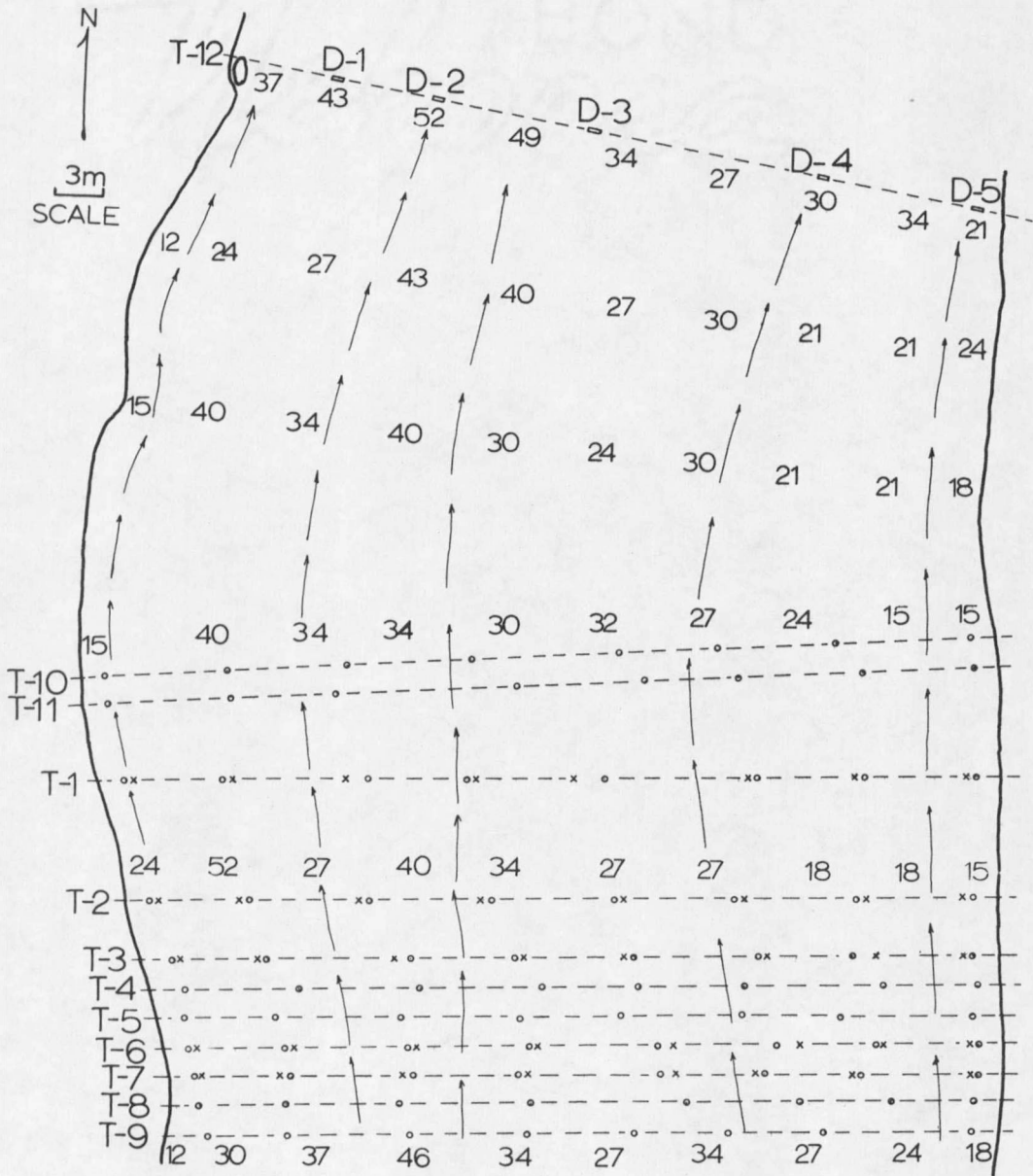


Figure 1. Study riffle on the Madison River showing: depths of the water (cm), locations of benthos transects (T-1 through T-11) and benthos samples (o=June 1963 through May 1964, x=June 1964 through January 1965), and drift stations (D-1 through D-5).

