The above data clearly demonstrate selectivity in the diets of the four common species that show predation on other coelenterates. However, no predator was dependent on a single prey species. It is difficult to evaluate the degree of competition involved. Not only do the four species vary in period of maximum abundance in the bay but all four species will accept noncoelenterate prey. This study will be extended to investigate predation on other possible prey including fish larvae.

Acknowledgments — We are very grateful for the facilities of the Pacific Biological Station, Nanaimo, B.C., where this study was carried out and the cooperation of the staff. Dr Z. Kabata kindly translated several Russian papers. Miss Valerie Overend assisted in collection of specimens. The project was supported by NRC Grant A2007 to M.N.A.

Leaf Litter Processing in a Regulated Rocky Mountain Stream

ROBERT A. SHORT1 AND JAMES V. WARD

Department of Zoology and Entomology, Colorado State University, Fort Collins, CO 80523, USA


Processing of alder (Alnus tenuifolia) was investigated during autumn and winter to determine the influence of stream regulation on leaf litter processing. Study sites were the Colorado River below Granby Dam and the Fraser River, an unregulated tributary. Alder leaves (5-g units) were attached to bricks and placed in riffles. Leaching controls were retrieved after 48 h; thereafter five replicates were collected from each site after 17, 38, 52, and 66 d. There were significant differences (P < 0.05) in processing rates between sites. The loss rate coefficient (k) was much higher (k = 0.0462) for leaves incubated in the regulated section

1Present address: Department of Biological Sciences, North Texas State University, Denton, TX 76203, USA.

Printed in Canada (J5676)
Imprimé au Canada (J5676)
Determinations of leaf litter processing rates have generated a great deal of information concerning stream ecosystem structure and function (e.g. Petersen and Cummins 1974; Sedell et al. 1975; Benfield et al. 1977) and have provided an experimental means to test various hypotheses (Reice 1974, 1977). The leaf pack method has also been used as a bioassay to determine the effects of man's activities on streams (Triska and Sedell 1976; Gelroth and Marzolf 1978). One significant anthropogenic impact has been the construction of numerous reservoirs on previously free-flowing streams. Large dams may greatly modify the physical-chemical conditions of downstream reaches with resultant changes in the diversity, density, and composition of the macroinvertebrate fauna (Ward 1976a; Ward and Stanford 1979). Since there is a selective elimination of certain taxonomic and functional groups (Ward and Short 1978), it was hypothesized that leaf litter processing would be altered by stream regulation. The leaf pack method was utilized to determine the influence of stream regulation by dams on leaf litter processing rate.

Materials and methods — Study area — Study sites were on the Colorado River below Lake Granby and on the Fraser River, a major tributary unregulated by dams. Lake Granby is a large storage reservoir located 10 km northeast of Granby in the Rocky Mountains of northern Colorado. The dam is 91 m high and impounds 666 \times 10^6 m^3 of water. The confluence of the Fraser and Colorado rivers is 12 km below Granby Dam. A site on the Fraser River was selected immediately upstream from Granby.

Study locations were at comparable elevations (2460 and 2420 m a.s.l.) and exhibited generally similar conditions. Woody riparian vegetation consisted predominantly of willows (Salix spp.) and alder (Alnus tenuifolia) and the stream bottom was predominantly rubble in both study sections. During the study period, discharge averaged 0.54 m/s in the Colorado River and 0.3 m/s in the Fraser River. Total dissolved solids (35.7 mg/L; 65.4 mg/L) and methyl orange alkalinity (11.0 mg/L; 22.5 mg/L) values were somewhat higher in the Fraser River. Nitrogen-nitrate (53 µg/L; 43 µg/L) and pH (7.6; 7.4) exhibited similar values at both locations. There were, however, considerable differences in water temperature (discussed later) between the regulated and unregulated streams.

Experimental procedures — Alder (Alnus tenuifolia) leaves were collected in September 1978 immediately prior to abscission. The leaves were air-dried then oven-dried at 60°C for 48 h and weighed into 5-g units and strung on monofilament line. A single leaf pack was lashed to each brick and placed into a riffle area of each stream on September 29. After 48 h, three replicate leaf packs were retrieved from each site to serve as leaching controls. Thereafter, five replicates were collected from each site after 17, 38, 52, and 66 d in the stream. At the time of collection the leaf pack was cut free of the brick and placed into a plastic bag containing 5% formalin. In the laboratory the leaf pack was thoroughly rinsed with tap water to remove accumulated sediments, dried at 60°C for 48 h, and weighed (±0.1 g). Macroinvertebrates associated with the leaf pack were placed into 80% EtOH until identified and enumerated. Dry weight of macroinvertebrates was determined following drying to constant weight at 60°C. No attempt was made to correct for weight loss during preservation. Water temperatures were monitored using maximum–minimum thermometers at each site.

Results — There were clear differences in leaf processing rates (Fig. 1A). On each sampling date leaf packs from the Colorado River had less weight remaining than those from the Fraser River. Analysis of variance showed these differences to be significant (P <
December

0.05) on each sampling date except day 38 (0.05 < 

P < 0.10). Even losses due to leaching exhibited sig-

nificant differences between sites. Gelroth and Marzolf

(1978) found that leaf packs apparently lost weight by

leaching to a greater degree in a natural stream than a

channelized stream. These results are difficult to re-

concile since leaching is thought to be a purely physical

process unrelated to variables such as temperature

(Petersen and Cummins 1974).

Leaf packs collected from the Colorado River site

were >90% processed after 52 d in the stream (Fig.

1A). Thus leaf packs were not again collected at this

site. The Fraser River samples collected on January 7

day 100) consisted only of monofilament line as either

the leaf packs had been completely processed or were

damaged by ice action. The leaf packs collected on this

date were therefore not included in the analysis.

After accounting for leaching losses, linear regres-

sion was used to estimate the loss rate coefficient (k)

following log, transformation of the percent remaining
data in Fig. 1A. This assumes that leaf pack processing
in streams follows an exponential decay model (Petersen
and Cummins 1974). These estimates are pre-

sented below along with calculated times for 50 and

90% processing.

<table>
<thead>
<tr>
<th>Site</th>
<th>k</th>
<th>50%</th>
<th>90%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colorado River</td>
<td>0.0462</td>
<td>15</td>
<td>50</td>
</tr>
<tr>
<td>Fraser River</td>
<td>0.0235</td>
<td>30</td>
<td>98</td>
</tr>
</tbody>
</table>

The k values for both sites indicate rapid processing

of alder leaf packs with the Colorado River loss rate

coefficient approximately twice that of the Fraser River.

Leaves with k values above 0.010 are considered “fast”

species (Petersen and Cummins 1974). Alder leaf

packs would be 90% processed in just 50 d at the

Colorado River site, a rate of processing nearly equal
to that obtained by Hart and Howmiller (1975) for

Alnus rhombifolia leaves in a much warmer southern

California stream.

Although numbers of macroinvertebrates per leaf

pack were generally similar at the two sites (Fig. 1B),

there were obvious differences in the species composi-
tion (Table 1). Eight of the taxa collected in the

Fraser River leaf packs were not found in the Colorado

River samples. Six taxa were collected only from the

Colorado River. These differences undoubtedly relate
to the effects of stream regulation (Ward and Short

1978). The most abundant species collected at both

sites was the mayfly Ephemerella infrequens which ac-
counted for 76% of the total number of macroin-
vertebrates in the Colorado River leaf packs and 34% in

the Fraser River samples. Many taxa in the Colorado

River leaf packs were present in very low numbers

(Table 1); often only 1 or 2 individuals were collected
during the entire study period (e.g. Tricorythodes sp.,

Skwala parallela, Pieronarcella badia, Lepidostoma

sp.). This occurred to a much lesser degree in the

Fraser River leaf packs.

Assignment of the macroinvertebrates to functional

groups (Merritt and Cummins 1978) also reveals

drastic differences between the sites (Table 2). Col-

lectors were by far the dominant group in the Colorado

River leaf packs, mainly due to the presence of large

numbers of Ephemerella infrequens. Shredders were

much less important at the location below Granby Dam.

In the Fraser River leaf packs, the collectors formed

the bulk of the biomass, but the shredder biomass value

was 10x that found in the Colorado River samples.

Alder leaves incubated in a small headwater stream in

Colorado (Short et al. 1980) had an even greater

shredder biomass than the Fraser River samples, yet

the loss rate coefficient (k = 0.0308) was less than that

of the Colorado River below Granby Dam where

shredders were virtually absent.

Minimum and maximum water temperatures recorded

at intervals over the sampling period are shown below.
The effect of impoundment was to elevate fall and winter temperatures and to increase thermal constancy (see Ward 1976b).

Discussion — The results of this study do not support our hypothesis that reduction of shredders would result in a slower processing of leaf litter in the regulated stream.

Temperature appears to be one factor to which the differences in leaf processing rates between the streams may be attributed. Weight loss of leaf litter often is directly proportional to stream temperature (Anderson and Sedell 1979). The elevated fall and winter water temperatures resulting from Lake Granby thus appear to provide an explanation for the higher loss rate coefficient in the Colorado River. The “winter warm” thermal regime below the reservoir seems to compensate for the virtual absence of shredder species. Inputs of coarse particulate organic matter (CPOM) are normally reduced below dams (which accounts for reduced shredder populations) since instream transport from upper reaches is eliminated (Ward 1976a). Therefore, CPOM probably plays a minor role in the energetics of regulated stream reaches. Regulated streams are characterized by large standing crops of autotrophs (Ward 1976a) which likely provide the major portion of the food base. What then accounts for the rapid processing of leaf litter below Granby Dam? Enhanced microbial processing at higher temperatures provides at least a partial explanation. It is also possible that surficial scraping by the large numbers of E. infrequens significantly contributed to weight loss of Colorado River leaf packs. Elevated temperature may increase leaf weight loss by increasing feeding activities of macroinvertebrates.

It is not known whether the findings of the present study are applicable to regulated streams in other regions or even to other lotic systems in the Rocky Mountains. The proliferation of dams necessitates a fuller understanding of the effects of stream regulation and provides a setting for testing and developing basic theories of stream ecology.

Acknowledgments — The authors wish to thank Dr J. A. Stanford, North Texas State University, for reading the manuscript.


A Motion for the Retirement of the Von Bertalanffy Function

Derek A. Roff

Department of Fisheries and Oceans, Fisheries and Marine Service, P.O. Box 5667, St. John's, Nfld. A1C 5X1


The reasons for the continued use of the von Bertalanffy equation are examined. It is suggested that these reasons are insufficient to overcome the drawbacks of this function and alternative procedures are recommended.

Key words: von Bertalanffy, growth, yield per recruit


Nous analysons les raisons pour lesquelles on continue d'utiliser l'équation de von Bertalanffy. Nous suggérons que ces raisons sont insuffisantes pour l'emporter sur les désavantages de cette fonction, et nous recommandons d'autres méthodes.

Received June 18, 1979
Accepted October 4, 1979

Reçu le 18 juin 1979
Accepté le 4 octobre 1979

One of the most ubiquitous equations in the fisheries literature is the von Bertalanffy function. Historically it gained wide currency because it claimed to be developed from bioenergetic principles. However, as pointed out by several authors (Parker and Larkin 1959; Paloeimo and Dickie 1964; Ursin 1967) this equation, from a bioenergetic perspective, is at best a special case and at worst nonsense (Knight 1968). Given that the equation can no longer be justified on the grounds upon which it was developed, why has it remained so much in use?

In this note I examine the reasons for this and suggest that they do not outweigh the disadvantages of the von Bertalanffy equation.

Probably the most general reason for the continued use of this equation is that it is a convenient statistical description of the data. But is it so convenient? There are principally two statistical reasons for selecting a particular equation: firstly, the equation may be very flexible and fit a wide range of data and secondly the equation may be easily fitted to the data. The first is certainly true of the von Bertalanffy function but the second is decidedly not true, as testified by the recurrence of papers providing methods of fitting it and other

Printed in Canada (15680)
Imprimé au Canada (15680)