INTERNAL REPORT 87

ESTIMATES OF BIOMASS OF DETRITUS FOOD CHAIN

Pamela Bissonnette and Frieda B. Taub
University of Washington

ABSTRACT

Macrobenthos populations of the IBP lakes were sampled during October and November of 1972. Analyses of the samples revealed dominance of chrinomids and oligochaetes in both littoral and profundal regions for at least this time of year. Due to sampling difficulties the oligochaete material was not used for chemical analyses. Biomass per square meter was determined for the chironomids. From these data, literature values were used to estimate calories, carbohydrate, fat, and protein per square meter.

A model taken from Johanson and Brinkhurst (1971b) is presented as a means of determining amounts and pathways of detrital input to higher trophic levels. Because this model encompasses more than the macrobenthos, data from other concurrent IBP studies will be used.

The model and the 1972 project have suggested different sampling regimes and methods to be undertaken in 1973.

INTRODUCTION

Benthic macrofaunal abundance and biomass were estimated to evaluate the quantity and routes by which detrital material may reenter the higher trophic feeding levels. This information will subsequently be used to compare the four IBP lakes and to evaluate the hypothesis that a significant proportion of fish productivity is supported by the detrital food chain, i.e., unutilized algae, zooplankton wastes and allochthonous materials. For this study, the benthic macrofauna are assumed to be detrital feeders. It is recognized, however, that epibenthic algal production, where it occurs, may also contribute to these organisms.

Significant studies on benthic productivity include Johnson and Brinkurst (1971a, b, c), Hargraves (1969), Gellak (1965), and Hayne and Ball (1956).

The only publications on the IBP lakes is the M.S. thesis of Thut. Studies by Klaasen on Fern are also applicable (Ph.D. thesis, University of Washington).

METHODS AND MATERIALS

The sampling sites are shown in Figure 1 where they are compared with those of Paulson and Thut. Future (1973) sampling sites are also shown.

The animals are collected in a 6'' by 6'' Eckman dredge and five samples are taken per station. Screening is done in the field with a number 30 of the Taylor series screens which approximates 0.04 meshes to the inch. Material remaining in the screen is transferred to bottles and preserved with alcohol to prevent carnivorous feeding before the samples can be analyzed. Temperature profiles and dissolved oxygen measurements at and near the bottom are taken at this time.

In the laboratory, the animals are separated and identified at least to order, dried in a vacuum oven at 60°C, and weighed. Values are reported as biomass/m^2, and numbers of conspecific organisms/m^2.

A single collection was made on each lake during October-November 1972. The values for calories/m^2 were calculated from Cummins and Wuychick (1971) and carbohydrate, fats and protein proportions from Ivlev (1935).

RESULTS

The results for chironomidae are summarized in Table 1. Oligochaete abundance was vastly underestimated by the screening technique and the oligochate samples were not used for chemical analysis. These results are too fragmentary for conclusions at this time, other than to say that chironomides and oligochaetes comprise the dominant benthic macrofauna.

DISCUSSION

Johnson and Brinkhurst, in their studies on the Bay of Quinte published in 1971, developed a model for evaluating quantities and routes of detrital contribution to higher trophic levels. This model is shown in Figure 2. The input for this model will come from the appropriate IBP studies concurrent with our own and from literature values. Several changes and new projects will be undertaken in 1973 suggested by last year's project and the model.

For the macroinvertebrates, age classes will be estimated where possible and growth rates, mortality rates, and productivity calculated according to Ness and Dugdale (1959). Where this method cannot be used, literature values for respiration will be taken from Johnson and Brinkhurst and production calculated according to their method. Carbon and nitrogen data on the animals will be obtained with the use of a carbon and nitrogen analyzer, so both energy and carbon can be followed. Emergence data is available on Findley Lake for summer 1972 from Dr. Paulson's group and will be obtained again in 1973 by Roy Heddon. For the other lakes emergence will be estimated from the literature.

The above information will be correlated with detrital input data and microbial activity provided by P. Birch and M. Wekell, respectively, when it becomes available. It has been decided to analyze only the sediment trap data with respect to the benthic invertebrates due to a study by Jan Lellák (1965) which showed that: ". . . it is impossible to prove that there is a direct relation between the content of nutrients in the fresh or dried mud and the fish-production or perhaps the standing crop of bottom fauna in such water bodies".

Although this may not be true in all cases, the nutrient content (C, N, P) of the sediments does not change significantly with respect to this study over the season for our laes (Dr. Spyridakis, personal communication), but the detrital input does. Lellák further found:

> "All the outstanding changes in the dynamics of the population of bottom fauna of the water bodies under observation suggest a direct trophic dependence of the bottom fauna on the biological regime in the water column. In all the observed cases the mass development of the bottom fauna was caused by the exceptional supply of food from the water column to the bottom."

It is for these reasons that only the nutrient and caloric content of the sediment trap samples will be used. The caloric content will be determined with a microbom calorimeter on samples obtained from P. Birch.

Meter square shore traps will be used to indicate how much and what kind of materials are entering from the lake periphery. These samples will be separated, identified and quantified per item by weight. Detrital input from the Cedar River will be obtained from data provided by J. Mallick when it becomes available. Detrital input from the Sammamish River will come from Dalseg (1969) and C. Rock. Data on fish carcass nutrient input will be estimated from data provided by Dr. Burgner's sample site and the bottom photographed, if possible. Detrital material will be gathered at these times over a wider area than the traps (one square meter) by hand or with a pump. Both the photographs and the collection are important because at the present we have no idea how homologous our bottom sites are or what volume of larger material is being missed by the traps.

Few studies seem to have related microbial productivity with invertebrate productivity. Brinkhurst and Chua (1969) have done a preliminary study on tubificid coexistence vs. bacterial exploitation. There is some controversy whether the aquatic invertebrates are actually assimilating the detrital material or the bacteria adsorbed onto the particles. Sorokin and Meshkov (1957), using a 14C on *Chironomus plumosus*, found that where they would not assimilate certain algae when they were alive, they would assimilate dead algae cells infested with bacteria and also bacteria-free, acid-hydrolyzates of the same algae. This suggests that detrital particles must undergo bacterial or mechanical breakdown in order to be assimilated, in some cases at least. Microbiological data from M. Wekell will perhaps give some more insight into this problem with respect to our lakes.

Fish stomach data from Drs. Whitney and Wydoski's group should give us enough information to estimate how much detritus finds its way into the higher trophic levels via the invertebrates. It will also give us some idea of the predation pressures on this group of organisms. Data already received from Fred Olney on the Squaw fish bear out the literature that dipteran larvae are a principle fish food whereas oligochaetes seem not to be used at least by some species of both.

A. Jensen, who will be measuring the respiration of the sediments, will complete the data needed for the model.

The model will facilitate comparison of the four lakes. In addition, we should be able to investigate what effects changes and pressures will have on the lakes individually. This implies some predictive power of the model. If, for example, temperature was raised, the lake was more heavily fished, or effluent was diverted, some notion could be obtained as to the impact on the benthos.

Use of this model does not exclude more comprehensive additions, such as a zooplankton model or elaborations, such as a particulate vs. dissolved organic model.

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Table 1. Chironomidae

Lake	Date (1972)	no. org/m^2*	biomass* g/m^2	cal/m^2**	CHO** g/m^2	protein** g/m^2	fat** g/m^2
Washington	15 Nov						
profundal		86.58	0.866	450	.195	.519	.065
littoral		-------	------	------	------	------	-----
Sammamish	29 Nov						
profundal		4288.9	42.89	21,780	9.470	25.734	3.227
littoral+		129.9	1.299	674	.292	.779	.097
Findley	1 Nov						
profundal		1515.15	15.152	7,879	3.419	9.091	1.136
littoral		4632.00	46.32	24,099	10.422	27.792	3.74
Chester Morse	25 Oct						
profundal		86.58	0.866	450	.195	.520	.065
littoral		129.1	1.291	674	.292	.779	.097

* Determined on field data alone.

** Used literature values given by Ivlev (1935) and Cummins (1971).

\+ Not an accurate representation due to type of animal retrieval.

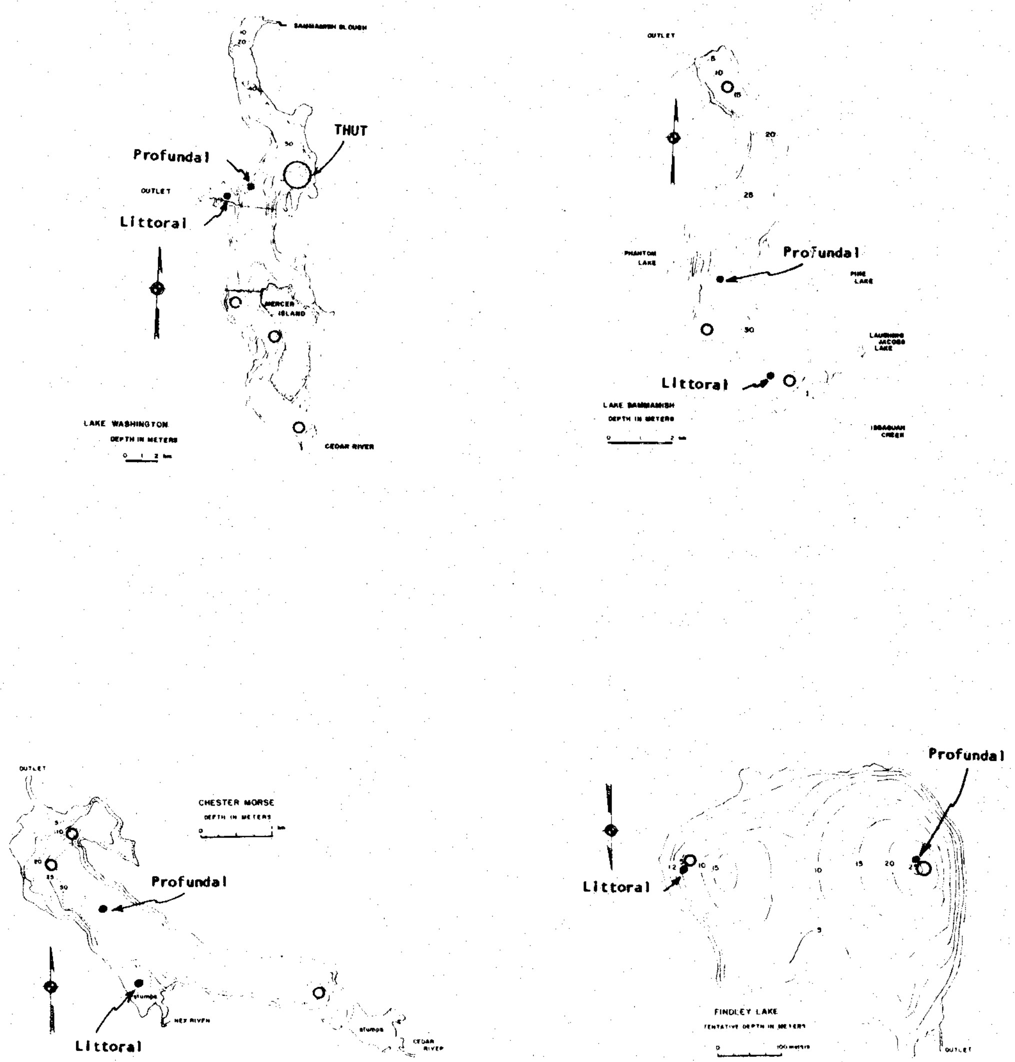

Figure 1. Benthic production sampling sites. o = future sampling sites