



Aquatic insects in sediment traps
by Francis Wayne Mangels

A thesis submitted in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE
in Zoology

Montana State University

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Abstract:

Sediment traps were set in three tributaries and in three areas of the upper Gallatin River. The kind, sizes and amount of sedimentation was analyzed and related to numbers and orders of aquatic insects found in gravel in the traps. From August, 1972, to October, 1973, samples were taken at monthly intervals in a monthly renewed sample and in a cumulative sample undisturbed since the beginning of the project. These sampling methods show that living space is of prime importance to aquatic insects and sculpins, and that it is a limiting factor for insect communities presently in the upper Gallatin. Measurable current speeds (up to 2.5 fps) did not seem to affect insect numbers. High percentages of organic matter in sediment coincided with high insect numbers, but actual weight had no apparent relationship.

High numbers of insects were present in the spring, but were drastically reduced after runoff. They recovered much more slowly and to lower levels in the cumulative traps, which remained filled with sediment.

The low sedimentation rates through fall and winter resulted in higher insect numbers in cumulative traps, presumably because they were undisturbed. Diptera was the dominant order in all areas.

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AQUATIC INSECTS IN SEDIMENT TRAPS

by

FRANCIS WAYNE MANGELS

A thesis submitted in partial fulfillment
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of

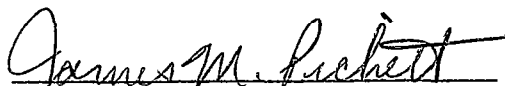
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Approved:


Chairperson, Graduate Committee


Head, Major Department


Graduate Dean

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ABSTRACT

Sediment traps were set in three tributaries and in three areas of the upper Gallatin River. The kind, sizes and amount of sedimentation was analyzed and related to numbers and orders of aquatic insects found in gravel in the traps. From August, 1972, to October, 1973, samples were taken at monthly intervals in a monthly renewed sample and in a cumulative sample undisturbed since the beginning of the project. These sampling methods show that living space is of prime importance to aquatic insects and sculpins, and that it is a limiting factor for insect communities presently in the upper Gallatin. Measurable current speeds (up to 2.5 fps) did not seem to affect insect numbers. High percentages of organic matter in sediment coincided with high insect numbers, but actual weight had no apparent relationship. High numbers of insects were present in the spring, but were drastically reduced after runoff. They recovered much more slowly and to lower levels in the cumulative traps, which remained filled with sediment. The low sedimentation rates through fall and winter resulted in higher insect numbers in cumulative traps, presumably because they were undisturbed. Diptera was the dominant order in all areas.

INTRODUCTION

Concern has been renewed in recent years as to the effects of sedimentation on aquatic life. "Silt pollution" as it is commonly called, is no doubt detrimental to aquatic life, but silt, or other forms of sediment, is a natural element in all streams. A heavy or increasing amount of it, however, is harmful to many organisms (Cordone and Kelley, 1961; Usinger, 1963). As early as 1936 (Ellis) the problem of increasing siltation was noticed but little attention was given to its effects on insects; most of the attention was directed toward its effects on fisheries. An investigation of china-clay siltation in England is probably the best comprehensive look in recent years at the trout-insect relations under conditions of increased sedimentation (Herbert, et al., 1961). This study, while measuring and stressing turbidity, made only a commentary of observation as to the appearance of the bottoms of the streams studied. This thesis will attempt to clarify further the relation between sedimentation and aquatic insects.

Whilm and Dorris (1968) have attempted to compute a "quality index" to quantify aquatic conditions in which silt plays a major part. They approached the problem from the standpoint of the diversity of species. However, Gaufin & Tarzwell (1956) claimed that association of species are more diagnostic of quality than the number of species. Without belaboring the point, we must agree that aquatic communities are influenced by numerous natural factors, of which sediment is a major one (Oshwald, 1972; Pennak and Gerpen, 1947; Tarzwell, 1937).

Should an aquatic insect community be eliminated, a logical question would concern the method of repopulation, including any observable pattern of species and time required for recovery. Gammon (1970) observed the complete elimination and recovery of a stream insect community due to a heavy discharge of sediment from a gravel-washing plant and the subsequent cleaning after the sedimentation ceased. He speculated on the possibility of downstream aquatic drift as the mode of repopulation of the stream, for the area above the washing operation was unaffected. Waters (1961, 1964, 1966) and Bishop and Hynes (1969) have gathered enough data to indicate this phenomenon is much more common than previously thought. They further indicated that the Ephemeroptera nymphs are common drifters, and Gammon (1970) provides further evidence that under stress, such as high turbidity, insect drifting can be induced. Dimond (1967) has indicated that not only may drift be density-related, but also that if a population is eliminated by pesticides, drift may repopulate an area. However, if the insects in an entire watershed are eliminated in this manner, repopulation may take years, through the slow process of stream ascension or chance dispersal by flying adults from a nearby unaffected stream as is suggested by Muller (1953). While channelization of a stream for such a purpose as road building has been shown to severely depress a trout population (Elser, 1968; Warner and Porter, 1960), the effect on aquatic insects for that immediate area is unstudied. Waters

(1964) and Gammon (1970) have indicated that recolonization may be only a matter of days, from drifting of insects. However, newly disturbed areas may be unstable, which may hamper the process of repopulation. Percival and Whitehead (1929) comment that since areas of unstable bottoms show comparatively low insect numbers, the lack of a safe resting place from physical damage or entrapment may be responsible.

Attempts to build or cause a population of aquatic insects to increase in uninhabited or sparsely inhabited small areas are rare. Sedimentation factors were not always studied, but some comparisons can be made. Sprules (1947) stacked rocks in a streambed to enhance catches in emergence traps, and was successful. Earlier, Sprules (1941) noted a decline in insect numbers as sediment deposition covered a stream area he was investigating. He suggested the increase or decrease of the amount of habitable substrate as the cause, a theory which has been supported by other studies (Cordone and Kelley, 1961; Hynes, 1970; Percival and Whitehead, 1929; Thorup, 1964; Williams, 1972). Wene and Wickliff (1940) found that rubble in wire baskets placed in stream bottoms yielded much greater insect populations than bottom samples. They do not imply space as a factor but such may be the case. Cummins (1964) found that insects tend to select the coarser bottom materials, and these materials also attract a greater variety of insects particularly stoneflies. Scott (1964) found that species react differently to substrate sizes. Cummins and Lauff (1969) later confirmed and

supported a theory that selection does indeed occur for larger sizes, and direction of current (influences due to drifting) is of no particular importance in selection of substrate size.

Plant detritus is an important item in stream ecology. Nelson and Scott (1962) reported that primary consumers in a piedmont stream derive 66% of their energy from plant detritus, most of which is leaf matter. Minshall (1967) reported that leaf material falling into a Kentucky stream was a main source of food for invertebrates. Although most of the animals present were *Gammarus*, his data show that insects, especially Ephemeroptera, had a diet of 50-100% of leaf detritus. Egglishaw's study in Scotland (1964) indicates that aquatic invertebrates are not only present in relatively greater numbers in detritus, but also are attracted to it in proportion to the amount of detritus present, probably for food.

DESCRIPTION OF THE AREA

The research for this paper was conducted in the Gallatin River Drainage, which is the easternmost of the three forks of the Missouri River in southwestern Montana. A nationally famous trout stream, the Gallatin River heads in Yellowstone National Park and flows 140 kilometers to the Missouri River at Three Forks. The upper 100 kilometers flows through a steep, timbered canyon with three sagebrush-willow meadows. The uppermost meadow area is the Snowflake Springs elk range and extends from Yellowstone National Park to Taylor Fork. The middle meadow is in the Porcupine-West Fork area where commercial interests are developing the Big Sky recreational area. The lower meadow is at Spanish Creek and is used for ranching. The upper Gallatin is mostly in the Gallatin National Forest; lodgepole and Douglas-fir are dominant conifers, while aspen often borders the many open areas on the forest. The upper area is historically winter range for the Yellowstone-Gallatin elk herd, (Lovaas, 1970), but like most western forests, its natural history is for the most part, unstudied.

The character of the bed material of the Gallatin River in the entire study area is a great variety of rocks ranging from sedimentary Madison limestone to Yellowstone volcanic types. Included are the rarer jasper and petrified wood to the dominant quartzite and basaltic cobbles and gravels. The soils of the entire river bottom are in the Bigel-

Hobacker Association, which is composed of alluvial gravels and sand as parent materials (Olsen, et al., 1971).

The six sampling sites in this study are now described in more detail. The accompanying map (Fig. 1) shows their location. Three tributaries of the West Gallatin River were chosen for sediment trap locations: Taylor Fork (code TF), Porcupine Creek (code PC), and the North-Middle Fork of the West Fork of the West Gallatin River in the Big Sky area (code BS), which is often shortened to Big Sky Creek or West Fork. The Taylor Fork traps were 400 meters above the highway bridge, where theft practically cancelled the data as to usefulness. The Porcupine Creek traps were located fifty feet below the ranger station bridge. The Big Sky traps on the West Fork were located fifty feet above the big culvert one mile below the Meadow Village of the Big Sky project.

In addition, three stations were established on the Gallatin River. It was floated in late June, 1972, to locate suitable areas for setting groups of sediment traps. Riffle areas similar to the preceding three areas were selected in three places: Snowflake (code SF), Milepost 1430 (code M), and the Ruins (code R). Snowflake station was located 100 feet above the Snowflake Springs highway bridge on the inside of a nearly straight meander. The banks and bed were stable, and the bottom sealed with silt in the trap area, but not so in the cobbled mainstream. Milepost 1430 station was located at a cement

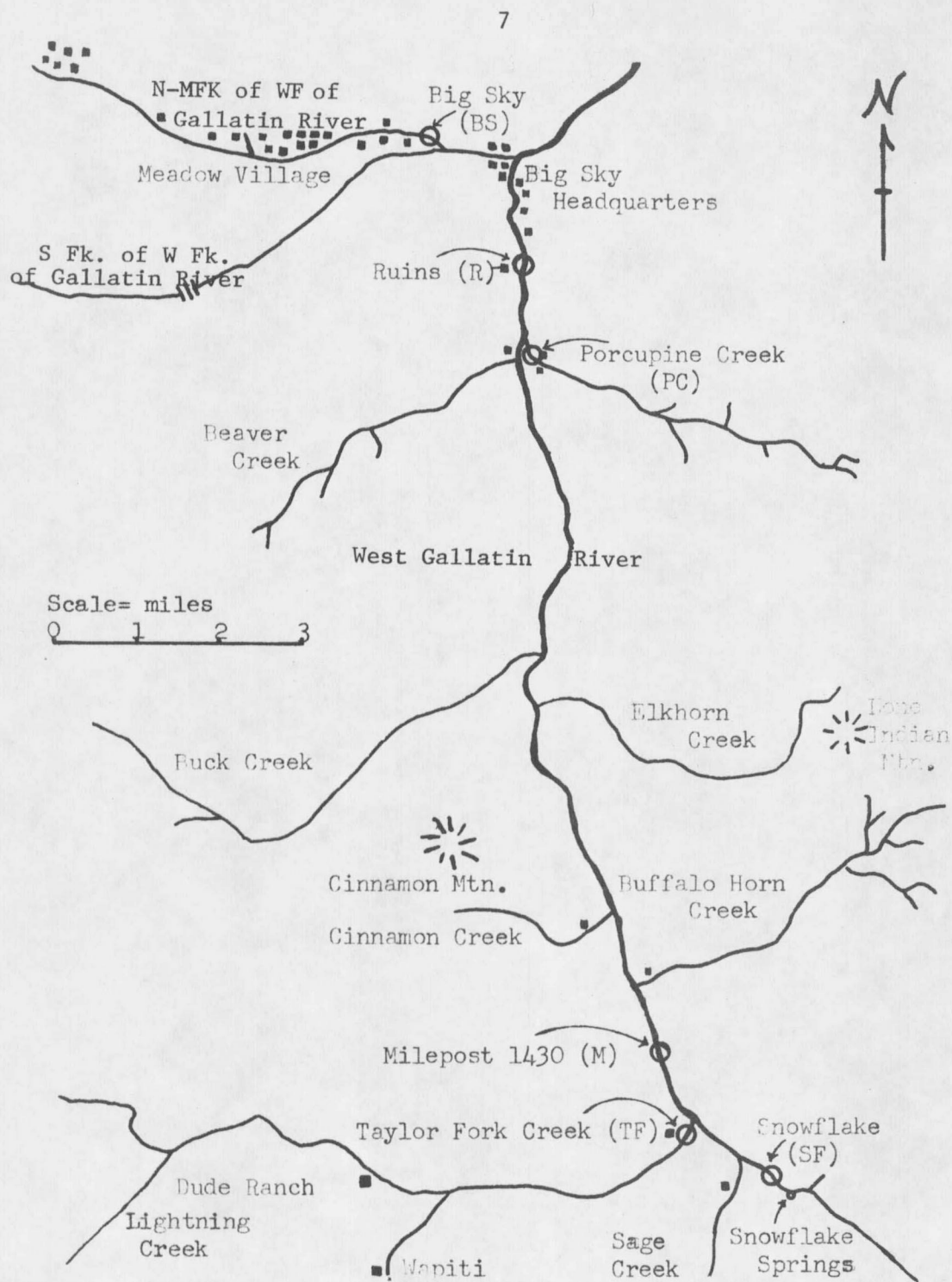


Figure 1. Map of Upper Gallatin River Drainage Area

monument one mile below Taylor Fork. The trap area was well-sealed with silt and on the inside of a slight meander along a gravel bar on the edge of the main current. This main current area was a deep run with a boulder bottom, but the backwaters out of the main current had deposits of the fine gray silt characteristic of Taylor Fork. Taylor Fork and Milepost had silted bottoms and very little algae growth. The Ruins station was at a large old cabin or waystation area one mile below Porcupine Creek, and the cabin wreckage marked the inside of a meander with a gravel bar similar to the other river sampling stations. The traps were set along the bar at the edge of the current, as in the other groups of traps.

The Snowflake sampling area is probably affected by sedimentation influenced by the Gallatin elk herd. The willow bottoms and south slope areas of the upper drainage in Yellowstone Park around Lava Butte have a history of severe overgrazing, and the problem persists to a lesser extent today. Subsequent erosion may be the source of most of the sediment. Snowflake springs is another factor, and its water quality effects on aquatic life are unknown; it is the largest tributary in the area and its waters are alkaline.

The Taylor Fork station is most affected by unstable gray volcanic-ash type soils in the drainage. This area, like Snowflake, has a history of severe overgrazing by elk and livestock. The Lightning Creek area is noted for mudslides which occasionally color the creek and then

the Gallatin River for days at a time with a very fine, gray silt at all seasons. Taylor Fork is usually at least partly cloudy with this material.

The Milepost station below Taylor Fork is fairly typical of the Gallatin River. It is in a narrow part of the canyon and the river is generally torrential in this area. The banks and the bed are predominantly boulders, and bank vegetation is dominated by conifers. The river deposits of gray silt from Taylor Fork in quiet pockets of water out of the main current.

Porcupine Creek is different from the other drainages in that human impact on the area is presently almost nil. At one time a road did follow the creek, but the bridge above the ranger station washed out about 1965 and was not replaced. The area has unstable soils, and efforts to begin logging the drainage have been blocked. The gravels of Porcupine Creek are basically calcarious argillites and quartzites with some granites from an exposed area $3\frac{1}{2}$ miles above the mouth. The area is winter range for the Gallatin elk herd and has been overgrazed in the past, but like the Snowflake area, attempts are being made to solve the problem. The major source of silt in this drainage is probably streambank erosion and wash from the old road.

The Ruins station area on the river below Porcupine Creek is similar to Snowflake in vegetation type and stream characters, but

willows are more abundant and erosion from the Porcupine elk range is probably much less than erosion at the Snowflake area. The dominant gravels are quartzites, with scattering of petrified wood and basaltic and granitic rocks.

The West Fork of the Gallatin River drains the basalt and granite of the slopes of Lone Mountain, cretaceous shale of the bottomland and the argillites of the Spanish Peaks. The banks and bed are composed of these materials. Stream vegetation is similar to Porcupine; the creek heads in pine forests and flows through a dry sagebrush, willow, and grass meadow. At present, Meadow Village of the Big Sky project is active in the drainage and disposes of sewage by a lagoon system; some cabins have drain fields. Most of the heavy sediment from construction is caught in an artificial lake at the village; roadbuilding and channelizing have been common. The lake is not entirely adequate as a catchment basin, for the Big Sky streams can be turbid at any time of year due to construction or rains. However, the stream clears rapidly after a few days. Taylor Fork, in contrast, remains very cloudy for weeks after rain. The West Fork is chemically similar to Porcupine Creek, but has a higher alkalinity (80 vs 109 ppm), and much higher phosphate (.005 vs .013 ppm) and nitrogen (.001 vs .030 ppm).

Snow surveys by the Soil Conservation Service reported the Gallatin drainage 6% above average, with the nearby Madison drainage 3% above

average over 15 year periods. Snow pack was nearly normal for 1973, the year of the study.

METHODS

Care was taken to choose stations for sampling in areas that were similar in gradient and bottom material, so that these sampling stations should be hydrologically similar. Although Hughes (1966) concludes that illumination of stream bottoms has a minimal effect on aquatic populations, all sampling stations were in exposed areas in the stream or only partially shaded.

The sediment traps were standard size 16" diameter by 4" deep galvanized steel oil drain pans placed in the stream bed. All pans had a slight film of oil on them, and they were wiped clean with a rag dampened with ethyl alcohol. This procedure avoided contaminants which could adversely affect insect populations. Rocks having an axis of over eighty centimeters were selected from the stream bed, scrubbed clean of all mud and algae, and packed into the cans. A vegetable brush was used to clean rocks because iron or brass brushes would have left a metallic sheen on the rocks. Approximately the same sizes and composition of rocks were used in all pans. These precautions were taken to maintain as nearly a natural situation as possible and standardize results.

The pans were set into holes in the stream bed so that the open top of a pan was level with the natural stream bottom. The holes were dug with a fork spade and with the feet. A sealing top lid was placed over the prepared can of cleaned rocks; and the unit was set in the

hole, leveled, and the material from the hole filled in around the outside of the can. The unit remained sealed for at least ten minutes and then was rechecked so material would not wash in from the disturbance of removing the lid. The lid was then removed and the set was complete.

A total of 13 cans was placed at each station, 12 for accumulative and one for a monthly sample. The cans were set in water four to eight inches deep beginning with the most upstream one first, then working downstream in a convenient pattern. No pan was nearer than four feet to another. All pans were set in an area where the streamflow was similar to that of the others in the same group and also the groups at other stations. A map was drawn to facilitate finding cans when snow or high water obscured them.

One accumulative and one monthly can was collected at each station about the first of every month. After the average water velocity over the top of the can at two inches was measured by a Gurley pygmy current meter, the sealing lid was clamped onto the can as it set in the stream bed, and the entire unit was lifted out. The farthest one downstream was taken first, then the next can upstream in the same manner. Each can's rocks were washed with the water in their can and the remaining gravel, mud, and insects were poured into an appropriately labeled plastic container. These contents were immediately preserved with 20-50 ml of formaline, with the greater amounts being used if much

The rocks from the upstream cumulative sample pan were placed in the hole left by its removal to retain the level riffle characteristic of the sampling station area. The rocks of the farthest downstream pan were repacked into the same can and reset according to the original method into the same hole to be repeatedly used as a monthly sample. The cumulative cans upstream revealed the accumulation of sediment and insects through the year and were not reset. Samples were processed within one week at the laboratory in Bozeman. In some cases cans could not be collected in winter due to several feet of ice cover. The monthly samples were reset in midstream in winter with the original methods so a sample could be obtained in mid-winter. In some areas, severe freezing made this impossible.

The steel cans used for sediment traps had a capacity of twelve liters, while sediment mixture was consistently four liters. Thus, the volume of prepared rocks in the cans was about eight liters. The uniformity of cobble sizes used in packing the cans explains this consistency (Granton and Fraser, 1935). The plastic containers used had a wide mouth, sealing lid, and a capacity of five liters. They were inexpensive and adequate for storing the mixture. However, small rocks which had come in with the bedload during spring runoff had to be kept separate or the container would overflow.

In the laboratory, the sediment mixtures in the plastic containers were separated into size classes of materials by wet sieving through

standard screens of sizes 10, 20, and 40. The field material was passed through, hand agitated, and rinsed if necessary. Even though this was difficult in the finer screens, field material was never ground through because of the insects in it. Precautions were taken to catch overflow and reduce sediment loss, and by observation practically none of the silt fraction was lost in sieving. This loss of sediment occurred only when over one thousand grams of material was processed and its loss was not considered significant. Material finer than the 40 sieve was obtained by settling for one hour and decanting. Standard Methods (APHA, 1970) defines unsettlable matter as that which remains suspended after one hour; this material was discarded.

Aquatic insects were picked by hand from the 10 to 20 sieves. Each load was washed into a white enameled pan to render the insects more visible. The insects were removed and labeled for later classification; and the remaining matter was set aside for oven drying. Standard Methods (APHA, 1970) states that 30 mesh is considered the minimum for screening aquatic insects. In spite of the gentle agitation of the sieving process and frequent insect picking sessions amounting to several per single sediment can, much breaking up of insects was common. No insects were found in the 30 mesh which was used May through August, some in the 20, and over half were in the 10 mesh screen. When insects were broken, half an insect was considered

a whole one. The only fish encountered, sculpins, were recorded separately.

The material remaining after insects and fish were removed was kept in its respective size classes and dried in a hot air oven at 65°C for at least 48 hours. All material had to be dry by sight, smell, and touch. All larger fragments of organic matter were broken to assure the inside was dry also. The clay-silt fraction (finer than 40 mesh) was ground with a mortar and pestle when dry to sight and touch and then dried an additional day. Frequent weighing for constant weight showed this was an accurate method for assuring samples were completely dry. Jackson (1956) recommended material be air dried at 55°C for 48 hours.

Samples were weighed to the nearest .01 gram except for sample sizes over 500 grams, where the measurement was to the nearest .1 gram. Care was used to pour the sample into the weighing containers slowly and carefully so that grains were not lost nor excessive fly dust created. The containers were rapped five times to shake clinging dust free.

The weighed oven-dry samples were then transferred to pyrex breakers and burned in a muffle furnace at $350-400^{\circ}\text{C}$ for 8-10 hours. This is the accepted temperature for removal of carbon without volatilizing nitrogenous and other inorganic compounds (Jackson, 1956). As an experiment, one sample was recorded after burning and then burned

again over a weekend; the difference was less than .1 gram in a 100 gram sample, so burning time was apparently adequate. Ash was considered negligible and the difference in weight after burning was regarded as the weight of organic matter.

RESULTS AT SNOWFLAKE STATION (SF)

An examination of the sizes of particles at Snowflake Station (Table 1) indicated that a greater weight of smaller particles was common in the traps sampled on a monthly basis, except during runoff when only heavier particles could settle. The cumulative traps more commonly held a greater proportion of pebbles than the monthly traps. Except for during the runoff period, silt always was the heaviest portion of the total sediment in all traps.

In monthly traps, the amount of sediment accumulated in the Snowflake area decreased slowly from summer to midwinter and rose slowly again until the spring runoff in May (Fig. 2). It then increased rapidly in May and peaked in July. The cumulative traps showed a slight increase over winter and a slight decrease in total weight of sediment as current speed increased slightly before the rain spring runoff period, when the highest weight of sediment occurred. During this May-June period, all sediment traps were filled completely due to the relatively heavy sediment load associated with the high water. During July and August following, the traps accumulated the same per month as before in August 1972.

The actual weight of organic matter (Fig. 3) essentially parallels the total sediment weight (Fig. 2). The percentage is high (16-5%) in the fall of both years (Table 1), and low (3-1%) during the runoff.

A similar pattern of percentage of organic matter is seen in the

Table 1. The size distribution of sediment and amount of organic matter from Snowflake station for monthly intervals. All weights in grams

<u>Date</u>	<u>Sieve 10</u>		<u>Sieve 20</u>		<u>Sieve 40</u>		<u>Silt</u>	
	<u>OD Wt</u>	<u>Ashed</u> (400°C)	<u>OD Wt</u>	<u>Ashed</u> (400°C)	<u>OD Wt</u>	<u>Ashed</u> (400°C)	<u>OD Wt</u>	<u>Ashed</u> (400°C)
9-1-72	6.50	2.16	6.32	2.07	4.65	3.05	520.0	485.
10-1-72	5.53	3.96	4.47	3.81	13.33	12.76	190.1	181.8
11-5-72	3.53	2.46	4.23	2.71	14.46	9.60	133.5	115.9
1-1-73	3.50	2.10	7.80	7.50	6.40	6.20	13.2	12.7
2-1-73	3.40	2.53	3.66	3.53	9.10	8.85	19.6	19.1
3-1-73	4.20	2.72	5.72	5.22	13.52	12.92	62.00	58.8
4-1-73	13.30	7.62	7.29	4.72	9.30	7.70	430.6	412.2
5-1-73	6.71	3.95	14.09	13.50	31.68	31.05	169.7	163.0
6-1-73	942.	917.4	723.7	708.2	435.0	427.0	1116.2	1078.0
7-1-73	2508.6	2468.7	1200.7	1186.2	561.2	554.7	858.7	845.8
8-1-73	6.82	4.34	21.83	20.86	23.03	22.43	418.9	402.6
9-2-73	4.13	1.65	3.07	1.41	4.60	3.01	448.8	419.7

19

<u>Date</u>	<u>Bedload</u>	<u>Totals</u>		<u>Organic Matter %</u>
	<u>Rocks</u>	<u>OD Wt</u>	<u>Ashed</u> (400°C)	
9-1-72		537.47	492.28	8.4%
10-1-72		213.43	202.33	5.2%
11-5-72		155.72	130.67	16.1%
1-1-73		30.90	28.50	7.8%
2-1-73		35.76	34.01	4.9%
3-1-73		85.44	79.64	6.8%
4-1-73		460.49	432.24	6.1%
5-1-73		222.18	211.50	4.8%
6-1-73	810.	3216.9	3130.6	2.7%
7-1-73	780.	5129.2	5055.4	1.4%
8-1-73		470.58	450.23	4.3%
9-2-73		460.60	425.77	7.6%

Table 1 (continued)

The size distribution of sediment and amount of organic matter in sediment traps in place for the number of months indicated at Snowflake station. All weights in grams.

<u>Mos.</u>	<u>Date</u>	<u>Sieve 10</u>		<u>Sieve 20</u>		<u>Sieve 40</u>		<u>Silt</u>	
		<u>OD Wt</u>	<u>Ashed</u> (400°C)	<u>OD Wt</u>	<u>Ashed</u> (400°C)	<u>OD Wt</u>	<u>Ashed</u> (400°C)	<u>OD Wt</u>	<u>Ashed</u> (400°C)
1	9-1-72	6.50	2.16	6.32	2.07	4.65	3.05	520.0	485.
2	10-1-72	6.12	2.64	6.01	3.81	6.50	4.44	397.0	356.6
3	11-5-72	18.53	9.23	9.60	6.76	11.79	10.44	561.0	526.1
4	12-1-72	179.68	173.68	22.23	20.26	12.16	10.56	544.7	514.0
6	2-1-73	111.52	108.01	51.40	49.86	70.40	68.20	540.3	495.2
7	3-1-73	12.26	9.82	5.42	4.28	10.57	9.80	636.7	594.7
8	4-1-73	41.68	37.16	15.84	13.62	31.15	28.78	453.2	422.0
9	5-1-73	9.12	6.64	4.76	3.17	2.99	2.03	375.7	349.0
10	6-1-73	1004.0	987.0	453.1	443.7	181.0	176.7	1292.0	1231.0
11	7-1-73	3072.2	3043.2	723.1	714.5	360.6	354.5	1103.7	1070.4

20

<u>Mos.</u>	<u>Date</u>	<u>Bedload</u> <u>Rocks</u>	<u>Totals</u>		<u>Organic Matter %</u>
			<u>OD Wt</u>	<u>Ashed</u> (400°C)	
1	9-1-72		537.47	492.28	8.4%
2	10-1-72		415.63	367.49	11.6%
3	11-5-72		600.92	552.53	8.1%
4	12-1-72		758.77	718.50	5.3%
6	2-1-73		773.62	721.27	6.8%
7	3-1-73		664.95	618.60	7.0%
8	4-1-73		541.87	501.56	7.4%
9	5-1-73		392.57	360.84	8.1%
10	6-1-73	150.	2930.1	2838.4	3.1%
11	7-1-73	400.	5259.6	5182.6	1.5%

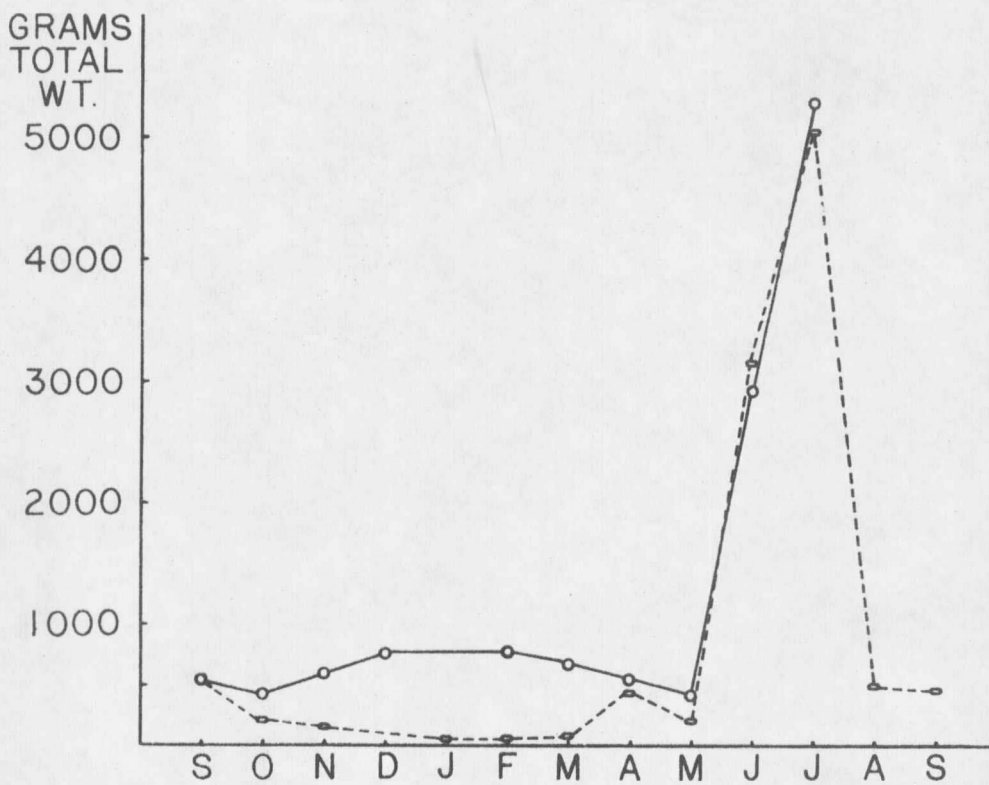


Figure 2. Total sediment collected in sediment traps at Snowflake station on a monthly (-----) and cumulative (——) basis.

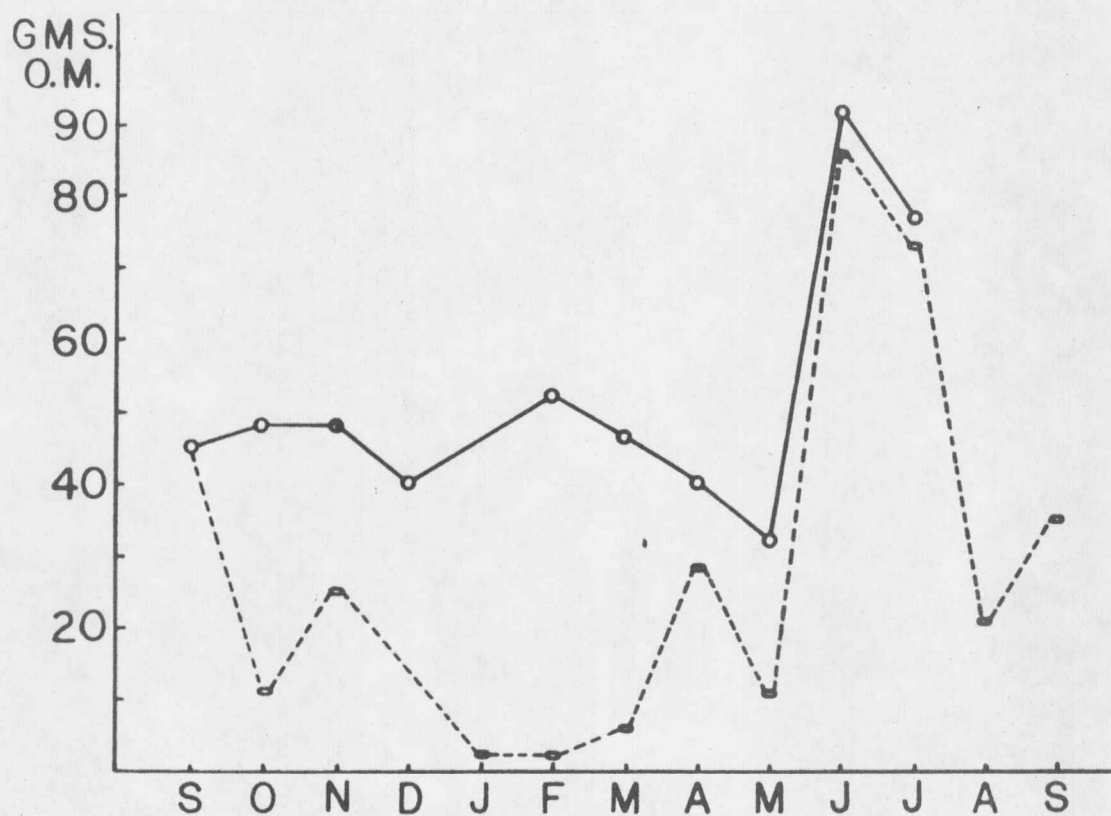


Figure 3. Organic matter collected in sediment traps at Snowflake station on a monthly (-----) and cumulative (——) basis.

cumulative traps, though the actual weight of organic matter averages considerably lower in the monthly traps. The total sediment weight also follows a pattern roughly similar to the per month sampled traps, but shows a slight decrease from midwinter until runoff. During this period the current speed is low but unstable due to the much shallower water occupied by the cumulative traps at this time. Current speed in general is increasing at this time of year.

Orders of invading aquatic insects at Snowflake on a monthly basis are shown in Figure 4. The population in general rises until December, when the monthly can was encased in ice and another was set in midstream so a continuous set of data could be gathered. The numbers of invaders are relatively very high in this trap, which accumulated very little sediment and had high current speeds over it. All orders show a definite rise in numbers per month, with Plecoptera being the most consistent and Diptera showing the greatest increase. The can was removed to the regular shallow space when the river bed thawed on May 1. At this time the regular monthly can was available, having thawed out, and was sampled. Note the .1 fps current speed in May and the low numbers of insects in this trap, which was set in the shallow water nearer the bank. Spring runoff peaked in June at Snowflake and with heavy sediment loads in the traps, insect numbers entering were low, with Diptera most numerous. On August 1, numbers were high and current speed maintained a rate of 1 fps, but as current speed dwindled to .2 fps, the numbers

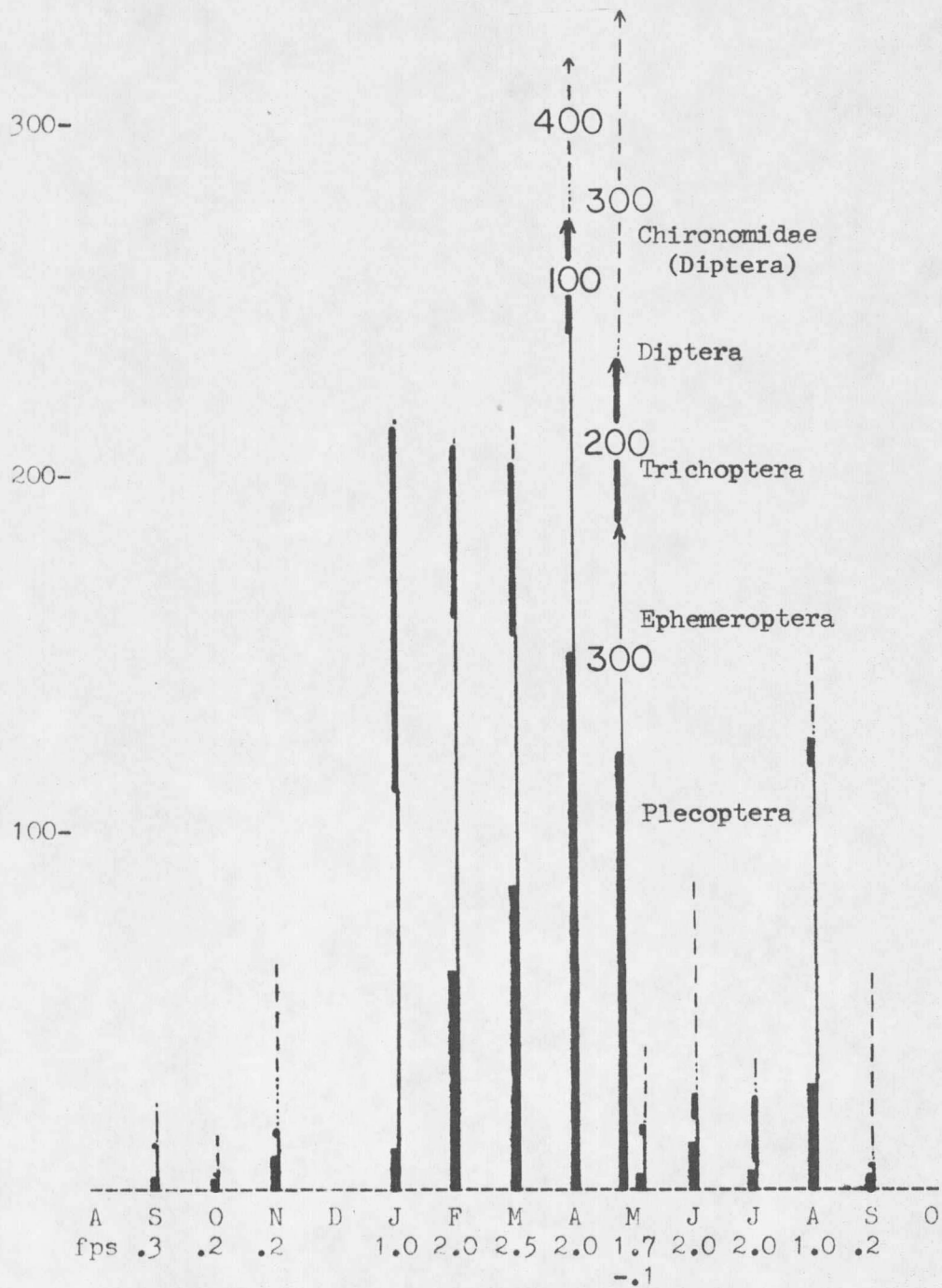


Figure 4. Snowflake August 1972-September 1973. Numbers of insects inhabiting gravel after it was in place for one month. Current speed indicated on bottom line of figures.

decreased to a level comparable to the previous year. The Diptera, however, continued to increase and maintained their previous position as the dominant order.

The cumulative traps were not replanted and represent invading populations under conditions of sustained, uninterrupted growth. They are like the monthly samples in that they, also, seem to show a relationship of larger populations associated with higher current speeds (Fig. 5). During the first four months, the populations that were undisturbed rose to double that of the monthly trap, but current speeds were also over double, at .5 fps. During February 1 to April 1, the cans were retrieved by cutting holes through the ice. The can sampled on March 1 was encased in ice and showed no insect life. May shows the typical late spring population rise recorded by Burns (1973) and subsequent decrease which he claims is due to emergence. However, during June the runoff peaked and filled all sediment traps to overflowing. It is unfortunate that someone dug up the cumulative traps in July, for it appeared logical that they would continue to show much lower populations than the monthly trap due to their completely filled condition. In general, the order Diptera dominated in numbers in the Snowflake area.

Some extra observations not associated with insect populations and invasions should be mentioned, as they may be significant in spite of their qualitative nature. On May 1 at Snowflake, large numbers of *Baetis parvus*(?) nymphs were seen in water 1" to 6" deep at about five

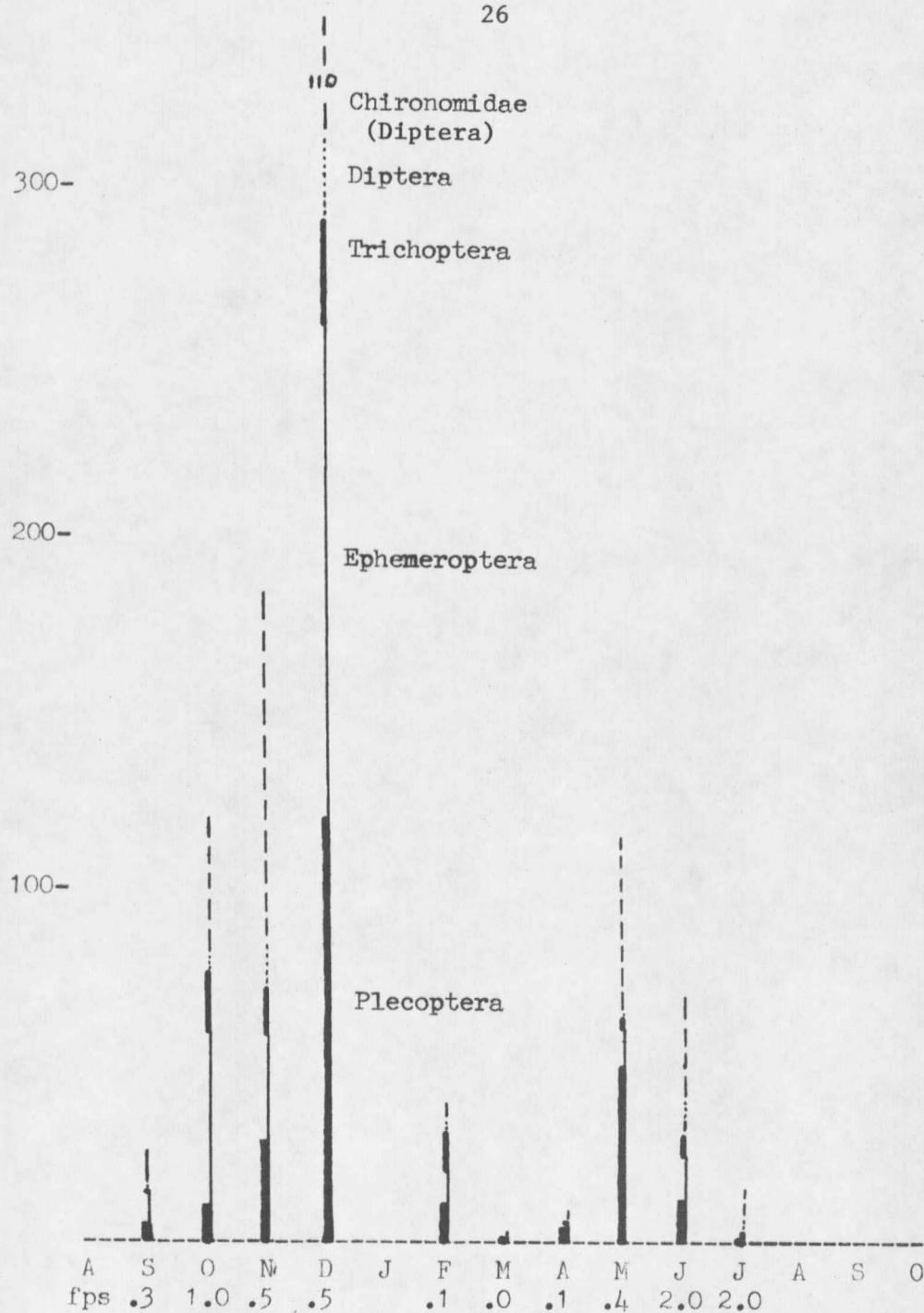


Figure 5. Snowflake station, August 1972-July 1973. Numbers of insects found in new gravel at monthly intervals for 11 months after introducing the gravel. Current speed indicated on the bottom line of figures.

per square foot. The day was warm and sunny and no hatch was evident. Drifting or migrating behavior was suspected after a half hour observation.

Web spinning and free-living caddis appear to be most abundant at Snowflake and Big Sky. These areas also seem to have the heaviest growth of algae in season and appear to have more organic matter on the stream bottoms. Some support is seen for this in the figures for percent organic matter in the Tables 1-6.

Sculpins (*Cottus bairdi*) were caught at the rate of about four per trap except during the winter. They were caught in the greatest numbers and with the most frequency at Snowflake and when caught were always in cans with less than 700 grams of total sediment.

RESULTS AT TAYLOR FORK STATION (TF)

The weight of sediment collected from Taylor Fork on both a monthly and cumulative basis showed an apparent decrease from the month of August 1972 to the time of freezing-in during November (Fig. 6). The high reading on September 1 was due to a big landslide in the upper drainage which colored Taylor Fork for two weeks in August. The spring runoff in Taylor Fork peaked in early June and the per month sample showed a high of 5000 grams total weight on July 1, 1973. During the winter severe, yet typical, ice jams four feet thick formed over Taylor Fork. Gray silt was present on ice in areas where the stream flowed over the top of ice frozen in the channel. Erosion and sediment transport was occurring during the winter, but ice prevented it being recorded.

The sediment size carrying the greatest proportion of weight was this silt commonly observed. Only once during the spring runoff did the pebble size (over #10 mesh) ever surpass a usually overwhelming weight of silt (Table 2). This was probably due to high current speeds which kept silt in suspension and allowed the larger sizes to settle in the traps.

The organic matter on a per month basis (Fig. 7) was highest during the time of spring runoff and was almost entirely woody debris, cones, and spruce needles. The amount of organic matter dropped rapidly as runoff subsided. This can at least be verified on a monthly basis.

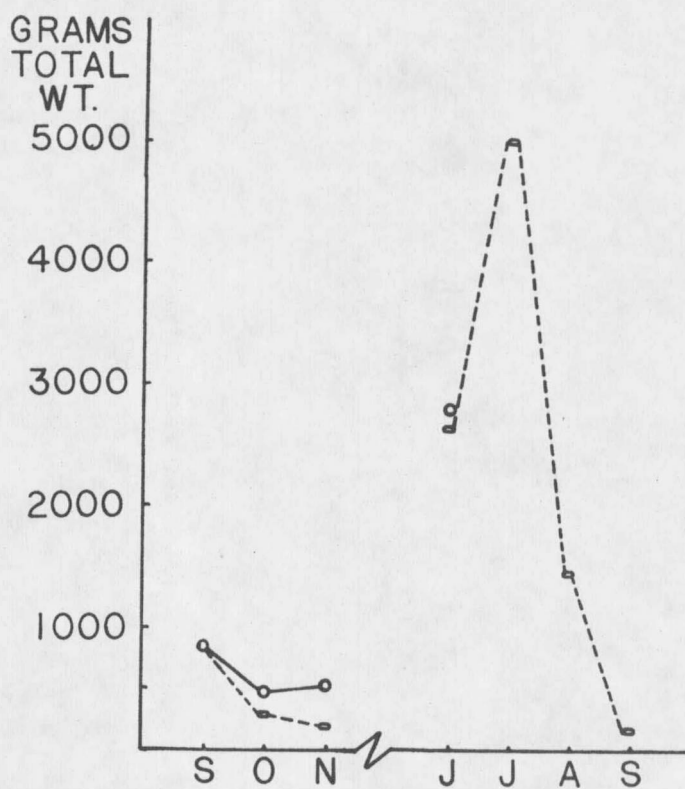


Figure 6. Total sediment collected in sediment traps at Taylor Fork on a monthly (-----) and cumulative (——) basis.

Table 2. The size distribution of sediment and amount of organic matter in sediment traps in place for the number of months indicated at Taylor Fork. All weights in grams.

Mos.	Date	Sieve 10		Sieve 20		Sieve 40		Silt	
		OD Wt	Ashed (400°C)	OD Wt	Ashed (400°C)	OD Wt	Ashed (400°C)	OD Wt	Ashed (400°C)
1	9-1-72	52.13	50.6	8.51	8.10	11.81	11.51	796.0	760.0
	10-1-72	12.97	10.57	.68	.45	2.40	2.14	270.0	258.0
	11-5-72	4.40	1.33	1.07	.67	1.32	1.00	191.6	183.0
	6-1-73	929.8	891.1	250.6	243.6	304.6	299.0	1141.4	1119.4
	7-1-73	3013.5	2980.0	571.7	564.5	468.2	463.0	940.0	928.5
	8-1-73	292.97	276.9	245.77	241.5	240.2	237.2	651.8	643.6
	9-1-73	16.96	16.03	8.70	8.45	28.10	27.75	69.30	67.3
2	10-1-72	44.50	37.62	5.84	4.97	11.11	10.59	417.3	403.3
3	11-5-72	56.50	53.55	4.08	3.71	6.94	6.60	461.0	445.4
10	6-1-73	829.3	796.0	184.5	179.5	282.1	276.1	1451.1	1421.0

30

Totals				
Mos.	Date	OD Wt	Ashed (400°C)	Organic Matter %
1	9-1-72	868.45	830.21	4.4%
	10-1-72	286.05	271.16	5.2%
	11-5-72	198.39	187.0	6.2%
	6-1-73	2632.4	2553.1	3.0%
	7-1-73	4993.4	4936.0	1.1%
	8-1-73	1430.74	1399.20	2.2%
	9-1-73	123.06	119.53	2.9%
2	10-1-72	478.75	456.48	4.6%
3	11-5-72	528.52	509.26	3.6%
10	6-1-73	2747.0	2672.7	2.7%

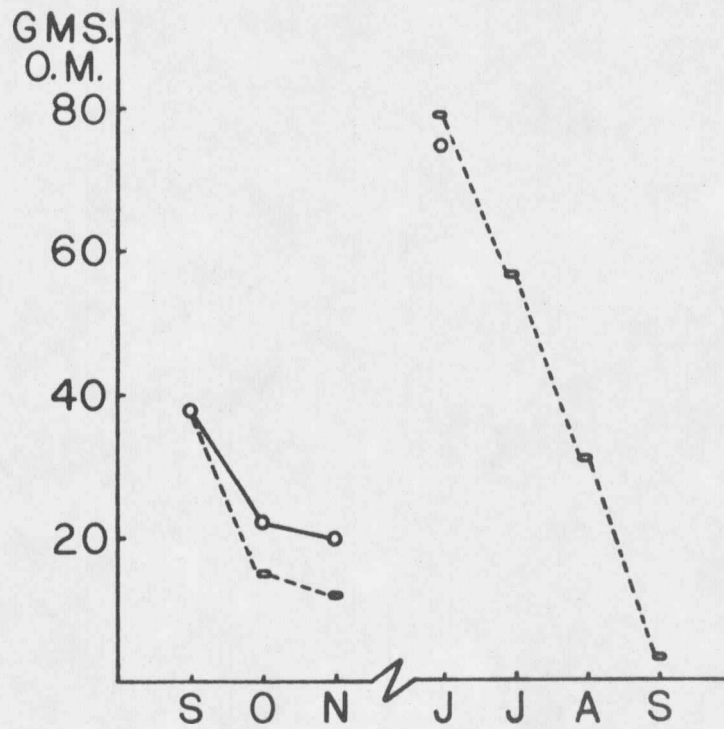


Figure 7. Organic matter collected in sediment traps at Taylor Fork on a monthly (-----) and cumulative (——) basis.

It is unfortunate that someone removed all traps except the monthly sample in June, as was done the previous fall.

Invading orders of insects at Taylor Fork, on a per month basis, show no relationship to current speed (Fig. 8), but show a decrease as current speed decreases in cumulative samples (Fig. 9).

During spring runoff, numbers of insects were low in the monthly traps (Fig. 8), but high on June 1 when runoff began and again on August 1, when sediment loads were much less. As current speed moderated September 1, insect populations were higher. Diptera is the dominant order in Taylor Fork, while very few Trichoptera were taken in the samples.

Sculpins were seldom taken in the traps, but an occasional very large specimen, up to 5.8" total length, was taken.

300-

200-

100-

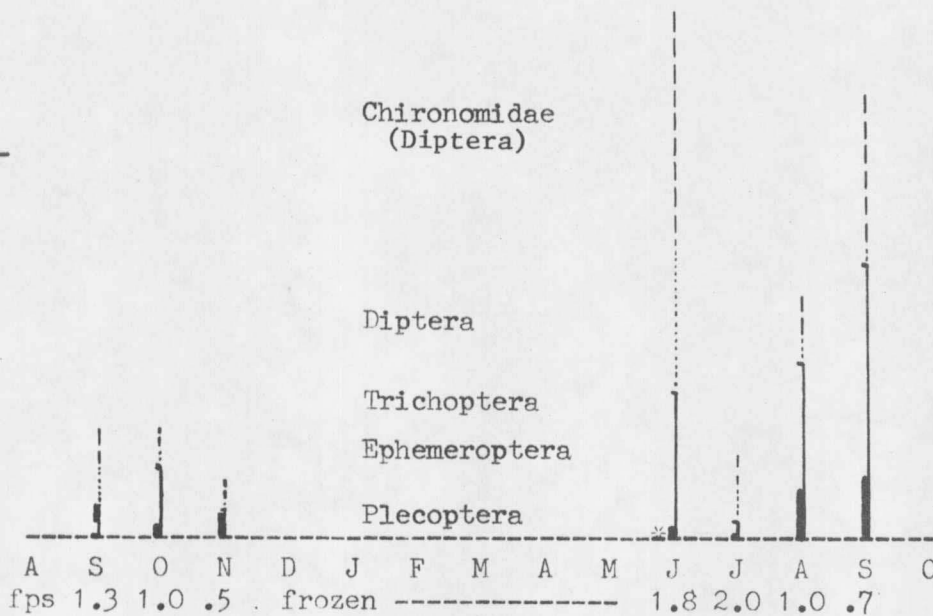


Figure 8. Taylor Fork station, August 1972-September 1973. Numbers of insects inhabiting new gravel after it was in place for one month. Current speed indicated on lower line.

RESULTS AT MILEPOST STATION (M)

On a per month basis, the amount of sediment caught in the Milepost area decreased slowly from summer to winter and remained low until the spring runoff, which lasted three months and had sediment loads averaging over 4500 grams per trap (Fig. 10). Loads would probably have been higher but the traps were all filled to capacity.

The sizes of the sieved materials show a pattern of less weight of the larger size particles to very large proportions of silt, which in color was similar to that in Taylor Fork. Pebble sizes were more dominant in the undisturbed traps. The occasional large odd pebble in a sample sometimes caused a misleadingly high reading for this size class (Table 3).

The organic matter weight followed the total sediment weight, with some minor variations of extra organic matter in October and April (Fig. 11). During the fall and spring, the percentage is higher (6-9%) than in the runoff period (2-3%), in spite of the fact that 80-130 grams of twigs and needles had accumulated in the traps in the spring (Table 3).

The cumulative samples were incomplete due to ice shelves up to five feet thick forming over shallow areas in the winter. However, the amounts of total sediment rose gradually from summer to winter (Fig. 11), and jumped to a very high 6000 grams level during runoff and remained

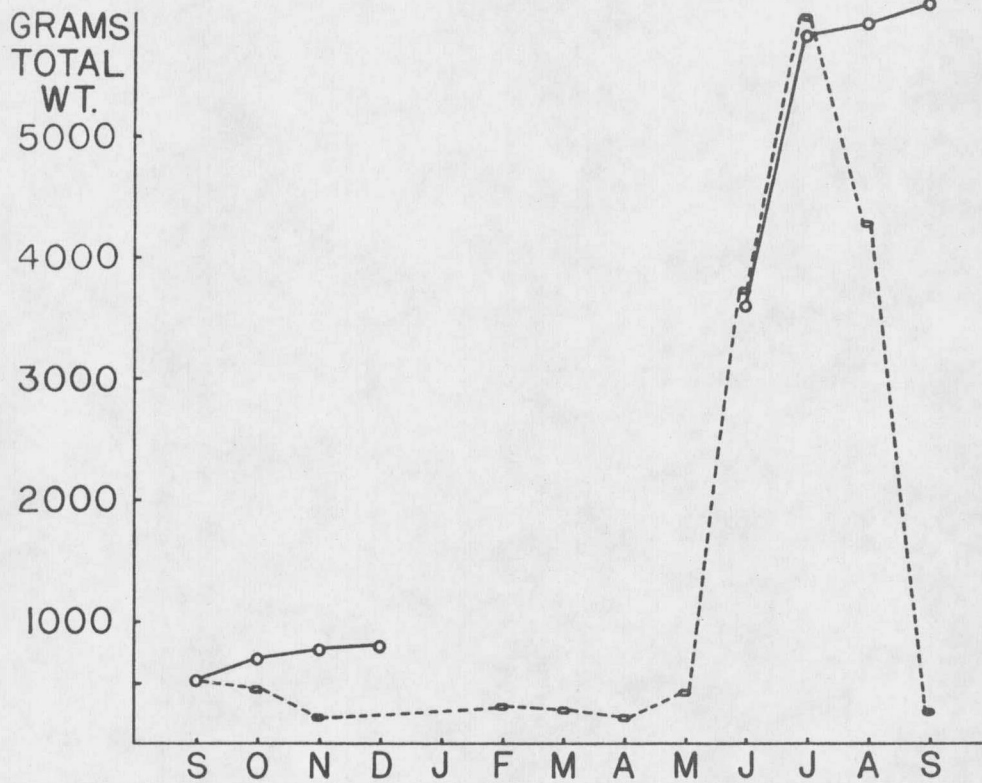


Figure 10. Total sediment collected in sediment traps at Milepost station on a monthly (-----) and cumulative (——) basis.

Table 3. The size distribution of sediment and amount of organic matter from Milepost for monthly intervals. All weights in grams.

Date	Sieve 10		Sieve 20		Sieve 40		Silt	
	OD Wt	Ashed (400°C)	OD Wt	Ashed (400°C)	OD Wt	Ashed (400°C)	OD Wt	Ashed
9-1-72	17.78	17.05	1.38	.72	1.42	.86	508.0	479.0
10-1-72	1.95	.42	1.37	.61	2.00	.97	447.0	411.3
11-5-72	4.80	3.50	1.46	1.01	1.23	.73	214.7	199.0
2-1-73	7.95	7.10	8.50	8.14	23.74	23.14	282.1	274.2
3-1-73	7.11	5.81	4.66	4.30	50.14	49.0	217.80	210.1
4-1-73	8.42	6.90	4.31	3.61	29.71	28.77	162.8	152.6
5-1-73	26.41	22.47	17.19	15.90	45.76	44.29	347.6	333.2
6-1-73	1454.6	1416.0	428.4	419.3	494.3	487.1	1390.6	1347.6
7-1-73	3319.0	3235.0	949.2	930.4	905.2	894.8	909.2	895.7
8-1-73	1758.7	1714.6	726.30	716.26	786.33	777.53	1102.4	1085.7
9-1-73	4.20	1.08	2.30	1.70	3.83	3.30	257.7	238.8

Totals			
Date	OD Wt	Ashed (400°C)	Organic Matter %
9-1-72	528.58	497.63	5.9%
10-1-72	452.32	413.30	8.6%
11-5-72	222.19	204.24	8.1%
2-1-73	322.29	312.58	3.0%
3-1-73	279.71	269.21	3.8%
4-1-73	205.24	191.88	6.5%
5-1-73	426.36	405.64	4.9%
6-1-73	3767.9	3670.0	2.6%
7-1-73	6082.6	5955.9	2.1%
8-1-73	4373.73	4294.09	1.8%
9-1-73	268.03	244.88	1.6%

Table 3 (continued)

The size distribution of sediment and amount of organic matter in sediment traps in place for the number of months indicated at Milepost. All weights in grams

<u>Mos.</u>	<u>Date</u>	<u>Sieve 10</u>		<u>Sieve 20</u>		<u>Sieve 40</u>		<u>Silt</u>	
		<u>OD Wt</u>	<u>Ashed</u> (400°C)	<u>OD Wt</u>	<u>Ashed</u> (400°C)	<u>OD Wt</u>	<u>Ashed</u> (400°C)	<u>OD Wt</u>	<u>Ashed</u> (400°C)
1	9-1-72	17.78	17.05	1.38	.72	1.42	.86	508.0	479.0
2	10-1-72	1.00	.24	1.60	.85	2.19	1.29	697.2	680.0
3	11-5-72	8.27	7.10	2.20	1.40	2.46	1.76	751.2	720.0
4	12-1-72	13.37	9.77	3.47	2.53	4.59	3.66	771.0	751.0
10	6-1-73	1128.0	1094.2	261.63	253.4	402.3	394.4	1841.5	1791.0
11	7-1-73	2786.3	2746.3	254.7	249.4	416.2	409.9	1376.0	1344.1
12	8-1-73	2452.2	2394.5	261.66	253.6	443.18	435.72	1860.0	1808.0
13	9-1-73	3649.0	3103.5	337.0	328.9	587.8	581.4	1610.0	1564.7

<u>Mos.</u>	<u>Date</u>	<u>Totals</u>		<u>Organic Matter %</u>
		<u>OD Wt</u>	<u>Ashed</u> (400°C)	
1	9-1-72	528.58	497.63	5.9%
2	10-1-72	701.99	682.38	2.8%
3	11-5-72	764.13	730.26	4.4%
4	12-1-72	792.18	766.96	3.2%
10	6-1-73	3633.43	3533.0	2.8%
11	7-1-73	5833.2	5749.7	1.7%
12	8-1-73	6017.04	5891.82	2.1%
13	9-1-73	6183.8	6078.5	3.3%

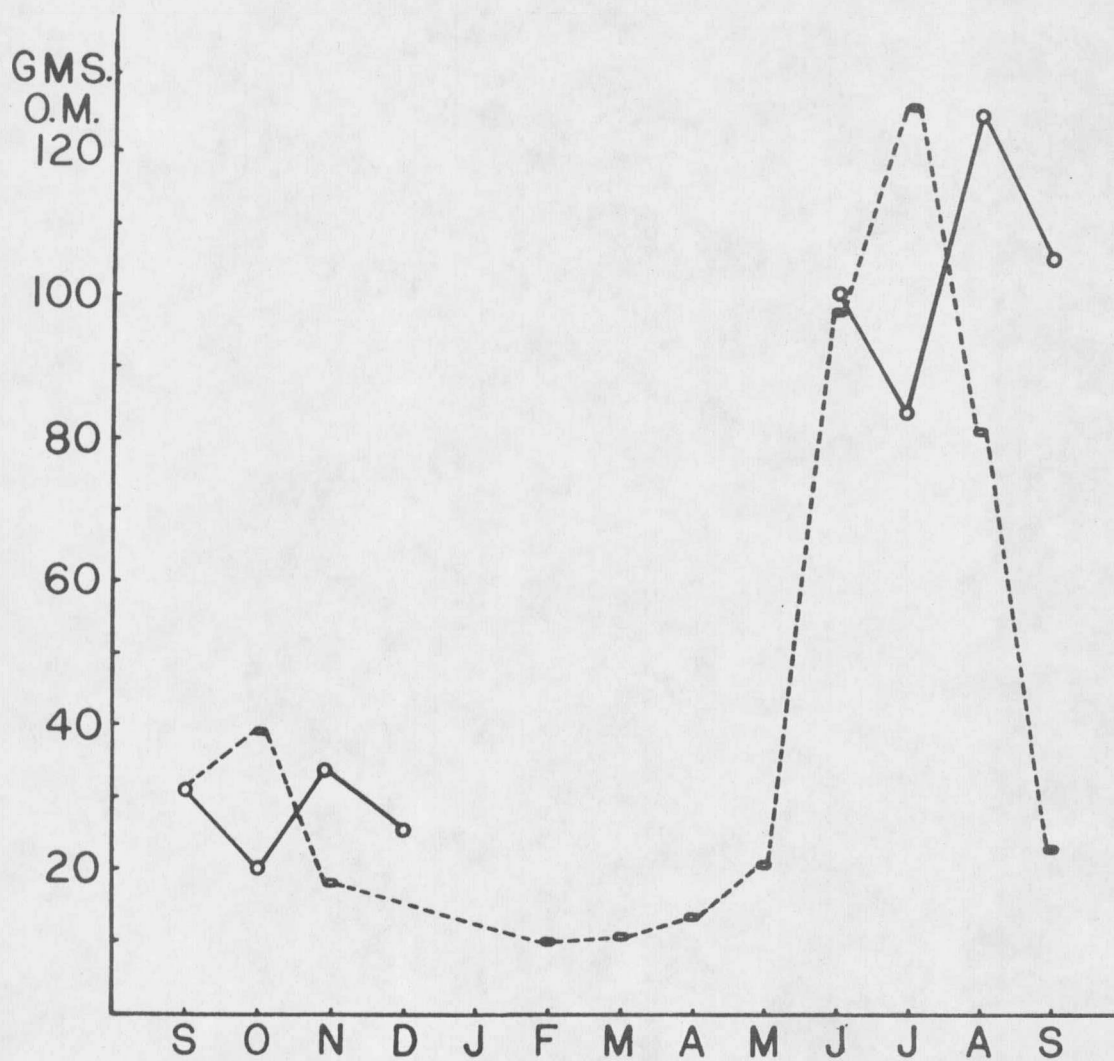


Figure 11. Organic matter collected in sediment traps at Milepost station on a monthly (-----) and cumulative (——) basis.

high to the end of the experiment. The amount of organic matter was erratic, mostly due to spruce cones and twigs which were in the traps.

Total numbers of aquatic insects on a monthly basis showed a correlation to current speed and total sediment (Fig. 12). Populations were exceptionally high in the moderate .6-.8 fps current speeds and low sedimentation rates prior to spring runoff. The low current speeds were related to shallow water over the traps. Diptera dominated the orders, but Plecoptera and Ephemeroptera populations closely followed the current and sedimentation rate changes. Trichoptera were significant only when the monthly samples were set in midstream during winter.

The cumulative samples of the station showed dominance of Diptera except in September when the insects had a clean, sediment-free trap to occupy (Fig. 13). Stoneflies were dominant then. Trichoptera were conspicuously absent, similar to the situation in Taylor Fork, which had a noticeable sedimentation influence on the area.

Sculpins were taken at the rate of one or two per trap except in winter.

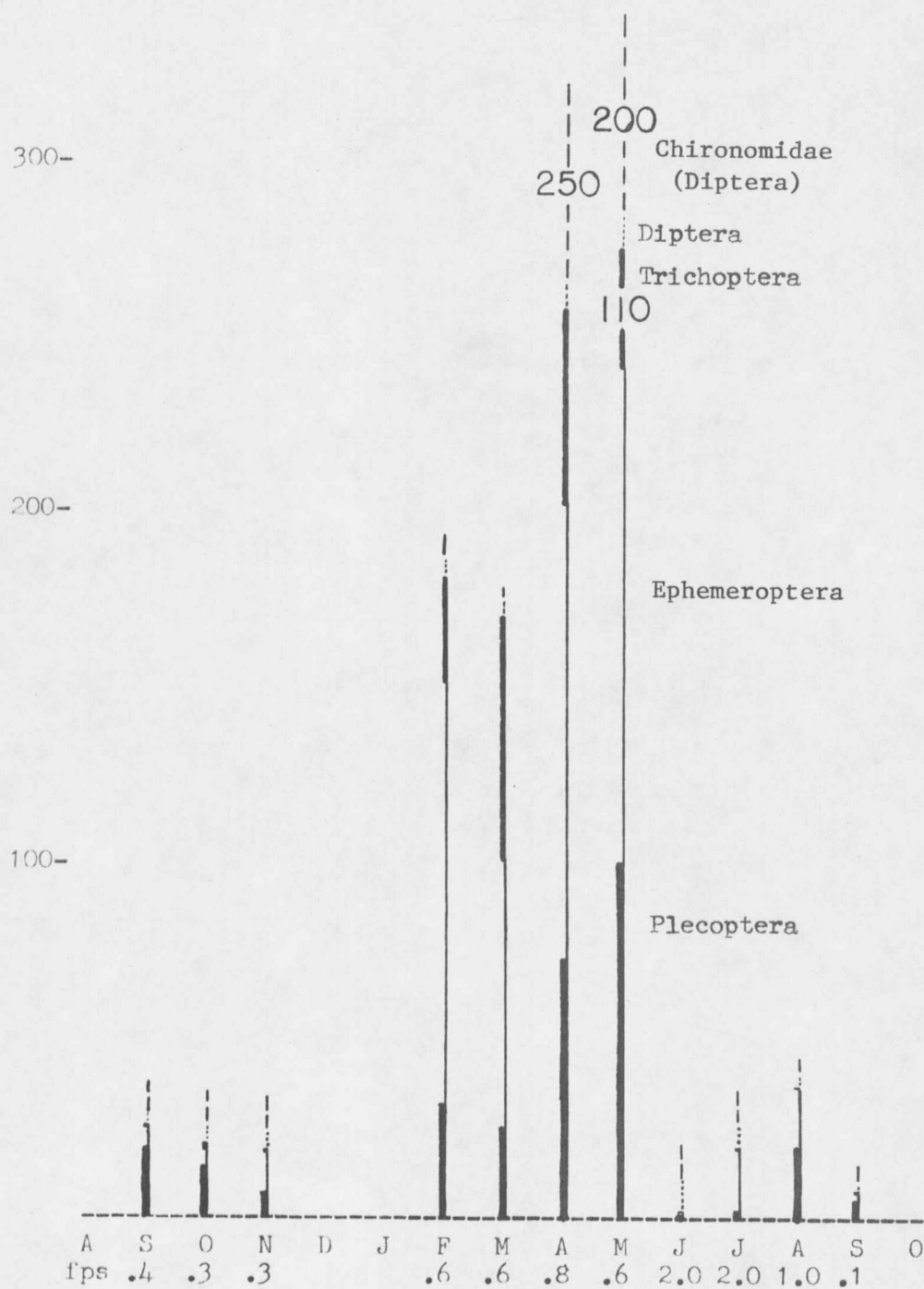


Figure 12. Milepost station, August 1972-September 1973. Numbers of insects inhabiting new gravel after it was in place for one month. Current speed indicated on lower line of figures.

300-

200-

100-

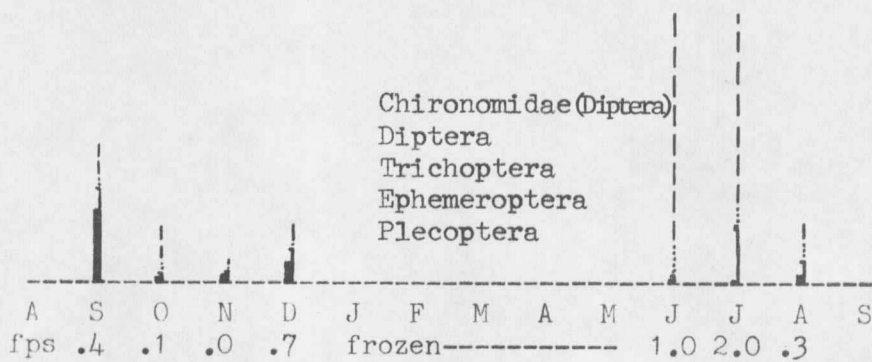


Figure 13. Milepost station, August 1972-August 1973. Numbers of insects found in new gravel at monthly intervals for 12 months after introducing the gravel. Current speed indicated on lower line of figures.

RESULTS AT RUINS STATION (R)

The total sediment load at the Ruins station weighed under 200 grams every month except during the spring runoff in May-July (Fig. 14). During this period the total weight approximated 3,000-4,000 grams. The cumulative weights from undisturbed traps showed a similar pattern and retained sediment buildups.

Silt dominated the size particles in practically all traps (Table 4). During runoff, pebble sizes dominated the silt and it appeared that silt sizes were flushed downstream and coarser material was retained. After runoff, pebble sizes continued to dominate in the cumulative traps, and the monthly-sample trap reverted to the typical silt-dominated sediment pattern.

Organic matter by actual weight paralleled the total sediment weight (Fig. 15). The percentage of organic matter approximated 6% and was slightly higher in the monthly sample which contained less sediment (Table 4). During runoff organic matter dropped to about 2% due to heavy sediment loads; this remained at 2% in the cumulative traps, but the monthly sample returned to the previous years' pattern. Cumulative traps showed fair growth of the algae *Nostoc* after the runoff period.

The insect populations on a monthly basis (Fig. 16) showed a consistent population of about forty per sample, with Trichoptera lacking and Diptera dominating. The one exceptionally high sample

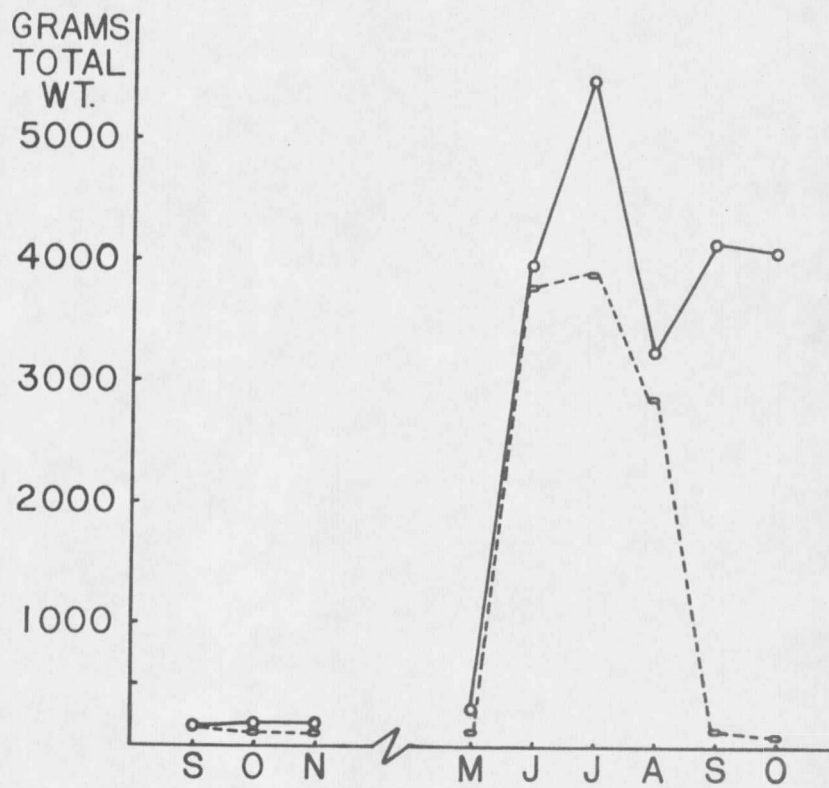


Figure 14. Total sediment collected in sediment traps at Ruins station on a monthly (-----) and cumulative (——) basis.

Table 4. The size distribution of sediment and amount of organic matter from Ruins station for monthly intervals. All weights in grams

<u>Date</u>	<u>Sieve 10</u>		<u>Sieve 20</u>		<u>Sieve 40</u>		<u>Silt</u>	
	<u>OD Wt</u>	<u>Ashed</u> (400°C)	<u>OD Wt</u>	<u>Ashed</u> (400°C)	<u>OD Wt</u>	<u>Ashed</u> (400°C)	<u>OD Wt</u>	<u>Ashed</u> (400°C)
9-1-72	2.10	1.87	1.24	1.11	3.50	3.33	154.0	147.0
10-1-72	.84	.40	.92	.73	2.41	2.07	125.00	113.60
11-5-72	1.72	1.37	1.05	.84	1.37	1.16	91.0	83.5
5-1-73	18.69	17.82	18.70	18.33	5.42	5.28	82.5	79.8
6-1-73	1766.0	1738.2	765.47	755.20	444.05	438.52	831.7	813.7
7-1-73	913.14	875.0	919.9	905.4	1015.6	1006.0	1041.6	1028.2
8-1-73	855.2	826.2	1057.0	1037.8	584.2	579.2	378.1	371.4
9-1-73	3.72	2.44	4.86	4.39	8.68	8.13	105.2	99.2
10-1-73	1.00	.40	.90	.70	1.81	1.60	50.7	46.3

<u>Date</u>	<u>Totals</u>		<u>Organic Matter %</u>
	<u>OD Wt</u>	<u>Ashed</u> (400°C)	
9-1-72	160.84	153.31	4.7%
10-1-72	129.17	116.80	9.6%
11-5-72	95.14	86.87	8.7%
5-1-73	129.25	125.11	3.2%
6-1-73	3807.21	3745.62	1.6%
7-1-73	3890.5	3814.6	2.0%
8-1-73	2874.5	2814.6	2.1%
9-1-73	122.46	114.16	6.8%
10-1-73	54.41	49.00	9.9%

Table 4 (continued)

The size distribution of sediment and amount of organic matter in sediment traps in place for the number of months indicated at Ruins Station. All weights in grams.

<u>Mos.</u>	<u>Date</u>	<u>Sieve 10</u>		<u>Sieve 20</u>		<u>Sieve 40</u>		<u>Silt</u>	
		<u>OD Wt</u>	<u>Ashed</u> (400°C)	<u>OD Wt</u>	<u>Ashed</u> (400°C)	<u>OD Wt</u>	<u>Ashed</u> (400°C)	<u>OD Wt</u>	<u>Ashed</u> (400°C)
1	9-1-72	2.10	1.87	1.24	1.11	3.50	3.33	154.0	147.0
2	10-1-72	3.36	2.75	.84	.47	1.74	1.38	171.0	162.3
3	11-5-72	2.85	2.24	.38	.20	.70	.62	157.5	149.4
9	5-1-73	5.69	5.00	2.52	2.05	6.59	5.97	292.0	273.9
10	6-1-73	1450.0	1419.0	770.10	756.1	522.70	516.2	1248.0	1219.0
11	7-1-73	1713.0	1677.0	620.3	609.1	768.6	855.5	1370.4	1329.7
12	8-1-73	923.6	902.5	489.70	478.9	387.5	381.3	986.3	961.0
13	9-1-73	2290.0	2264.9	578.79	572.17	377.26	373.20	911.1	888.5
14	10-1-73	2376.0	2334.0	321.1	313.9	188.7	183.3	1194.2	1135.0

46

<u>Totals</u>				
<u>Mos.</u>	<u>Date</u>	<u>OD Wt</u>	<u>Ashed</u> (400°C)	<u>Organic Matter %</u>
1	9-1-72	160.84	153.31	4.7%
2	10-1-72	176.94	166.83	5.7%
3	11-5-72	161.51	152.46	5.6%
9	5-1-73	306.80	286.92	6.5%
10	6-1-73	3990.8	3910.3	2.0%
11	7-1-73	5472.3	5371.3	1.8%
12	8-1-73	3287.1	3223.7	1.9%
13	9-1-73	4157.15	4098.77	1.4%
14	10-1-73	4080.0	3966.2	2.8%

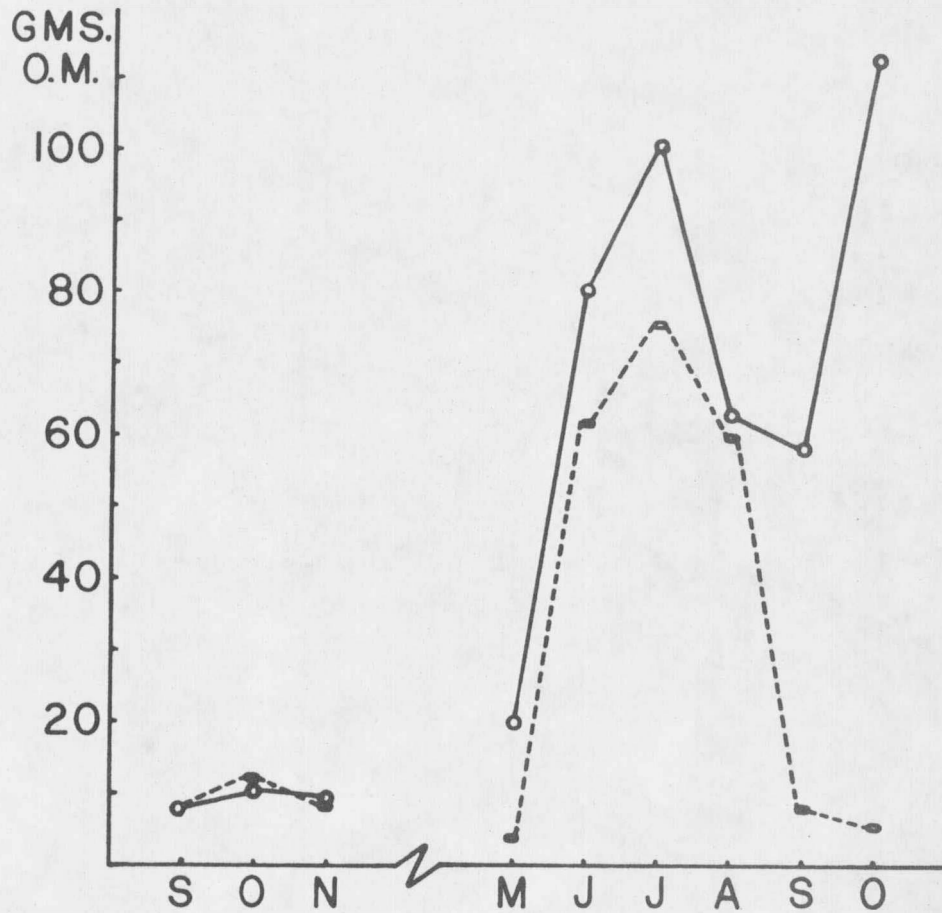


Figure 15. Organic matter collected in sediment traps at Ruins station on a monthly (-----) and cumulative (——) basis.

300-

200-

100-

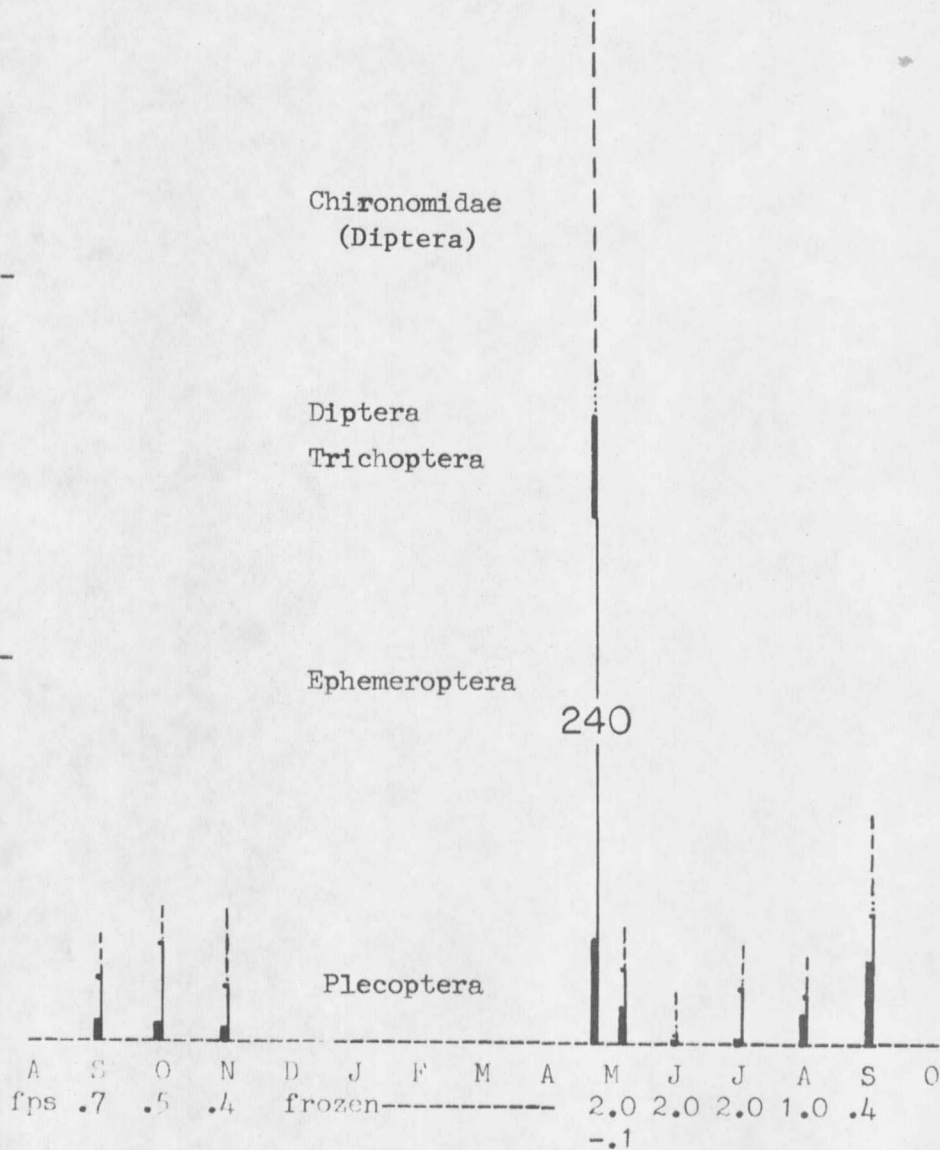


Figure 16. Ruins station, August 1972--September 1973. Numbers of insects inhabiting new gravel after it was in place for one month. Current speed indicated on lower line of figures.

occurred in a sample moved out into the mainstream on November 5 and sampled on May 1, just before spring runoff. Samples could not be obtained between these times due to severe ice conditions. Times of heavy sedimentation due to spring runoff showed low populations, with recovery after runoff.

Cumulative samples showed similar numbers of insects to monthly-sample traps, with less Trichoptera and with a larger proportion of Diptera (Fig. 17). The total population declined during the runoff period, but recovered. After the runoff subsided, current speed, if not unusually high, seemed to make little difference in this area for either cumulative or monthly samples.

Sculpins were caught regularly at the rate of two per trap.

300-

200-

100-

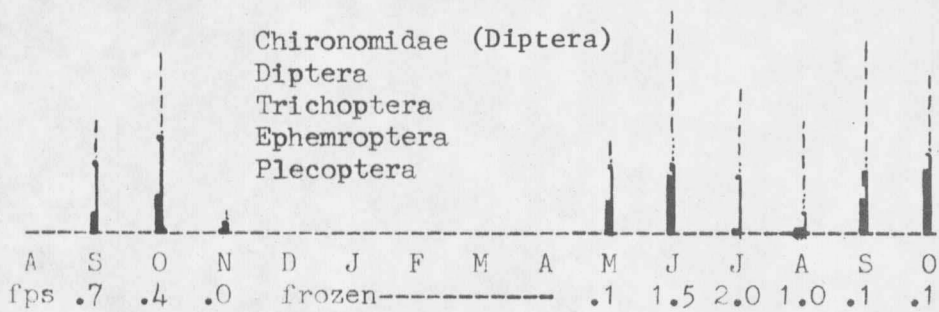


Figure 17. Ruins station, August 1972--October 1973. Numbers of insects found in new gravel at monthly intervals for 14 months after introducing the gravel. Current speed indicated on the lower line of figures.

RESULTS AT PORCUPINE (P)

The total sediment load at the Porcupine Creek station was very low in weight for a monthly basis compared to the other areas studied, probably due to the lack of human disturbance of the watershed (Fig. 18). The monthly sediment weight was very low except for the runoff period in June. The cumulative traps showed a slow buildup until frozen in, then a steady rise during and after runoff of 1,000 grams per month in June and July. August and September traps maintained the deposited loads, which were sealed with a layer of the alga *Nostoc*.

Silt was the dominant size class at all times, even during runoff, for the monthly sample (Table 5). The pebble size (greater than #10 sieve) only slightly dominated silt in cumulative traps after runoff.

Organic matter made up about 8% of the total sediment in monthly traps except during runoff when it dropped to about 3% (Table 5). It maintained a higher percentage in the fall. In terms of actual weight, this organic matter generally followed the total sediment weight (Fig. 19). This was expected because nearly all of it was allocthanous material. In cumulative traps, organic matter generally increased during the project's duration.

The insect populations in the monthly sample (Fig. 20) showed a population dominated by mayflies, although on July 1 tremendous masses of blackfly larvae (Simuliidae) were seen in midstream. The typical low-numbers phenomenon is not as notable here as at other stations, but

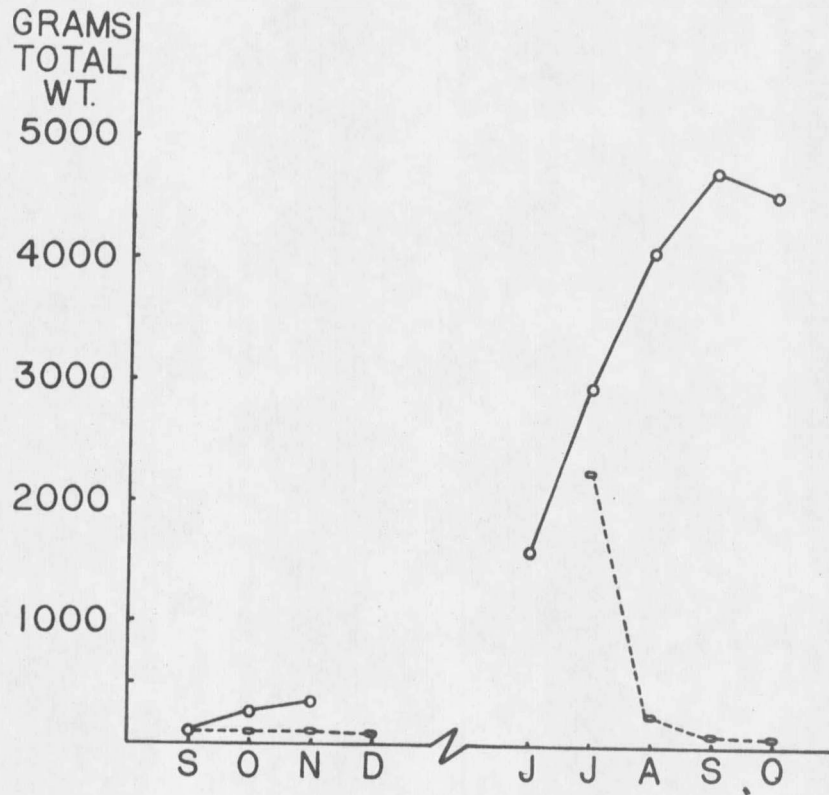


Figure 18. Total sediment collected in sediment traps at Porcupine Creek on a monthly (-----) and cumulative (——) basis.

Table 5. The size distribution of sediment and amount of organic matter from Porcupine Creek for monthly intervals. All weights in grams

<u>Date</u>	<u>Sieve 10</u>		<u>Sieve 20</u>		<u>Sieve 40</u>		<u>Silt</u>	
	<u>OD Wt</u>	<u>Ashed</u> (400°C)	<u>OD Wt</u>	<u>Ashed</u> (400°C)	<u>OD Wt</u>	<u>Ashed</u> (400°C)	<u>OD Wt</u>	<u>Ashed</u> (400°C)
9-1-72	2.23	.85	.92	.47	2.55	2.20	101.0	91.0
10-1-72	2.20	.41	2.77	2.32	2.53	2.26	112.0	101.0
11-5-72	2.02	.38	1.31	.84	2.39	2.00	94.70	88.4
12-1-72	2.20	1.62	.90	.62	1.02	.74	81.0	76.0
7-1-73	523.0	476.0	397.7	388.6	655.2	641.9	691.7	679.9
8-1-73	37.64	24.36	44.78	44.00	58.07	54.61	123.1	119.9
9-1-73	1.05	.49	2.27	2.02	9.70	9.28	38.6	36.8
10-1-73	2.34	.60	.94	.72	2.23	2.03	45.1	42.2

<u>Date</u>	<u>Totals</u>		
	<u>OD Wt</u>	<u>Ashed</u> (400°C)	<u>Organic Matter %</u>
9-1-72	106.70	94.52	11.4%
10-1-72	119.50	105.99	11.3%
11-5-72	100.42	91.62	8.8%
12-1-72	85.12	78.98	7.2%
7-1-73	2267.6	2186.4	3.6%
8-1-73	263.59	242.87	7.9%
9-1-73	51.62	48.59	5.9%
10-1-73	50.61	45.55	10 %

Table 5 (continued)

The size distribution of sediment and amount of organic matter in sediment traps in place for the number of months indicated at Procupine Creek. All weights in grams.

Mos.	Date	Sieve 10		Sieve 20		Sieve 40		Silt	
		OD Wt	Ashed (400°C)	OD Wt	Ashed (400°C)	OD Wt	Ashed (400°C)	OD Wt	Ashed (400°C)
1	9-1-72	2.23	.85	.92	.47	2.55	2.20	101.0	91.0
2	10-1-72	16.57	4.00	3.50	1.90	8.79	7.65	244.9	233.8
3	11-5-72	8.06	1.58	2.85	1.19	3.07	2.19	330.5	314.5
10	6-1-73	352.5	333.5	263.28	258.35	324.33	318.65	682.5	667.5
11	7-1-73	1063.8	1020.1	434.0	414.4	446.5	435.7	943.5	908.7
12	8-1-73	1375.5	1330.0	714.0	695.2	725.0	704.8	1268.2	1239.9
13	9-1-73	1993.3	1943.0	815.90	791.2	573.8	563.4	1343.8	1306.7
14	10-1-73	1787.0	1740.0	671.3	657.7	527.7	518.0	1560.0	1493.0

54

Mos.	Date	Totals		Organic Matter %
		OD Wt	Ashed (400°C)	
1	9-1-72	106.70	94.52	11.4%
2	10-1-72	273.76	247.35	9.6%
3	11-5-72	344.48	319.46	7.3%
10	6-1-73	1622.6	1578.00	2.7%
11	7-1-73	2987.8	2878.9	3.7%
12	8-1-73	4082.7	3969.9	2.8%
13	9-1-73	4726.8	4604.3	2.6%
14	10-1-73	4546.0	4408.7	3.0%

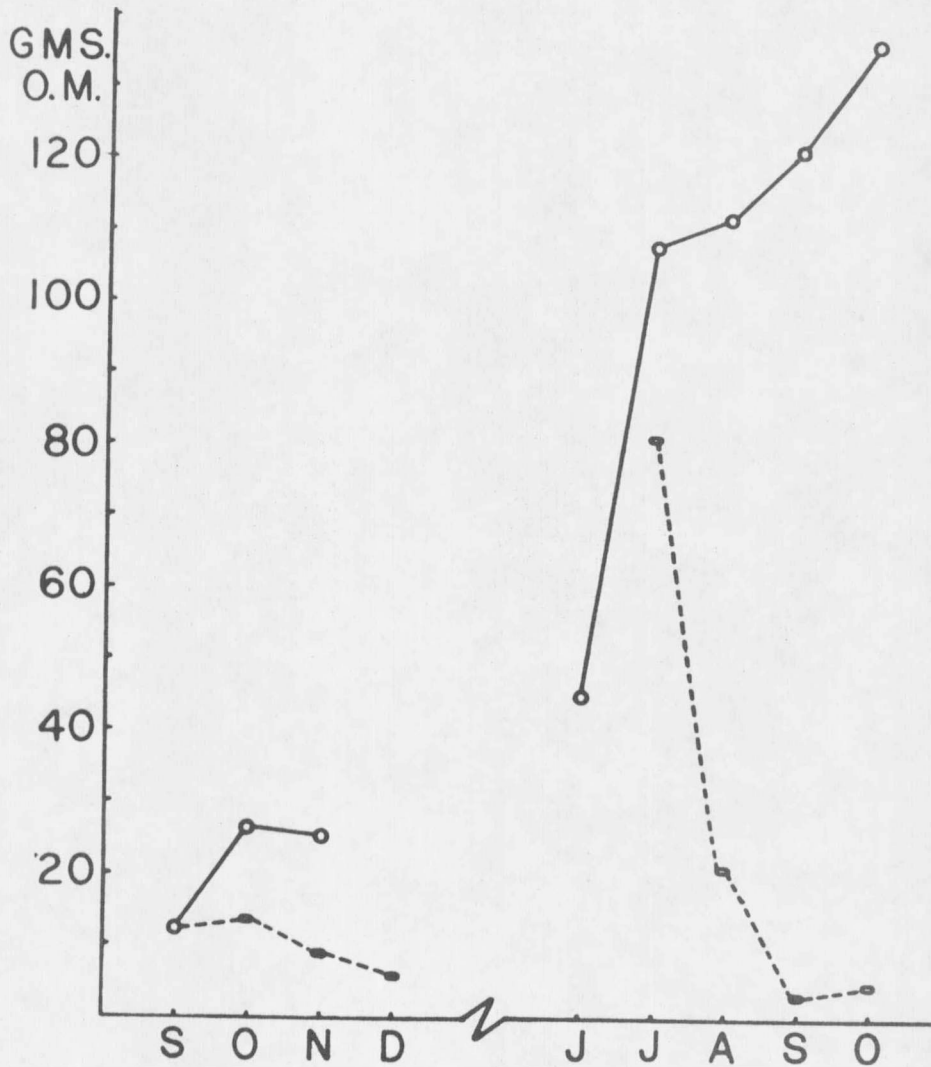


Figure 19. Organic matter collected in sediment traps at Porcupine Creek on a monthly (-----) and cumulative (——) basis.

300-

200-

100-

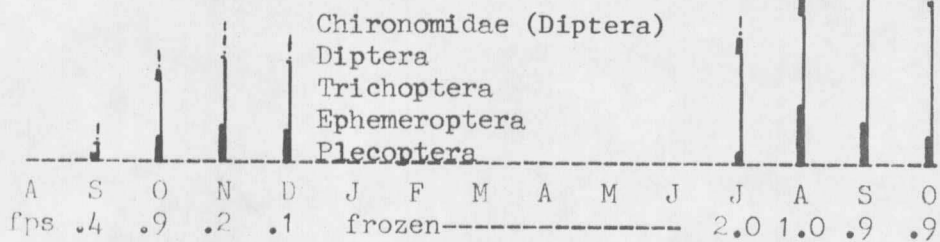


Figure 20. Porcupine station, August 1972–October 1973. Numbers of insects inhabiting new gravel after it was in place for one month. Current speed indicated on lower line.

sediment loads were not exceptionally high for runoff, being 2,200 grams on July 1, 1973. Of special interest in these monthly samples was a current change for September and October. Here the variables of current speed may be an important factor, as the higher speed in 1973 shows a correspondingly higher population. Sediment was low in both years.

Flow over the cumulative traps showed a variable current speed (Fig. 21) early in the year. But insect populations showed a steady increase, most likely because populations build up when not disturbed. The population at this time was dominated by mayflies, but after runoff and the traps were filled with sediment, populations were low. Diptera were more dominant with Plecoptera generally low in numbers.

Sculpins were captured occasionally all year when traps were available, especially in spring at about 3 per trap. At other times, the normal was one per trap.

300-

200-

100-

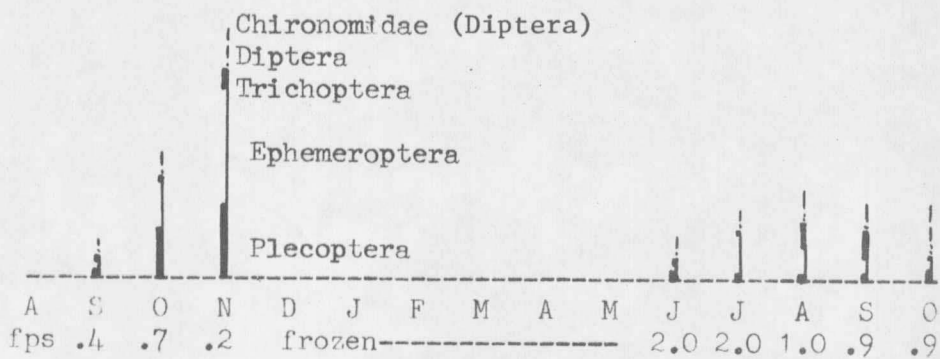


Figure 21. Porcupine Creek station, August 1972-October 1973. Numbers of insects inhabiting new gravel at monthly intervals for 14 months after introducing the gravel. Current speed indicated on lower line of figures.

RESULTS AT BIG SKY (BS)

The sediment in West Fork on a monthly basis was low all year except during runoff months of May-July, when total sediment weight was 3,000 to 4,000 grams (Fig. 22). Cumulative samples were always higher than the monthly samples and paralleled them closely until July but retained their heavy sediment load after runoff.

Silt greatly dominated the weights of sediment size particle classes in all samples, except during runoff and in cumulative traps thereafter (Table 6). Pebble sizes (over #10 sieve) from the bedload of the stream dominated the sediment weights in these situations.

The actual weight of organic matter (Fig. 23) essentially paralleled the total weight and in cumulative traps showed a general increase. The organic matter before runoff was about 12%, usually higher in the fall and dropped to under 2% during runoff (Table 6). Low percentages were maintained in cumulative cans. Algae and mosses, while still minor in proportion to dry weight of organic matter, were more visibly apparent than in other areas at almost all times of year, surpassing the Snowflake area, which also had much algae visible.

The aquatic insect populations gave evidence of the relatively high productivity of this stream. Qualitatively, variety was much greater than at other stations. Trichoptera were present in relatively high numbers, especially free-living and web-spinning varieties.

In the monthly sample (Fig. 24) Diptera usually dominated, but in winter and spring mayflies appeared in great numbers, disappearing after

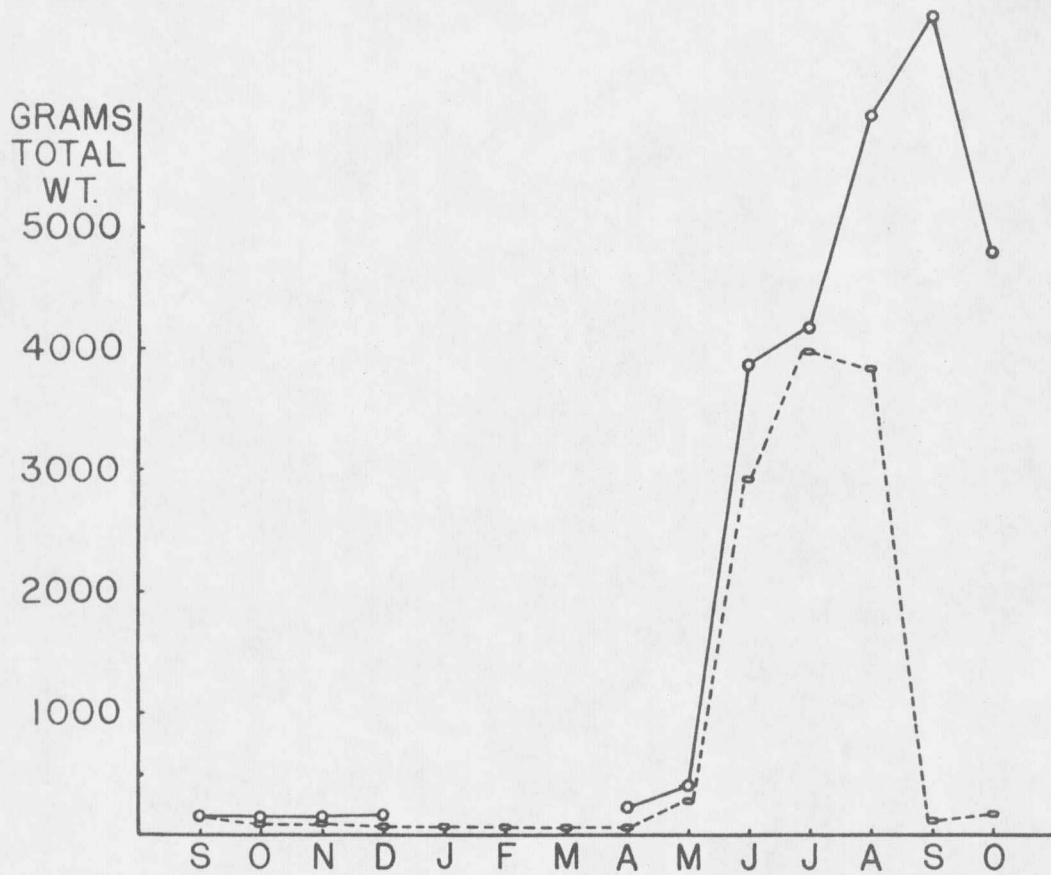


Figure 22. Total sediment collected in sediment traps at Big Sky on a monthly (-----) and cumulative (——) basis.

Table 6. The size distribution of sediment and amount of organic matter from Big Sky for monthly intervals. All weights in grams.

<u>Date</u>	<u>Sieve 10</u>		<u>Sieve 20</u>		<u>Sieve 40</u>		<u>Silt</u>	
	<u>OD Wt</u>	<u>Ashed</u>	<u>OD Wt</u>	<u>Ashed</u>	<u>OD Wt</u>	<u>Ashed</u>	<u>OD Wt</u>	<u>Ashed</u>
9-1-72	8.54	7.50	16.00	15.43	7.76	7.35	110.0	96.00
10-1-72	2.47	1.14	1.03	.71	1.12	.89	83.3	74.1
11-5-72	7.29	2.71	3.63	2.60	2.32	1.88	112.0	100.3
12-1-72	3.82	1.95	2.51	2.00	4.41	4.00	55.5	51.1
1-1-73	1.22	.40	.71	.41	2.12	1.78	63.3	60.2
2-1-73	.52	.20	.17	.11	.30	.22	16.20	15.3
3-1-73	.45	.11	.62	.38	.36	.25	31.00	28.0
4-1-73	1.22	.71	.96	.71	.47	.31	38.4	35.1
5-1-73	6.93	2.32	2.52	1.06	2.14	1.24	264.6	242.4
6-1-73	1284.3	1260.5	646.9	639.1	525.1	520.6	488.4	473.4
7-1-73	2951.2	2916.2	698.8	694.3	304.3	302.4	219.0	213.4
8-1-73	1939.3	1911.3	764.3	757.1	478.2	475.4	625.8	603.0
9-1-73	9.48	6.82	4.82	4.31	4.70	4.42	88.6	82.5
10-1-73	14.18	6.50	4.73	3.92	6.88	6.02	156.3	143.7

Table 6 (continued)

<u>Date</u>	<u>Totals</u>		<u>Organic Matter %</u>
	<u>OD Wt</u>	<u>Ashed</u> (400°C)	
9-1-72	142.30	126.28	11.3%
10-1-72	87.92	76.84	12.6%
11-5-72	125.24	107.49	14.2%
12-1-72	66.24	59.04	10.9%
1-1-73	67.35	62.79	6.8%
2-1-73	17.19	15.83	7.9%
3-1-73	32.43	28.74	11.4%
4-1-73	41.05	36.83	10.3%
5-1-73	276.19	247.02	10.6%
6-1-73	2944.7	2893.6	1.7%
7-1-73	4173.3	4126.3	1.1%
8-1-73	3807.6	3746.8	1.3%
9-1-73	107.60	98.05	8.9%
10-1-73	182.09	160.14	12.1%

Table 6 (continued)

The size distribution of sediment and amount of organic matter in sediment traps in place for the number of months indicated at Big Sky. All weights in grams.

<u>Mos.</u>	<u>Date</u>	<u>Sieve 10</u>		<u>Sieve 20</u>		<u>Sieve 40</u>		<u>Silt</u>	
		<u>OD Wt</u>	<u>Ashed</u> (400°C)	<u>OD Wt</u>	<u>Ashed</u> (400°C)	<u>OD Wt</u>	<u>Ashed</u> (400°C)	<u>OD Wt</u>	<u>Ashed</u> (400°C)
1	9-1-72	8.54	7.50	16.00	15.43	7.76	7.35	110.0	96.00
2	10-1-72	5.60	3.21	.78	.51	1.06	.78	96.0	81.0
3	11-5-72	11.32	5.00	3.20	2.13	2.95	2.34	113.0	102.0
4	12-1-72	23.90	18.00	9.18	7.72	4.69	4.12	134.5	122.7
8	4-1-73	16.23	9.45	1.47	.83	2.11	1.54	206.3	183.3
9	5-1-73	33.69	22.62	11.00	9.98	24.42	23.45	319.8	299.7
10	6-1-73	1566.0	1541.6	488.1	481.7	289.6	287.1	530.7	510.1
11	7-1-73	1664.0	1634.8	476.0	468.8	304.4	301.7	414.0	397.6
12	8-1-73	3267.0	3233.8	1227.4	1215.3	432.8	430.6	274.8	268.3
13	9-1-73	4818.0	4767.0	829.50	822.0	543.00	539.8	559.5	539.5
14	10-1-73	2036.8	1994.4	514.6	508.1	374.8	371.2	878.7	839.2

<u>Totals</u>					
<u>Mos.</u>	<u>Date</u>	<u>OD Wt</u>	<u>Ashed</u> (400°C)	<u>Organic Matter %</u>	
1	9-1-72	142.30	126.28	11.3%	
2	10-1-72	103.44	85.50	17.3%	
3	11-5-72	130.47	111.47	14.6%	
4	12-1-72	172.27	152.54	11.5%	
8	4-1-73	226.11	195.12	13.7%	
9	5-1-73	388.91	355.75	8.5%	
10	6-1-73	3874.4	3820.5	1.4%	
11	7-1-73	3958.4	3902.9	1.4%	
12	8-1-73	5922.0	5868.0	1.0%	
13	9-1-73	6750.0	6668.3	5.9%	
14	10-1-73	4804.9	4712.9	1.9%	

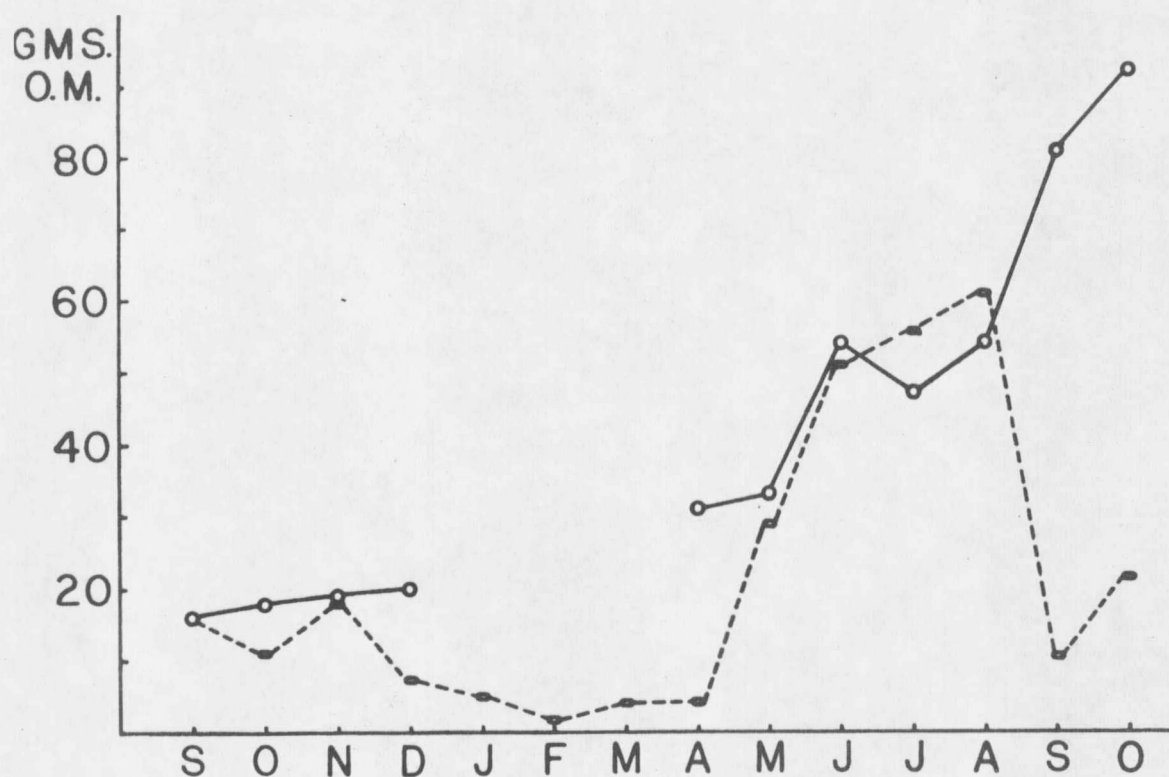


Figure 23. Organic matter collected in sediment traps at Big Sky on a monthly (-----) and cumulative (——) basis.

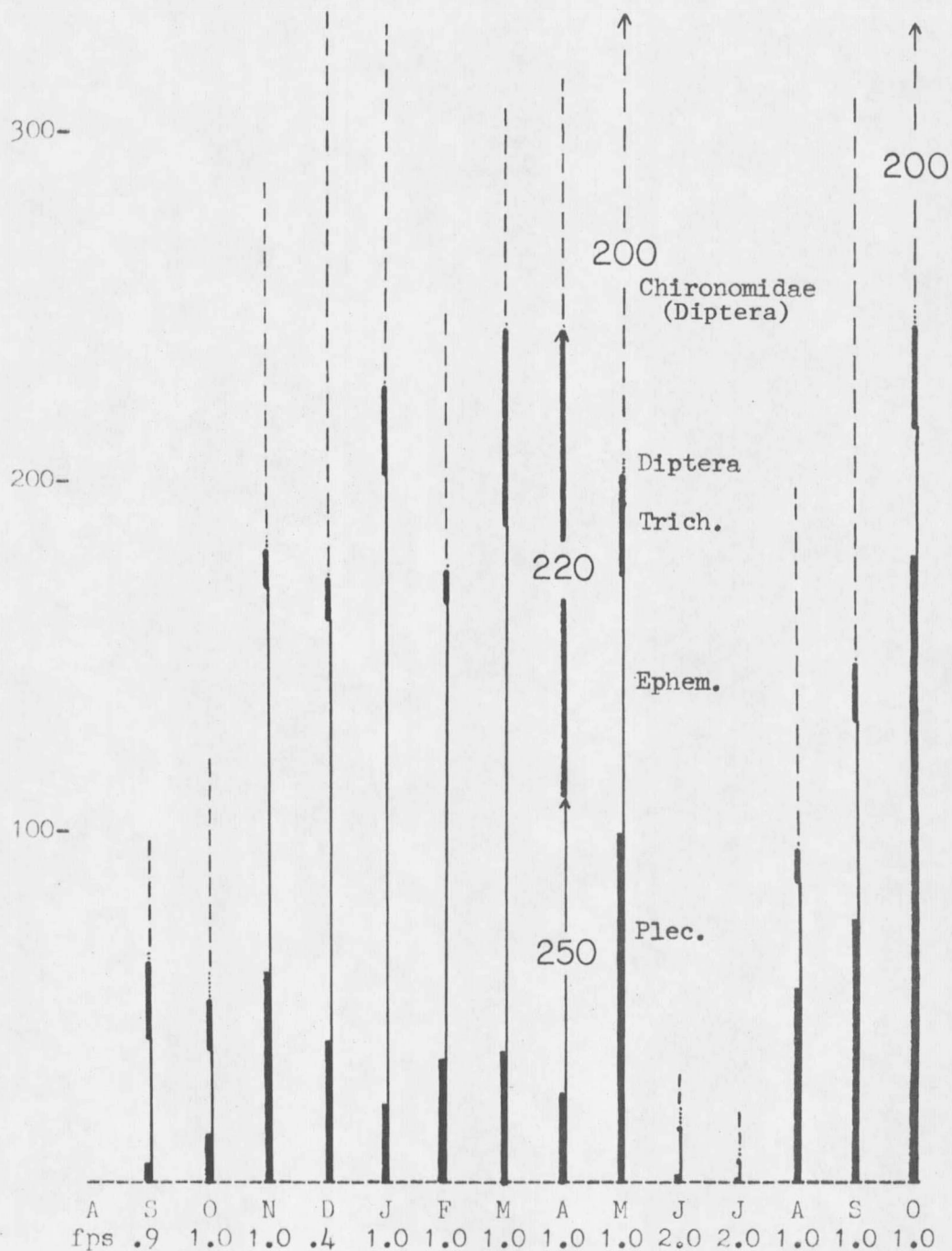


Figure 24. Big Sky station, August 1972-October 1973. Numbers of insects inhabiting new gravel after it was in place one month. Current speed indicated on lower line of figures.

several swarms were observed in late April. Current speeds were almost always 1.0 fps., except during runoff, when heavy sedimentation and 2.0 fps. current speeds coincided with drastically reduced populations. In September-October, 1973, growth of algae was much greater than that observed in 1972, and this qualitative observation coincided with much higher populations in the fall of 1973.

In the cumulative traps, Diptera showed a definite dominance at all seasons (Fig. 25). The April trap showed an unexpected low compared to the monthly traps, and this is thought to be a function of the low current speed. The higher-building population of both fall seasons may be a function of non-disturbance. Populations were very low during runoff, but surprisingly higher after runoff even with high sediment loads. However, at this time heavier growths of algae were present.

Sculpins were caught regularly at the rate of one or two per trap except during winter.

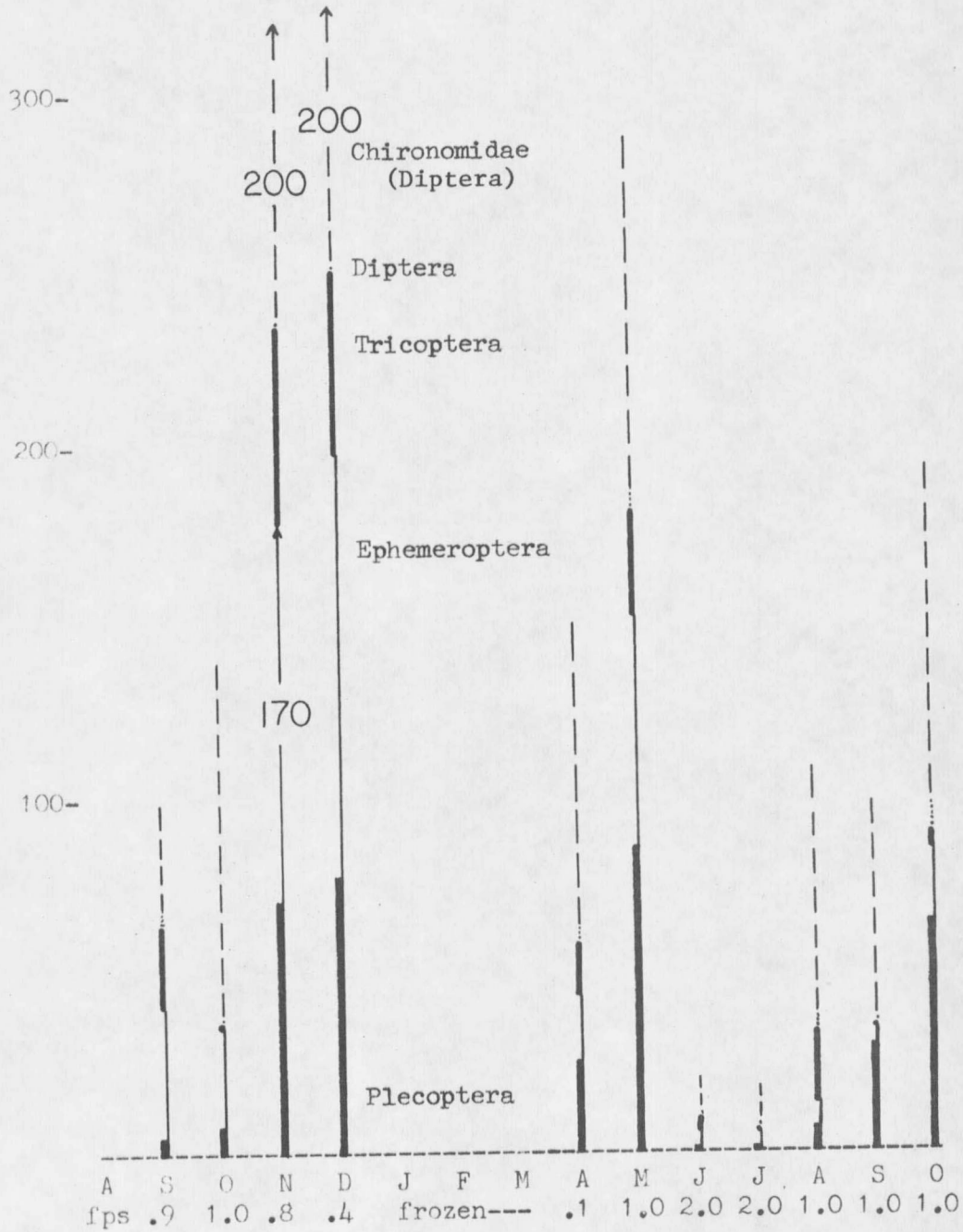


Figure 25. Big Sky station, August 1972-October 1973. Numbers of insects inhabiting new gravel at monthly intervals for 14 months after introducing the gravel. Current speed indicated on lower line of figures in feet per second.

DISCUSSION

The total sediment weight was over 2000 grams in all monthly samples coinciding with the period of heavy runoff from May 1 to August 1. The normal monthly sediment catch was less than 500 grams, and least in winter.

The total sediment weight in cumulative or undisturbed traps typically showed a slight increase in the fall until the traps were frozen in or stranded out of the water in midwinter. At Snowflake, where the most complete data of this type is seen (Fig. 2), a decrease occurred in late spring. During this time current speed gradually increased, with no appreciable sediment being introduced. This decrease in sediment may have been due to scouring.

In almost all cases, silt was the size fraction dominating sediment weights. In all traps, during runoff, and in cumulative traps after runoff periods, the pebble and gravel sizes became dominant as they settled, and silt continued to be carried in the current. The interstices between the larger size particles were filled with silt as flood waters receded and the stream lost competence and deposited its load.

The amount of organic matter in the traps was of two types, allochthonous and algae. The allochthonous, in the form of twigs, cones, and needles of evergreens, by observation made up a much greater proportion of organic matter weight than algae. The occasional odd large twigs in the traps often accounted for irregularities in graphs of

organic matter weights (e.g. Fig. 3). If samples could have been gathered in much greater numbers, a smooth curve could probably be obtained on the graphs. Organic matter was always greatest in weight in all traps sampled during runoff and in cumulative traps after runoff. In monthly samples, of September through October, minor peaks occurred (e.g. Figs. 3, 23), but whether this is due to leaf and twig drop in the fall or the usual later summer algae growths could not be determined. Samples from Taylor Fork were an exception to showing this minor peak; however, its sedimentation rates were very high and this may have affected it.

The percent of organic matter was always lowest in all samples gathered during runoff and in cumulative samples gathered after runoff. It tended to be higher in cumulative samples during the first fall, maintaining a slightly higher percent than the monthly sample. By observation, some of this was due to algae growth in the undisturbed traps. Scouring seen at Snowflake (Figs. 2, 3) seemed to not affect this higher percent (Table 1) in cumulative traps. The percent of organic matter in monthly traps was lower in winter than in the fall, probably due to the reduction of surface runoff in the watershed.

Some interesting relationships were noted between some aspects of the physical environment measured or observed and the insect community in the sediment traps.

First, insect numbers were relatively low in both monthly and

cumulative traps at most stations when the total sediment weight rose to over 2,000 grams due to spring runoff. During this time emergence may have contributed to reduced numbers. Also during these times, no algae was observable in the traps, no interstices were apparent below the surface layer of the traps, and current speed was usually about 2.0 fps.

Second, after runoff, insect numbers remained lower in cumulative traps than in the monthly trap at each station. When the monthly trap was cleaned and replanted, the number of insects was much greater the next month. The undisturbed sample with over 2,000 grams of sediment also recovered slightly, but not as much as the monthly sample (e.g. Figs. 20, 21, 24, 25, 12, 13). As was typical of bottom samples gathered in these areas, (Garret, 1973) cumulative samples were dominated by Diptera. During late summer, algae were growing in most traps, particularly cumulative traps, which had no interstices below the surface gravel.

Third, current speeds of 1.9 fps. to 2.5 fps. were not always associated with higher insect numbers. When monthly traps in some stations were set in midstream so samples could be gathered in winter, then the high current speeds did not seem to limit populations (Figs. 4-5, 16-17). When current speeds remained relatively the same, then the high winter and spring population still occurred (Figs. 12-13, 24-25). Current speeds of less than .1 fps indicated, according to the methods of recording current speed, near stagnation and very little direct

connection with the stream. Accordingly low populations were expected and seen under these conditions.

Finally, there appeared to be a direct correlation between observable large amounts of organic detritus and algae and high numbers in an insect community. A greater diversity of species also appeared to be present. Conversely, active silt deposition was correlated with relatively low numbers and diversity. The percentage figures of organic matter (Tables 1-6) supported this theory. Furthermore, algae was observed to be present in greater amounts in the fall of 1973 than the fall of 1972 at all stations. These stations had higher numbers of insects in their monthly traps. At Milepost the trap was almost out of the water on September 1, and numbers were slightly lower (Fig. 12). Big Sky is the best example of this observation (Figs. 24, 25).

Diptera dominated the orders of aquatic insects present. During the clear, low-water period before runoff, however, Plecoptera and Ephemeroptera appeared in large numbers and occasionally surpassed Diptera in numbers. At stations Snowflake and Big Sky, which had relatively high percentages of organic matter, Trichoptera were much more evident than at the other stations, but this may have been a result of their higher productivity at these stations.

An attempt was made at the Big Sky station to determine if certain families were "invaders" of new gravel. Cumulative and monthly samples

were examined, classified, and compared, but no relationship was evident. It is doubtful one could find such a correlation even if a large statistically significant number of samples were taken, because Waters (1964) and Muller (1953) have reported that repopulation occurred in a matter of days. Samples in this study were collected monthly.

The idea of sampling an ecosystem in place in a "closed can community" using natural conditions has certain limitations. However, this type of experiment adds to the increasing amount of data indicating that living space is essential for any population. For aquatic insects, it provides further evidence that increasing sedimentation decreases populations while numerous rocky interstices in stream bottoms allow higher populations. Organic detritus is beneficial to many insect populations, and the visible presence of algae is also helpful. A current speed of around 1 fps. over the stream bottom is helpful but more data is needed to resolve current speed significance. This study indicates the sediment deposited by the current has a much greater effect on insect communities.

From observations in this study, sediment traps of this type might be used for several related studies. For instance, the sediment trap could be used as a sediment-pollution index indicator to find sedimentation rate changes before and after logging in a watershed.

The sediment traps proved such ideal habitat for sculpins that they might be used to study some aspect of this interesting little fish. It

appears that, if handled properly and the trap reset, the fish could be released back into the reset trap and individual fish might even be studied for a relatively long period of time. Present studies of the native sculpins are few compared to game fish.

SUMMARY

The data gathered by the means of sediment traps placed in a stream bottom indicates that space between rocks in the stream bed are of great benefit to aquatic insects. Current speeds between .2 and 2.0 fps. are of little consequence except as they contribute to the removal or deposition of sediment in the interstices, where current speeds are less. A high percent of dead organic matter or the visible presence of algae is related to higher insect populations but a direct numerical relationship to the insects could not be determined.

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M314 Aquatic insects in
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