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Species diversity of stream insects as a measure of ecological stress Post Creek Lake County Montana

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SPECIES DIVERSITY OF STREAM INSECTS AS A MEASURE OF ECOLOGICAL STRESS, POST CREEK, LAKE COUNTY, MONTANA

BY

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The investigation period, April through September 1973, marked the initial attempt to relate changes in standing crop, productivity, and species diversity of benthic insects as a measure of ecological stress on the aquatic community of Post Creek with respect to changes in the physical and chemical nature of the environment brought about by man's activities along its lower reaches in the Mission Valley.

The main tool employed in this study was the basic course mesh Surber square foot bottom sampler. Four bottom samples were taken from each site at approximately weekly intervals throughout the study period from which a composite sample was produced for each site on every sampling day. Standing crop and Shannon diversity indices were calculated from these composite samples.

The study demonstrated that the agricultural eutrophication and stream alteration of the lower Post Creek drainage produced readily detectable changes in the number and distribution of aquatic benthic insects and therefore in the consequent values in the Shannon diversity indices for the given sites. This established the Shannon index of diversity as an extremely valuable tool in the monitoring of the chemical and physical environmental stress placed on running water ecosystems by man and his activities. Duncan's multiple range test was used to test for significant difference between the mean Shannon diversity indices of each study site.

In conclusion, the standing crop and diversity of benthic insects at the four sites of Post Creek which were sampled during the six month study period can be related to changes in the annual water temperature cycle, insolation, physical environmental stability and bicarbonate alkalinity. These four factors undoubtedly work in combination to bring about the observed changes in biota.

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CHAPTER I

INTRODUCTION

Statement of the Problem

Man's activities in the past have drastically altered the biotic equilibrium of stream communities by changing the physical and chemical environment of the aquatic ecosystem. The results of adverse land use are many. However, very little concrete data are available that monitor the actual changes in the stream community as a result of man's activities along its course. The scientific community is confronted with a multitude of "after the fact" information with little or nothing to which it can be related. It is imperative, at least from a management point of view, that ecological studies be set up to monitor the "stress" placed on streams by man's activity along its drainage which results in subsequent changes in the physical, chemical, and biotic characteristics of the ecosystem. With the ever-increasing population and the associated need for increased food production, building material, and recreational facilities, the number of streams in pristine condition will undoubtedly continue to decrease at an alarming rate unless such an ecological monitoring system is initiated.

This study monitored the ecological stress on lower

Post Creek resulting from agricultural activity in the Mission Valley. Several of the major agricultural activities in the Post Creek area which substantially alter the stream's community structure include: 1) stream impoundment and the associated variable discharge and alteration of the natural annual temperature cycle; 2) stream relocation and water removal for irrigation; 3) agricultural wastes water runoff into the stream; and 4) the removal of vegetation along stream banks and bottom by the use of herbicides, algicides, burning, and dredging.

The investigation relates changes in the standing crop and diversity of benthic insects as a measure of ecological stress placed on the aquatic community of Post Creek by the above activities. To properly relate any changes in the aquatic environment, an indicator assemblage of organisms was selected that plays an integral role in the community. One of the major components of any running water community is the benthic aquatic insects. This dynamic group forms extremely complex interrelationships with the physical and chemical factors that shape the stream drainage. Benthic insects are particularly suitable as indicators of physical and chemical changes in the aquatic ecosystem because their very specific habitat preference and relatively low mobility causes them to be directly affected by any foreign substances entering the environment. Hynes (1963) stated that when pollution is fairly heavy, the effects on most invertebrates are so marked that whole taxonomic groups are affected, whereas actual specific differences only become important when pollution is rather mild such as seen in lower Post Creek. The Shannon diversity index was used to describe and quantify the extent of these readily detectable changes in the distribution of individual species of benthic insects. Data on biomass and productivity are also considered as an indicator of the degree of eutrophication of running water systems. More information on the biota of oligotrophic waters is urgently needed to provide reference points against which the rate of euthrophication can be assessed. Upper Post Creek, still in nearly pristine condition, provides such a reference point from which to compare these vital ecological parameters. Thus, a change in the community structure of a stream, be it species diversity, biomass, or productivity, reflects an altering of the physical and chemical environment of the stream and should indicate the source of the pollution and dictate further, more intensive water quality investigation if the stream is to remain in its natural condition.

The study covered a six-month period from April through September 1973 and provided a useable format for the analysis of ecological stress placed on a waterway by adverse land use by monitoring the subsequent changes in the benthic insect populations. Such a program would provide management with the data and methodology to assess the potential degredation of streams in the future as man's activities continue to increase along these waterways.

General Location and Description of the Post Creek Area

Post Creek is a fast, cold water stream which has its headwaters in First Lake located in the Mission Range northeast of St. Ignatius. It cuts its way through the glacial till between Mt. McDonald and Mt. Harding flowing into McDonald Lake. McDonald Lake was formed by a terminal moraine of a valley glacier but has since been impounded further by a small dam constructed in the 1920's. The dam was constructed for irrigative purposes and thus controls the discharge of water below this point. It is from this point to the site where Post Creek passes under Highway 93 which was the section subject to this study. The relative relief and longitudinal gradient of Post Creek from First Lake to McDonald Lake and from McDonald Lake to Highway 93 are 2714 ft, 678 ft/mi and 556 ft., 107 ft/mi respectively. The precise location of the study sites are marked on Figure 1.

The geologic history of the Mission Range begins with the Laramide Revolution (late Cretaceous through early Tertiary) when Precambrian, Paleozoic, and Mesozoic rocks were folded, faulted, and uplifted thousands of feet above sea level. Then during the Oligocene and part of the Miocene, the Tertiary Peneplain reduced western Montana to a low, rolling type of topography. Later uplift and erosion have subsequently modified the Peneplain with remnants being found only as ridge crests along the existing mountains (Johns, 1966).

The glacial deposits of the Mission Valley record

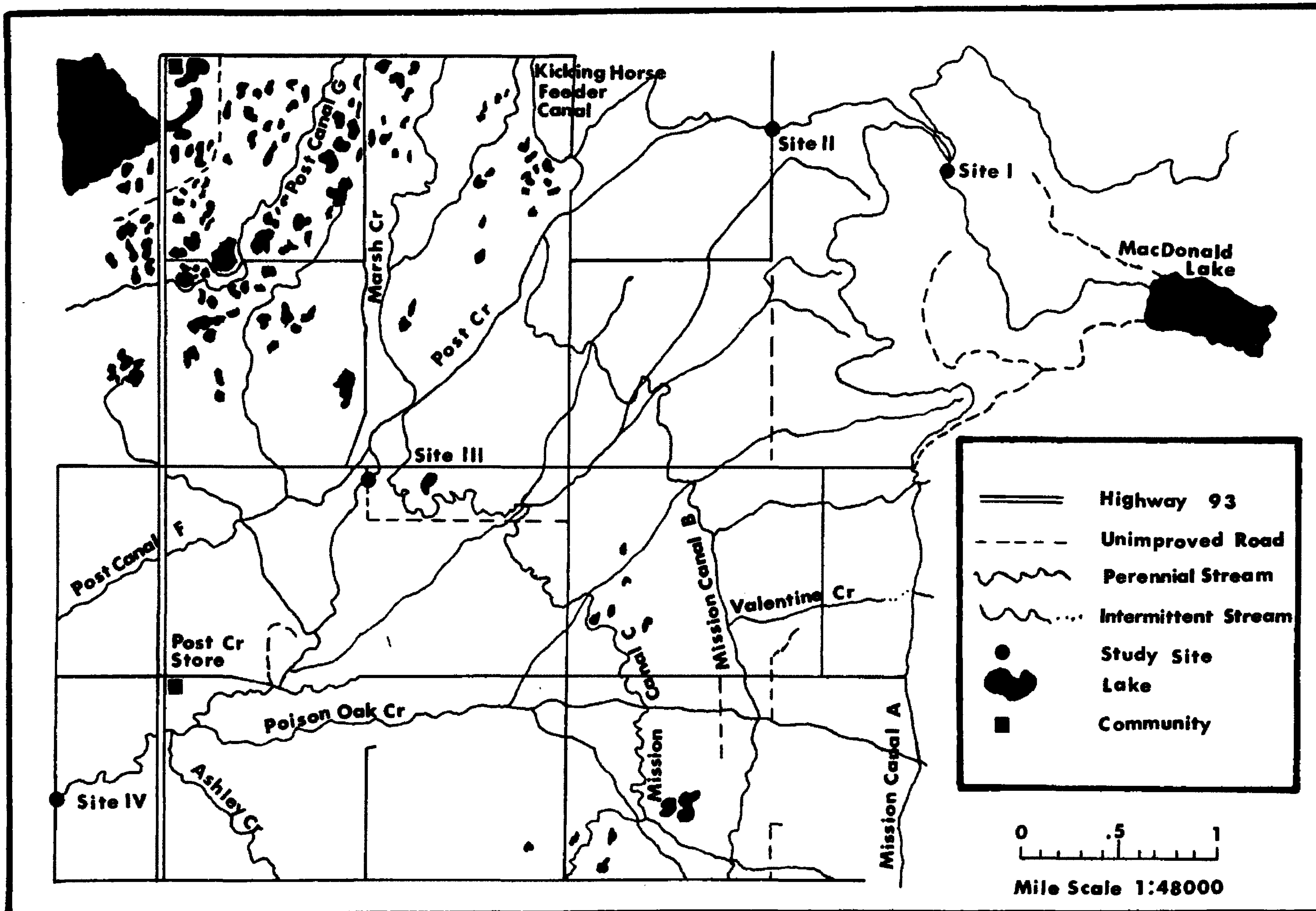


Fig. 1. Lower Post Creek Drainage

three Wisconsin advances of a large, intermontane lobe of the Cordilleran ice sheet. The clay-rich till portion of the southern valley represents the early Wisconsin substage, whereas the broad ridge of clay-rich till near the center of the valley represents the terminal moraine of the Mid-Wisconsin substage. Extensive lacustrine and fluvial deposits in the valley are also of Mid-Wisconsin age. At the southern end of Flathead Lake lies the terminal moraine of the late Wisconsin advance. It consists of poorly sorted sands and gravels and is bordered on the south by an extensive outwash plain. The terminal moraine of the late Wisconsin substage was formed subaerially but was later covered by the waters of glacial Lake Missoula in the very late Wisconsin epoch. Glaciation of the Mission Valley by ice flowing southward from a Canadian ice sheet was accompanied by local mountain glaciation with maximum glacial activity being simultaneous in the valley and mountains (Nobles, 1952).

The Mission Range separates the Mission Valley and Flathead Lake from the Swan Valley and is a distinctive north-south group extending north to Big Fork, disappearing under the gravels and silts of the Flathead Valley. The range has been ~~been~~ described as a tilted and moderately dissected block bounded by faults beneath the surficial materials of the Flathead and Swan Valleys. The topographic expression of the range to the north is a low, flat-topped divide of moderate relief bounded by gentle slopes (Davis, 1915). Just east of Yellow Bay, the crest rises abruptly to 6000 ft, and from Polson south continues to rise to an elevation of 9800 ft at Mt. McDonald. The western slope is very steep as opposed to a more broad and gradual eastern slope. The streams of the area are of the consequent type, their pattern being solely determined by the relief and direction of the slope (Davis, 1915).

The mean annual temperature of the Mission Valley at altitudes of approximately 2800 ft is 45° fahrenheit and 2 to 3° lower at slightly higher elevations. The annual precipitation in the valley averages approximately 14.5 in, whereas precipitation at higher elevations ranges from 23 to 30 in. The accumulative snowfall within the range usually amounts to more than 12 ft during the winter months (Johns, 1966).

Rocks of the Mission Range vary in age from Precambrian (Beltian Series) to Quaternary deposits. Sedimentary rocks of Ordovician, Silurian, Pennsylvanian, Triassic, and Jurassic are missing either by erosion, non-deposition, or faulting. The more ancient sedimentary rocks can be seen as argillites, dolomites, quartzites, and several types of sandstones and shales. The more modern Cenozoic sediments are consolidated and unconsolidated rocks of clastic deposits, ground moraine, lacustrian silt, and recent alluvial sand, gravel, and silt deposited on flood plains adjacent to streams and rivers. A few sills and other irregular intrusions are composed of diorite and gabbroid igneous rocks believed to be of Precambrian age (Johns, 1966).

CHAPTER II

DESCRIPTION OF STUDY SITES

Site I

Site I is located just above the A-Canal diversion approximately two miles below McDonald Lake. The velocity and discharge of this section of stream are controlled at the lake outlet, which makes this section subject to rapid and extreme fluctuations in current velocity, discharge, and depth in relation to irrigative demand in the valley. Under "normal" irrigative demand, the average stream depth is 64 cm, with a width of 12.8 m. The mean substrate size is 20 x 25 cm. This portion of stream is characterized by a relatively steep gradient of 155 ft/mi with large pools and eddies caused for the most part by large rocks up to 2.5 m in diameter. The physical and chemical characteristics at the time of sampling are discussed in Chapter IV.

The dominant vegetation of this area is largely a larch, cedar, Ponderosa pine, Douglas fir, and poplar forest. The algal flora is sparse but quite varied (see Appendix A, Table 4 for complete listing). The dominant aquatic plants of this section of Post Creek are the mosses *Fontinalis sp*. and *Drepanocladus sp*. There are several peat-type bogs located intermittently along the stream channel. There is little or no cultivated land in the immediate vicinity with the only agricultural activity being a few grazing cattle.

According to the latest Montana Fish and Game Department electro-shocking project No. F-7-R-19 (Domrose, 1970) and some personal observations, the major fish species of this section of Post Creek from most to least abundant respectively are mountain whitefish (*Prosopium williamsoni*), rainbow trout (*Salmo gairdneri*), large scale sucker (*Catostomus macrocheilus*), longnose sucker (*Catostomus catostomus*), and eastern brook trout (*Salvelinus fontinalis*). The rainbow trout range in size from 3 to 8 in., eastern brook trout from 3 to 5 in., and the mountain whitefish from 4 to 11 in.

Site II

Site II is located about one mile below the A-Canal diversion. The velocity and discharge of this section of Post Creek are controlled by the amount of water diverted down the A-Canal. Thus, the stream at this locality is also subject to some variation in discharge and velocity in relation to agricultural demand. These fluctuations are much less extreme at this site as opposed to above the A-Canal diversion, giving this section of Post Creek a rather homogeneous appearance throughout much of the summer and autumn. The large pools and eddies characteristic of Site I are absent for the most part while the longitudinal gradient appears to be nearly equal to that of Site I, (163 ft/mile). The physical and chemical characteristics of this site at the time of sampling are discussed in Chapter IV.

Site II lies in the same basic type of forest habitat as Site I but with much more understory in the form of willow, wild rose, mountain maple, chokecherry, dogwood, and false hellebore. Again, the dominant aquatic plants are the mosses Fontinalis sp. and Drepanocladus sp. The algal flora (see Appendix A, Table 5 for complete listing) is still basically the same as observed at Site I but has substantially increased in overall density. The major fish species of this section of Post Creek are the same as at Site I, although their individual abundance and size is slightly increased.

Here, as at Site I, there is little or no cultivated land in the near vicinity of the stream channel, with the only agricultural activity being a few grazing cattle and minor logging operations. Under "normal" agricultural demand, the mean depth is 25 cm and the mean width is 9.7 m. The mean substrate size is approximately 20 x 25 cm.

Site II, although regulated somewhat by man's activities, retains most of its natural characteristics (especially its relative stability) and produces a reasonably close approximation of the stream in its pristine unspoiled condition. This rather subjective conclusion was derived from the comparison of this section of Post Creek to a section of stream above McDonald Lake, which is still in its unspoiled state. Chemical, physical, and biological data from the two sites where compared during the first week of June, July, and August. It was established that Site II was characteristic of a stream in its oligotrophic state and would be suitable as a reference point from which to relate the effects of man's activities along the stream. The site above McDonald Lake could not be used in this study because its relative inaccessibility makes the logistics involved in sampling too great to facilitate weekly collecting.

Site III

Site III is located approximately three miles below Site II. Stream velocity and discharge are approximately one-eighth that of Site II. There is a marked increase in turbidity and temperature as a result of extensive agricultural use. The substrate of this section of Post Creek is covered by a layer of mucilaginous periphyton from 1/4 to 1/2 in in thickness. It consists primarily of diatoms, fungus and detritus. The longitudinal gradient of the area is extremely low, 104 ft/mi. This coupled with the removal of approximately 90% of the initial water supply are the main factors in the drastic decrease in stream velocity. The flow in this section of Post Creek and below remains relatively constant throughout the year. The chemical and physical characteristics are given in Chapter IV. Under "normal" conditions, the mean depth is 15 cm and the mean width is 3.5 m. The mean substrate size is 15 x 20 cm.

Site III is located in a small poplar grove which is bordered on one side by grassland and pasture. Within the grove are a few scattered elms, mountain maples, cattails, willows, dogwood, and wild rose. Cattle use this area quite heavily. The understory is not as thick as that of Site II, probably because of the browsing and grazing of the cattle. But there is a great increase in the number of perennials and annuals along the stream bank. Elodea sp. and Lemna minor are the dominant forms of higher aquatic plants. The number of algal species or richness throughout the section of Post Creek studied remained about the same (Appendix A, Table 6), but there was a great increase in the density of resident species as the insolation increased and the water warmed up, became less turbulent, and more eutrophic all in direct relation to agricultural use. This phenomenon can be readily observed by the greatly increased size and number of aufwucks at Sites III and IV.

The only apparent species of fish in this section of Post Creek are small suckers (largescale and longnosed) and several small cyprinids.

Site IV

Site IV is located about 2 mi below the point at which Post Creek passes under Highway 93. The stream exhibits canal-type parameters of steep sides and a flat, regular bottom. This section has received a substantial amount of runoff from the surrounding farms, thus greatly increasing the average stream depth, discharge and turbidity while maintaining a velocity nearly equal to that of Site III because of the low gradient 30 ft/mi. Heavy silt deposits were noted in backwater areas and along stream banks. These characteristics give the stream a rather homogeneous appearance, with only a few scattered riffles of relatively low turbulence. The physical and chemical characteristics at the time of sampling are discussed in Chapter IV. The mean depth of this section of Post Creek is 50 cm in the riffles and 88 cm in the more lamellar water. The mean width is 11 m and the mean substrate size is 15 x 20 cm. The flow in this section remains relatively constant with no extreme fluctuations in discharge or velocity the year round.

The surrounding vegetation of the area consists mainly of grasses, sedges, perennials and annuals such as mustards, thistles, Rumex sp., cattails, nightshade, chickweed, forget-me-not, and Equisetum spp. There are also scattered bunches of poplar trees, willows, buckbrush, wild rose, dogwood, and an occasional Ponderosa pine. The higher aquatic plants of this section of Post Creek consist of Potamogetan sp. pectinatous, Zennochelia sp., Nasturtium sp., (water cress), Elodea sp., Lemna minor, and the moss Drepanocladus sp. algal flora is much the same as at Site III (Appendix A, Table 7).

According to the latest Montana Fish and Game Department electro-shocking project No. F-7-R-19 (Domrose, 1970), and some personal observations, the major fish species of this section of Post Creek from most to least abundant respectively are mountain whitefish, rainbow trout, largescale suckers, longnose suckers, and eastern brook trout. The rainbow trout range in size from 3 to 10; eastern brook trout from 3 to 5 in, and the mountain whitefish from 4 to 13 in.

CHAPTER III

METHODS AND MATERIALS

The main tool employed in this investigation was the basic, coarse-mesh Surber square foot bottom sampler. The Surber incorporates a Nitex net with a mesh size of 9 threads per centimeter. This size net was selected in favor of a finer net because it retains a sufficient percentage of the biomas of a sample, yet allows the fine silt and organic detritus to be washed away, thus avoiding clogging of the pores which could produce washout currents and greatly lower the efficiency of the sampler. It also reduces abrasive action on the captured organisms by allowing for a free current through the net. Because of irregularities in the substrate size in Post Creek, an attempt in standardizing rather than randomizing the sampling was pursued by taking all samples at each respective site from riffles as nearly identical in substrate size, water velocity and depth as possible. A riffle is a series of integrating communities. Any one square foot sample probably selects from several communities; another sample may select from different communities. Or if sampling is from the same communities, the individuals of the commumity may be present in different proportion. To overcome these biases, four bottom samples were taken at each site riffle on each of the weekly sampling days, and the results averaged to produce one composite sample from which percentage composition and diversity indices were calculated. The samples were placed in 70% alcohol and returned to the laboratory for sorting, counting, and identifying. Species identification was accomplished with the aid of a Bausch and Lombe variable power (7 to 30) dissecting microscope. Biomass was determined volumetrically in cubic centimeters of alcohol following the procedure outlined in Welch (1948).

The advantages and limitations of the Surber bottom sampler are well documented. Leonard (1939) took numerous bottom samples from a uniform bottom type and concluded that one sample may yield a reasonably accurate index of the amount of bottom fauna per unit area of uniform bottom type. However, it does not provide a reliable indication of the relative numbers of individual species from an area larger than that from which the sample was collected. Needham and Usinger (1956) calculated that 194 square foot bottom samples would be required to give statistically significant data on total weights or organisms, and that 73 samples would be necessary to give statistically significant data on total numbers. Maitland (1966) showed that up to 70% of the numbers and 50% of the biomass can be lost from nets having fewer than 16 meshes per centimeter. He points out that with a net of 16 meshes per centimeter up to 50% of the total number, mainly small dipteran larvae, may be lost, but 99% by weight of the fauna is retained. The Surber sampler, like most common bottom samplers, only samples the upper part of the zone occupied by the benthos, missing many of the organisms of the deeper layers of the substratum or hyporheal zone. Hynes and Coleman (1969) indicate that in some instances at least 80% of the benthos occurs below 10 cm. in depth, and may penetrate to a depth of up to 30 cm. Gaufin, Harris, and Walters (1956) indicated from their qualitative data that an average set of 5 Super samples yielded over 80% of the observed resident species. Needham and Usinger (1956) found that 2 or 3 samples are sufficient to insure (at a 95% confidence level) that at least one representative of each of the most common species in the bottom fauna is present. In conclusion, it appears that the Surber sampler may not be as reliable as previously accepted, but is probably sufficient for gross analysis of standing crop and fairly precise qualitative work. It can be stated without a doubt that the quantitative data obtained from Surber sampling are underestimations. But the Surber sampler was employed because of the lack of a stream sampler that yields statistically improved data. The Surber does have the advantage of being the sampler most extensively used in the existing literature, allowing for relative comparisons between similar studies in different areas.

Physical and chemical parameters were recorded from each site prior to bottom sampling. The following chemical tests were taken using the Hach Direct Reading Engineers Laboratory, Model DR-EL, and the Bausch and Lombe Spectronic 20: dissolved oxygen, free carbon dioxide, total alkalinity, pH, total hardness, phosphate, nitrate and nitrite and turbidity.

Water temperature was taken with a hand-held, partial immersion thermometer (-20 to 110° c, ± 1°). Ten depth measurements were taken with a metal meter stick at each sampling site and averaged to determine the mean depth. The width was measured with a nylon rope calibrated in meters. Velocity and discharge were measured by the use of a float and stop watch.

CHAPTER IV

RESULTS

Physical and Chemical Characteristics

Site I

Stream Discharge and Current Velocity

Site I of Post Creek reached near maximum discharge and velocity of 300 csf and 3.5 ft/sec respectively during the height of the spring runoff. Increased agricultural demands again brought an increased discharge and velocity of 350 csf and 3.5 ft/sec respectively by late June and early July, and remained near 300 csf until late August. Reduced irrigative demand produced a low of 130 csf and 2.7 ft/sec in September. The lack of precipitation in the Post Creek drainage during the summer undoubtedly was responsible for this unusually low discharge in September (Fig. 6 and 7).

Temperature

Water temperature at this site ranged from a low of 4.5° C in April to a high of 16° in mid-August (Fig. 8). No attempt was made to measure the diurnal variation in water temperature at each station.

Turbidity

Maximum turbidity occurred during the height of the spring runoff in early June, reading only an 8 on the Jackson scale but normally averaged around 5 for most of the study period.

Chemical Characteristics

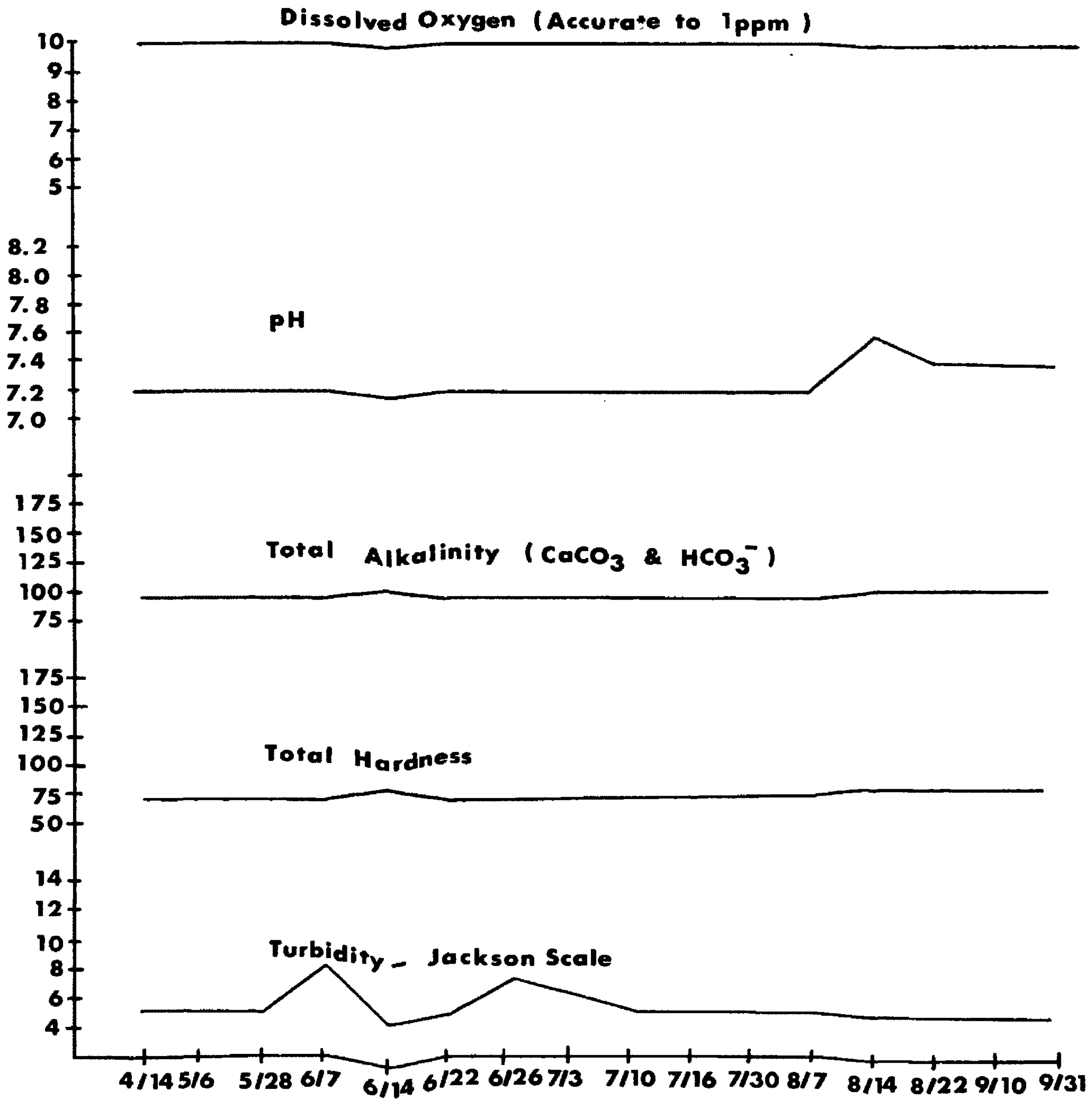
Dissolved oxygen remained at a constant 10 ppm throughout the entire study period, probably as a result of the extreme turbulence and lack of any substantial BOD at this oligotrophic site. (Note: the Hach drop method for dissolved oxygen utilized is only accurate to 1 ppm). Both total alkalinity and hardness were generally low, averaging around 70 ppm throughout most of the study period, but jumping to 80 to 85 ppm during the height of the spring runoff and again in late August and September. Free carbon dioxide maintained a low but constant value of less than 5 ppm throughout the entire study period. pH also remained constant at 7.2 until the water level dropped following reduced agricultural demands in mid-August, at which time it jumped to a maximum of 7.6. Nitrates, nitrites, and phosphates were absent from Site I. The chemical and physical tests are not highly sophisticated, and the data should be interpreted as indicative of the water at the time of sampling, and not as absolute values (Fig. 2).

Site II

Stream Discharge and Velocity

Site II of Post Creek reached near-maximum discharge and velocity of 135 csf and 2.4 ft/sec respectively at the height of the spring runoff in early June. Increased

Fig. 2. Chemical Analysis of Site I at Time of Sampling



agricultural demand again brought an increase in both discharge and velocity to a maximum of 140 csf and 2.5 ft/sec by late June and early July. A low of 48 csf and 2 ft/sec was recorded in September, again as a function of reduced agricultural demand and the lack of precipitation in the Post Creek drainage (Fig. 6 and 7).

Temperature

Water temperature at this site ranged from a low of 5°C in April to a high of 17°C by mid-summer.

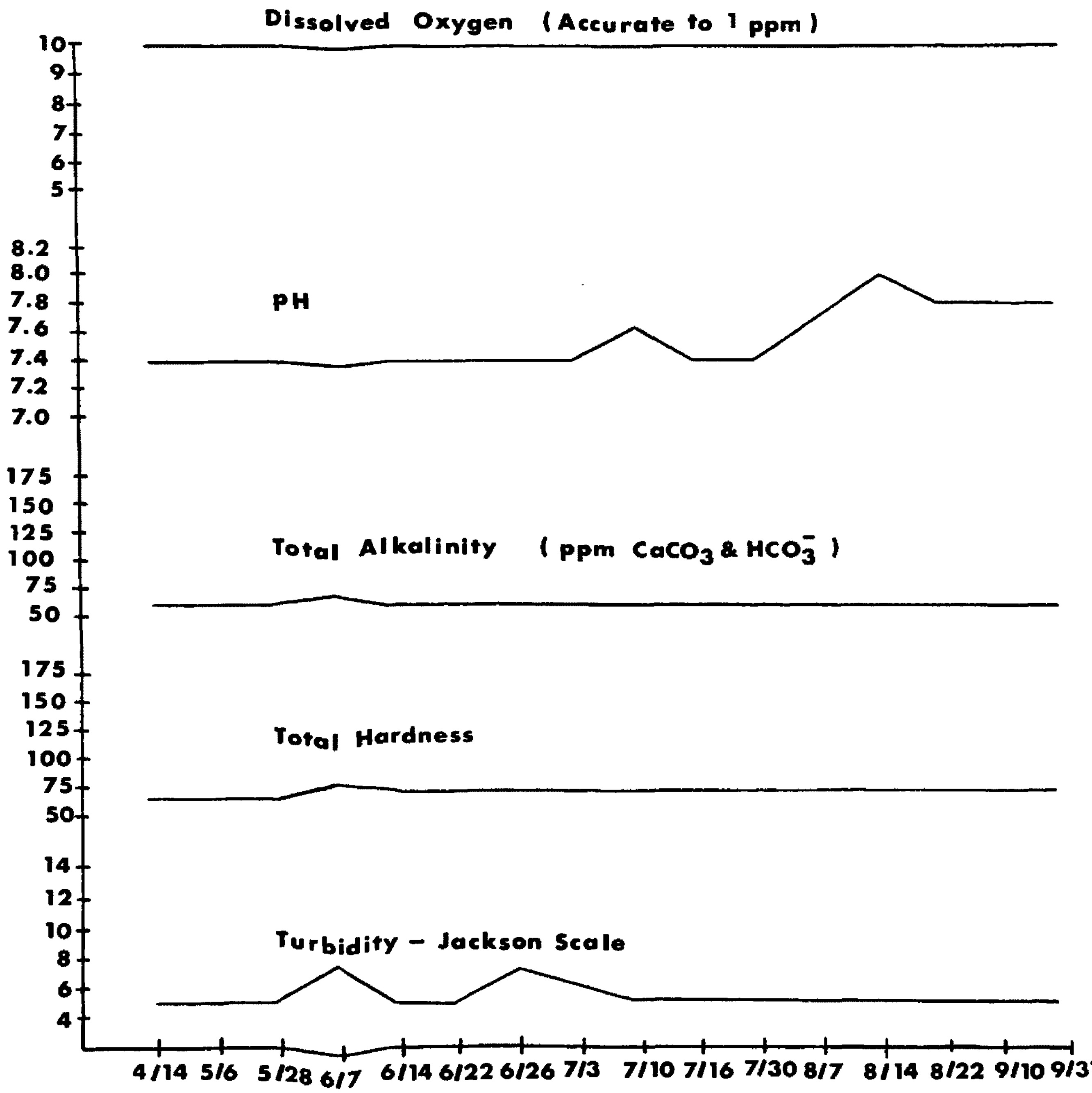
Turbidity

Maximum turbidity occurred during the height of the spring runoff in early June, reading only 8 JTU. The average was around 5 JTU throughout most of the study period.

Chemical Characteristics

Dissolved oxygen, as at Site I, remained at a constant 10 ppm throughout the entire study period, again as a result of high turbulence and low BOD in the area. Both total alkalinity and hardness were still low and averaged approximately 60 and 70 ppm respectively throughout the entire study period. Free carbon dioxide remained constantly less than 5 ppm throughout the study period. The lowest pH was 7.4 in the early spring and summer, gradually increasing to a maximum of 7.8 to 8.0 in late August and September as the water dropped with reduction of agricultural demand in the valley. Nitrates, nitrites, and phosphates were absent from Site II (Fig. 3).

Fig. 3. Chemical Analysis of Site II at Time of Sampling



Site III

Stream Discharge and Velocity

At Site III, Post Creek reached maximum discharge of 10 csf during the height of the spring runoff in early June, whereas the maximum velocity of 1.6 ft/sec did not occur until late June and early July at which time the discharge was 8.4 csf. The discharge dropped to a low 4 csf and .9 ft/sec in late August, again as a function of reduced agricultural demand and low summer precipitation in the Post Creek drainage (Fig. 6 and 7).

Temperature

Water temperature at this site ranged from a low of 11°C in April and May to a high of 18°C in mid-July. The temperature dropped rapidly in late August to 12°C with the reduction of the warmed agricultural runoff, also resulting in reduced flow, velocity, and turbidity. This section of Post Creek has several small springs along the channel aiding substantially to the cooling effect during reduced flow (Fig. 8).

Turbidity

A maximum turbidity of 14 JTU occurred during the height of the spring runoff in early June, and again in late June and early July as irrigative activity was reaching a maximum. As the agricultural activity substantially slowed in mid-August, runoff was reduced and the turbidity dropped to a relatively clear 6 JTU.

Chemical Characteristics

Dissolved oxygen remained at a constant 8 ppm through the spring and summer until mid-August, when it jumped to 9 ppm, possibly as a function of reduced BOD with the reduction in agricultural runoff and its corresponding decrease in water temperature. Both total alkalinity and hardness were greatly increased over Sites I and II, averaging 140 and 150 ppm respectively throughout the entire study period. Free carbon dioxide was again constant at less than 5 ppm. There was a gradual increase in pH from a low of 7.8 in the early spring and summer to a high of 8.2 in late summer and autumn. A trace of phosphate showed up whereas nitrates and nitrites ranged from .2 ppm in the spring and early summer to .5 ppm at the height of mid-summer irrigation (Fig 4).

Site IV

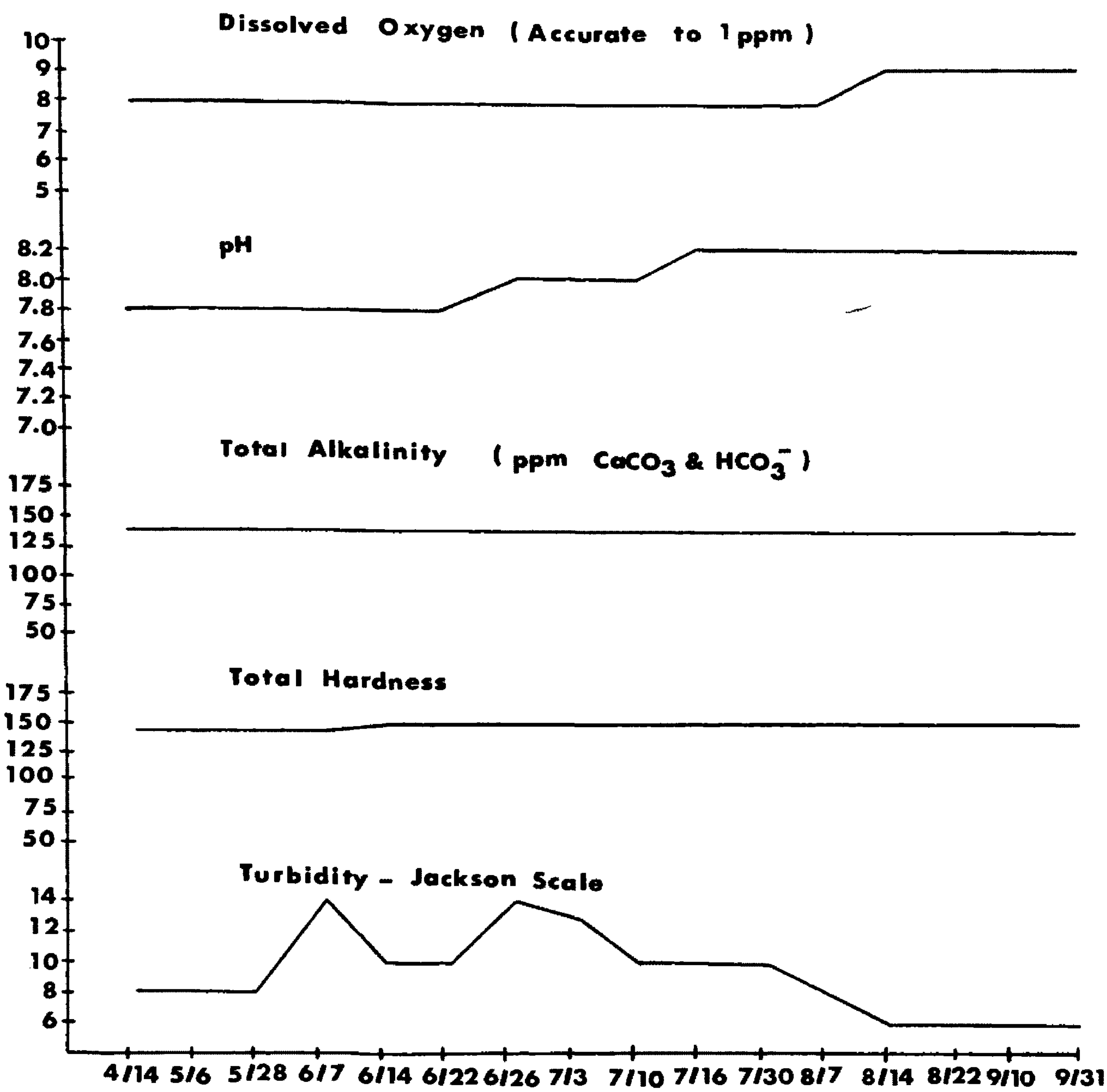
Stream Discharge and Velocity

Site IV of Post Creek reached a maximum discharge and velocity of 140 csf and 2.2 ft/sec respectively at the height of the spring runoff in early June. An average of 120 csf and 2 ft/sec was maintained throughout the summer, dropping to a low of 95 csf and 1.8 ft/sec in September as a result of reduced agricultural activity and lack of precipitation in the area (Fig. 6 and 7).

Temperature

Water temperature ranged from 12° C in April and

Fig. 4. Chemical Analysis of Site III at Time of Sampling



May to a maximum of 18° C during the height of the irrigative activity from late June through July, and dropped rapidly to a low of 10° C in September as a result of reduced runoff which allowed surrounding springs to substantially cool the water (Fig. 8).

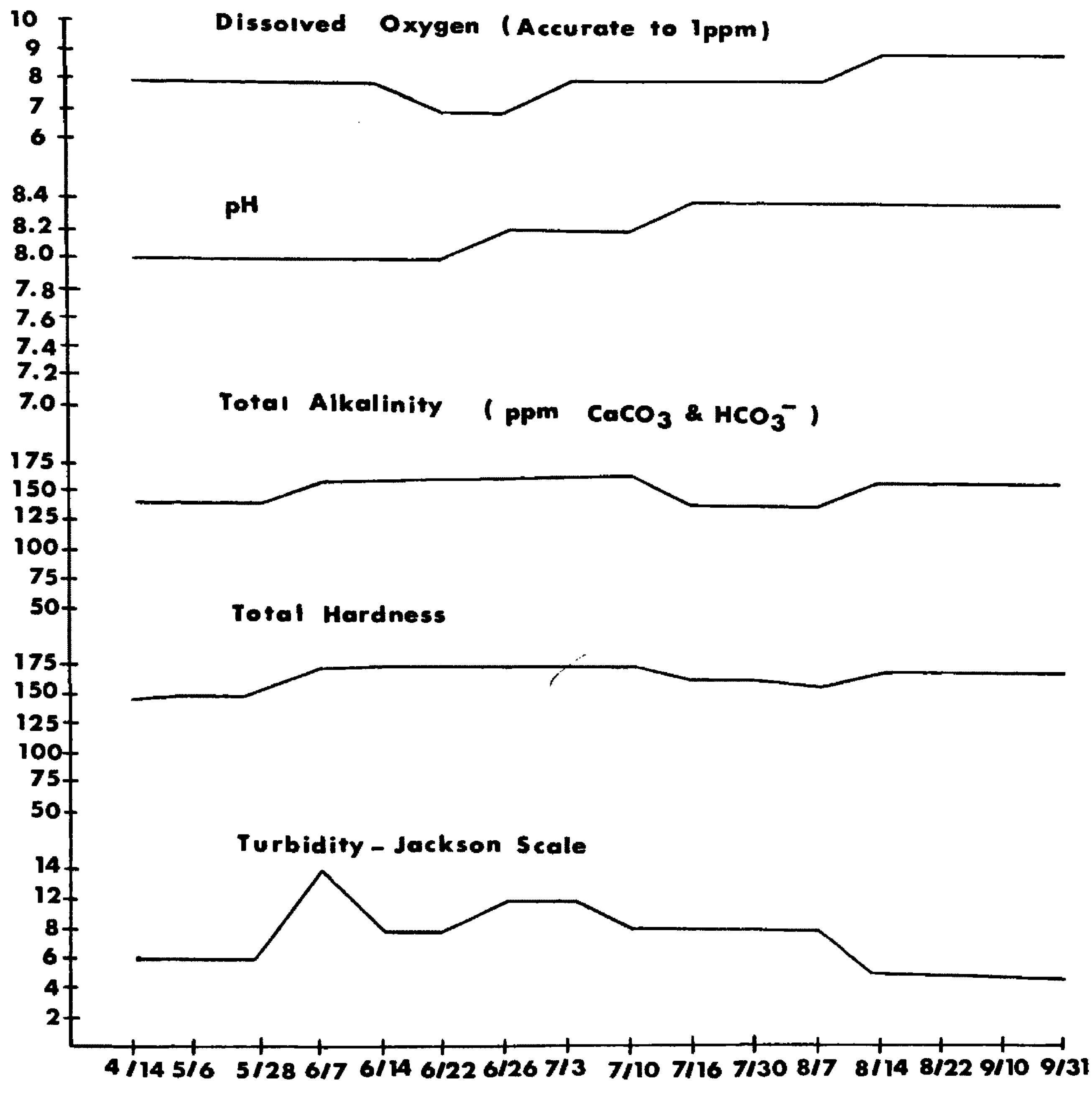
Turbidity

Maximum turbidity again occurred at the height of the spring runoff in early June, reading 14 JTU. Turbidity averaged between 10 and 12 during the mid-summer irrigative period. Following the termination of the irrigative season, the turbidity dropped to 7 in late August and September.

Chemical Characteristics

Dissolved oxygen averaged 8 ppm throughout most of the study period and reached a low of 7 ppm in late June and a maximum of 9 ppm in late August and September, possibly as a result of reduced BOD with the reduction of agricultural runoff and its corresponding decrease in water temperature. Both total alkalinity and hardness again increased over Site III ranging from 140 to 165 ppm and 145 to 174 ppm respectively. Free carbon dioxide was constant at less than 5 ppm. Gradually pH increased from a minimum of 8.0 in the early spring and summer to a maximum of 8.4 in the late summer and autumn. As at Site III, a trace of phosphate was indicated and the total nitrogen (nitrates and nitrites) ranged from .3 to .5 ppm (Fig. 5).

Fig. 5. Chemical Analysis of Site IV at Time of Sampling



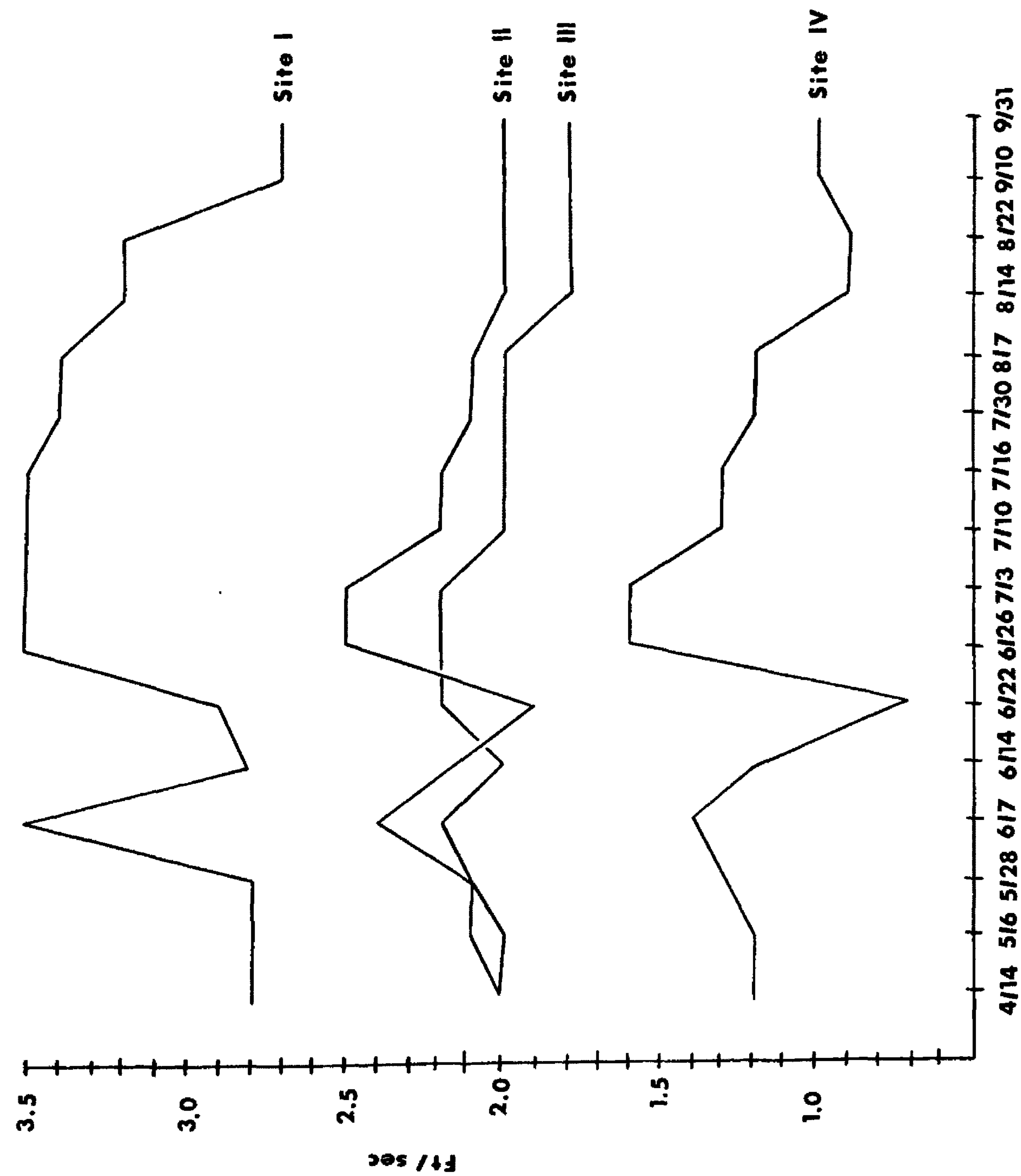


Fig. 6. Stream Velocity at Time of Sampling

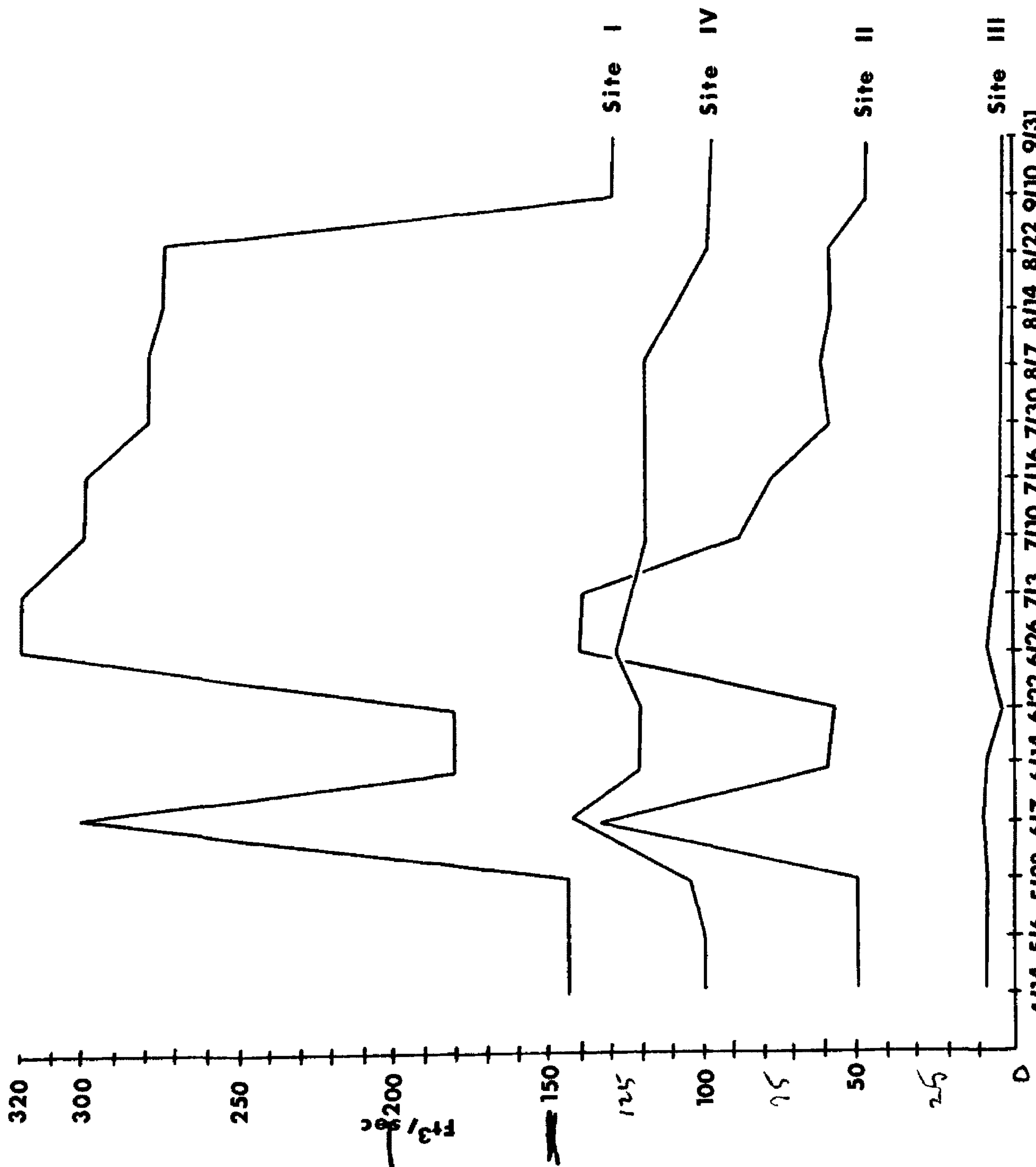
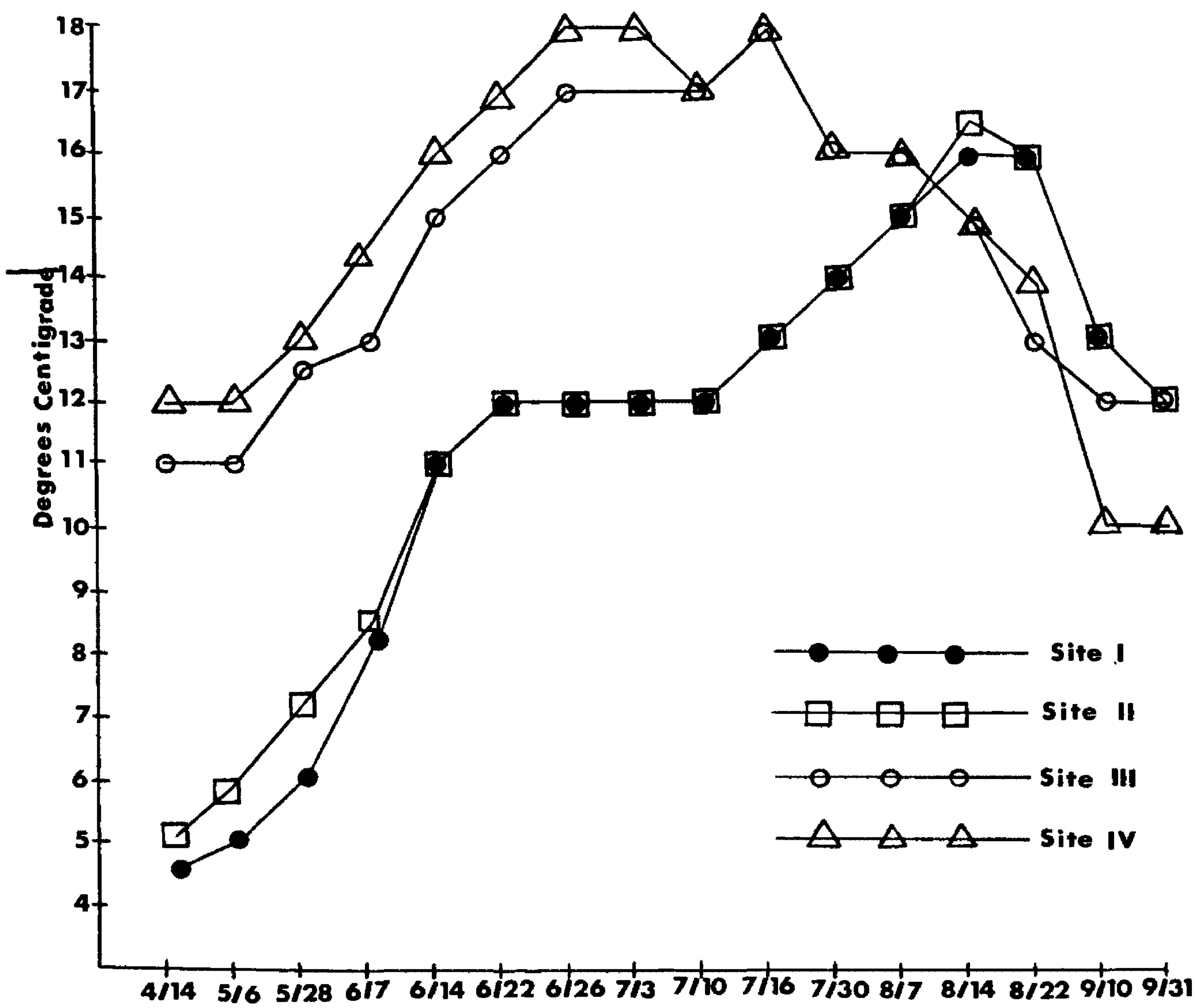


Fig. 7. Stream Discharge at Time of Sampling

Fig. 8. Water Temperature at Time of Sampling



Community Composition

During the study period, April 1973 through September 1973, 22 species of Ephemeroptera, 14 species of Plecoptera, 15 species of Trichoptera, 4 species of Coleoptera, 10 species of Diptera, and 1 species each of Odonata, Lepidoptera, and Megaloptera were collected from the four sampling sites on Post Creek. No attempt was made to correlate positive nymph-adult associations. Table 1 is a species list of aquatic insects which represents the total number of each species collected by the Surber sampler during the six month study period.

On a seasonal basis, direct comparison of absolute numbers cannot be made because there may be differences as a result of sampling inefficiency. For example, the small number of animals which was collected during the spring runoff and increased discharge as a result of agricultural demand may have been a function of lower population densities at this time, but the physical factors and mechanical difficulties encountered during sampling were undoubtedly important as well. Conversely, the high number of animals collected when discharge and velocity were low was in part a function of sampling bias. The Surber sampler is more efficient under these circumstances. Also, when the discharge is very low, it effectively concentrates the stream organisms into a more narrow channel. To eliminate these biases caused by sampling inefficiency, absolute numbers of each order were converted to a percentage of

TABLE - 7

Species List of the Aquatic Insects of Post Creek

		Total No. Collected			
	Site	I	II	III	IV
Order Ephemeroptera					
Family Heptageniidae:	Rithrogena hageni	728	632	132	328
	Cinygmula sp.	764	480	120	64
	Cinygma integrum	0	0	420	272
	Epeorus deceptivus	532	412	76	0
	Epeorus albertae	128	120	576	424
	Epeorus longimanus	248	60	0	0
Family Ephemerellidae:	Ephemerella doddsi	136	352	0	0
	Ephemerella hystrix	32	24	0	0
	Ephemerella inermis	44	68	160	344
	Ephemerella infrequens	0	49	68	460
	Ephemerella flavilinae	133	264	16	36
	Ephemerella margarita	0	0	48	269
	Ephemerella tibialis	0	16	0	0
	Ephemerella hecuba	0	0	8	4
	Ephemerella micheneri	46	28	0	28
Family Baetidae:	Baetis parvus	224	92	912	48
	Baetis tricaudatus	488	960	1112	1568
	Baetis bicaudatus	128	344	72	84
Family Siphlonuridae:	Ameletus oregonensis	0	57	44	23
	Ameletus cooki	33	39	0	0
Family Leptophlebiidae:	Paraleptophlebia debelis	376	236	158	489
Family Tricorythodidae:	Tricorythodes minuta	0	0	780	164
Order Plecoptera					
Family Perlodidae:	Arcynopteryx cpc.*	52	56	0	52
	Diura knowltoni	49	140	124	0
	Isoperla fulva	0	0	96	20
	Isoperla mormona	0	0	20	112
	Isogenus aestivalis	0	0	28	80
Family Perlidae:	Acroneuria pacifica	27	64	96	144
	Classenia sabulosa	24	188	209	241

*Compacta, Curvata, Parallela group

TABLE 1 - Continued

		Total No. Collected			
	Site	I	II	III	IV
Family Chloroperlidae:	Paraperla frontalis	35	39	34	0
	Alloperla sp.	144	228	108	32
	Hastaperla sp.	3	0	0	0
Family Pteronarcidae:	Pteronarcys californica	0	37	0	0
Family Nemouridae:	Nemoura oregonensis	0	56	344	28
	Nemoura californica	4	44	204	72
	Capnia sp.	0	3	13	8
Order Trichoptera					
Family Rhyacophilidae:	Rhyacophila acropedes	101	326	628	643
	Glossoma sp.	180	461	1176	2160
	Agapetus sp.	56	0	356	208
Family Hydropsychidae:	Hydropsyche 2sp.	77	247	1332	6788
	Arctopsyche grandis	0	32	0	0
	Parapsyche elsis	0	76	0	0
	Parapsyche almota	0	35	0	0
Family Brachycentridae:	Brachycentrus sp.	0	0	422	1244
Family Limnephilidae:	Limnephilus sp.	0	12	281	107
Family Leptoceridae:	Leptocella sp.	23	11	16	22
	Oecetis cinerascens	0	7	0	0
Family Psychomyiidae:	Polycentrops sp.	33	63	12	4
Family Philopotamidae:	Wormaldia sp.	0	0	0	12
Family Helicopsychidae:	Helicopsyche borealis	0	0	44	33
Order Coleoptera					
Family Elmidae:	Cleptelmis sp.	920	1008	2156	2536
	Lara sp.	124	16	33	0
	Narpus sp.	47	26	28	0
Family Halipidae:	Haliplus sp.	21	76	28	24
Order Megaloptera					
Family Sialidae:	Sialis sp.	0	0	8	0
Order Diptera					
Family Tipulidae:	Hexatoma sp.	68	37	9	36
	Tipula sp.	0	0	0	24
	Antocha sp.	0	96	260	812

TABLE 1 - Continued

		Total No. Collected			
	Site	I	II	III	IV
Family Chironomidae:	Chironomus sp.	527	492	1188	1284
	Calypsectra sp.	0	28	496	428
Family Simulidae:	Simulium sp.	66	31	276	840
Family Culicidae:	Culicus sp.	0	0	132	147
Family Rhagionidae:	Atherix vareigata	13	19	24	12
Family Tabanidae:	Chrysops sp.	0	0	6	0
Family Blephlaceridae:	Blephlacera sp.	0	0	0	4
Order Lepidoptera Family Pyralidae:	Parargyractes sp.	0	0	0	13
Order Odonata Family Gomphidae:	Ophiogomphis montanus	0	0	22	0

the total bottom fauna. These data are shown in Figures 10, 13, 16, and 19 and were calculated from the last sample taken in each month of the study period. Because of interspecific influences, variations in percentage composition can be misinterpreted. For example, variation could have been caused by an absolute increase in the number of individuals in one species or by an absolute decrease in the number of another species. To overcome this problem, percentage composition of individual species was also calculated and presented in Figures 11, 14, 17, and 20.

It is intuitively obvious that numbers and volumes of benthos are directly related. But it must be pointed out that the total volume of a population does not necessarily follow the trend in numbers. For example, when the numbers of a given species are at a minimum, the individual volumes they displace are at a maximum and vice-versa. Thus, the fluctuations in total volume of a population tends to be smaller in amplitude than the fluctuations in total number (Maitland, 1964).

Site I

Monthly Trends in Percentage Composition by Order

During the sampling period, Site I of Post Creek had an average of 104 benthic insects per square foot and a corresponding average biomass of .58 cc's per square foot (Fig. 9). For the actual data, see Appendices C and D.

Ephemeroptera were by far the dominant group in this section of Post Creek. For most of the study period,

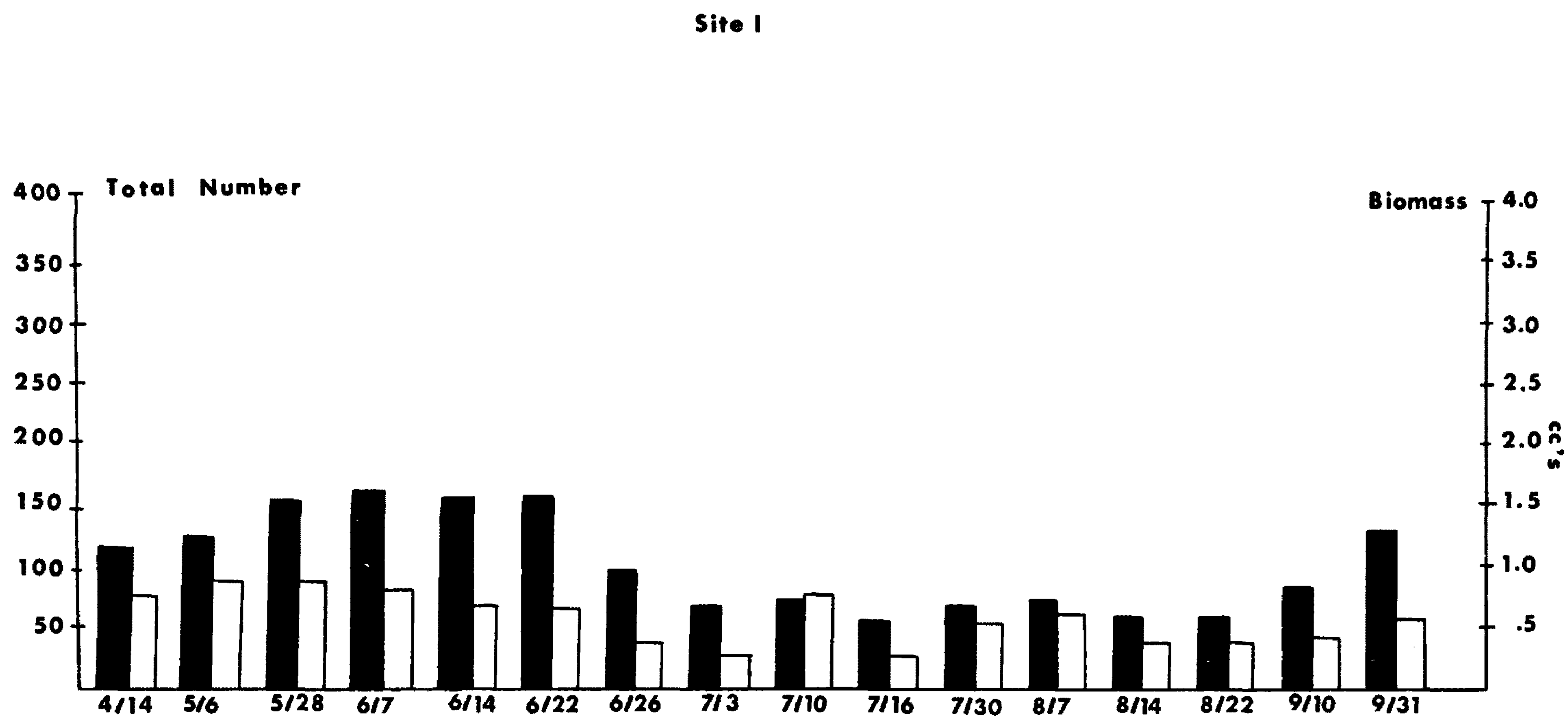
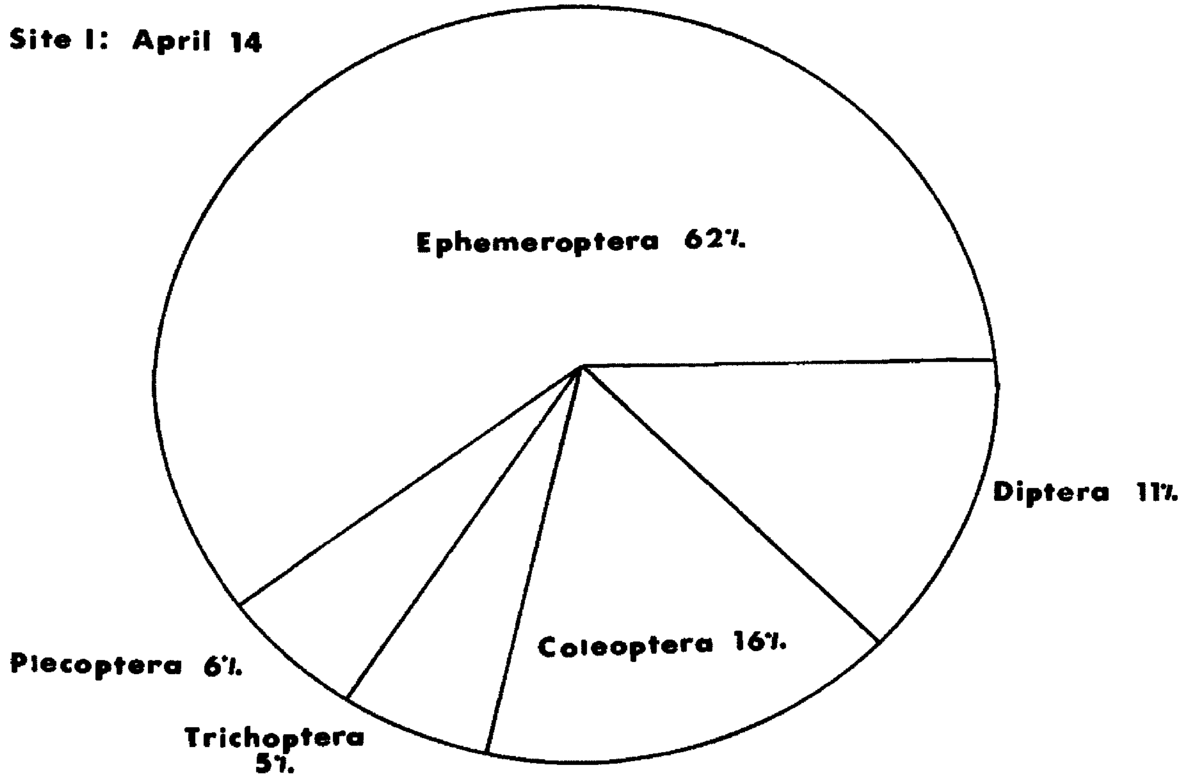


Fig. 9. Comparison of the Total Number of Benthic Insects Collected to Their Biomass

Fig. 10. Percentage Composition of the Bottom Fauna by Order, Site I



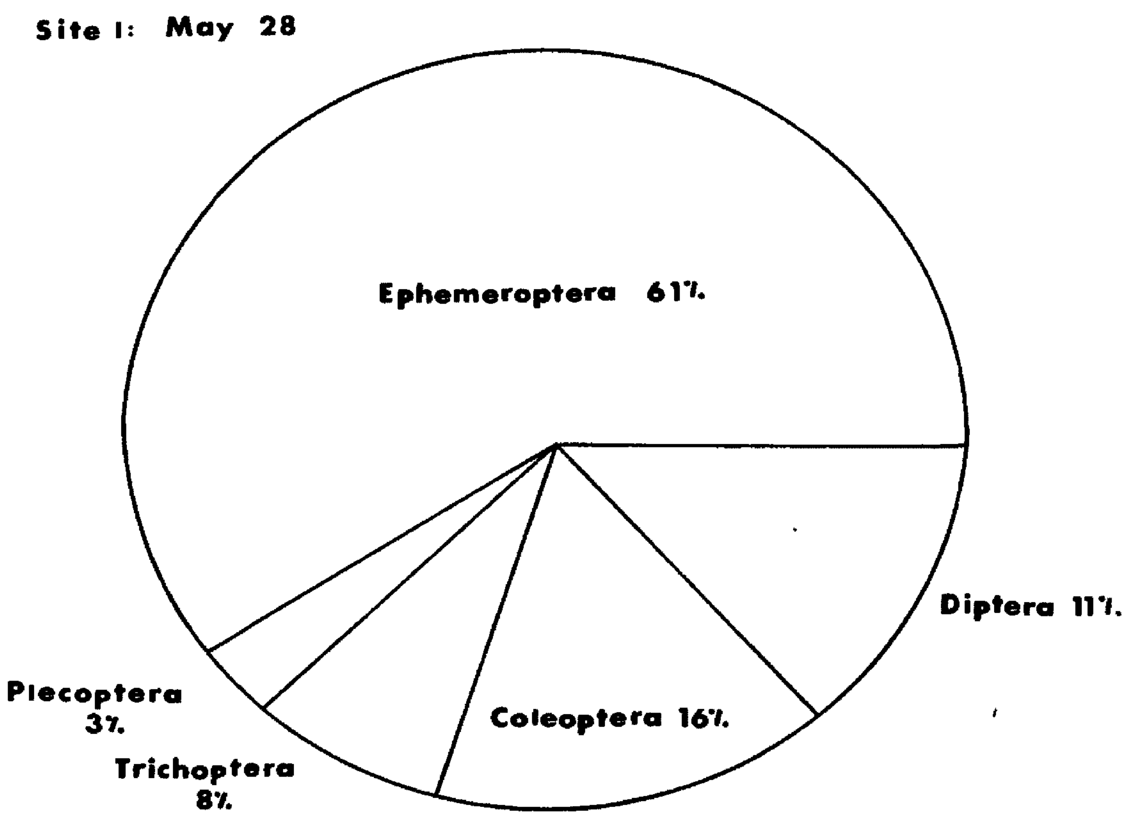
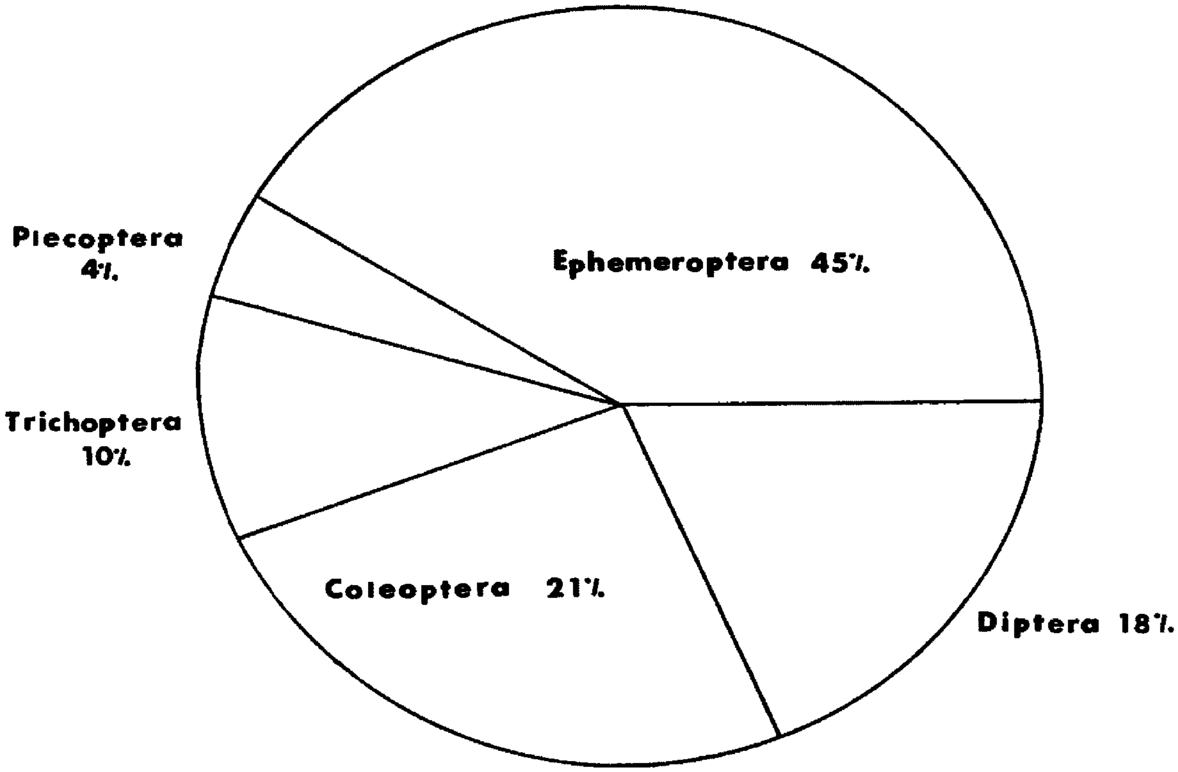


Fig. 10 - Continued

Site I: June 26



Site I: July 30

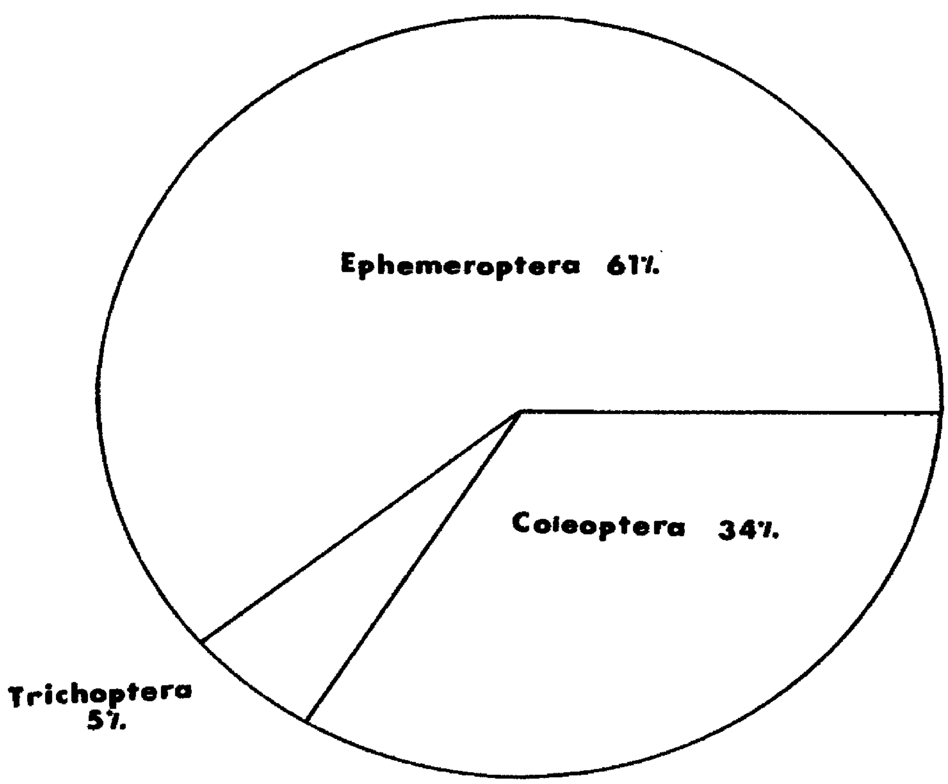
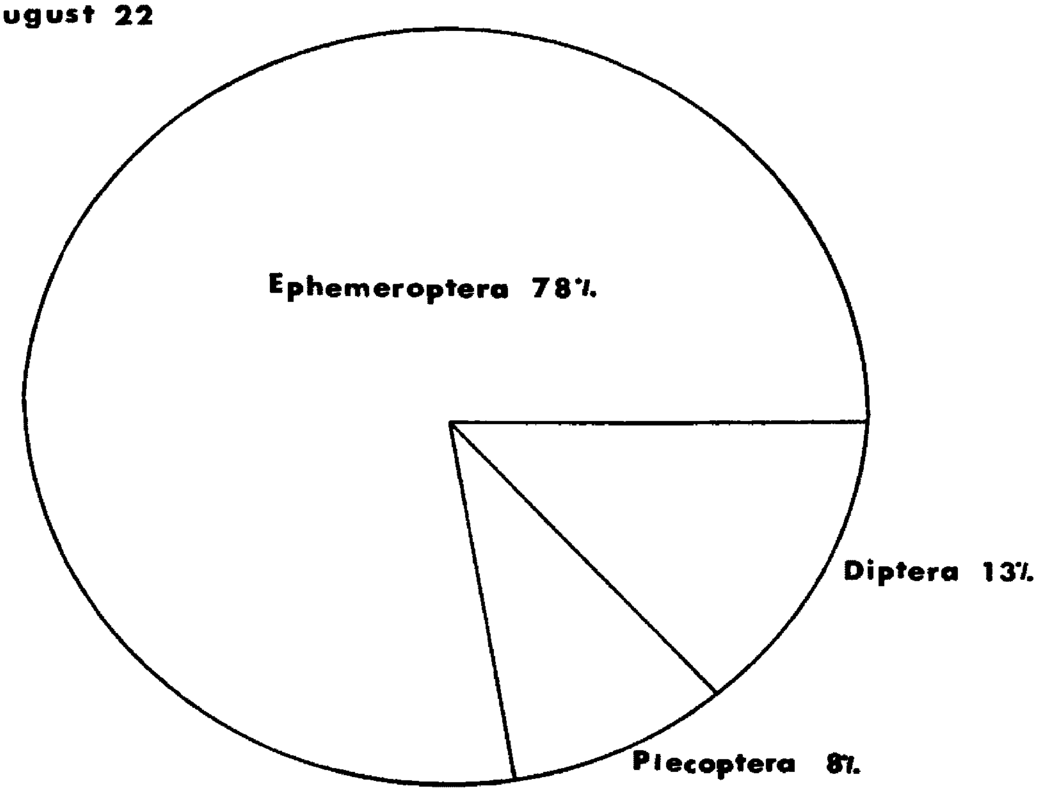
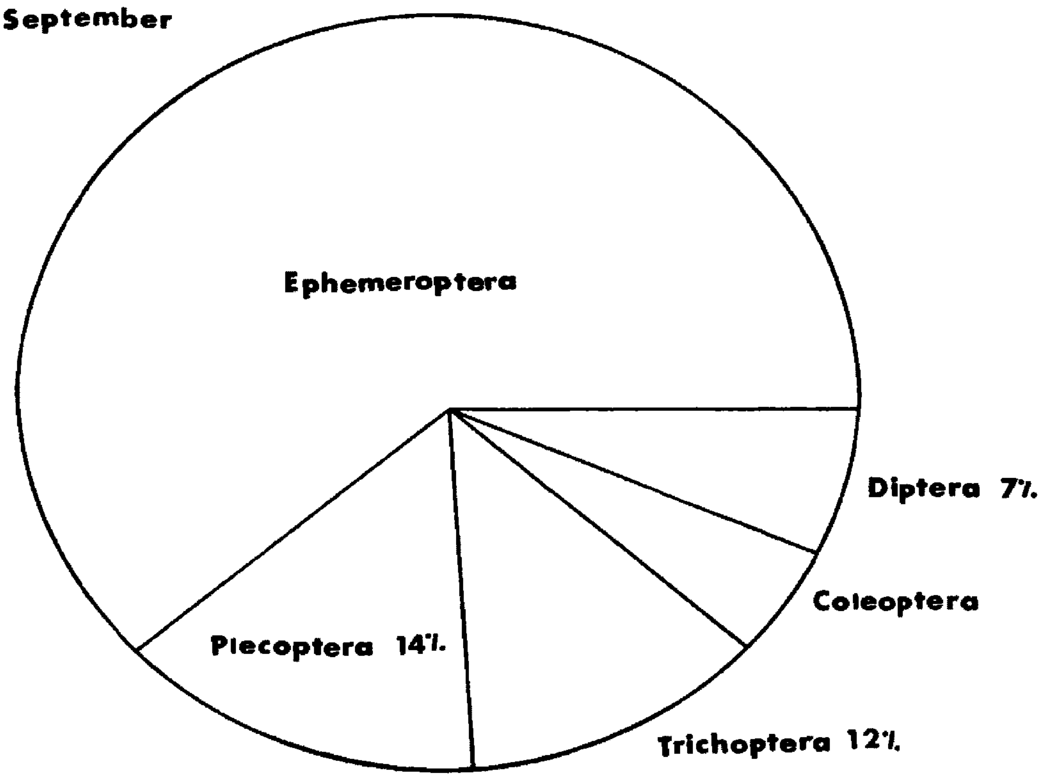


Fig. 10 - Continued

Site I: August 22



Site I: September



the mayflies contributed at least 60% of the total bottom fauna. Maximum percentages greater than 75% were found in August and minimum values of 45% occurred in June. The August high is evidently a function of the large absolute decrease in the orders Trichoptera, Coleoptera, and Diptera rather than any significant increase in the absolute numbers of Ephemeroptera.

The Plecoptera contributed a maximum of 14% of the total bottom fauna at Site I during the months of August and September, probably as a result of egg hatching which was indicated by the complete absence of this group in the latter part of July, probably indicating emergence and subsequent reproduction.

A similar phenomenon was observed for the Trichoptera, which were completely absent in late August, and reached a maximum of 12% of the total bottom fauna in late September.

The Coleopteran fauna appeared to remain relatively constant throughout the study period with a high of 34% of the total bottom fauna in late July. This again was a function of the absolute decrease in other orders at this time rather than any significant change in the beetle population.

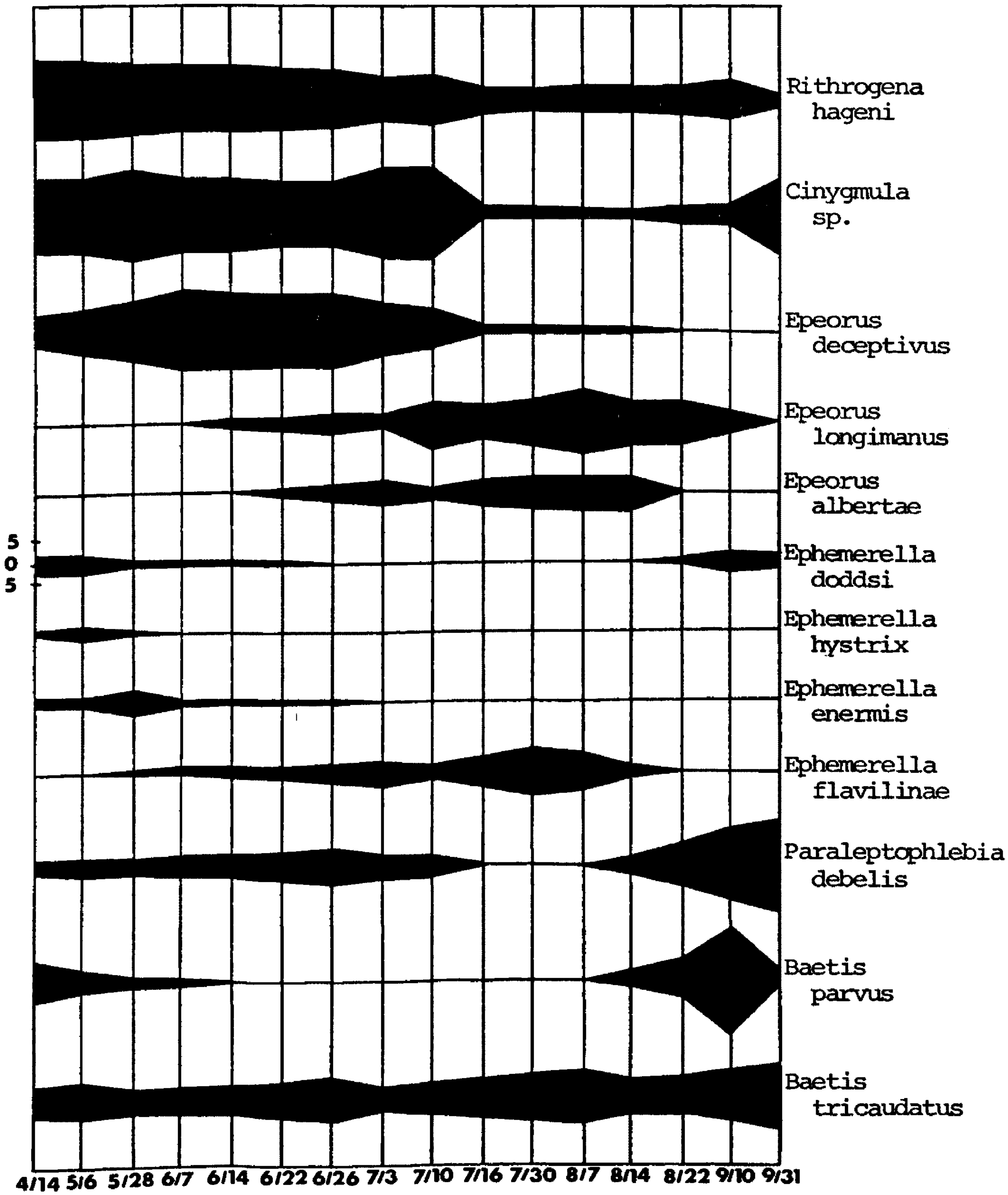
The Diptera contributed a maximum of 18% of the total bottom fauna by late June and completely disappeared from the benthos during July and August. As previously stated, this is undoubtedly a gross underestimation of the Diptera standing crop. This bias is a function of the rather coarse mesh size of the Surber sampler (9 meshes/cm) and the delicate structure of the Dipteran larvae. It appears highly probable that many of these small larvae simply pass right through the net of the sampler or are destroyed in the mechanics of collecting or transporting and are thus overlooked in the sorting process.

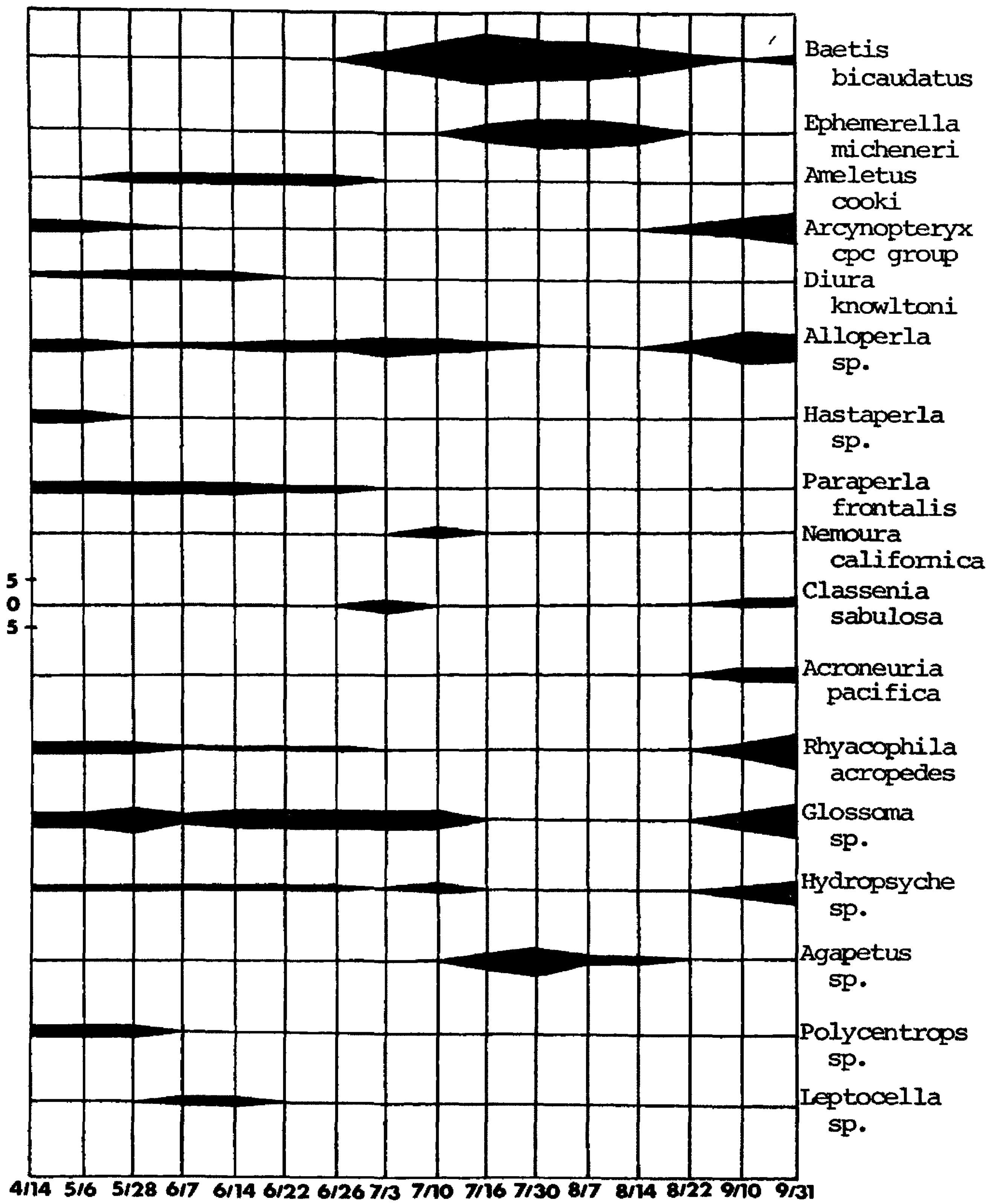
Site I

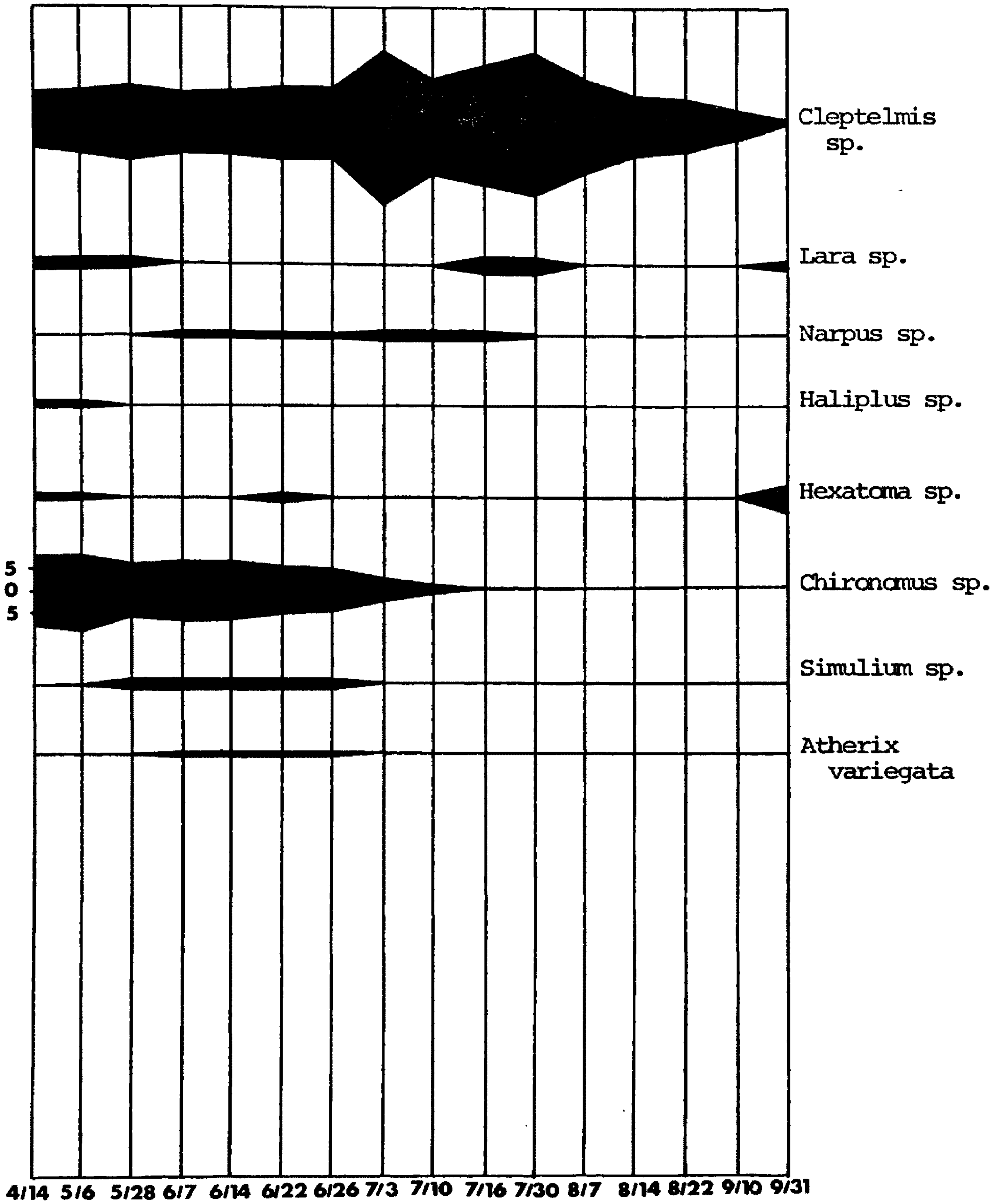
Percentage Composition by Species

Each of the 15 species of mayflies contributed substantially to the total mayfly fauna of Site I. The greatest contribution was made by two Heptageniid mayflies, Rithrogena hageni and Cinygmula sp., amounting to well over 50% of the mayfly fauna during the early spring and summer. Both species were at maximum density and percentage composition (26/ft^2, 20%; 29/ft^2, 19% respectively) in the spring and early summer. Rithrogena and Cinygmula appear at all four sites but in decreasing numbers, indicating at least some degree of wide range tolerance to environmental factors especially temperature which ranges from 5 to 18° C. Cinygmula sp. appeared to begin emergence in mid-July and hatch into first nymphal instars by mid-September, producing a large increase in the absolute numbers and percentage composition (2 to 17%) of the species. Epeorus deceptivus, Ephemerella doddsi, and Baetis tricaudatus also produce a sizeable proportion of the mayfly fauna ranging from 15 to 20% at this particular site. Epeorus deceptivus reached a maximum density of 22/ft^2 and percentage composition of the total bottom fauna of 17% by the last week in June. Epeorus deceptivus appeared to overwinter as eggs (with no

Fig. 11. Percentage composition of the individual species in the bottom fauna, Site I. The width of the spindle is proportional to the percentage composition of each individual species.


Rithrogena hageni
Cinygmula sp.
Epeorus deceptivus
Epeorus longimanus
Epeorus albertae
Ephemerella doddsi
Ephemerella hystrix
Ephemerella enermis
Ephemerella flavilinae
Paraleptophlebia debelis
Baetis parvus
Baetis tricaudatus
5
0
5
4/14 5/6 5/28 6/7 6/14 6/22 6/26 7/3 7/10 7/16 7/30 8/7 8/14 8/22 9/10 9/31


Baetis bicaudatus
Ephemerella micheneri
Ameletus cooki
Arcynopteryx cpc group
Diura knowltoni
Alloperla sp.
Hastaperla sp.
Paraperla frontalis
Nemoura californica
Classenia sabulosa
Acroneuria pacifica
Rhyacophila acropedes
Glossoma sp.
Hydropsyche sp.
Agapetus sp.
Polycentrops sp.
Leptocella sp.
5
0
5
4/14 5/6 5/28 6/7 6/14 6/22 6/26 7/3 7/10 7/16 7/30 8/7 8/14 8/22 9/10 9/31


Cleptelmis sp.
Lara sp.
Narpus sp.
Haliplus sp.
Hexatoma sp.
Chironomus sp.
Simulium sp.
Atherix variegata
5
0
5
4/14 5/6 5/28 6/7 6/14 6/22 6/26 7/3 7/10 7/16 7/30 8/7 8/14 8/22 9/10 9/31

evidence of hatching during the study period), hatching into first nymphal instars in the early spring with emergence beginning in early July and running through August. It must be noted that some of this increase in absolute numbers may in part be caused by an increase in recruitment as a function of increased size of the mature nymphs prior to emergence. Ephemerella doddsi on the other hand, overwinter as nymphs with maximum density of $7/ft^2$ or roughly 5% of the total bottom fauna (excluding hatching) occurring in April and May. Emergence lasts from late May through June, with hatching occurring in late August. Baetis tricaudatus was a conspicuous part of the mayfly fauna throughout the entire study period. There was a gradual increase throughout the summer with maximum density and percentage composition ($15/ft^2$ and 12%) occurring in late August and September, probably as a result of summer hatching. Emergence of this multibrooded species probably ranges throughout the summer, giving the population its rather uniform and constant structure. Therefore, it is of considerable importance as a source of food for the fish fauna of the stream.

Almost simultaneous with the emergence of Epeorus deceptivus, there was a corresponding hatching and development of two sister species Epeorus longimanus and Epeorus albertae to a percentage roughly equivalent to that of the species replaced, Epeorus deceptivus. This demonstrated the biological phenomenon of temporal isolation of competing species and is most likely regulated by the annual water temperature cycle. As the temperature of the water warms, *Epeorus deceptivus* emerges, leaving a vacant niche and subsequent hole in the food web which is available for some other suitable species to occupy. It seems only logical in a well-ordered system that such a hole would immediately be filled to maintain maximum ecological efficiency within the ecosystem. Temporary holes or vacancies in the food web appear to be very prominent in the aquatic ecosystem and are undoubtedly one of the most important factors in the development of a rather large diversity of apparently similar species in such a limited environment. *Epeorus albertae* and *Epeorus longimanus* generally do not occupy the same section of stream (Edmuns and Musser, 1960). Usually *Epeorus longimanus* occurs in the higher, colder sections of stream whereas *Epeorus albertae* occupies the lower, warmer portion of stream. Evidently Sites I and II lie on the temperature transition for these two species, which allows them to coexist in the same portion of stream. Downstream from Site II as the water warms substantially, *Epeorus longimanus* disappeared completely from the bottom fauna and *Epeorus albertae* doubled in density, probably as a result of a lack of the direct competition from *Epeorus longimanus*. This is a type of geophysical isolation characteristic of benthic insect faunas along the longitudinal gradient of a stream from its source to its mouth.

Throughout most of the study period, the Plecopteran fauna consisted of 7 species contributing a small but constant percentage of the total bottom fauna. Arcynopteryx (compacta, parallela, and curvata group), Diura knowltoni, and Alloperla sp. were the most abundant Plecopteran species, each of which averaged about 2 to $3/ft^2$ or 2% of the total bottom fauna. Both Arcynopteryx and Diura emerged in mid-June and spent most of the summer as eggs, hatching in late August and September. The density of the one species of Alloperla remained relatively constant throughout the study period with emergence occurring in late July and hatching a month later in late August and early September.

The Trichoptera, like the Plecoptera, maintained a low but relatively constant population density with the three main species being Rhyacophila acropedes, Glossoma sp., and Hydropsyche sp. ($3/ft^2$, 2% of the total bottom; $5/ft^2$, 5%; $2/ft^2$, 1% respectively). All three of these species emerged in late June and early July with the eggs hatching in September, as indicated by the sudden increase in density and percentage composition, primarily a function of the many first nymphal instar stages. The overall lack of Trichopteran species and the low density of existing species at this site may be a function of the inability of some of the net-spinning forms to maintain their life style in the extreme fluctuations of discharge and velocity characteristic of this section of Post Creek. Their filtering nets are probably not efficient over such a wide range of conditions. Some species such as Parapsyche elsis require very specific current velocity for maintenance of net function (Hickin, 1967). Forms such as

Glossoma are algal feeders and do not frequent in high densities such sections of stream because of the scouring effect the extremely high discharge has on the algal periphyton. The effects of this phenomenon can be readily ascertained by tracing the quite substantial increase in Trichopteran fauna from 6 to 14% at Site I to well over 50% at Site IV as the stream becomes progressively more stable and homogeneous; warmer and more eutrophic.

The Coleoptera, primarily in the family Elmidae, apparently have an extremely wide range of tolerance to environmental factors because they remain as a consistantly high percent (15 to 20) of the total bottom fauna in all four sites studied. The most abundant species by far (90 to 100%) of the Coleopteran fauna was the riffle beetle, Cleptelmis sp. Both the adults and larvae are entirely aquatic and were found in varying proportions throughout the study period.

The Diptera of Site I range from 11 to 18% of the total bottom fauna in the early spring and summer. As previously stated, this is without a doubt a gross under-estimation of the standing crop of the existing resident Dipteran fauna. By far the most abundant species were the midges of the family Chironomidae, primarily the genus Chironomus, which averaged approximately 12% of the total bottom fauna. Second in abundance were the black flies of the genus Simulium, averaging only 2% of the total bottom fauna. The Dipteran fauna all but disappeared in the latter part of July and August, probably as a result of emergence, but the greatly increased discharge during this time span on this section of stream undoubtedly was a major factor also. Here again as in the Trichoptera, filter-feeding and net-spinning forms such as *Simulium* and *Calypsectra* cannot function efficiently under such a wide range of physical conditions.

Site II

Monthly Trends in Percentage Composition by Order

During the six month study period, Site II of Post Creek had an average of 121 benthic insects per square foot and a corresponding average biomass of 1.33 cc's per square foot. Maximum density occurred in late August and early September with minimum density occurring in late July and early August (Fig. 12). Both are undoubtedly a function of normal, heavy, late-summer emergence and subsequent hatching a few weeks later.

The Ephemeroptera, as at Site I, were again the dominant group in this section of Post Creek. For most of the study period, the mayflies contributed roughly 50% of the total bottom fauna. Maximum percentages were found in the early spring and summer and again in September as a function of increased numbers of first nymphal instars as a result of late summer hatching. Minimum values were obtained in late August mainly as a result of emergence of nearly all mayfly species in this section of stream.

The maximum percentages of Plecoptera, or stone-flies, occurred in April, May, and July. The high in July was most likely the result of increased recruitment as a

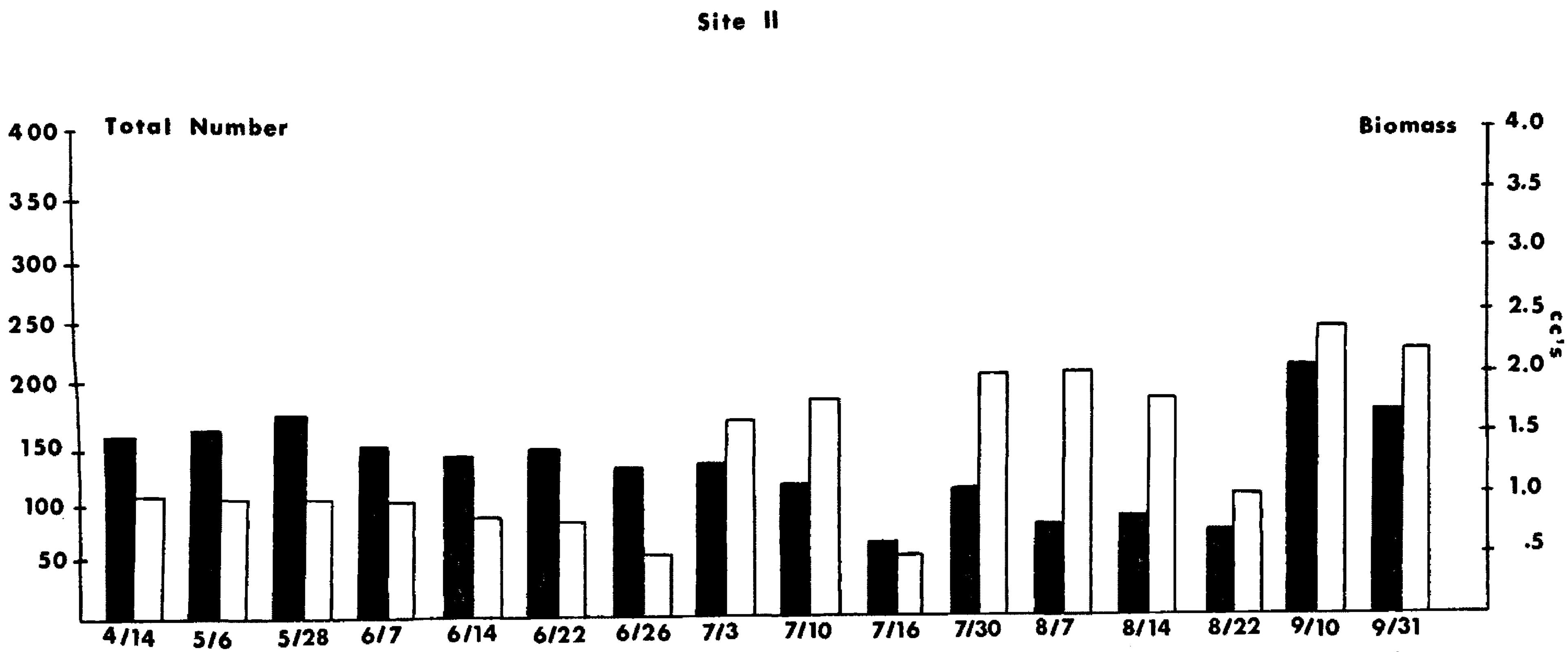
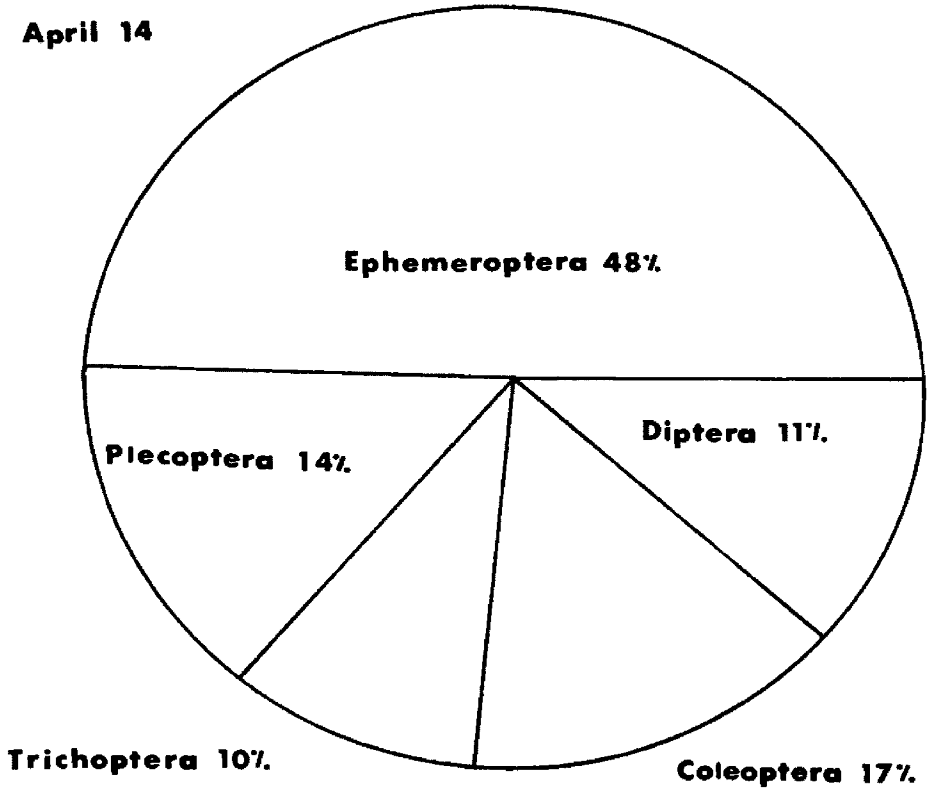


Fig. 12. Comparison of the Total Number of Benthic Insects Collected to Their Biomass

Fig. 13. Percentage Composition of the Bottom Fauna by Order, Site II

Site II: April 14



Site II: May 28

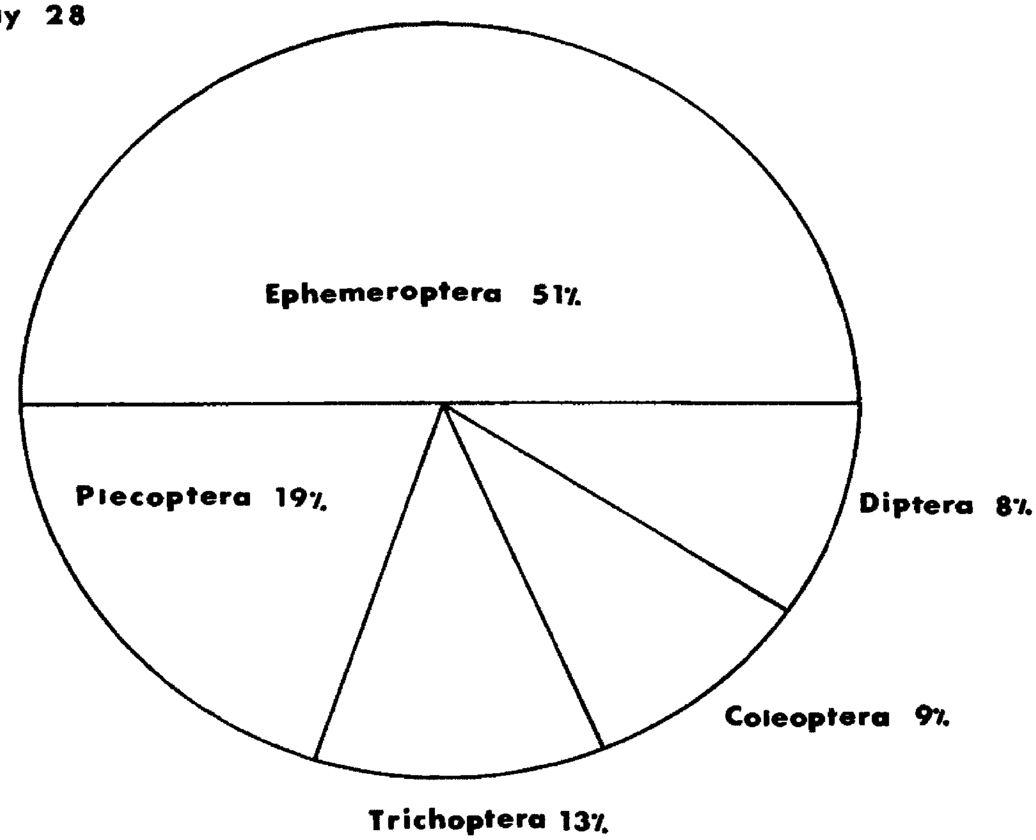
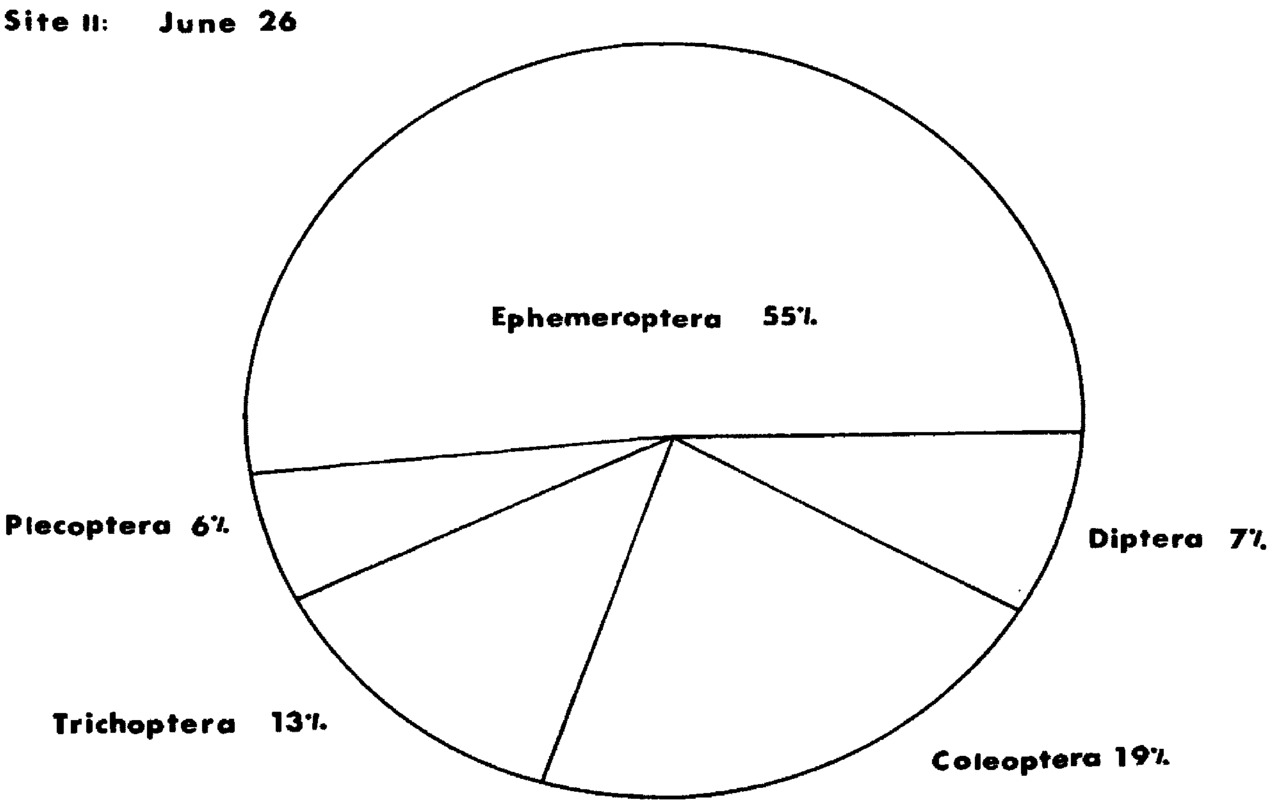


Fig. 13 - Continued



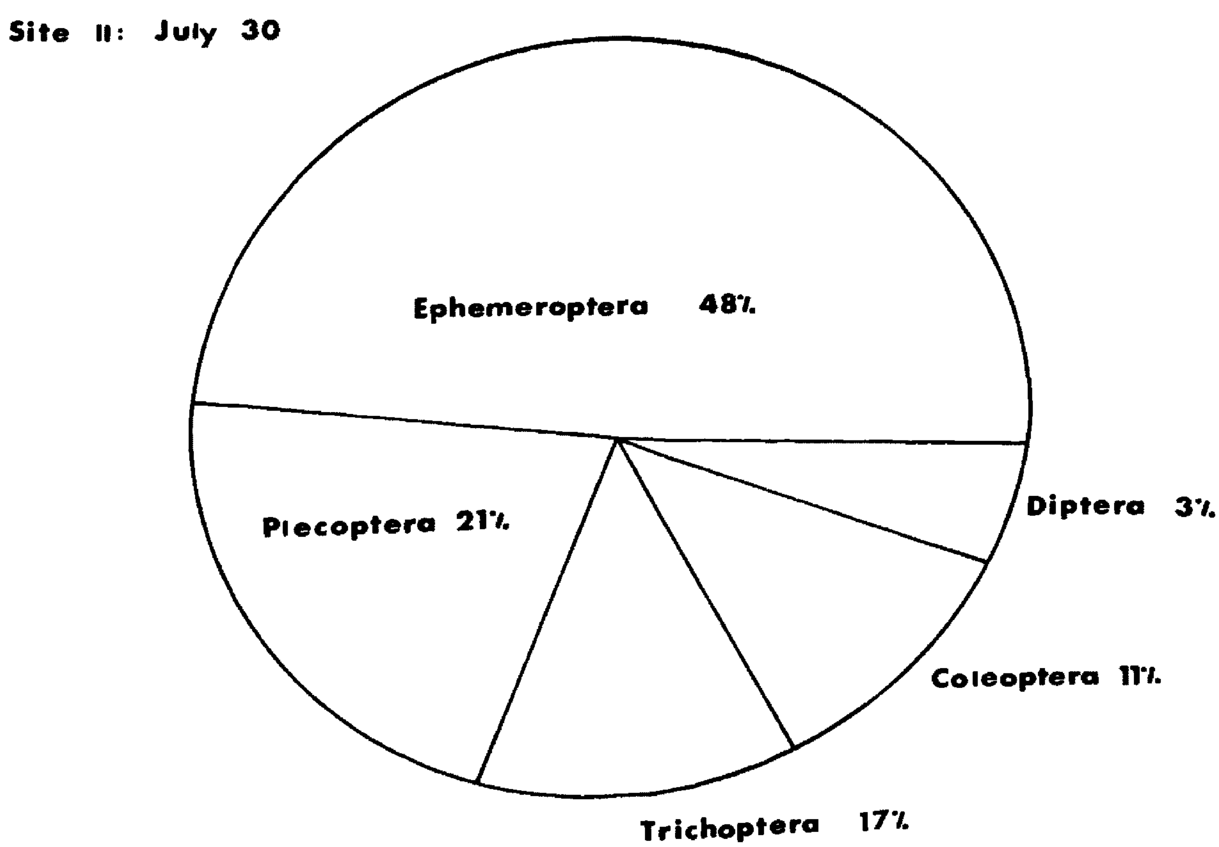
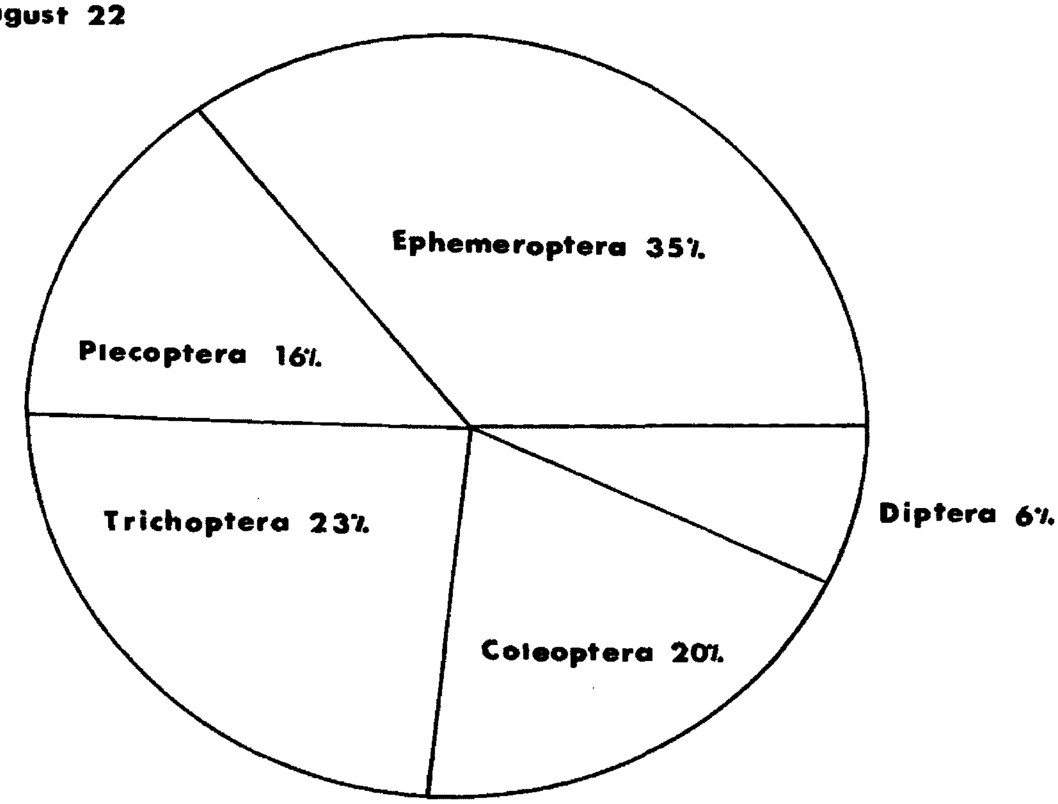
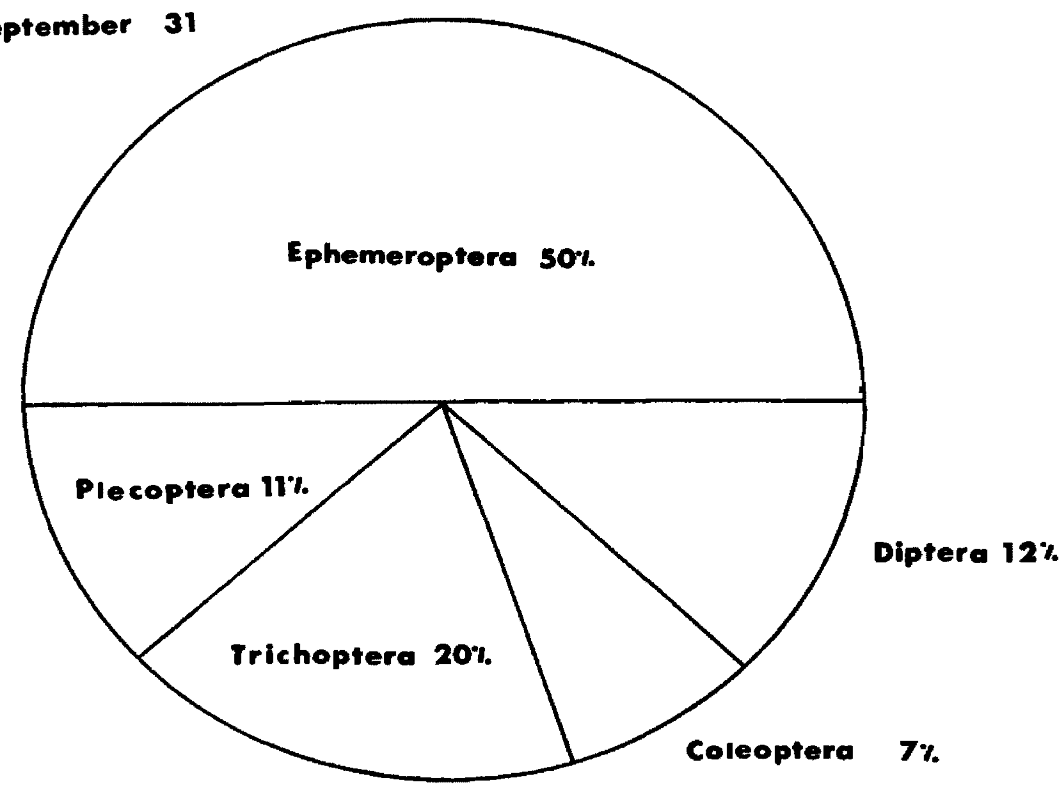


Fig. 13 - Continued

Site II: August 22



Site II: September 31



function of increased size of mature nymphs just prior to emergence. The Plecopteran fauna contributed an average of nearly 15% of the total bottom fauna throughout the study period. For the most part, the emergence of this group was complete by mid-July but did continue to some degree throughout the remainder of the study period. Classenia sabulosa was the most obvious exception, emerging in late August.

The Trichopteran, or caddisfly, fauna remained relatively constant at approximately 15% throughout the study period, with a moderate increase in lage August and early September to over 20% of the total bottom fauna. This was the result of hatching and the appearance of two species of the genus Parapsyche previously not collected. It was not ascertained whether this phenomenon was a result of sampling error or if these species spend most of the summer as eggs.

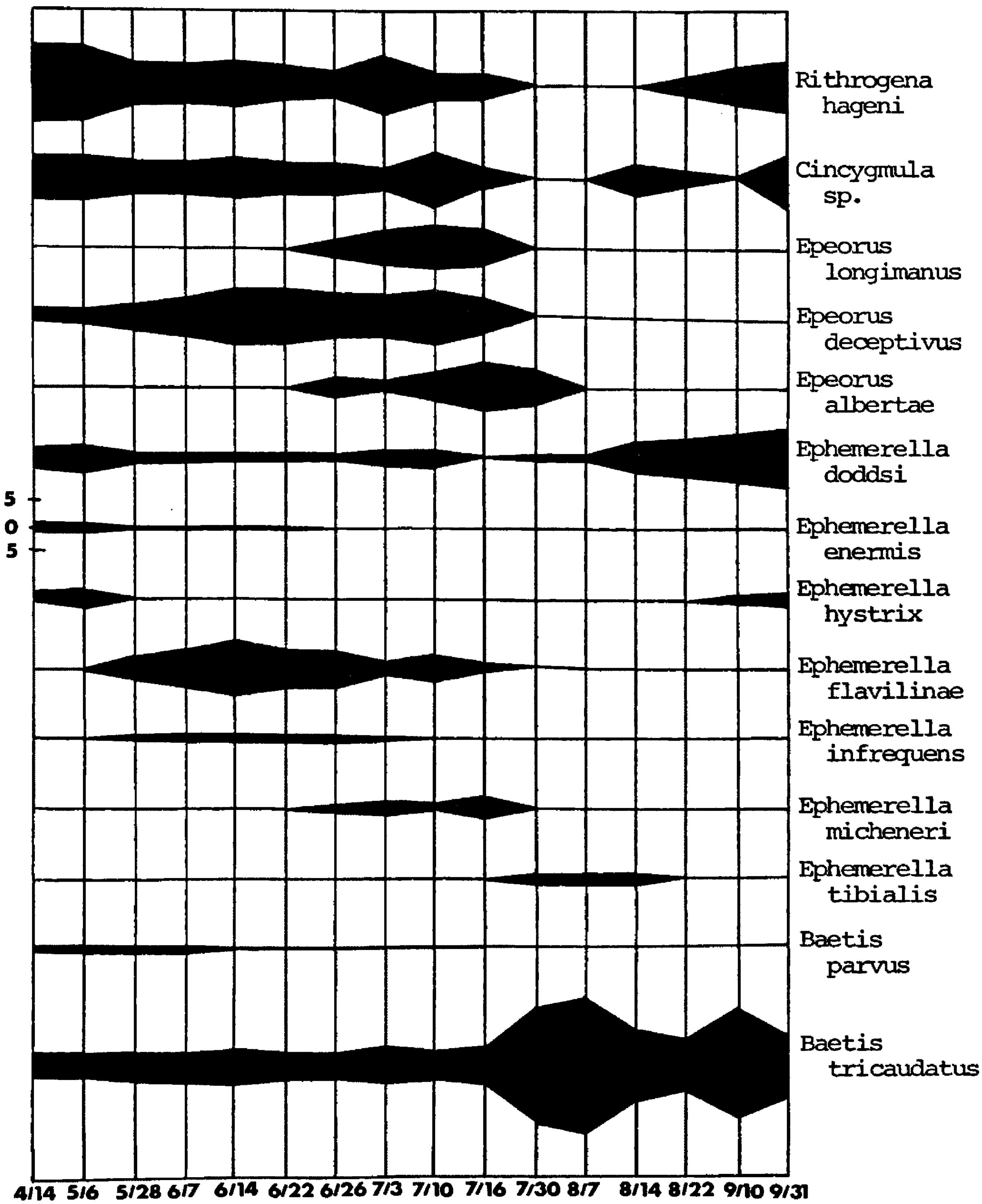
The Coleoptera appeared to gradually increase from 13% in April to a high of 23% in late August. These data contain both larvae and adults as both are entirely aquatic. This undoubtedly adds to their consistently high percentage composition of the total bottom fauna.

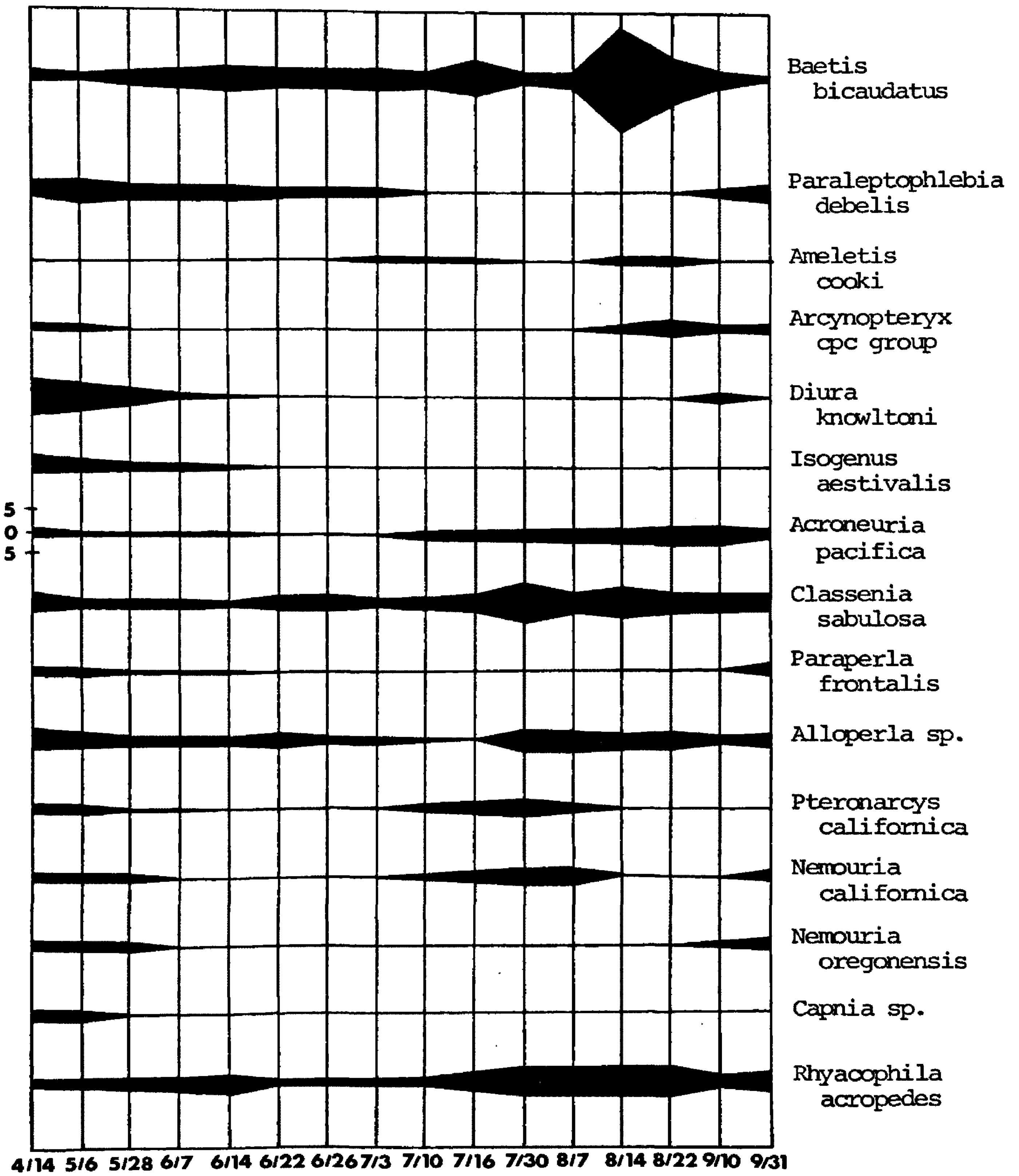
The Dipteran fauna showed a rather typical aquatic insect life cycle with a maximum composition of 8 to 11% in the late spring and early summer to a low of 3% after heavy emergence in mid-July. Correspondingly, hatching began about a month late and continued to a high of 12% by late September.

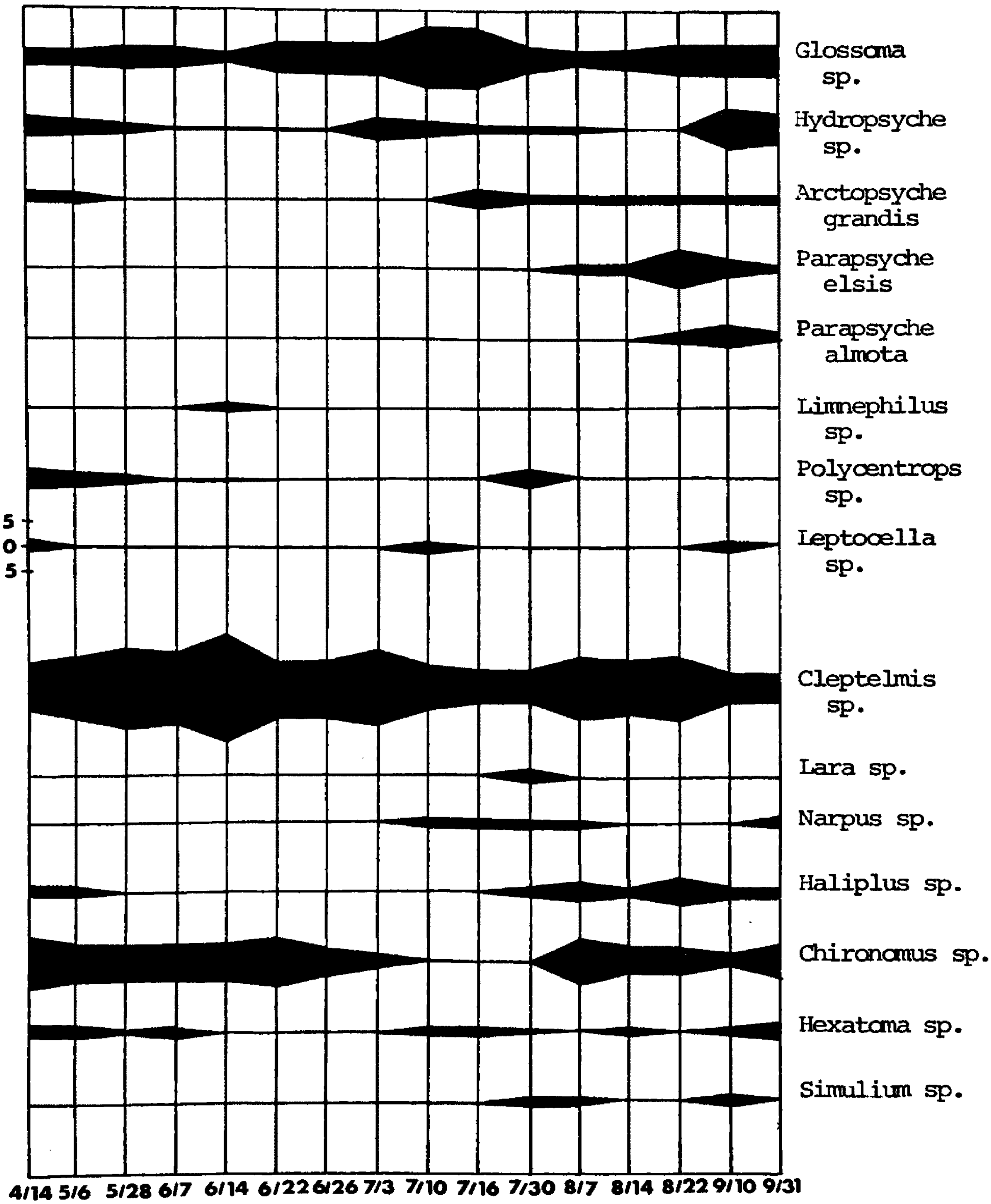
Site II

Percentage Composition by Species

Each of the 18 species of mayflies contributed substantially to the total Ephemeropteran fauna at Site II. Again, as at Site I, the greatest contribution was made by Rithrogena hageni and Cinygmula sp. which amounted to as much as 40% of the mayfly fauna in early spring and summer. Both species were at a maximum density and percentage composition ($22/ft^2$, 16% and $15/ft^2$, 10% respectively) in the spring and early summer and again following hatching in late August and early September ($17/ft^2$, 10% for both). Rithrogena hageni began emergence in mid-July, about two weeks earlier than the same species at Site I. Hatching occurred in late August and continued through September. Cinygmula sp. began to emerge in mid-July and began to hatch in late August continuing to a maximum in late September. Epeorus deceptivus, Ephemerella doddsi, and Baetis tricaudatus also produced a sizeable proportion (30 to 40%) of the mayfly fauna at this site. Epeorus deceptivus appeared to emerge in mid-July with no evidence of hatching during the study period which suggests that they overwinter as eggs, hatching in the early spring. Epeorus deceptivus reached a maximum of 12% of the total bottom fauna in late June. Ephemerella doddsi began emergence in mid-June continuing through July. First nymphal instars appeared by mid-August and were at a maximum of 10% of the total bottom fauna by mid-September. Barring hatching, Ephemerella doddsi was at a maximum density of $6/ft^2$ or


Rithrogena hageni
Cincygmula sp.
Epeorus longimanus
Epeorus deceptivus
Epeorus albertae
Ephemerella doddsi
Ephemerella enermis
Ephemerella hystrix
Ephemerella flavilinae
Ephemerella infrequens
Ephemerella micheneri
Ephemerella tibialis
Baetis parvus
Baetis tricaudatus
5
0
5
4/14 5/6 5/28 6/7 6/14 6/22 6/26 7/3 7/10 7/16 7/30 8/7 8/14 8/22 9/10 9/31


Baetis bicaudatus
Paraleptophlebia debelis
Ameletis cooki
Arcynopteryx cpc group
Diura knowltoni
Isogenus aestivalis
Acroneuria pacifica
Classenia sabulosa
Paraperla frontalis
Alloperla sp.
Pteronarcys californica
Nemouria californica
Nemouria oregonensis
Capnia sp.
Rhyacophila acropedes
5
0
5
4/14 5/6 5/28 6/7 6/14 6/22 6/26 7/3 7/10 7/16 7/30 8/7 8/14 8/22 9/10 9/31


Glossoma sp.
Hydropsyche sp.
Arctopsyche grandis
Parapsyche elsis
Parapsyche almota
Limnephilus sp.
Polycentrops sp.
Leptocella sp.
Cleptelmis sp.
Lara sp.
Narpus sp.
Haliplus sp.
Chironomus sp.
Hexatoma sp.
Simulium sp.
5
0
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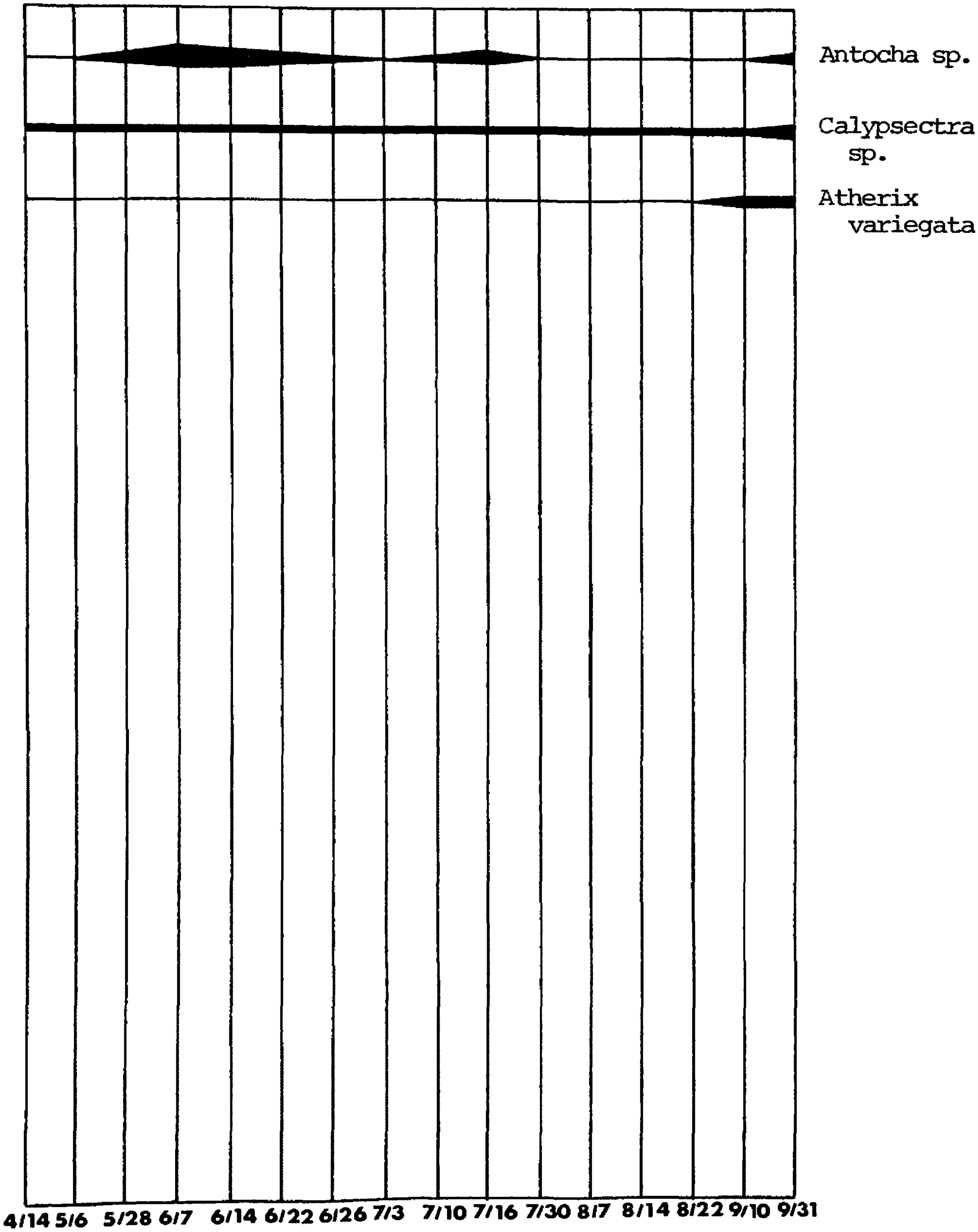
4/14 5/6 5/28 6/7 6/14 6/22 6/26 7/3 7/10 7/16 7/30 8/7 8/14 8/22 9/10 9/31


Antocha sp.
Calypsectra sp.
Atherix variegata
4/14 5/6 5/28 6/7 6/14 6/22 6/26 7/3 7/10 7/16 7/30 8/7 8/14 8/22 9/10 9/31

approximately 6% of the total bottom fauna during April and May. There also was a significant increase in early July just prior to emergence but was most likely a function of decreased discharge and increased size of mature nymphs both increasing the efficiency of the sampler. *Baetis tricaudatus* was a conspicuous part of the mayfly fauna at Site II throughout the entire study period. There was a gradual increase through the summer with a maximum density of 54/ft^2 in early September and maximum percentage composition of 29% of the total bottom fauna in late July and early September. *Baetis tricaudatus* is a multibrooded species and emerges continuously throughout the summer which gives the population a rather oscillating but constant structure until late July and early August when a hatch of great magnitude increased their percentage bottom composition from 7 to 29% becoming nearly 50% of the mayfly fauna and maintained this high percentage for the remainder of the study period. This phenomenon is most likely a function of increased water temperature and slightly decreased discharge at this time. Here, as at Site I, *Baetis tricaudatus* because of its consistently high percentage is still probably the main article of diet for the resident fish fauna particularly the rainbow trout.

Throughout most of the study period, the Plecopteran fauna consisting of 11 species showed a two-fold increase over the Plecopteran fauna at Site I. This is without a doubt a result of the more homogeneous nature of this section of Post Creek, especially the absence of extreme and rapid fluctuations in stream discharge and velocity. The Plecoptera are not nearly so well-adapted to the harsher conditions characteristic of Site I as are the Ephemeroptera. The lack of a very diverse Plecopteran fauna and the relatively low density of the existing forms in Post Creek as a whole may be a result of the interrelationship between substrate size and current velocity. Plecoptora as a group normally prefer riffles with small rubble-type bottoms of moderate velocity as opposed to the 15 x 20 cm average sustrate size characteristic of most of Post Creek. It must be noted that this is a very subjective and risky generality to propose because of the complexity of interactions of the many factors involved. It is almost impossible to quantify such relationships except in general terms. Arcynopteryx cpc, Diura knowltoni, Isogenus aestivalis, Alloperla sp., and Classenia sabulosa were the predominant Plecopteran species in this section of Post Creek. Diura knowltoni was by far the most abundant stonefly species with a maximum of 6% of the total bottom fauna and 40% of the stonefly fauna throughout the early spring and summer. Isogenus aestivalis was next in abundance at 3% of the total bottom fauna. Because of its three year life cycle, Classenia sabulosa was the only stonefly species found continually throughout the entire study period at approximately 3% of the total bottom fauna. The one species of Alloperla was also a nearly continual member of the Plecopteran fauna at approximately 3% of the total bottom fauna, apparently emerging in early July and hatching a month later in early

August. Arcynopteryx, Diura, and Isogenus emerged in mid-June, apparently spending the rest of the summer as eggs hatching in late August and September.

The Trichoptera like the Plecoptera exhibited a two-to-three-fold increase in density and percentage composition as compared to Site I with Rhyacophila acropedes, Glossoma sp., and Hydropsyche sp. still the dominant forms. Rhyacophila remains relatively constant at approximately 4 to 5% of the total bottom fauna. The life history of Rhyacophila acropedes was not evident from the data collected. It appeared possible that it might emerge from mid-June to mid-July with hatching seemingly occurring in late July and early August. It is quite possible that Rhyacophila may have a life cycle of more than one year. Glossoma sp. on the other hand quite clearly increased in density from early spring to a maximum of $12/ft^2$ or nearly 13% of the total bottom fauna by mid-July, probably as a result of increasing size as the nymphs near maturity and continuous hatching throughout the spring and early summer. It should be noted that all pupae were counted when discernible to genus. Glossoma apparently began to pupate in early July with emergence ranging from August through September.

The Coleopteran fauna, primarily the riffle beetle Cleptelmis sp. (90 to 100% of the beetle fauna) of the family Elmidae, still constituted an important part of the total bottom fauna. Cleptelmis ranged from a high of 25% in mid-June to a low of 6% in September. This is slightly lower than observed at Site I and was most likely a function of increased competition from increased densities in other orders.

The Diptera of Site II only averaged approximately 8% of the total bottom fauna, a nearly 50% reduction from Site I. Still by far the most abundant species were the midges of the family Chironomidae, primarily the genus *Chironomus*. The black fly, *Simulium* *sp*., does not appear to play a significant role in the bottom fauna of this section of Post Creek. The emergence of *Chironomus* was continuous throughout the spring and early summer with completion for all practical purposes by mid-July when the Dipteran fauna dropped to only 3% of the total bottom fauna.

Site III

Monthly Trends in Percentage Composition by Order

During the study period, Site III of Post Creek had an average of 249 benthic insects per square foot and a corresponding average biomass of 4.1 cc's per square foot (Fig. 15). Maximum density occurred in early June probably as a result of increased recruitment with the increasing size of mature nymphs and continued hatching. A significant increase also occurred in late August and September as a result of the late summer hatching of most aquatic insects.

The Ephemeroptera were still the dominant group in this section of Post Creek, averaging approximately 40% of the total bottom fauna throughout the study period. But the most striking trend was the nearly three-fold increase in the Trichoptera which averaged nearly 25% of the total bottom fauna throughout the study period.

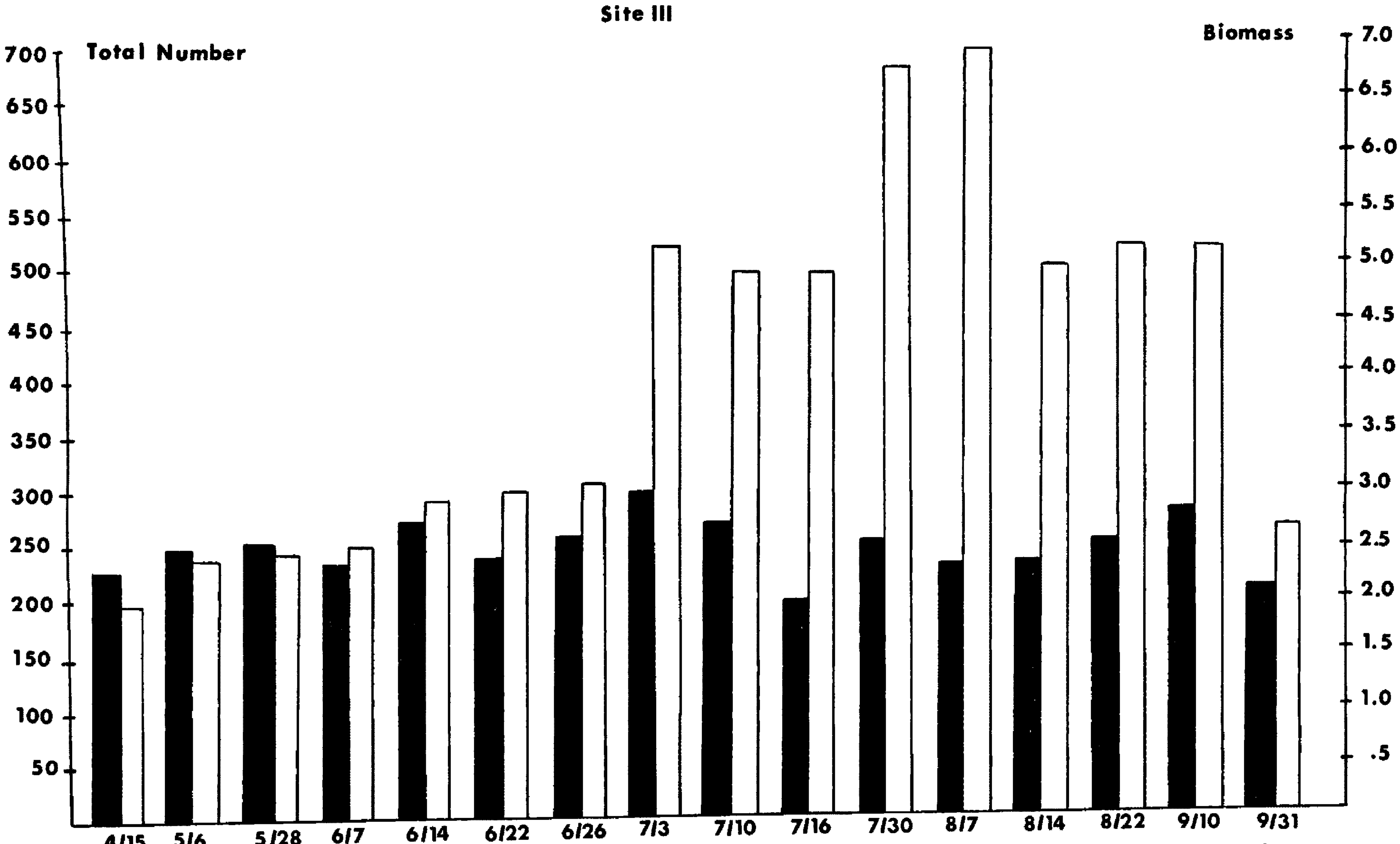
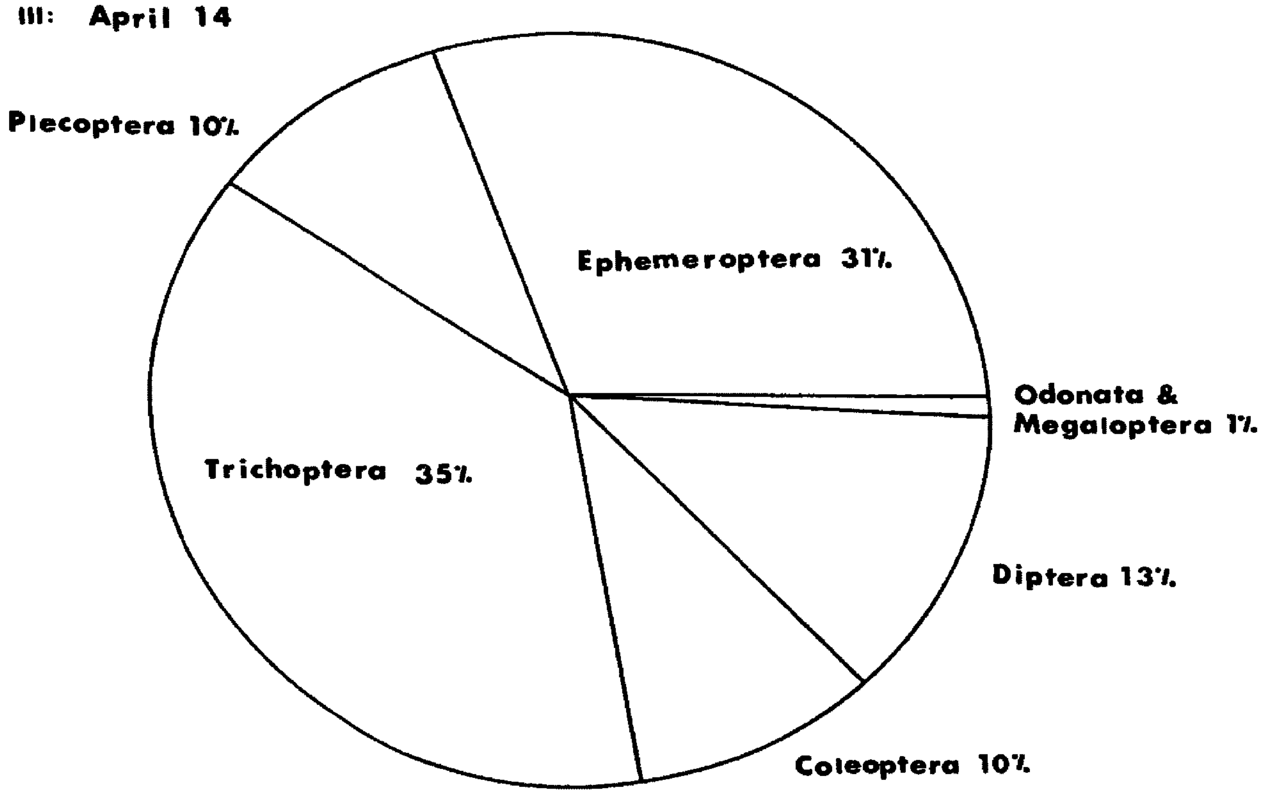


Fig. 15. Comparison of the Total Number of Benthic Insects Collected to Their Biomass

Fig. 16. Percentage Composition of the Bottom Fauna by Order, Site III

Site III: April 14



Site III: May 28

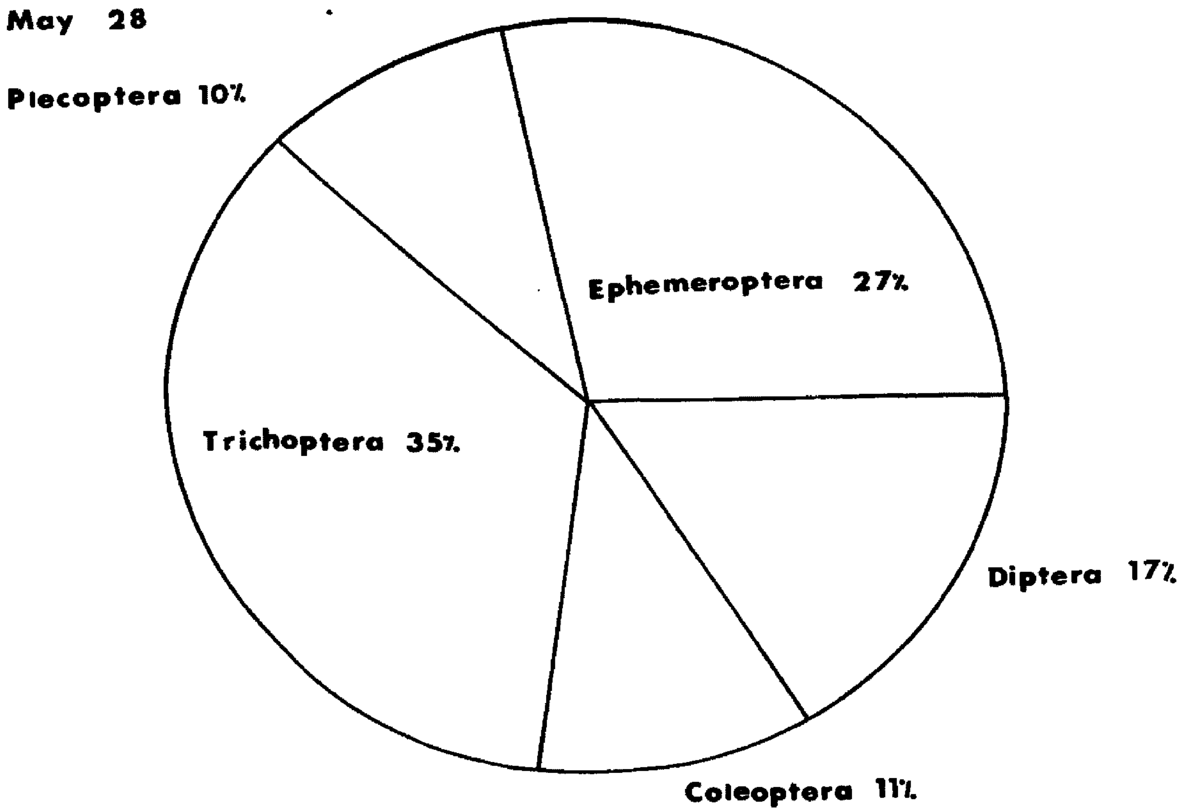
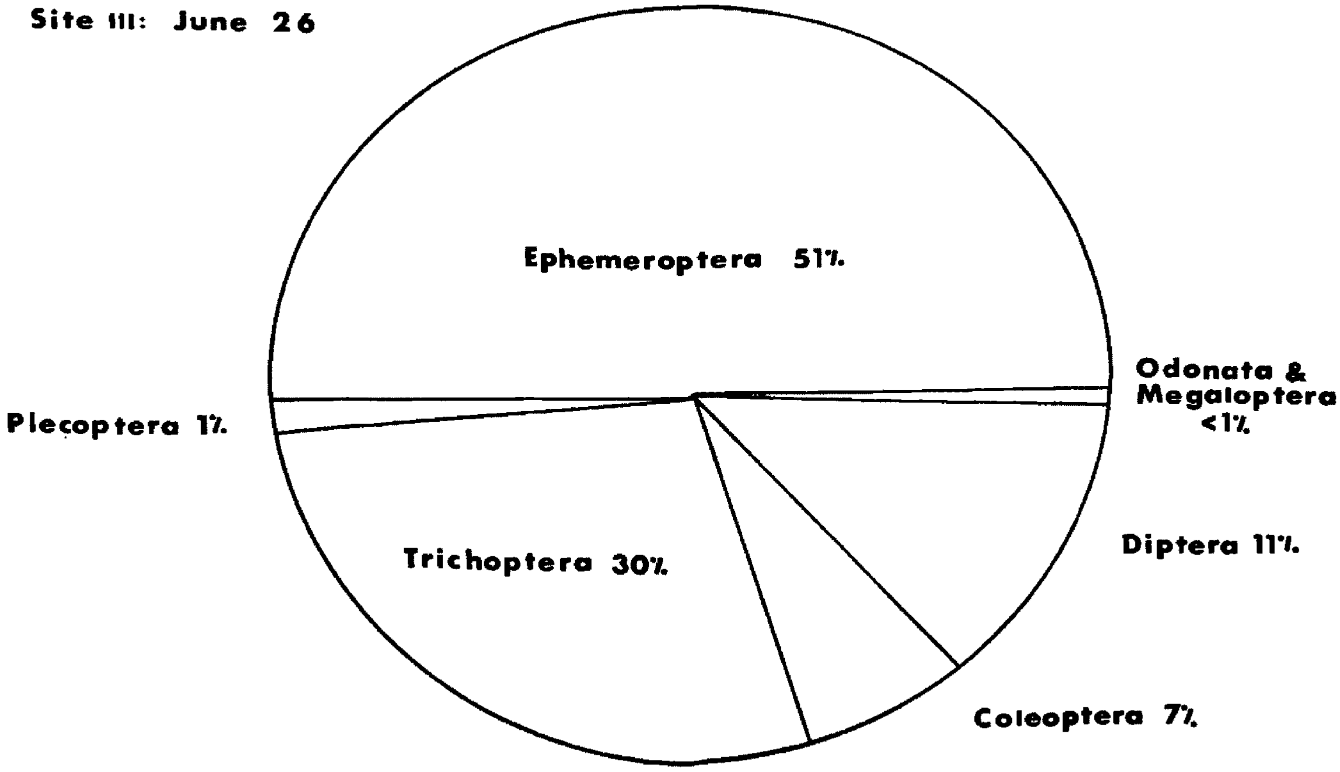


Fig. 16 - Continued

Site III: June 26



Site III: July 30

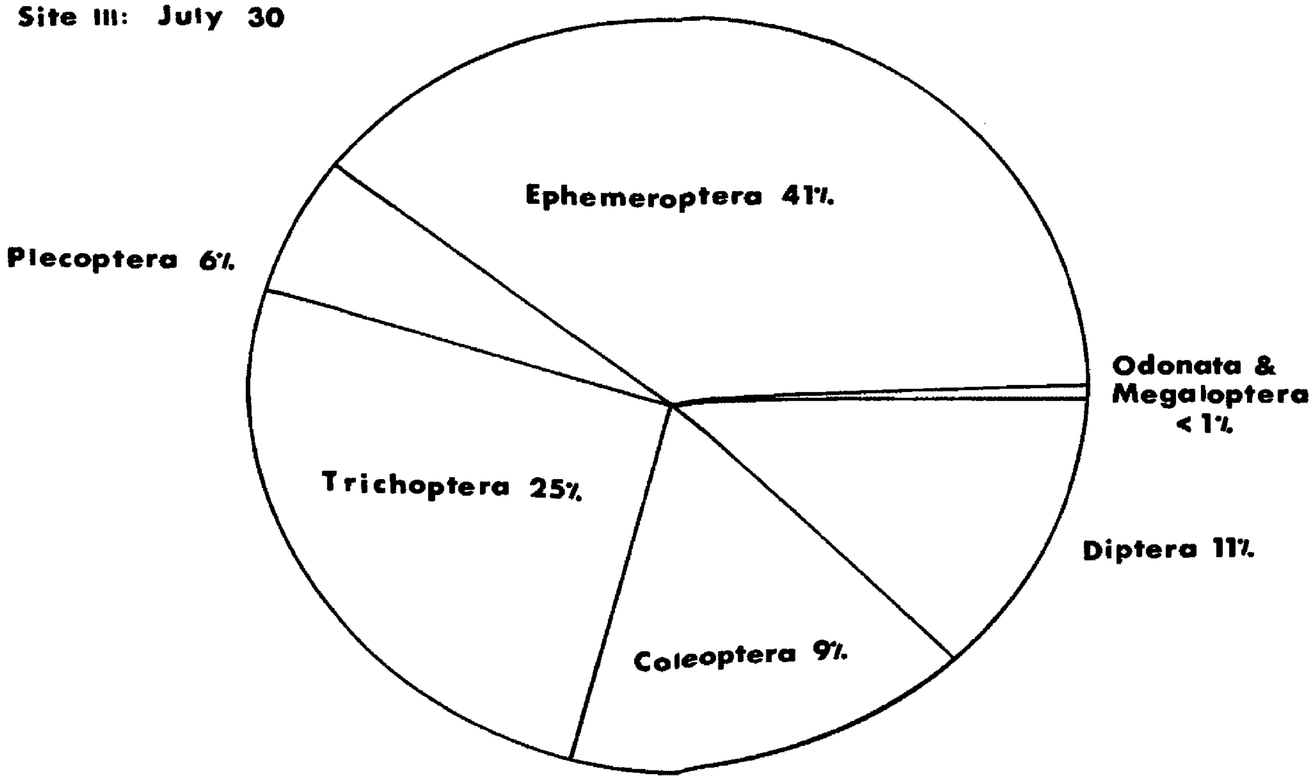
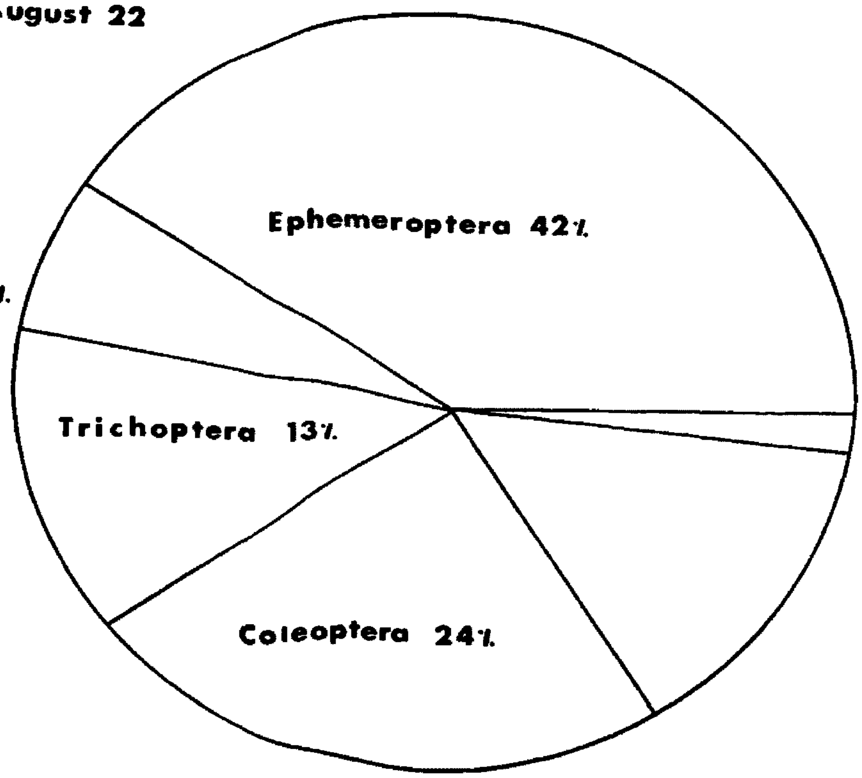
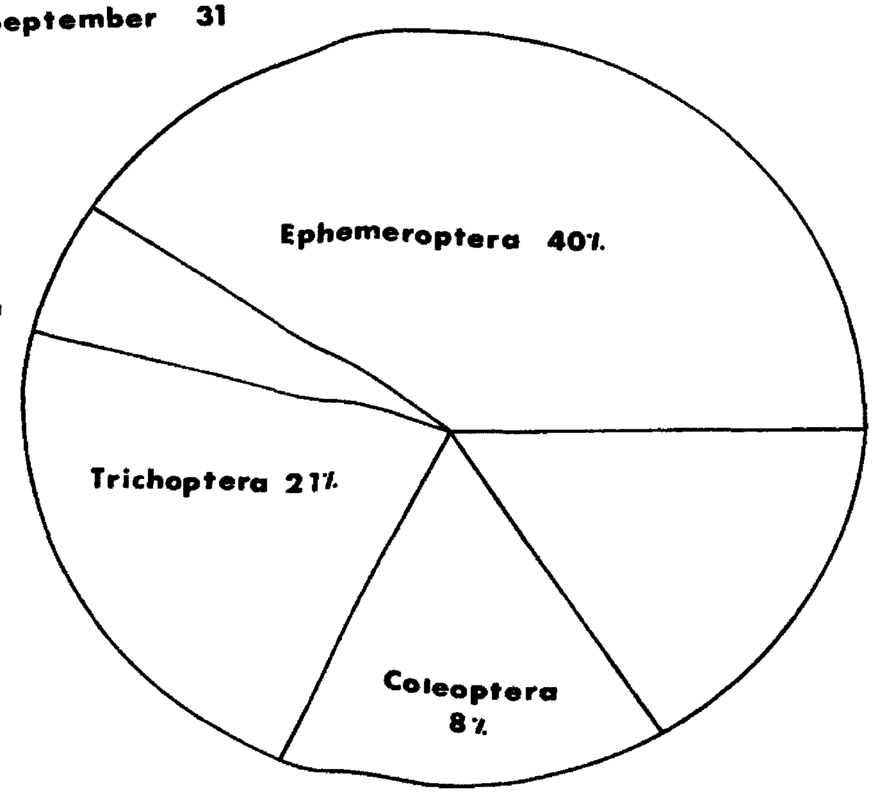


Fig. 16 - Continued

Site III: August 22



Site III: September 31



The maximum percentage of mayflies was found in late June at slightly more than 50% of the total bottom fauna and remained consistently high through September. Minimum percentages of nearly 27% occurred in April and May. The June increase was evidently a function of summer hatching.

Maximum percentages of Plecoptera occurred in April and May, averaging approximately 10% of the total bottom fauna while the water temperature was still relatively low (11°C). This section of stream warms up quickly to a high of 18°C because of its greatly reduced flow; over 80% of the streams initial water supply has been removed for agricultural purposes. This rapid warming results in an early emergence of most of the stonefly species which reduced them to their minimum percentage composition of 1% as early as late June.

The Trichoptera were at a maximum percentage of the total bottom fauna, 30 to 35%, in the early spring and summer and gradually decreased to a minimum of 13% by late August as a result of late summer emergence characteristic of a great many caddisfly species.

The Coleopteran fauna remained as a conspicuous part of the benthos throughout the study period with a low of 17% in late June and a high of 24% occurring in late August. The significant increase from July to August was undoubtedly a function of continuous hatching. The adults, also entirely aquatic, are much larger and more readily collected. This bias undoubtedly overestimated this mid-summer increase in percentage composition of the beetles.

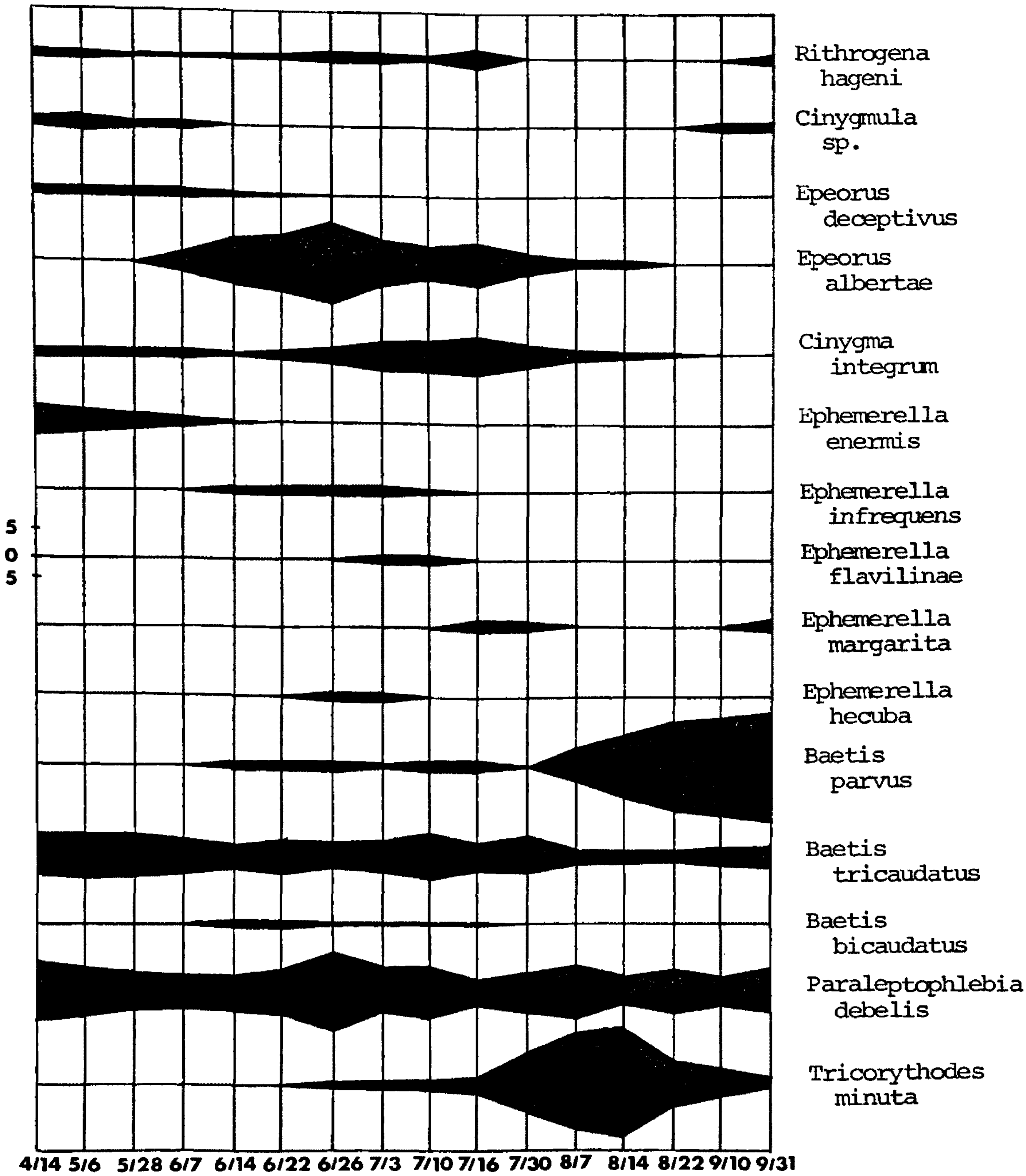
The Diptera increased to an average of approximately 14% of the total bottom fauna. This increase is undoubtedly a function of increased efficiency of the Surber sampler as a result of low stream discharge and velocity. Because of this increase in sampling efficiency, the percentage composition data for the delicate Dipteran larvae at this site is probably a much more reasonable estimate of their actual composition at this site than are the data from Sites I or II.

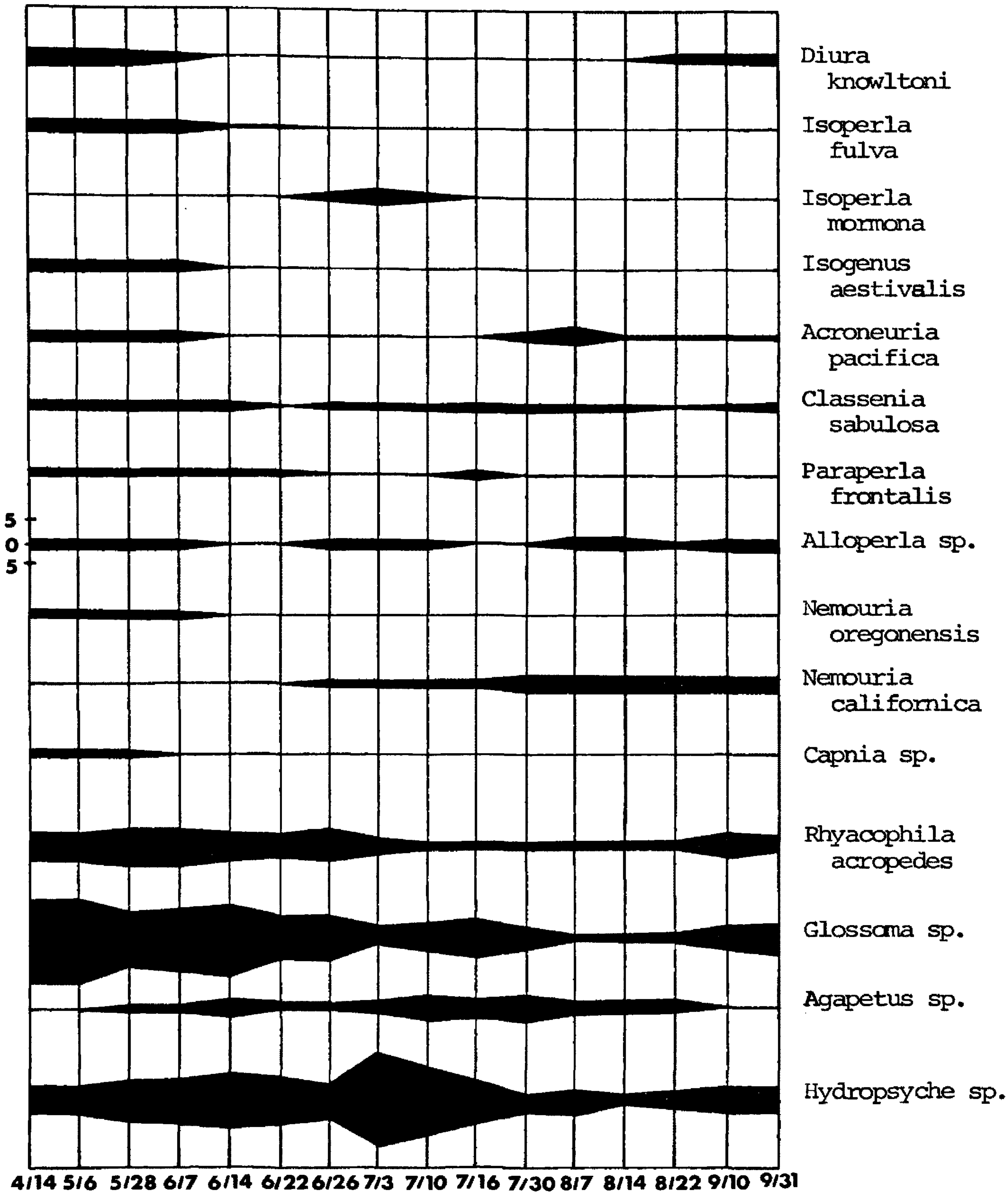
Site III

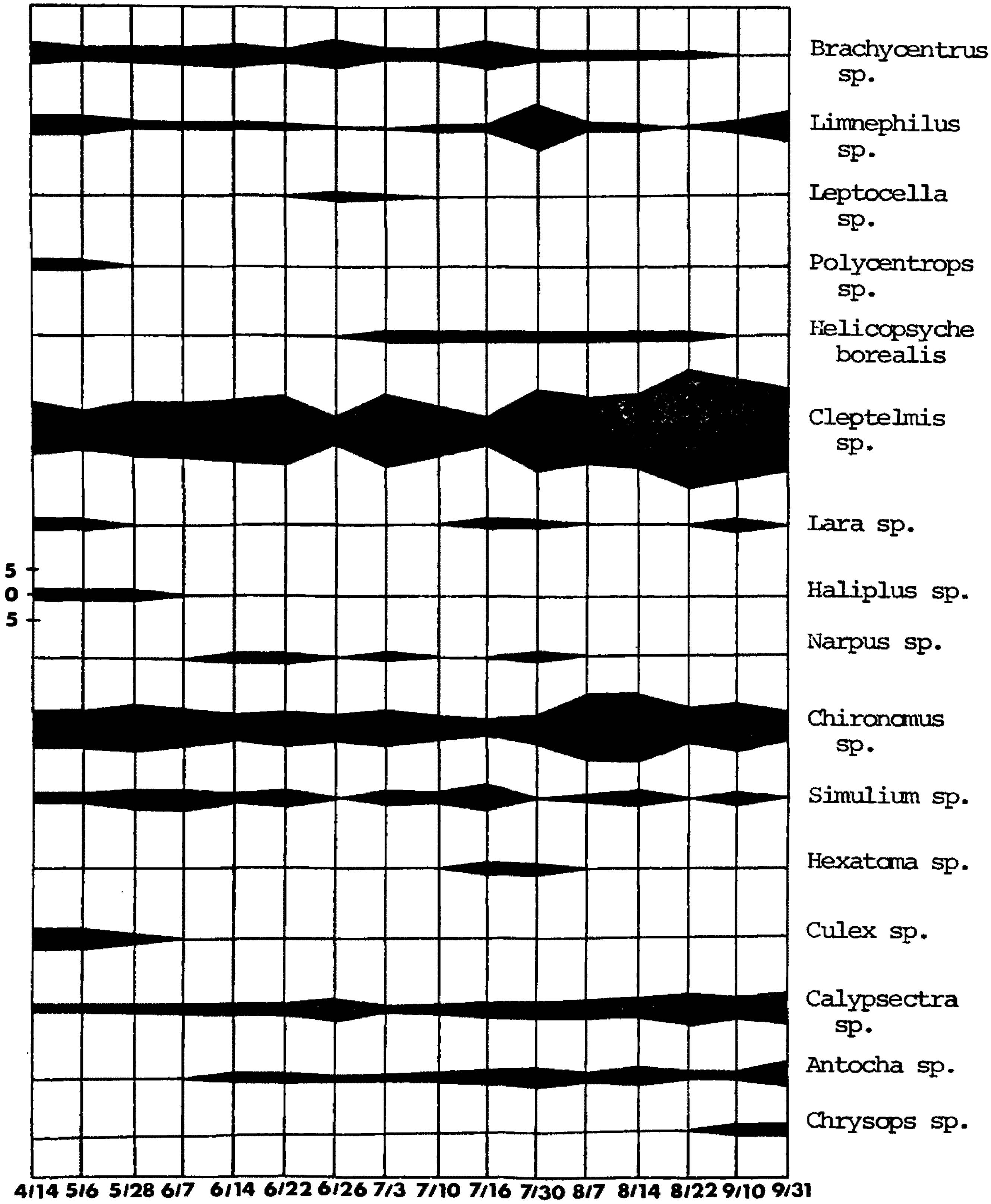
Percentage Composition by Species

As a result of the reduction in stream velocity and water temperature, Rithrogena hageni and Cinygmula sp. dropped from their number one position in the mayfly fauna at 50% to a mere 10%. Rithrogena was at a maximum density of from 3 to 5/ft^2 during the spring and early summer with a maximum percentage composition of the total bottom fauna of 2% which occurred in late June. The life history of Rithrogena hageni does not appear to be much affected by the substantial increase in water temperature, with emergence in mid-July and hatching in late September. Cinygmula sp. on the other hand was greatly affected by the increase in water temperature, emerging in late May, a month and a half earlier than at the colder, faster Sites I and II. This genus was absent from this site for the remainder of the study period with no evidence of hatching. Hatching evidently occurs in the late winter and

Fig. 17. Percentage composition of the individual species in the bottom fauna, Site III. The width of the spindle is proportional to the percentage composition of each individual species.


Rithrogena hageni
Cinygmula sp.
Epeorus deceptivus
Epeorus albertae
Cinygma integrum
Ephemerella enermis
Ephemerella infrequens
Ephemerella flavilinae
Ephemerella margarita
Ephemerella hecuba
Baetis parvus
Baetis tricaudatus
Baetis bicaudatus
Paraleptophlebia debelis
Tricorythodes minuta
5
0
5
4/14 5/6 5/28 6/7 6/14 6/22 6/26 7/3 7/10 7/16 7/30 8/7 8/14 8/22 9/10 9/31


Diura knowltoni
Isoperla fulva
Isoperla mormona
Isogenus aestivalis
Acroneuria pacifica
Classenia sabulosa
Paraperla frontalis
Alloperla sp.
Nemouria oregonensis
Nemouria californica
Capnia sp.
Rhyacophila acropedes
Glossoma sp.
Agapetus sp.
Hydropsyche sp.
5
0
5
4/14 5/6 5/28 6/7 6/14 6/22 6/26 7/3 7/10 7/16 7/30 8/7 8/14 8/22 9/10 9/31


Brachycentrus sp.
Limnephilus sp.
Leptocella sp.
Polycentrops sp.
Helicopsyche borealis
Cleptelmis sp.
Lara sp.
Haliplus sp.
Narpus sp.
Chironomus sp.
Simulium sp.
Hexatoma sp.
Culex sp.
Calypsectra sp.
Antocha sp.
Chrysops sp.
5
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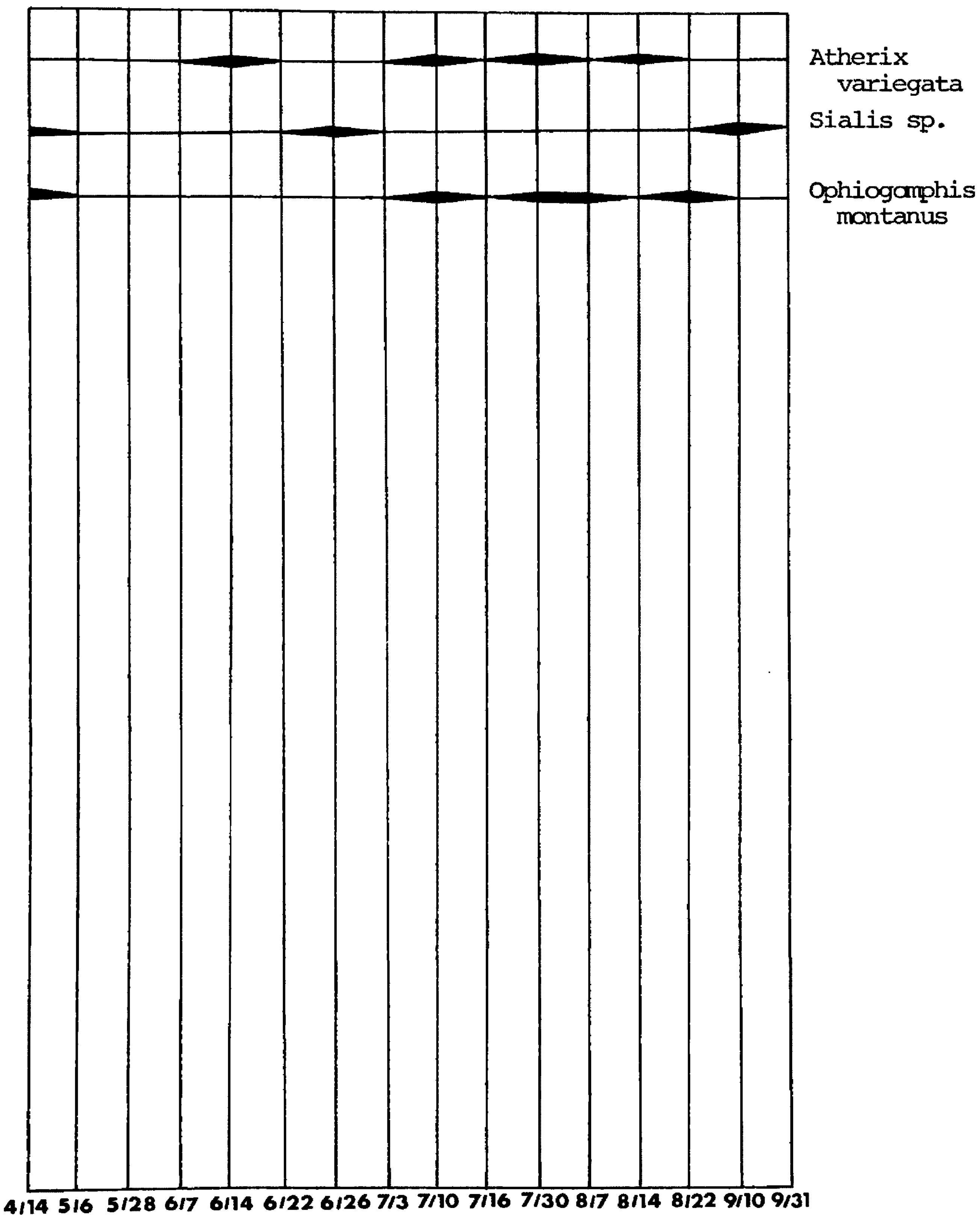
4/14 5/6 5/28 6/7 6/14 6/22 6/26 7/3 7/10 7/16 7/30 8/7 8/14 8/22 9/10 9/31


Atherix variegata
Sialis sp.
Ophiogomphis montanus
4/14
5/6
5/28
6/7
6/14
6/22
6/26
7/3
7/10
7/16
7/30
8/7
8/14
8/22
9/10
9/31

early spring. A similar phenomemon was noted for the three species of Epeorus collected at Sites I and II. Epeorus deceptivus was much reduced in numbers, averaging only about 3/ft^2 and a maximum percentage composition of only 2% in late May. Emergence was in mid-June, approximately one month earlier than the same species at Site I or II with no evidence of hatching by late September. As Epeorus deceptivus was emerging from the stream, its position in the ecosystem was again evidently taken by Epeorus albertae as the water continued to warm. Subsequently, Epeorus albertae also hatched a month earlier here than at Site I or II, and quickly proliferated to the dominant mayfly species at 17% of the total bottom fauna by late June. Emergence began in early August. Epeorus longimanus completely disappeared from the mayfly fauna at this slower and warmer site. Along with Epeorus albertae, a new mayfly species, Cinygma integrum, became the dominant Heptageniid mayflies in this section of Post Creek. Both species are large-gilled and flat-bodied, rendering them very well adapted for the warmer water temperatures, lower dissolved oxygen, lower current velocity, and increased detrital accumulation and siltation. Cinygma integrum gradually increased from a percentage composition of less than 1% in April and May to a maximum density of 17/ft^2 and 9% of the total bottom fauna by mid-July. Cinygma integrum emerged around the first of August, evidently overwintering as an egg. Baetis tricaudatus is still a dominant portion (10%) of the total bottom fauna and about

30% of the mayfly fauna. The changes in the aquatic environment seem to have very little effect on the population structure or life history of this particular euryokous species. The most noticeable change in the mayfly fauna and the total bottom fauna for that matter was the substantial increase in the density of Paraleptophlebia debelis. This species averaged 10% of the total bottom fauna with a high of 17% in late June. This species is an algal and detrital feeder and obviously greatly increased in density in relation to its increased food source in this section of Post Creek. Paraleptophlebia debelis began its emergence in late July and early August continuing through September evidently hatching the following spring. There was one other new and quite conspicuous species that appeared in this section of Post Creek-Tricorythodes minuta, also a warm water, low current, algal and detrital feeding mayfly. Tricorythodes minuta hatched in late June and early July and quickly proliferated to 23% of the total bottom fauna by early August, at which time emergence began. This life history corresponds quite closely to the periphytic and detrital build up and decline on the substrate. This rather small but stout, hairy-bodied, dorsally gilled animal appears to be highly adapted for life under the existing conditions of low discharge and current velocity, relatively high water temperatures and high algal and detrital build up. It has been suggested that the dorsal position of the gills and the actual mechanical beating of the gills enables this insect to survive in such habitats.

In Tricorythodes, the first gill is reduced or absent and the second forms a sort of operculum over the others which lie superimposed beneath like pages of a book. This operculum not only acts as a baffle maintaining a constant circulation over the gills but also acts as a shield against damage to the fragile gills. This insures the maintenance of an adequate respiratory current to the gills without their becoming clogged with silt or detritus. The overall hairiness aids in respiration by keeping silt and detritus from the gills and preventing smothering. Most of the members of the genus Ephemerella at this site show the same characteristic adaptations to some degree. Many genera such as Epeorus and Cinygma are greatly flattened to prevent them from sinking in the soft algal and detrital build up, whereas others like the Odonate, Ophiogomphis montanus use anal respiration. As a rule of thumb, species tend to be stouter-bodied in streams of low flow and dissolved oxygen to achieve a better surface to volume ratio.

Of the 11 species of Plecoptera collected at Site III, 8 species emerged for the most part by mid-June. This again was undoubtedly a function of increased water temperature as a result of decreased flow and agricultural activity along its banks. These generally cold water species are Diura knowltoni, Isoperla fulva, Nemoura oregonesis, Isogenus aestivalis, Capnia sp., and Paraperla frontalis. Diura knowltoni makes up roughly 35% of the total bottom fauna in the early spring and summer. Emergence occurred in the first week of June followed by hatching in late August and September. Isoperla fulva and Nemoura oregonesis both contributed 1% to the total bottom fauna with no evidence for either hatching during the study period. Isogenus aestivalis, Capnia sp., and Paraperla frontalis generally contribute less than 1% of the total bottom fauna again with no evidence of hatching during the study period. The most obvious exceptions to this early emergence of stoneflies are the members of the family Perlidae, Classenia sabulosa and Acroneuria pacifica. These large, heavy-bodied stoneflies have a three-year life cycle which accounts for their continuous importance as part of the total bottom fauna. During the spring and summer all three-year classes in the life cycle were collected. Although small in numbers, averaging only about 3/ft^2 or 1% of the total bottom fauna, these two species add substantially to the biomass of the section because of the large size of the mature nymphs (1.5 to 2.0 in in length). The three-year-old mature nymphs began to emerge in mid-July, continuing through August and the first nymphal instars appeared by late August. Both species have profusely branched gills at the lower angles of the thorax which enables efficient respiration under the environmental conditions characteristic of this section of stream. This type of gill system is not nearly so subject to clogging or abrasion as is the lamellate type characteristic of the fast water forms. But conversely, this type of gill system would be very disadvantageous in areas of swift current because of the greatly increased amount of water friction. One other stonefly species, Nemoura californica, appeared to thrive under these environmental conditions. It is a very small, hairy-bodied insect having no gills. Respiration is entirely by diffusion through the integument with the extreme hairiness removing any adverse effects from extensive siltation and detritus build up. Nemoura californica hatched in late June and early July reaching a density peak at 8/ft^2 by mid-August, again roughly corresponding to the algal and detrital build up and decline in this section of Post Creek. Emergence is believed to occur the following winter.

It becomes intuitively obvious that current is a major factor affecting the respiration of aquatic invertebrates. It operates by the rapid replacement of the water in the immediate vicinity of the gills. It has been shown by many workers that the respiratory rate of some species such as Rhyacophila, Baetis, and Rithrogena is directly related to the current speed, and that the faster the current the lower the level of oxygen concentration an insect can tolerate. Most aquatic stream insects have lost nearly all their ability of mechanical respiratory activity to maintain a current over the gills which makes them rheostenic or current obligates, effectively restricting these animals to running water. "It is undoubtedly true, at least as regards many dissolved substances, flow increases the effective physiological concentration in the water, and that, for animals as well as plants, running water is a richer environment than still water of the same chemical content" (Hynes, 1970).

The Trichopteran fauna made substantial increases in both density and diversity. As seen previously, the 9 species contribute well over 30% of the total bottom fauna and well over 50% of the total biomass. The two species of the family Rhyacophilidae, *Rhyacophila acropedes* and *Glossoma sp.*, contribute roughly 20% of the total bottom fauna and well over 60% of the total caddisfly fauna. Both species are at a maximum percentage composition (6 and 17% respectively) during the early spring and summer. *Rhyacophila* appeared to emerge in mid-July, whereas *Glossoma* emerged a month later in mid-August. Hatching began for both species by mid-September. Another member of the Rhyacophilidae, *Agapetus sp.*, also was a conspicuous member of the Trichopteran fauna. It apparently hatched in late May and emerged in late August. Rivaling *Glossoma* for the number one position in the Trichopteran fauna was the genus *Hydropsyche spp*. It showed a four-to-five fold increase over Site II. Its density increased gradually throughout the spring and summer from 17 to 49/ft^2 in early July which amounted to 19% of the total bottom fauna. Emergence began in late July and continued through August and September with the first nymphal instars appearing in late September. *Brachycentrus* and *Limnephilus* both contribute approximately 3% to the total bottom fauna, a substantial increase over Site II. *Brachycentrus* maintained a relatively constant percentage of the total bottom fauna throughout the study period with emergence running through August and September. *Limnephilus* showed a rather constant oscillating density throughout the study period, evidently a function of its two year life cycle. Both age classes were collected throughout most of the study period while the population showed periodic emergence from late June through September. Without a doubt, the major factor in the drastic increase in Trichopteran diversity and standing crop was the substantial increase in the algal flora in relation to increased solar radiation, water temperature, bicarbonate alkalinity, and the reduced but extremely constant flow characteristic of this section of Post Creek. Most of the Trichoptera collected were herbivorous, algal, and detrital feeders; some being grazers such as Limnephilus, Glossoma, and Agapetus, whereas others such as Brachycentrus, Hydropsyche, Wormaldia, Leptocella, and Polycentrops are filter feeders. The efficiency of the net-spinning, filter-feeding types in procuring food is greatly increased in the uniform, stable environment offered by this section of Post Creek.

Again, the most abundant species in the Coleopteran fauna was the small riffle beetle, Cleptelmis sp. Both adults and larvae were found in varying proportions throughout the study period which gave the population a uniform structure of high density averaging 30 to 40/ft^2 accounting for between 10 and 15% of the total bottom fauna.

The Diptera of Site III ranged from 11 to 17% of the total bottom fauna and as previously stated, this is probably a reasonably accurate estimation of their actual standing crop. Again, by far the most abundant species are the midges of the family Chironomidae, primarily the genus *Chironomus* averaging 22/ft^2. It is generally felt by most workers that *Chironomus* is generally more abundant in colder, faster sections of stream. If more care was taken in sampling for these delicate organisms, a much more significant drop in density would have occurred between Sites II and III. *Simulium sp*. was the second most abundant Diptera in this section of Post Creek and made a quite substantial increase from Site II. The blackflies gradually increased to a maximum of 5% of the total bottom fauna by mid-July and emerged periodically throughout the summer whenever environmental factors were favorable. Another net-spinning Diptera, *Calypsectra sp*., also flourished as a conspicuous and continuous member of the bottom fauna, averaging approximately 3% of the total bottom fauna throughout the study period. These two species proliferated in this section of stream for the same basic reasons previously discussed for the same phenomenon observed in the Trichoptera.

Two new orders made an appearance in this section of Post Creek; Megaloptera in the form of the alderfly, *Sialis sp*., and Odonata in the form of the dragonfly, *Ophiogomphis montanus*. Neither species ever amounted to any significant portion of the total bottom fauna.

Site IV

Monthly Trends in Percentage Composition by Order

During the sampling period, Site IV of Post Creek had an average of 355 benthic insects and a corresponding average biomass of 5.3 cc/ft^2 (Fig. 18). Maximum density

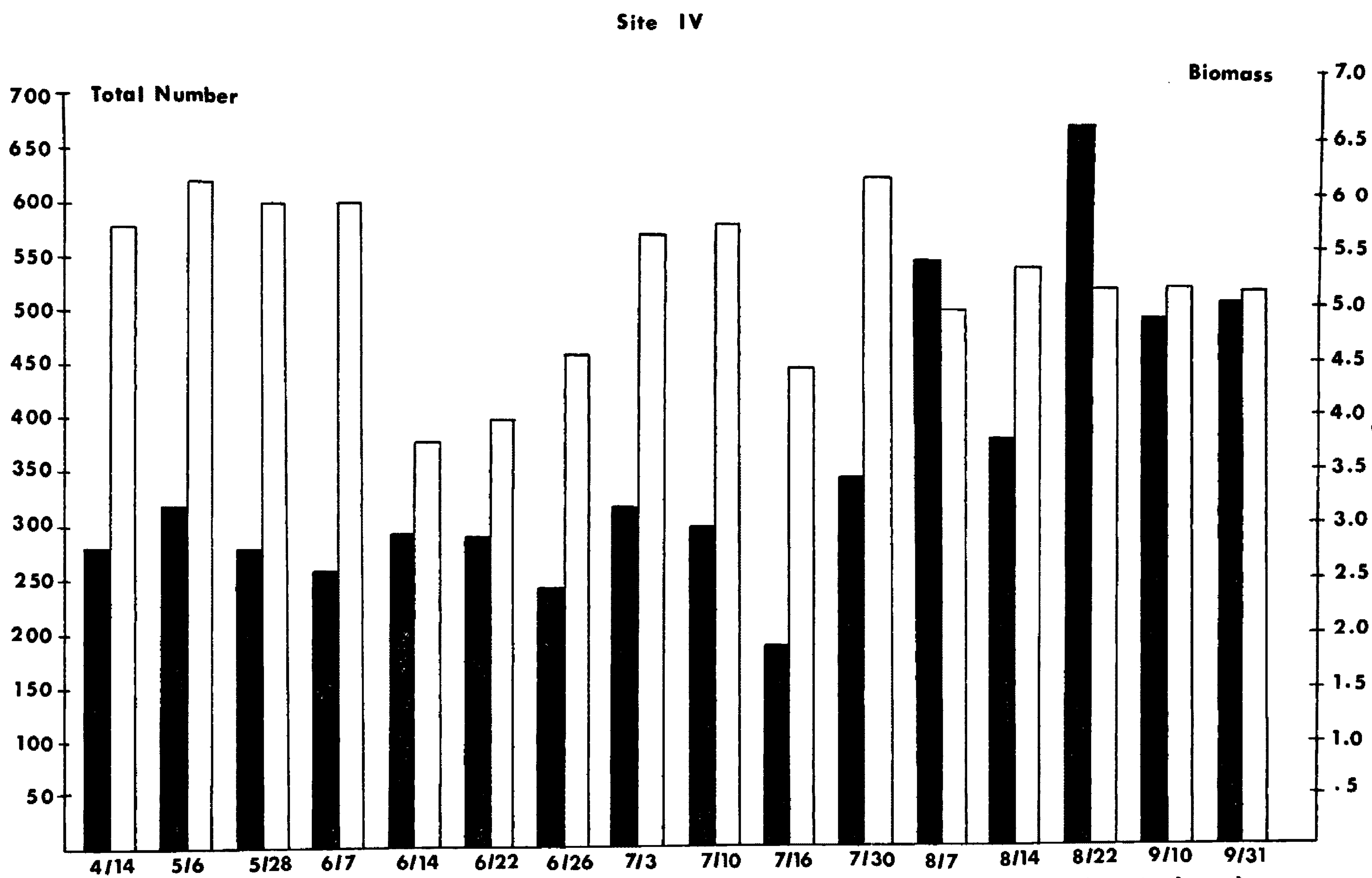
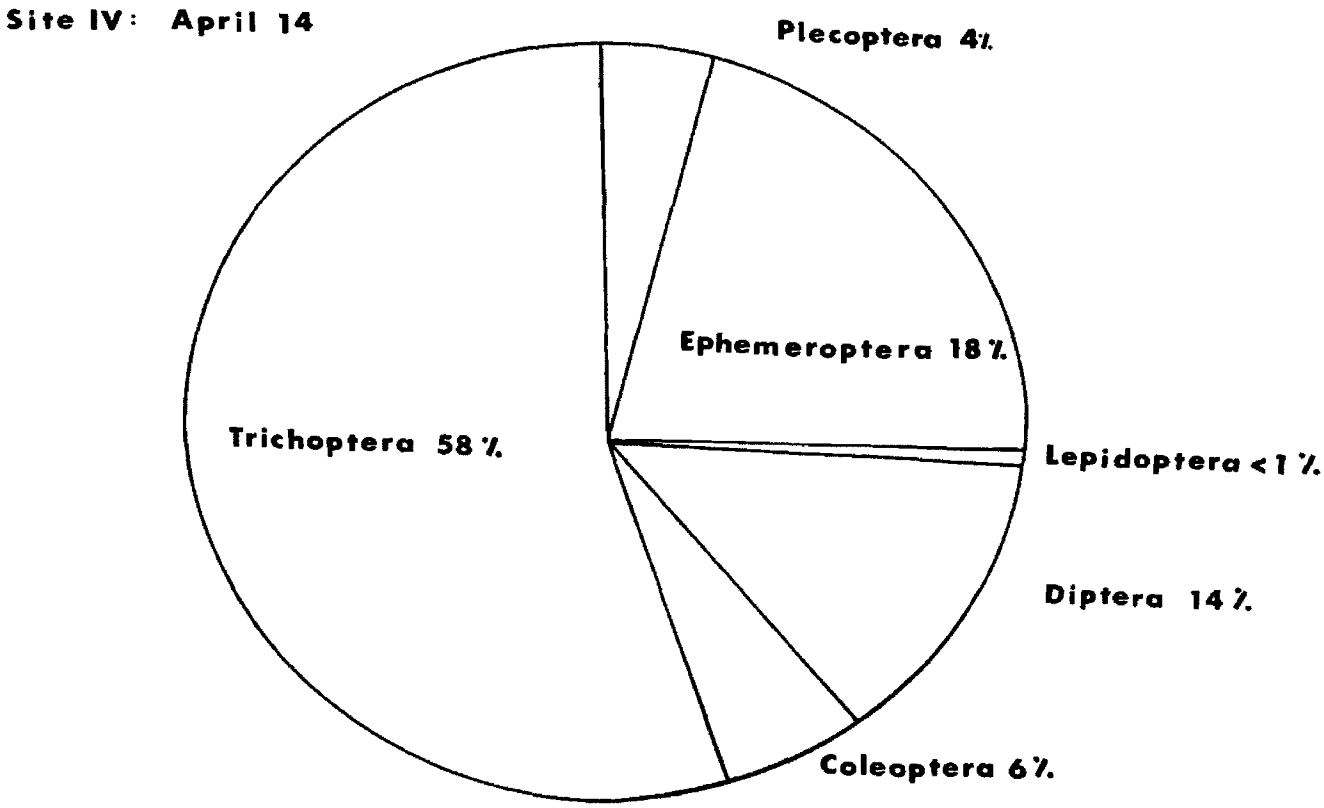


Fig. 18. Comparison of the Total Number of Benthic Insects Collected to Their Biomass

Fig. 19. Percentage Composition of the Bottom Fauna by Order, Site IV



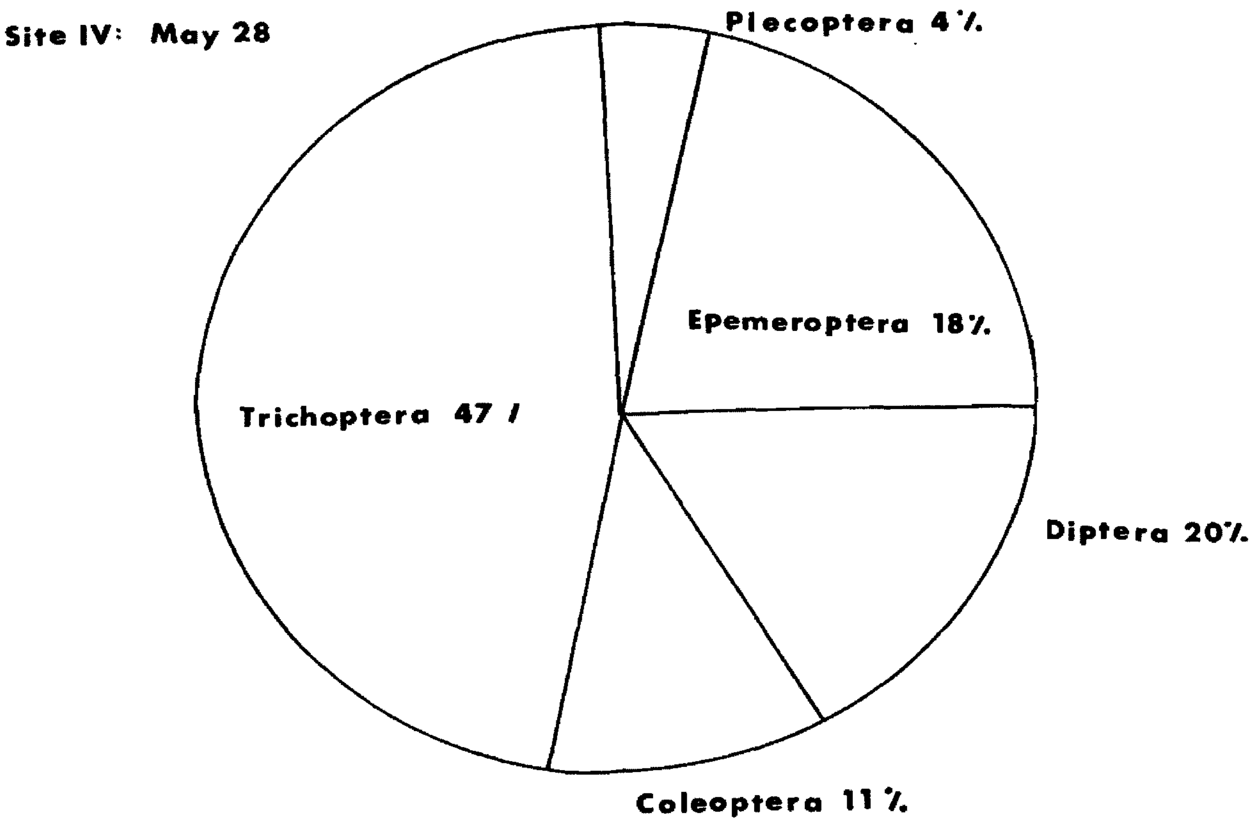
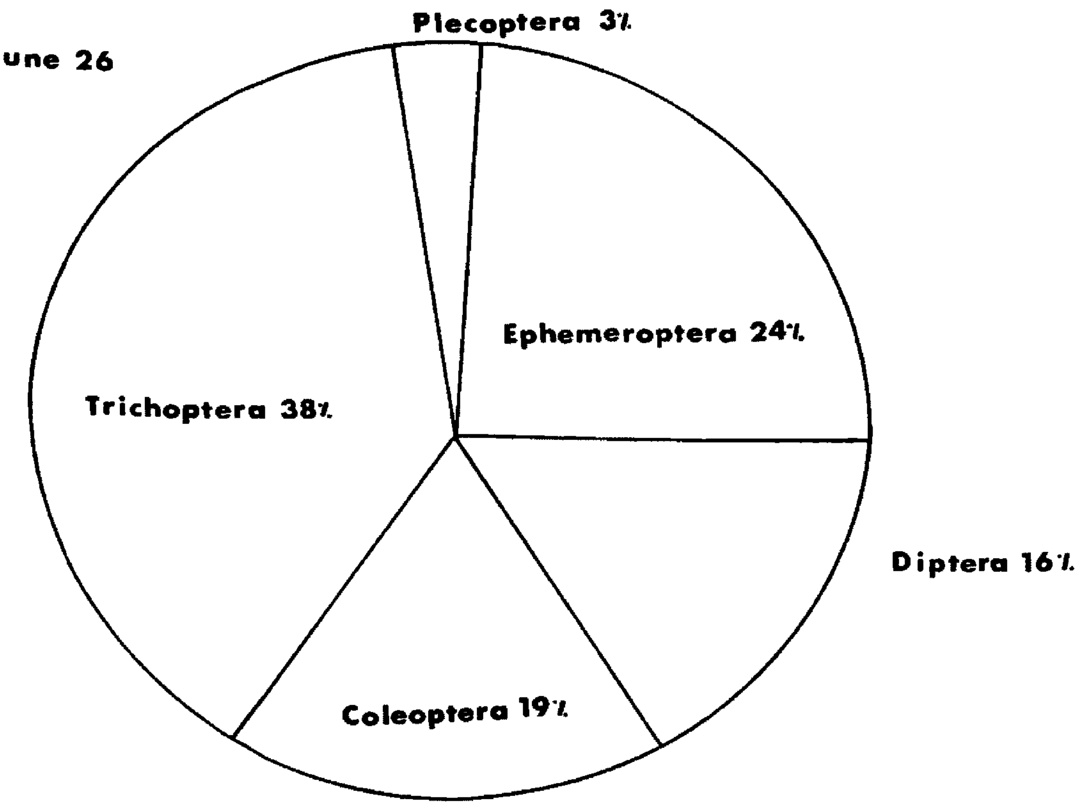


Fig. 19 - Continued

Site IV: June 26



Site IV: July 30

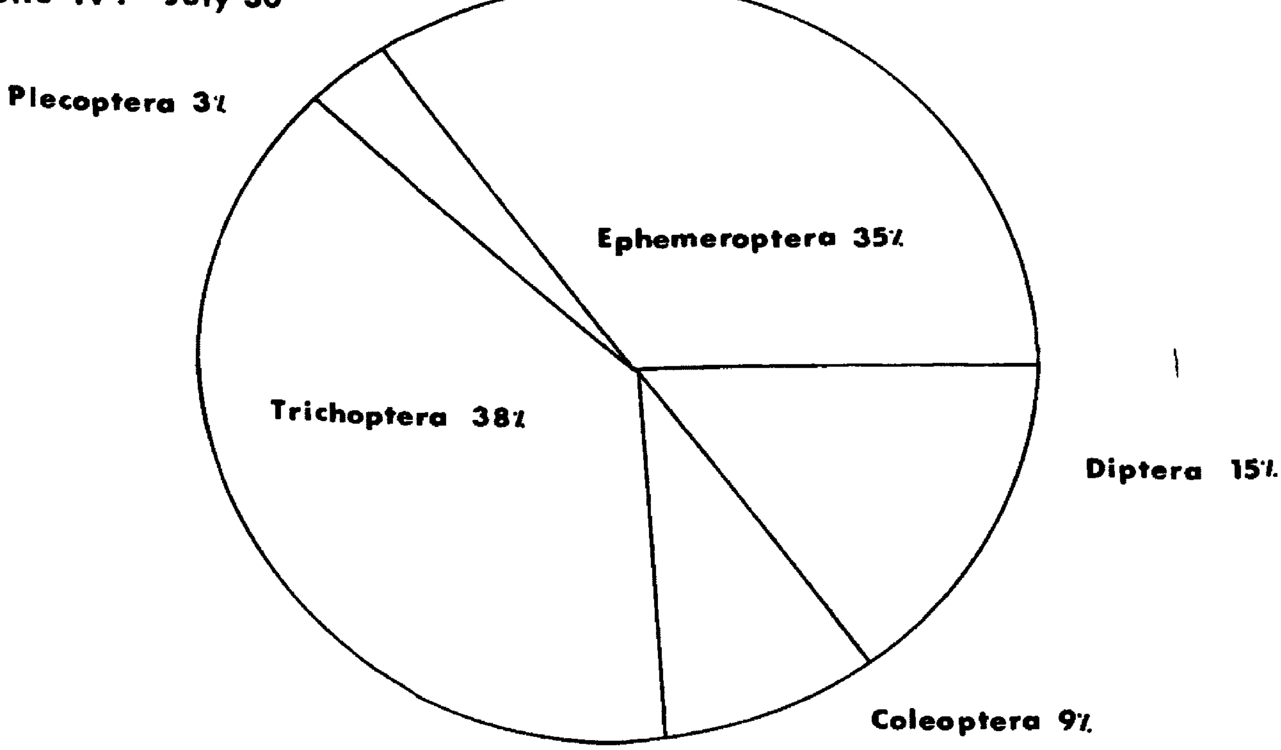
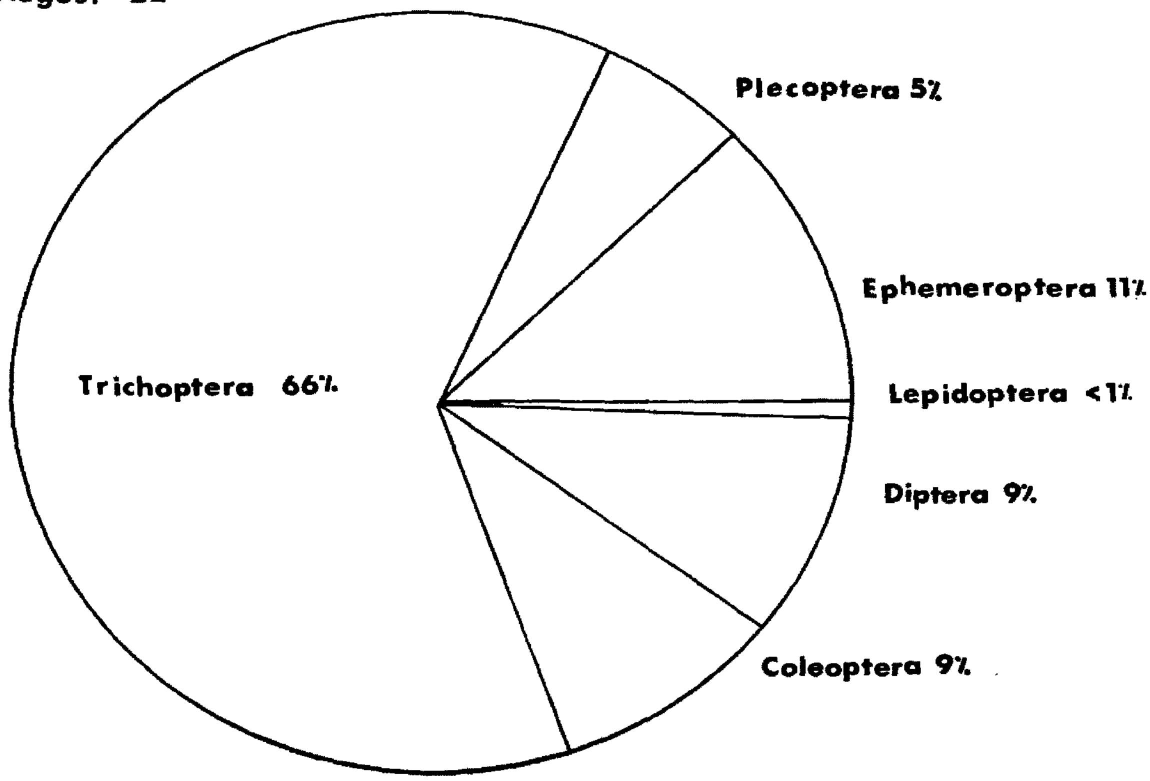
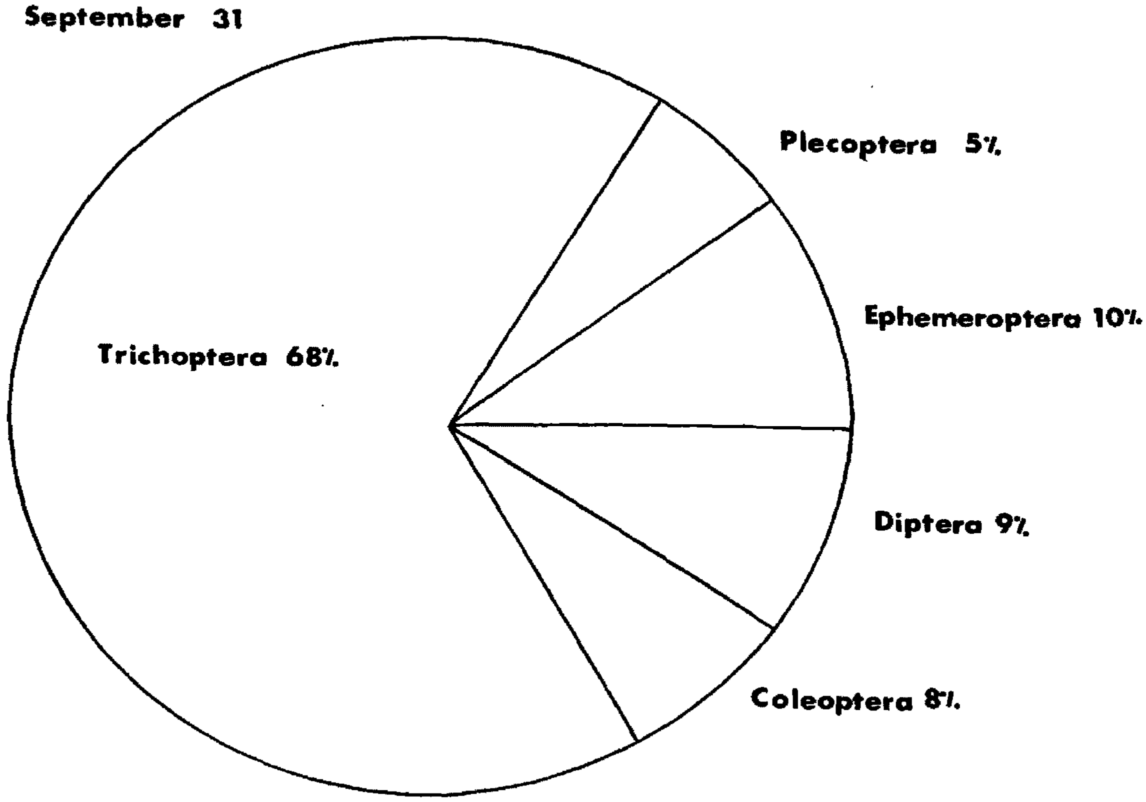


Fig. 19 - Continued

Site IV: August 22



Site IV: September 31



occurred in late August primarily as a result of summer hatching and increased recruitment of mature nymphs.

The Trichopteran fauna continued to increase to an average of nearly 50% of the total bottom fauna throughout most of the study period. The caddisflies were at a maximum percentage of approximately 60% during the early spring and summer and again in late September. The minimum percentages of near 40% of the total bottom fauna occurred in mid-July. These percentages entail a two-fold increase over Site III and nearly a six-fold increase over Sites I and II.

The mayflies were still a dominant group at Site IV averaging 20% of the total bottom fauna throughout the study period, entailing a two-fold reduction from Site III and well over a three-fold reduction from Sites I and II. This group more than any other has diminished as a result of the massive proliferation of the caddisflies as the water continued to become warner, more eutrophic, and stable. The mayflies increased gradually from early spring to a maximum of 35% of the total bottom fauna by late July.

The Plecopteran fauna was still constant throughout the study period, but at 4% was only about half of what it contributed at Site III. The maximum percentages of Plecoptera occurred in the spring, late summer, and autumn when the water temperature was still at a minimum of 12° C.

The Coleoptera, as at all previous sites, remained as a conspicuous portion of the benthos throughout the study period with a low of 6% in the early spring and a a high of 19% in late June. As seen in all previous sites, this mid-summer increase was a function of hatching; the aquatic adults were more readily collected than the small larvae.

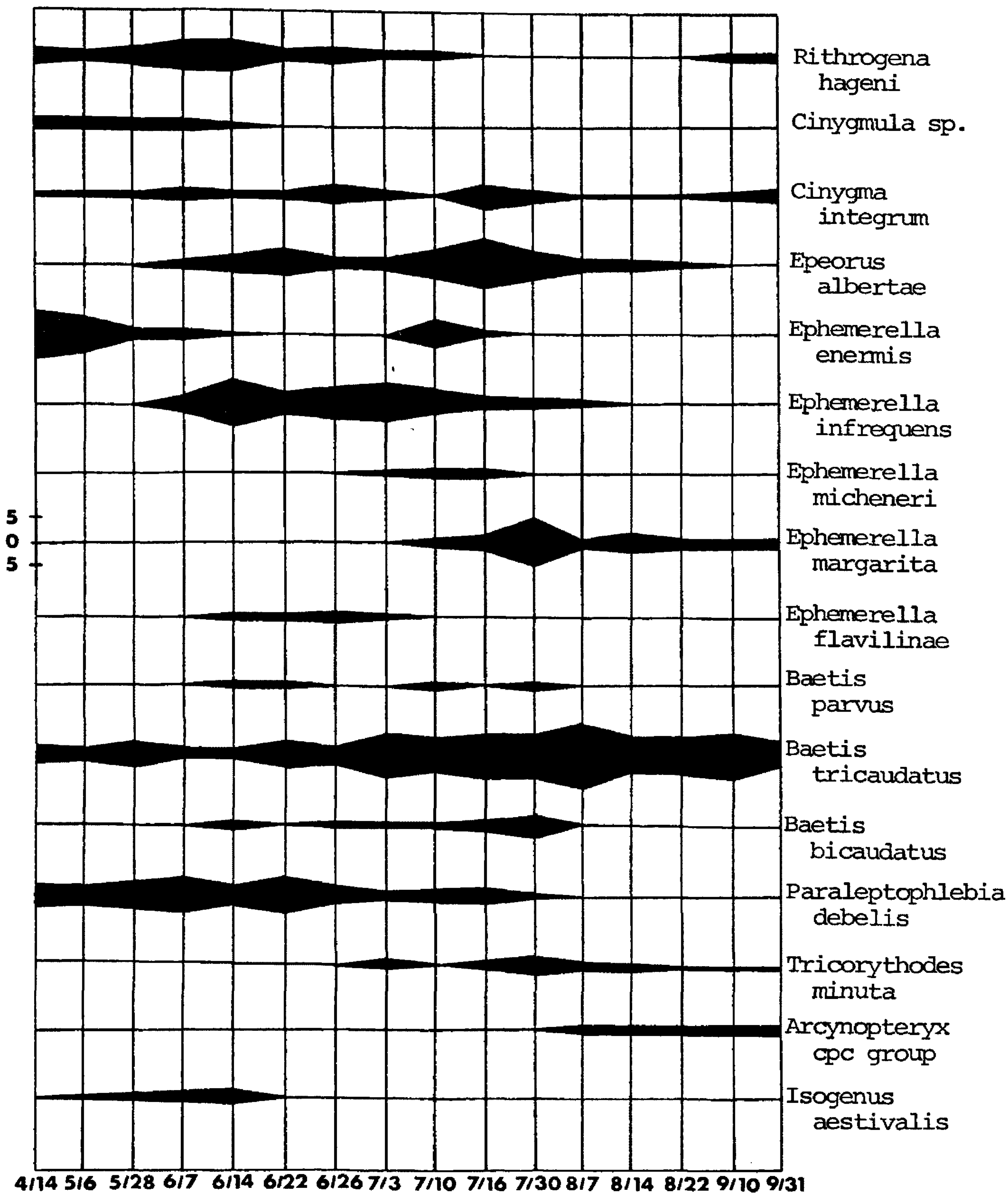
The Diptera, as at Site III, remained at an average of approximately 15% of the total bottom fauna. Again, as at Site III, this increase in Dipteran larvae is undoubtedly a function of increased efficiency of the Surber sampler under these conditions of reduced discharge and velocity and a fairly regular bottom substrata. For these reasons, the percentage composition observed was probably a relatively close estimation of the actual standing crop of the Diptera at this site.

Site IV

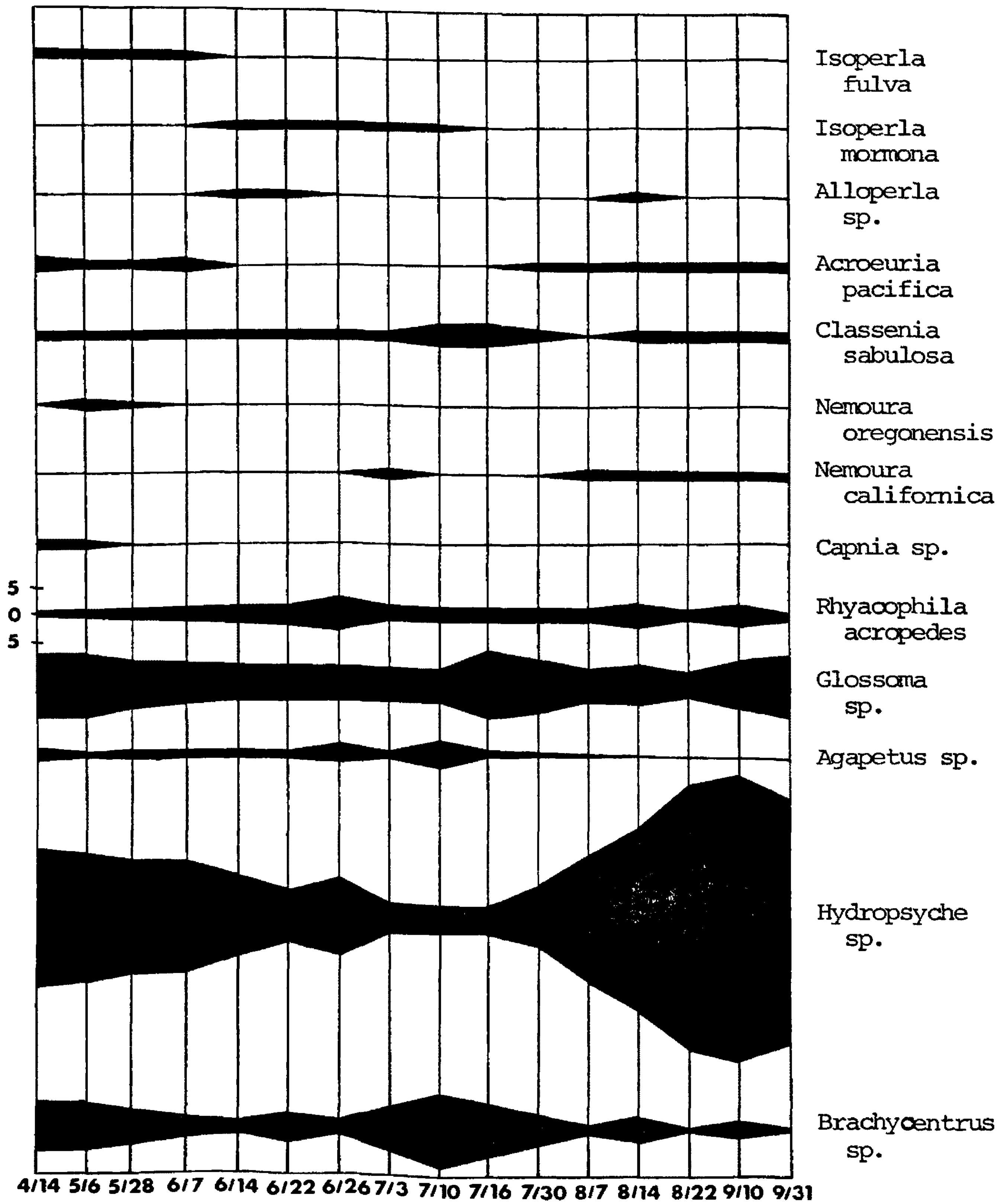
Percentage Composition by Species

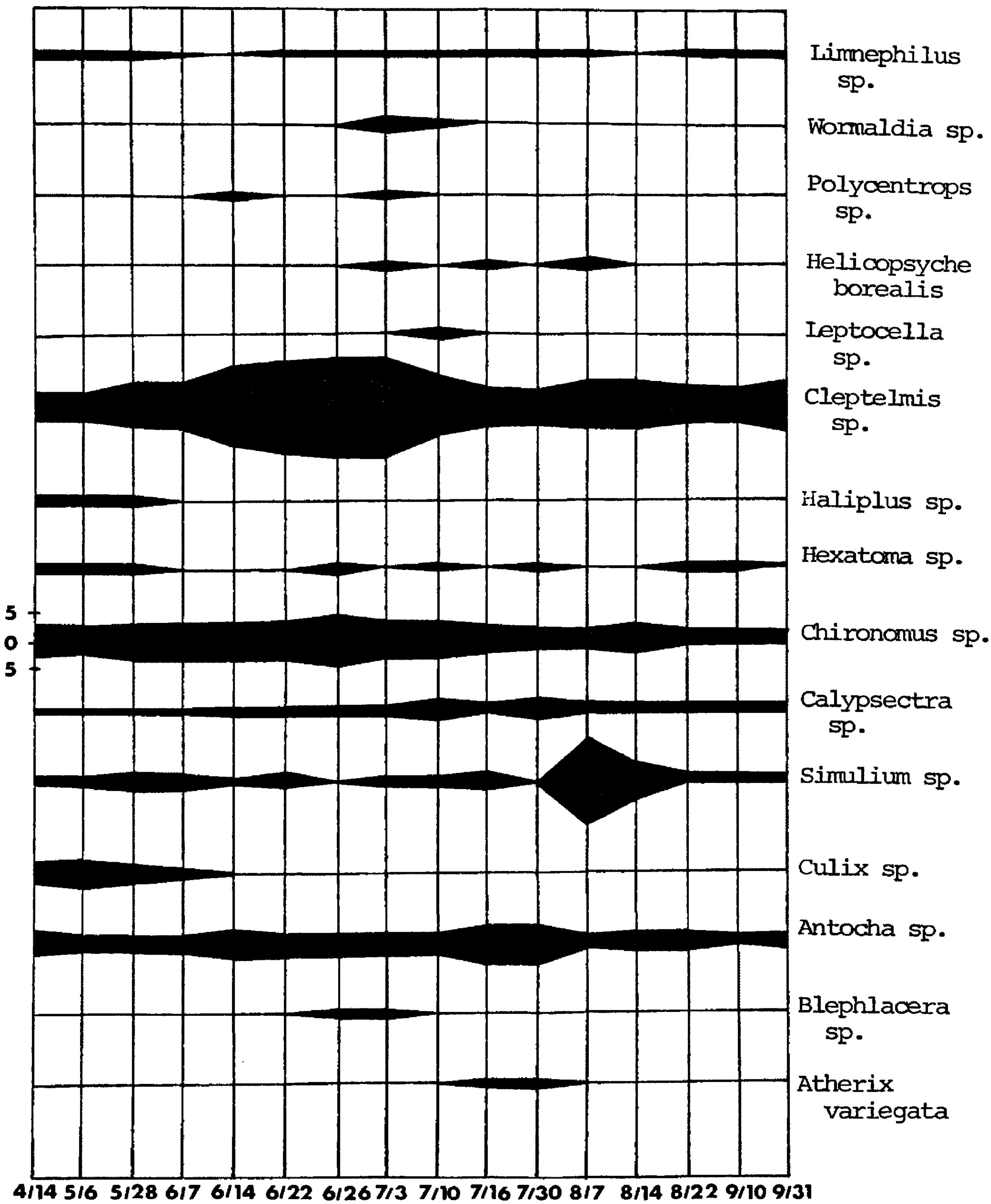
Again, as at Site III, Rithrogena hageni and Cinygmula sp. dropped from their top position in the mayfly fauna of nearly 50% to less than 10% as a result of the reduction in stream velocity and increased water temperature. The life cycles of both species appeared to be the same as found at Site III. Rithrogena hageni reached a maximum density of $15/ft^2$ or roughly 5% of the total bottom fauna by the first week in June. Cinygmula sp. on the other hand, reached a maximum density of only $4/ft^2$, just over 1% of the total bottom fauna by May. Epeorus deceptivus disappeared from the benthos leaving only Epeorus albertae to represent the genus as the water continued to warm downstream. Epeorus albertae hatched in early June and increased to a maximum

Fig. 20. Percentage composition of the individual species in the bottom fauna, Site IV. The width of the spindle is proportional to the percentage composition of each individual species.



Rithrogena hageni
Cinygmula sp.
Cinygma integrum
Epeorus albertae
Ephemerella enermis
Ephemerella infrequens
Ephemerella micheneri
Ephemerella margarita
Ephemerella flavilinae
Baetis parvus
Baetis tricaudatus
Baetis bicaudatus
Paraleptophlebia debelis
Tricorythodes minuta
Arcynopteryx cpc group
Isogenus aestivalis
5
0
5
4/14 5/6 5/28 6/7 6/14 6/22 6/26 7/3 7/10 7/16 7/30 8/7 8/14 8/22 9/10 9/31


Isoperla fulva
Isoperla mormona
Alloperla sp.
Acroeuria pacifica
Classenia sabulosa
Nemoura oregonensis
Nemoura californica
Capnia sp.
5
0
5
Rhyacophila acropedes
Glossoma sp.
Agapetus sp.
Hydropsyche sp.
Brachycentrus sp.
4/14 5/6 5/28 6/7 6/14 6/22 6/26 7/3 7/10 7/16 7/30 8/7 8/14 8/22 9/10 9/31


Limnephilus sp.
Wormaldia sp.
Polycentrops sp.
Helicopsyche borealis
Leptocella sp.
Cleptelmis sp.
Haliplus sp.
Hexatoma sp.
Chironomus sp.
Calypsectra sp.
Simulium sp.
Culix sp.
Antocha sp.
Blephlacera sp.
Atherix variegata
5
0
5
4/14
5/6
5/28
6/7
6/14
6/22
6/26
7/3
7/10
7/16
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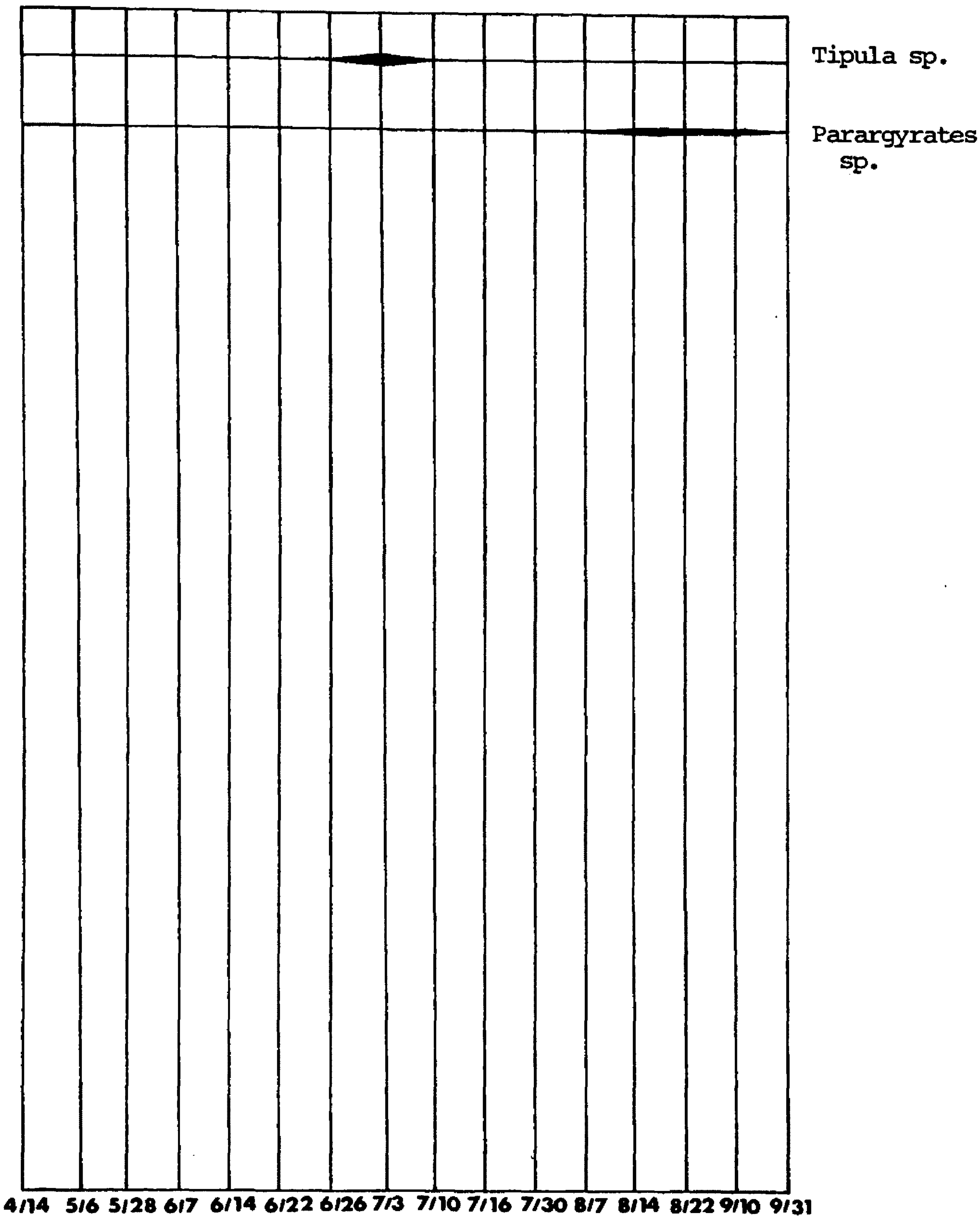
8/22
9/10
9/31



Tipula sp.
Parargyrates sp.
4/14 5/6 5/28 6/7 6/14 6/22 6/26 7/3 7/10 7/16 7/30 8/7 8/14 8/22 9/10 9/31

of $21/ft^2$ or approximately 10% of the total bottom fauna by mid-July. Emergence began in early August and was complete by the first of September. As at Site III, Epeorus albertae and Cinygma integrum were still the dominant Heptageniid mayfly species in this section of Post Creek. Cinygma integrum continued to increase gradually from an average of $1/ft^2$ in the spring to a maximum of $11/ft^2$ or 5% of the total bottom fauna by mid-July. Cinygma integrum emerged around the first of August and evidently overwinters as an egg, hatching the following spring. As stated previously, both species are very well adapted for the conditions characteristic of this site. Five species of the genus Ephemerella progressively succeeded one another through the study period, each adding significantly to the mayfly fauna. First to appear in any numbers was Ephemerella enermis with a maximum density of $28/ft^2$ or approximately 9% of the total bottom fauna during April and May. Emergence of this species apparently began in early June and continued to the end of the month. Most Ephemerella species overwinter as eggs. Following the emergence of Ephemerella enermis, Ephemerella infrequens hatched and quickly proliferated to an average of 7% of the total bottom fauna until they emerged in mid-July at which time Ephemerella margarita hatched and moved into the vacant niche. Ephemerella margarita quickly increased to a maximum of 9% of the total bottom fauna or $31/ft^2$ by the end of July, with emergence from mid-August through September. Ephemerella flavilinae and Ephemerella micheneri both make a short mid-summer appearance, but neither ever amount to any significant portion of the benthos. The staggered life histories of related species, allows more species to utilize the available resources of the immediate environment by avoiding direct competition. This temporal isolation of similar species greatly increases the overall diversity of the community in its relatively limited area. Baetis tricaudatus maintained its role as the ever-present mayfly member of the benthos ranging from 4 to 13% of the total bottom fauna and nearly 40% of the mayfly fauna. Evidently the environmental changes encountered from Site I to Site IV had very little effect on the life cycle or population structure of this euryokous species. Paraleptophlebia debelis was still a very conspicuous part of the mayfly fauna, but the average of 5% of the total bottom fauna represented a reduction of nearly one-half from Site III. This significant reduction in absolute numbers and percentage of the bottom fauna was most likely a result of reduced detritus accumulation and increased competition and predation from such groups as the Trichoptera which continued to greatly increase in numbers at this site. Paraleptophlebia debelis grew to a density maximum of 24/ft^2 or approximately 8% of the total bottom fauna by mid-June. Emergence began in late June and continued through July. This is nearly a full month earlier than at Site III, apparently corresponding to a mere 1 to 2° C change in the water temperature. There was no evidence of hatching during the study period. Apparently Paraleptophlebia debelis overwinters as an egg, hatching the following spring. The detritus feeder, Tricorythodes minuta hatched around the first of June, again a month earlier than at Site III. It increased to a maximum of only 2% of the total bottom fauna by late July. This constituted a reduction of greater than ten-fold over Site III as a result of reduced detrital build-up in this section of Post Creek as compared to Site III. Emergence began in mid-August and continued through September. As observed at Site III, the life history of this species corresponded quite closely to the periphytic and detrital build-up and decline on the substrate. This phenomenon, as well as the life histories of most aquatic insects, is closely related to the annual water temperature cycle.

Of the 10 species of Plecoptera at Site IV, 6 species emerged for the most part by mid-June as a function of increased water temperature as a result of agricultural activity along its channel. These cold water species include Arcynopteryx cpc., Isogenus aestivalis, Isoperla fulva, Nemoura oregonesis, Capnia sp., and Alloperla sp. - none of which ever contributed much over 1% of the total bottom fauna. These species are then replaced by two warm water species of stonefly, Isoperla mormona and Nemoura californica. Isoperla mormona hatched in mid-June and reached a maximum density of $6/ft^2$ or 2% of the total bottom fauna by late June followed by emergence which was complete by mid-July. This was followed by the hatching of Nemoura californica in early August. Nemoura californica remained at approximately 1% of the total bottom fauna for the rest of the study period. This succession of similar species is still another example of temporal isolation which leads to increased diversity in the aquatic ecosystem. As at Site III, the most obvious exceptions to this early stonefly emergence were the two species of the family Perlidae, Classenia sabulosa and Acroneuria pacifica. These large, heavy-bodies stoneflies have at least a three-year life cycle, thus accounting for their constant and continuous percentage of the total bottom fauna throughout the entire study period. Although small in number, these animals contribute substantially to the biomass of benthic insects in this section of Post Creek because of the large size of the mature three-year-old nymphs. The nymphs appeared to emerge from mid-July through August with the first nymphal instars appearing in late August and early September.

The Trichopteran fauna continued to make substantial increases in population density. As seen previously, these 10 species now contribute well over 50% of the total bottom fauna and well over 70% of the total biomass of the benthic insects at this site. Two species of the family Rhyacophilidae, Rhyacophila acropedes and Glossoma sp., contributed 15% to the total bottom fauna and approximately 30% of the caddisfly fauna. Rhyacophila acropedes reached a maximum density of $14/ft^2$ or roughly 5% of the total bottom fauna by mid-summer. Emergence began in mid-July and hatching proceeded through August and September. Glossoma sp. added substantially more to the benthos than did Rhyacophila. It reached a maximum density of 44/ft^2 or 14% of the total bottom fauna in April and May. Pupation apparently began in late June with emergence in mid-July. Hatching began in mid-August and continued through September increasing the density to 53/ft^2. Another member of the Rhyacophilidae, Agapetus sp., contributes a small but conspicuous portion of the Trichopteran fauna averaging 2% of the total bottom fauna. They apparently hatched throughout the early spring and summer and emerged in late August. The most spectacular increase noted at Site IV over the previous sites was that of Hydropsyche spp. and Brachcentrus sp. The density of Hydropsyche was at a maximum (exluding hatching) of 80/ft^2 or 30% of the total bottom fauna during April and May and fell to a minimum of 5% following emergence in late June. Hatching began in early August and increased the density to as high as 377/ft^2 or over 60% of the total bottom fauna by mid-September. Brachycentrus sp. showed a three-fold increase over Site III with a maximum density of 47/ft^2 by mid-July just prior to emergence in early August which continued through September. This species, like Hydropsyche, is a net-spinning form which is very efficient at filter-feeding at the constant current velocity characteristic of this section of Post Creek (Hynes, 1960), and is undoubtedly one of the major factors in its substantial increase from 5 to 15% of the total bottom fauna from Site III. Limnephilus sp. maintained a low but constant density averaging 2/ft^2 throughout the study period because of its two-year life cycle in this section of Post Creek. Although they are few in number, they add substantially to the total biomass because of the large size of the mature two-year-old nymphs. Periodic emergence occurred throughout the late summer and autumn. It was plain to see that as the algal flora continued to increase as a function of increased eutrophication, water temperature and the overall stability and uniformity in the stream's physical characteristics, the Trichoptera continued to become a larger and larger proportion of the total bottom fauna mostly at the expense of the Ephemeroptera and Plecoptera.

As in all previous sites, the Coleopteran fauna consisted almost entirely of the small riffle beetle, *Cleptelmis sp*. There was a mid-summer maximum of 21% of the total bottom fauna and a minimum of 5% in the early spring.

The overall diversity of the Dipteran fauna increased to 9 species with several warm, slow water species evidently moving into the niches vacated by the declining Chironomids. But as in all previous sites, the midges of the family Chironomidae were still by far the most abundant Dipteran species. *Chironomus* averaged about 8% of the total bottom fauna throughout the study period. The filter-feeding blackflies of the genus *Simulium* made a substantial increase in population density averaging about 3% of the total bottom fauna but jumping to a maximum of 22% following hatching in early August. This increase was undoubtedly a result of increased filtering efficiency at the uniform current characteristic of this section of Post Creek. The same statement can be made for the case-building, filter-feeding Diptera, Calysectra sp., which maintained a relatively constant average of 2% of the total bottom fauna throughout the entire study period. Antocha sp. increased from Site III to a viable part of the benthos averaging 4% of the total bottom fauna throughout the study period and reached a maximum of 7% in mid-July. As with most Diptera, they emerged periodically throughout the summer and early autumn. The remaining Dipteran species encountered never amounted to any significant portion of the bottom fauna. They were Hexatoma spp., Tipula spp., Blephlacera sp., and Atherix variegata. Also of biolgoical interest, but of little faunal significance, was the appearance of the aquatic Lepidoptera, Pararygractes sp., from mid-August through mid-September.

Community Diversification

All four study sites appeared to be basically similar in kinds of taxa and relative richness but show substantial differences in the relative abundance of individual species. The Shannon diversity index (Shannon and Weaver, 1963) was used to describe and quantify the extent of these readily detectable changes in the density and distribution of individual species of benthic insects. Table 2 presents a summary of the diversity indices calculated from a square foot bottom sample from selected sites on Post Creek, April through September 1973. Four bottom samples were taken at each site on each of the weekly sampling days and the results

TABLE - 2

Diversity Indices of the Benthic Insect Fauna (ft^2), Post Creek, April through September 1973

Date	Site I	Site II	Site III	Site IV
4-14	2.2730	2.9370	2.6233	2.3601
5-6	2.2818	3.2882	2.9084	2.4899
5-28	2.4231	2.9635	2.9246	2.7256
6-7	2.4320	2.9800	2.9332	2.8143
6-14	2.3970	2.7424	2.5678	2.8191
6-22	2.4859	2.6542	2.8432	2.8016
6-26	2.2908	2.4982	2.6354	2.7274
7-3	2.2040	2.7060	2.8278	2.9972
7-10	2.4333	2.6766	2.8094	2.9393
7-16	2.1427	2.6925	3.0715	2.8670
7-30	2.2002	2.4569	2.8969	2.7937
8-7	2.2013	2.4975	2.4665	2.2440
8-14	1.5422	1.9839	2.5035	2.4154
8-22	2.0021	2.5833	2.5061	1.8540
9-10	2.2181	2.6917	2.6384	1.4670
9-31	2.4722	3.0765	2.4708	1.7480

averaged to produce a composite sample from which the diversity indices were calculated.

Site I ranged in diversity from an early summer high of 2.4859 to a late summer low of 1.5422 with a mean diversity of 2.2499. Site II had a substantially higher mean diversity of 2.7142 which ranged from 3.3883 in May to 1.9839 in mid-August. Site III had a mean diversity of 2.7268—very nearly equal to that of Site II. But as opposed to Site II, Site III had a very consistent diversity which ranged from a high of 3.0715 in mid-July to a low of 2.4605 the first week in August. This consistently high diversity was indicative of a more complex physical and chemical nature of the ecosystem along this section of Post Creek. Site IV ranged in diversity from a mid-summer high of 2.9973 to a late summer low of 1.4670 with mean diversity of 2.4039.

A comparison of the Shannon index of diversity and total number of benthic insects for each site is presented in Figures 21, 22, 23 and 24. This was done to establish the relative maturity of the ecosystems of the sections of Post Creek studied. Low diversity or high numbers of individuals among a few of the resident species is accepted by most authorities as indicative of an immature ecosystem. Sites I and IV appear to fall into this category. High diversity or an equitable distribution of individuals among the resident species is indicative of a more mature ecosystem. Sites II and III fall into this category.

Site I had a low number of resident species and a

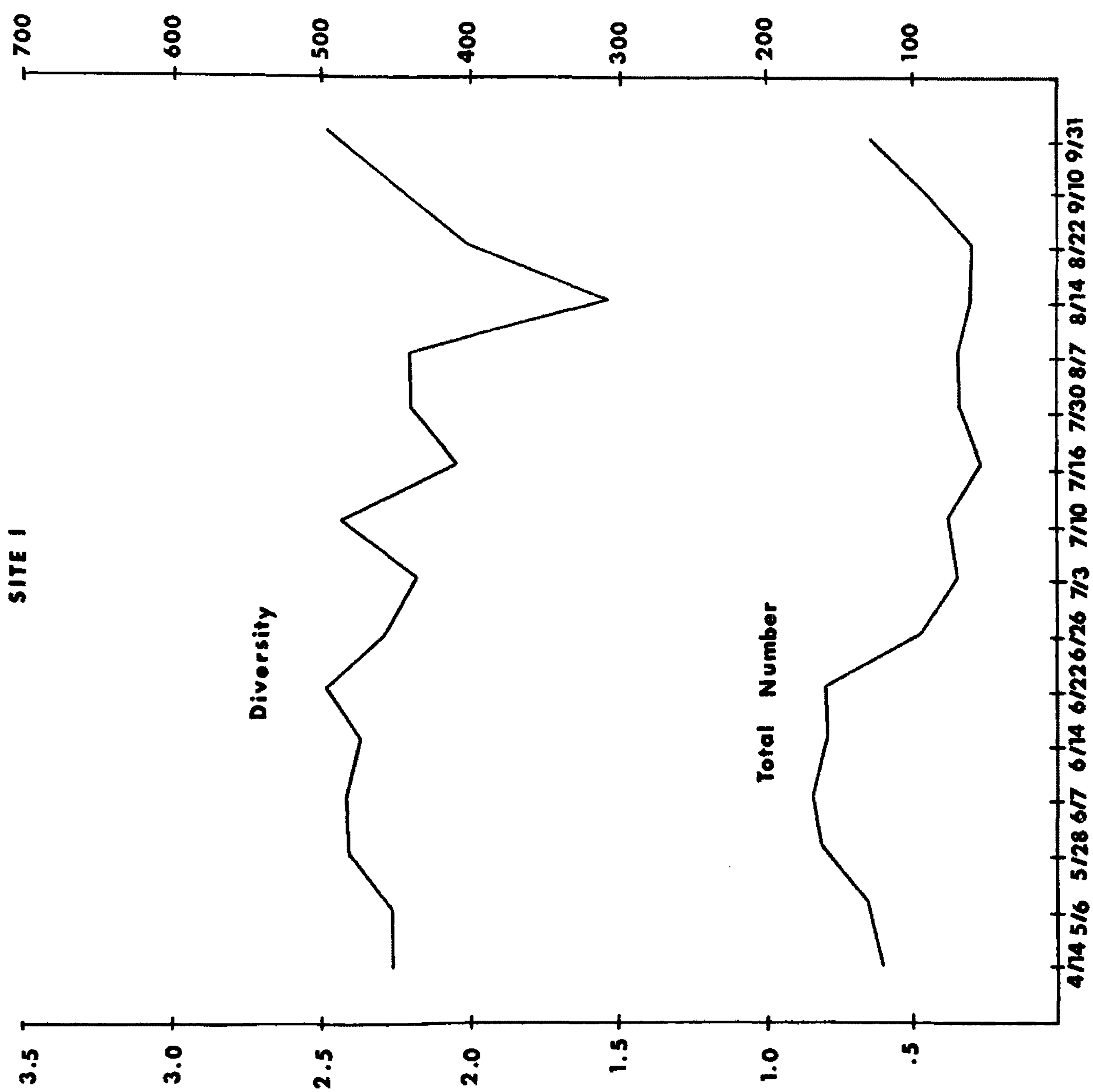


Fig. 21. Comparison of Diversity to Total Numbers

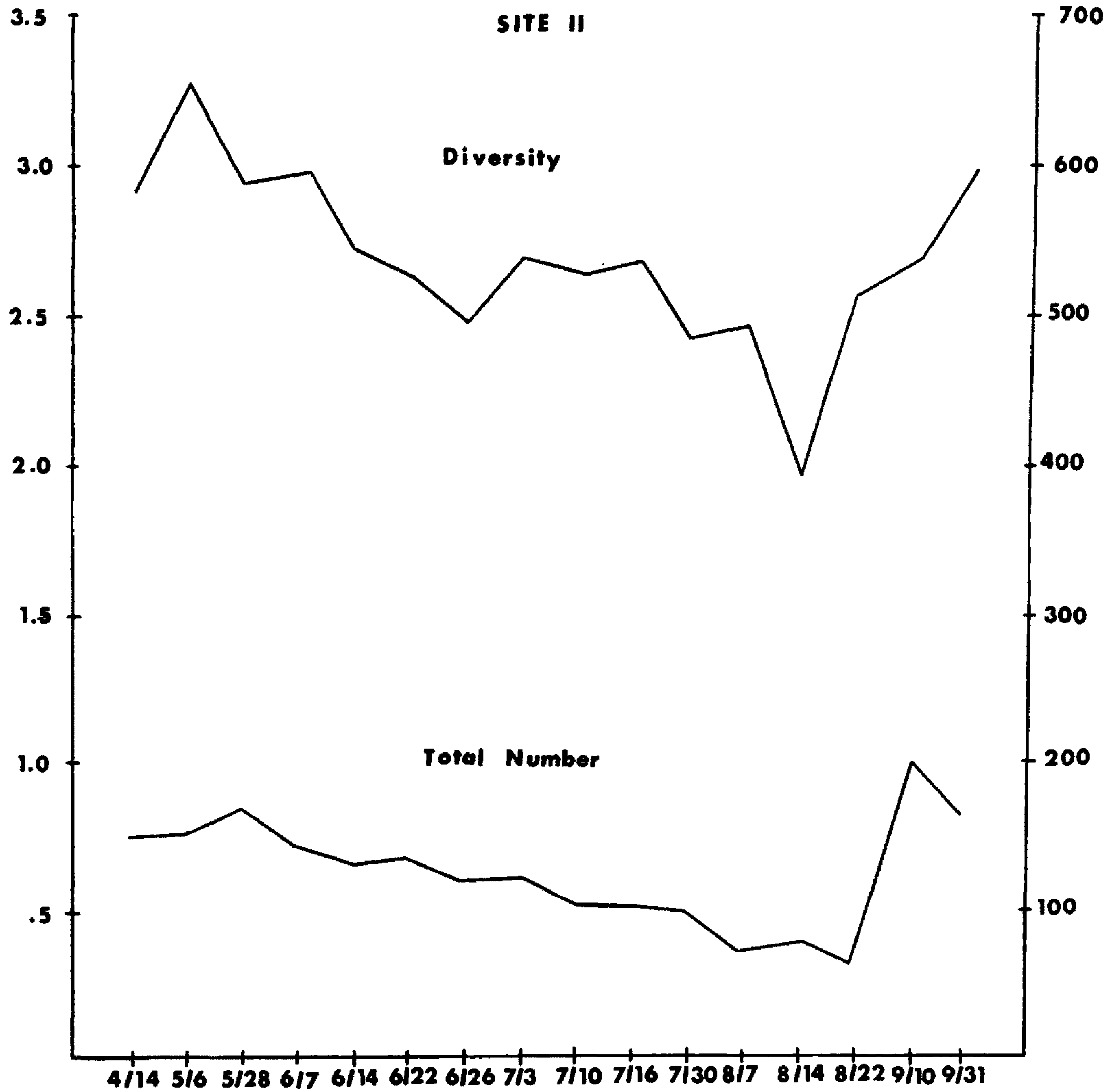


Fig. 22. Comparison of Diversity to Total Numbers

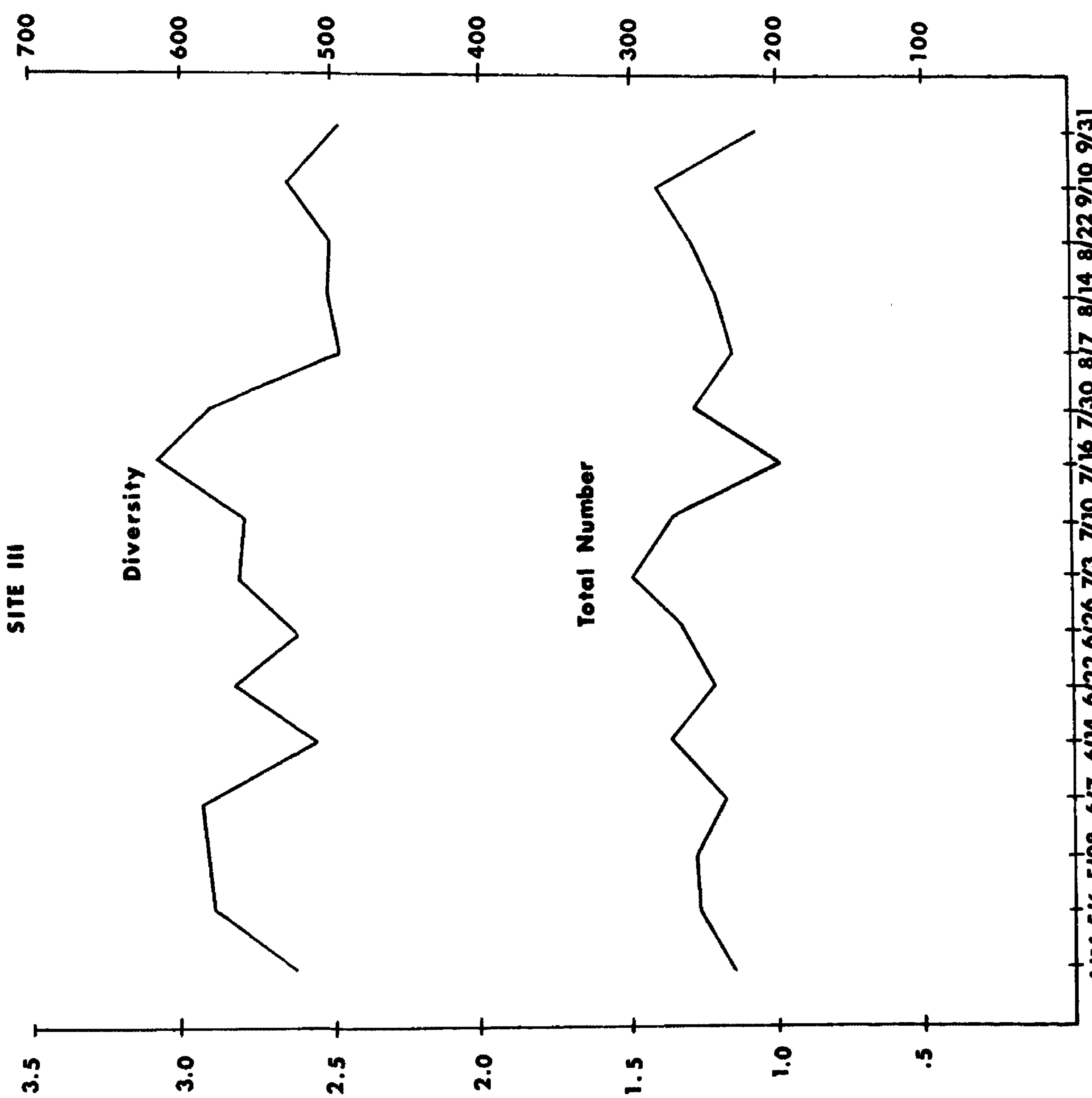


Fig. 23. Comparison of Diversity to Total Numbers

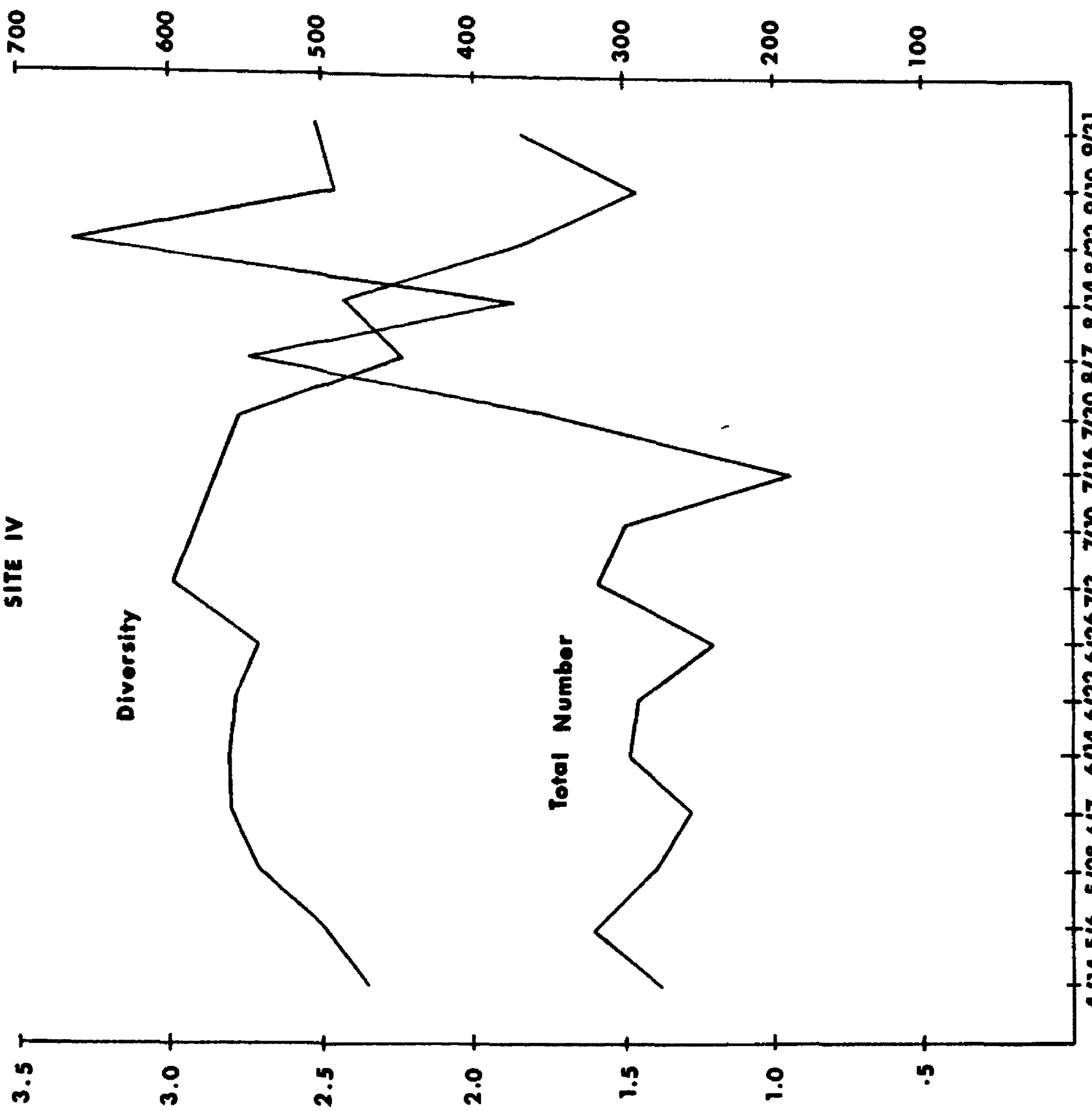


Fig. 24. Comparison of Diversity to Total Numbers

low number of total individuals (104/ft^2) as a result of the extreme instability of this section of Post Creek. Only a small number of the few resident species collected ever contributed substantially to the percentage composition of the total bottom fauna, which produced the extremely low diversity. This is characteristic of an oligotrophic stream with some other extensive physical factor pushing the ecosystem even further back into a condition of immaturity.

Site II still had a relatively low total number of individuals (121/ft^2) but a substantially larger number of resident species than observed at Site I. The total number of individuals was much more equitably distributed among the resident species, which produced a relatively high diversity characteristic of an oligotrophic stream in a moderate stage of maturity or ecological development. This is undoubtedly characteristic of the lower Post Creek drainage in its pristine condition.

Site IV had an extremely high total number of individuals (355/ft^2) with a moderate to low number of resident species. Of these resident species, only a very small number contribute substantially to the percentage composition of the total bottom fauna, which produced an extremely inequitable distribution among the resident species which effectively lowered the overall diversity. This is characteristic of a stream receiving substantial nutrification of consistent composition which effectively pushed the ecosystem back into a stage of immaturity.

Site III produced somewhat of an anomaly. It showed physical and chemical characteristics similar to that of Site IV, which is a disturbed site, and biotic characteristics similar to Site II which is in its nearly pristine condition. It had a relatively high number of total individuals (249/ft^2) and a high number of resident species. The individuals are fairly equitably distributed among the resident species, which produced a consistently high diversity throughout the entire study period. This consistently high diversity is indicative of a mature ecosystem and quite possibly characteristic of the natural climax condition of the lower Post Creek drainage if left to its own demise. It must be noted that this is purely conjecture and by no means completely substantiated by the data in this presentation.

Duncan's multiple range test (1955) was used to test for significant differences between the mean Shannon diversity indices of the four selected sites. The common practice for testing for significant difference between sampling dates and sites of a community or population is to run an analysis of variance on the collection means using the F-test. A two-way, repeated-measure design, analysis of variance test at $p = .05$ confidence level was run on the diversity indices in Table 2. It showed a very significant difference. In other words, the probability of all four sites being of the same population was extremely low. The F-test only indicates that there is significant difference between the collection means but gives no decision as to which of the collection means may or may not be considered significant from one another. Duncan's multiple range test does precisely that by utilizing: 1) means of the collection data, 2) standard error of the mean, 3) the degree of freedom in which the standard error was based. First, special significant studentized ranges for a 5% level test are extracted from a table divised by Duncan under the appropriate degree of freedom. The significant studentized ranges are then multiplied by the standard error to form the "shortest significant ranges." Each difference between means was tested in the following order: the largest minus the smallest, and so on to the largest minus the second largest; then the second largest minus the smallest and so on, finishing with the second smallest minus the smallest. Each difference is significant if it exceeds the corresponding shortest significant range.

Figure 25

Duncan's Multiple Range Test

p		(2)	(3)	(4)
Shortest Significant Range		.1657	.1733	.1800
Site	I	IV	II	III
Mean Diversity	2.2499	2.5039	2.7142	2.7268

Any two means not underscored by the same line are significantly different

Any two means underscored by the same line are not significantly different

Thus, the mean diversities of Sites II and III are not significantly different from each other, but are both significantly different from Sites I and IV. As noted throughout this presentation, Sites I and IV are the two sites most drastically disturbed. Similarity indices (Table 3) run on all four sites showed a typical longitudinal gradient change in the benthos. In other words, the fauna of Site I was most closely related to that of II, II to III, and III to IV.

TABLE - 3

Similarity Indices Between Four Selected Sites on Post Creek

Site I & II	Site I & III	Site I & IV
.7058	.6279	.5121
Site II & III	Site II & IV	Site III & IV
.7766	.6464	.8800

CHAPTER V

DISCUSSION

Community Structure

An ecosystem is a natural unit composed of abiotic and biotic elements interacting to produce an exchange of materials and energy. Action of the abiotic on the environment and coactions between biotic components results in a characteristic assemblage of organisms. This complex of individuals belonging to different species in the ecosystem is referred to as community structure (Wilhm and Dorris, 1966).

The concept of diversity is of particular biotic importance because it is commonly considered an attribute of a natural or organized community as it relates to important ecological processes. Diversity has been said to increase in a successional sequence to a maximum or climax, enhancing community stability by relating to community productivity, integration, evolution, niche structure, and competition (McIntosh, 1967).

Diversity generally has two distinct meanings often encountered in modern literature. In one sense, diversity refers to the species richness or number of species in a given area. The more species that are present the greater the diversity (herein referred to as richness). This type of analysis fails to give the investigator any indication of the ecological interrelationships among the members of the community or assemblage of organisms to be studied. More recently, species diversity has been calculated by mathematical equations known as diversity indices. This approach is not only based on the number of species present (richness) but also the relative composition of the species present which measures how equally the individuals are distributed among the resident species. The more equal the distribution, the greater the diversity. Many have referred to this interpretation as dominance diversity.

The linear relationship between the number of species and the logarithm of the area studied was first noted by Gleason (1922). Margalef (1956) considered the area studied to be proportional to the number of individuals and used this relationship as a measure of diversity. This relationship forms the foundation upon which most modern diversity indices are built but fails to consider the relative composition of the species present and must therefore still be considered as only a measure of richness rather than diversity. Shannon and Weaver (1963) introduced the following expression $H = -\sum (P_i \log_e P_i)$ as a measure of diversity. The use of this equation has been discussed in detail by Patten (1962), Pielou (1966), and Wilhm (1968). Shannon's formula has been found to be most satisfactory because of the following factors. First, it is based on dominance diversity and expresses the relative importance of each species collected, not merely the relationship between the total number of species and individuals. Secondly, the Shannon index is not affected by sample size as much as an index that requires an estimate of total species. It is highly unlikely that all species present in the community will be taken in a sampling program because of the large number of samples necessary to collect the many rare species present. When the Shannon index is used, maximum contribution to the total diversity will be made by species comprising the largest percentage of the sample while the contribution to the total diversity by rare species is small. Wilhm and Dorris (1968) reported that diversity stabilized by the fourth sample in Skeleton Creek, Oklahoma. The Shannon index is dimensionless allowing numbers, biomass, or calories in any units to be used as basic data in the equation (Wilhm, 1972).

In the mathematical expression of the diversity indices, numbers of individuals of the different species were used in this presentation with no consideration for variation in weight among species. With certain species, this variation may be slight and insignificant. However, differences in weight may be considerable among some populations of benthic invertebrates. This discrepancy could have been eliminated by using biomass units instead of numbers. This modification would redefine diversity in biomass terms and would be more closely realted to the energy distribution among the species (Wilhm, 1972).

Benthic macroinvertebrates have frequently been used to evaluate conditions in streams receiving organic effluents. Benthic organisms are particularly suitable for such studies because their specific habitat preference and relatively low motility causes them to be directly affected by foreign substances entering the environment. In addition, most aquatic macroinvertebrates have longer life histories than do microbenthos and are thus better fitted for indications of past ecological conditions in a given area. The macroinvertebrates are much easier to collect, identify, analyze, and preserve than are microscopic organisms. Hynes (1963) stated that when pollution is fairly heavy, the effects on most invertebrates are so marked that whole taxonomic groups are affected, whereas actual specific differences only become important when pollution is rather mild as observed in the lower Post Creek drainage. Tarzwell (1956) emphasized that associations of macroinvertebrates provide a more reliable criterion of organic enrichment than mere occurrence of indicator species. Many organisms which occur in large number in extremely enriched areas may also be found in limited numbers in more oligotrophic situations. Thus, it should be noted that the mode of occurrence of the indicator species is just as significant as their presents of absence in a given area.

The Shannon diversity index was first used to describe the extent of pollution by Wilhm and Dorris (1966). Their study demonstrated that organic wastes produced readily detectable changes in the distribution of individuals among species and therefore in the consequent values of the diversity indices.

Site I

The effects of stream regulation on the biotic community have just in the last decade really begun to be documented in the literature. Minshall and Winger (1968) observed that artifically reducing stream discharge resulted in an increase in the benthic invertebrate drift with virtually all bottom dwelling forms being affected. Pearson and Franklin (1968) while studying the Green River in Utah, observed that a sudden increase in discharge resulted in catastrophic rises in the number of animals in the drift for approximately an hour and a half after the initial rise in the water level. In such cases, entry into the drift appeared to be an active process initiated by rapid changes in stream velocity and discharge and the subsequent temperature and load increase, effectively increasing scouring and decreasing available illumination. Finally, Neal (1963) stated that daily fluctuations in discharge from an impoundment discourages littoral and benthic stream life and may drastically reduce the carrying capacity of the stream. This in fact appears to be the case at Site I of Post Creek.

In conclusion, the low population density, productivity and overall species diversity appeared to be related to the extreme and rapid fluctuations in discharge from McDonald Lake as a result of agricultural demand in the valley. During the week of July 22 through 26 the mean discharge increased from 182 cfs to 320 cfs and remained near that level until the end of August. This rapid fluctuation brought about a reduction in the total bottom fauna from 160 to 98 organisms/ft^2 and a corresponding reduction in biomass from .7 to .3 cc/ft^2. The absolute low occurred in mid-July at 55 organisms/ft^2. The causative agent for this drastic drop in standing crop was a combination of increased current velocity causing catastrophic increase in the drift and extreme scouring from the abrasive effect of the increased suspended load and bed movement as a result of rapid and sustained changes in stream discharge. This abrasive action not only denudes the area of invertebrate fauna but also virtually removed all noticeable traces of algae from the substrata, which effectively reduced the primary productivity of this section of stream for the entire summer. Algae are the primary food source of trophic level in the aquatic ecosystem. The scouring effect from increased discharge was demonstrated in early September approximately two weeks after the discharge had returned to its pre-irrigation levels. In this short time, at this lower level of discharge, there was an algal bloom of such magnitude as to render bottom sampling almost impossible because of clogging of the nets by algae.

The most productive sites for benthic insects in any stream are the riffles. At Site I, the riffles are for all practical purposes eliminated from this section of stream for the duration of the irrigative season in the Mission Valley.

The overall lack of Trichopteran species and the low density of resident species at this site may be a function of the inability of some of the net-spinning and filter-feeding forms to maintain their life style in the extreme fluctuation in discharge and velocity. Their filtering mechanisms are probably not efficient over such a wide range of conditions. And finally, the normal annual temperature cycle is disturbed under the regulated flow from an impoundment. The reservoir delays the stream temperature rise in the spring and conversely delays its drop in the autumn. Such a phenomenon may alter the development and emergence of aquatic insects as changes in water temperature influences their life histories.

Site II

The increase in population density, richness, productivity, and overall species diversity was undoubtedly related to the more homogeneous characteristics of this section of Post Creek. These characteristics are primarily a much more constant stream discharge and velocity. All other physical and chemical parameters measured were for the most part nearly identical at both Sites I and II.

Biologically, this stability increased the overall productivity of the stream by allowing for the establishment of a significant algal flora, consequently increasing the primary productivity of the ecosystem. This was basically a function of reduced scouring from suspended sediment and substrate movement in the absence of rapid and extreme changes in stream discharge and velocity. Also as a result of constant discharge and velocity, there is a "normal" circadian cycle of active insect drift as opposed to the catastrophic drift effectively denuding the area of invertebrate fauna for several weeks following any rapid fluctuation. This more stable condition with respect to discharge and velocity allows the invertebrate fauna to alter their position on the stream bed in response to a more gradual change in discharge and velocity, thus avoiding any significant increase in the drift.

As previously stated, riffles and rapids are the most productive sites for benthic invertebrates along any section of stream. Except for the several weeks of spring runoff, these areas remained as riffles for the entire study period adding greatly to the diversity and standing crop of this section of Post Creek.

And finally, the relative stability inherent in this section of Post Creek greatly enhances the efficiency of the filter-feeding and net-spinning forms of aquatic insects (especially Trichoptera), allowing them to proliferate and diversify under a constant set of ecological conditions.

Site III

Site III had a consistently high summer diversity approximately equal to that of Site II. This was probably the result of the more complex chemical nature of the environment as a function of reduced discharge and velocity allowing for the accumulation of leaf litter and detritus. This substantially increased the number of potential microhabitats available by increasing the physical complexity of the substrate and by increasing the variety of food particle size as the detritus accumulates and breaks down. Margalef (1958) found that the diversity index of marine plankton increased as organic by-products of metabolism accumulated and increased the complexity of the available food material. Thus, the species diversity of a habitat is directly proportional to the number of potential microhabitats which have been shown to be a function of available food and substrate complexity. For instance, a sandy substrate offers the least variety of microhabitats for organisms in running water systems and supports the lowest numbers and types of organisms. The number of potential microhabitats is also proportional to the stability of the substrate. Fewer species are consistently found in areas of continual substrate shift as observed in sandy areas. Ultimately connected with and possibly a measure of substrate stability is the amount of organic detritus that is trapped by the substrate. Sand again is least efficient at this process. Sprules (1947) compared insects that emerged from areas which ranged from gravel to stones embedded in gravel to rocks piled on top of each other. Six times as many insects emerged from the latter, more complex habitat. Similar results were observed by Maitland (1966). Wene and Wichleff (1940) introduced rubble into a sandy area and obtained similar data not only as a result of increased surface area and complexity but also as a result of the increased number of available niches by an ever increasing growth of biotic assemblages such as mosses, algae, and high aquatic plants. Thus, the number of benthic insects per unit area is least in sand and increases through gravel, stones, leaves, detritus and combinations thereof. The number of insect species in any one habitat varies according to the apparent spacial heterogeneity of the environment, substrate stability, life history, and food resources. Ultimately, the level of diversity of a community is determined by the amount of energy flowing through its food webs. The rate of energy flow is thus determined by the chemical and physical environmental limiting factors previously mentioned along with the degree of stability of the environment (Connell and Orias, 1964). Thus, further studies of streams and rivers will probably yield more information about the fauna if based on an examination of food material available rather than on distribution according to substrate type.

Another important ecological factor peculiar to a section of stream such as Site II of Post Creek is the amount of insolation received. The total incidence of radiation at Site II is relatively low as a result of the dense shade of the forest throughout the year and the ice and snow during the winter. This phenomenon causes the stones to lack a sufficient algal or mossy covering that could provide food and shelter for the much larger number of individuals as observed at Site III. Moreover, the current responsible for the stony substrate at Site II does not allow for any substantial accumulation of allochtonous material which probably counteracts any potential increase in microhabitats as a result of increased physical complexity of this section of Post Creek. Site III maintains the same physical complexity of its former fast water condition. But with the reduction in discharge and velocity as the result of agricultural demand, Site III has none of the current factors which tend to negate potential microhabitats with the increase in physical complexity. Obviously, this situation greatly increases the overall diversity of the ecosystem.

In conclusion, the drastic increase in algal density (primary productivity) and the corresponding maintenance of a relatively high overall species diversity of benthic insects appeared to be directly related to the low but extremely stable discharge and velocity and the complex physical and chemical nature of this section of Post Creek. Thus, current velocity is a major factor in running water, in that it controls the occurence and abundance of species and hence the whole structure of the biotic community. However, its mode of action is extremely complicated; it is variable in time and over short distances making it almost impossible to quantify except in general terms. "It is undoubtedly true, at least as regards many dissolved substances, flow increases the effective physiological concentration in the water, and that, for animals as well as plants, running water is a richer environment than still water of the same chemical content" (Hynes, 1970).

Biologically, the stability characterized by this section of Post Creek increased the overall productivity of the stream by allowing for the establishment of a significant algal flora, increasing the primary productivity of the ecosystem. As a function of the relatively warm water of constant low flow and current velocity, the detrital accumulation and decomposition along with substantial nutrification in the form of bicarbonate alkalinity from agricultural runoff greatly increased the physical and chemical complexity of the ecosystem. In effect, this produced a relatively mature ecosystem characterized by a consistently high species diversity. The efficiency of the net-spinning and filter-feeding organisms (primarily Trichoptera and Diptera) in procuring food was greatly increased by the low current velocity and stable environment offered by this section of Post Creek.

This rather constant environment gives a distinct reproductive advantage to the warm water algal feeders, primarily the Trichoptera, at the expense of the other orders especially the Ephemeroptera. Although the overall diversity remained quite high at Site III, this trend in faunal composition change indicated the direction of community development toward a condition of immaturity beyond this point.

Site IV

The increased eutrophication of Post Creek along its lower reaches as a result of agricultural activity appeared to be primarily in the form of increased alkalinity. Alkalinity is a measure of the bicarbonate ion which plants utilize in photosynthesis. Unless there is some other chemical or physical limiting factor, high alkalinity results in an increase in benthic and littoral plant life. This fact along with increased solar radiation are probably the two main factors in the quite substantial increase in the benthic insect productivity and reduced species diversity at Site IV. This increased plant life in relation to increased bicarbonate alkalinity not only furnished an increased food supply but also increased the available surface for attachment superficially increasing the number of potential microhabitats. But the low species diversity at this section of stream indicates that this potential was never fully utilized. Why? Armitage (1958) indicated that alkalinity has a qualitative as well as quantitative influence on the benthic insects. The relative density of Trichoptera, Ephemeroptera, Coleoptera, and Diptera was plotted against average alkalinity. The Trichoptera had a statistically significant positive correlation while the Ephemeroptera had a significant negative correlation. Coleoptera and Diptera had a negative but non-significant correlation. The trends in faunal changes of percentage composition observed in the lower Post Creek drainage appeared to follow these correlations quite closely. As the agricultural activity increased from Site I to Site IV, there was a corresponding increase in total alkalinity from 70 ppm to 175 ppm respectively. As the alkalinity increased along the longitudinal gradiant of the lower Post Creek drainage, there was a consequent faunal change characterized principally by a substantial reduction of Ephemeroptera from 61% to 18% of the total bottom fauna and a corresponding increase in Trichoptera from 7 to 52% of the total bottom fauna.

In conclusion, the drastic increase in productivity and standing crop and the corresponding decrease in overall species diversity appeared to be directly related to the extreme stability in physical characteristics indigenous to this section of Post Creek and increased bicarbonate alkalinity from agricultural runoff. This extremely uniform set of environmental conditions intensified the trend indicated at Site III by continuing to give a distinct reproductive advantage to the warm water algal feeders such as the Trichoptera at the expense of the other orders, primarily the Ephemeroptera. This in effect pushes the ecosystem back into a more immature state which is characterized by fewer resident species and disproportionately large numbers of individuals within a few of the tolerant species groups. In other words, this extreme uniformity and stability reduced the number of available niches that could be occupied by many specialists and produced a community of a few prolific generalist best adapted for this particular set of constant environmental conditions.

Pollution from agricultural activities along the lower reaches of Post Creek resulted in a depression of the diversity of aquatic insects and a corresponding increase in individual density of the more tolerant resident species. Obviously, many species occurring upstream were unable to survive in this altered environment while other intolerant species persisted but in reduced numbers. Why? The universal occurrence of regulation in living systems seems to imply that living processes are best carried out under relatively constant conditions. Any alteration in environmental conditions presents a challenge which must be dealt with by the appropriate corrective physiological response by the organism. Thus, the amount and type of regulatory activity required for the maintenance of a steady state condition is in fact a function of the environment. This concept was first formalized by Asby (1958) as the "Law of Requisite Variety" which states that for maximum stability, the variety of homeostatic responses required in any system is equal to the variety of environmental changes presented that system. By the law of requisite variety, it follows that in a more stable environment less energy is needed for regulatory activity so that a greater proportion of assimilated energy is made available for production (Connel and Orias, 1964).

With the reduction of competition caused by the elimination of intolerant species, certain species best adapted for the altered situation (those expending the smallest amount of regulatory energy) may be able to attain great abundance by exploiting their biotic potential or intrinsic rate of growth to a maximum. This in fact appears to be the major factor in the substantial increase in the Trichoptera, primarily the genera Hydropsyche and Glossoma and the corresponding reduction in the largely intolerant Ephemeropteran and Plecopteran species as the environment became extremely stable and increased in temperature, insolation, and eutrophication (principally bicarbonate alkalinity).

Site IV ranged in diversity from a mid-summer high of 2.9973 to a late summer low of 1.4670 with an average diversity of 2.4039. Site II had an average diversity of 2.7142 which ranged from 3.2882 to 1.9839. The high species diversity and richness of aquatic insect fauna at Site II (statistically comparable to the stream in its pristine condition) when compared to the substantially lower diversity and richness at the more eutrophic Sive IV is indicative of an oligtrophic environment of moderate maturity characterized by a large number of species and an annual standing crop of poor to intermediate richness as estimated by Lagler (1956). Site II can therefore serve as an indication of the trophic level of Post Creek in general, against which data from disturbed sites can be compared.

In conclusion, the changes in average standing crop and diversity of benthic insects of the four sites which were sampled during the six-month study period appeared to be directly related to increased temperature, insolation, physical stability, and bicarbonate alkalinity as Post Creek flows from the mountains through the Mission Valley. These four factors undoubtedly work in combination to bring about the observed changes in biota.

This presentation clearly demonstrated that the species diversity of benthic insects is an extremely useful tool in monitoring the amount of eutrophication in a running water system by analyzing the subsequent changes in community structure and ecosystem maturity.

Implications for Man

The lowering of the diversity of the benthic insect fauna directly affects the overall diversity of the entire aquatic ecosystem and inter-related ecosystems such as the riparian area. For example, from a sport-fishing point of view, any change in environmental conditions allowing for the proliferation of an invertebrate species which can not be effectively utilized as a food source by the desired fish species at the expense of a species that can be effectively utilized obviously will result in a drastic reduction in the size and number of the desired sport fish that the ecosystem can support. As this process continues to intensity, the entire food web begins to collapse as the stenokous species decline greatly in numbers or disappear entirely from the fauna while the euryokous species proliferate, substantially lowering the overall diversity and pushing the system back into a state of immaturity. This is precisely the major problem with the trout fishery along the lower reaches of Post Creek as it moves through the cultivated land of the Mission Valley. For at least 9 months out of the year (except during summer when a large percentage of the trout's food is terrestrial insects) the most widespread and important food stuff of running-water trout is undoubtedly invertebrates of which aquatic insects constitute as high as 90% in a stream with the characteristics of Post Creek. Trout feed primarily on drift and do not often seek food down on stream beds (Hynes, 1970). Most of the Trichoptera, such as the families Rhyacophilidae and Hydropsychidae, which constitute nearly 60% of the total bottom fauna and 70% of the total biomass of the lower sections of Post Creek, are not normally subject to any significant amount of drift in most streams (Anderson, 1967) and most certainly not in a stream characterized by such extreme stability in velocity and discharge. This, for all practical purposes, renders most of the Trichoptera of this section of Post Creek unavailable as an adequate source of food for the rainbow trout. Surber (1933) indicated that the riffle beetles, although common in most streams, are not utilized effectively as a source of food by the rainbow trout.

Thus, in a stream that is superficially teeming with invertebrate life, less than 20% of its total biomass is available as food stuff for the rainbow trout, making food availability the major limiting factor in the growth and reproduction of the rainbow trout in this section of Post Creek. Apparently the other major factor in the continual decline in the numbers of rainbow trout along the lower sections of Post Creek is the lack of suitable spawning grounds for the building of redds and the process of extensive siltation which reduces the overall success of the trout on the available spawning grounds.

A study by Maciolek and Needham (1951) showed a marked difference between the winter food habits of brown and rainbow trout. In cold weather, both species consumed large numbers of mayfly and stonefly nymphs, with Dipteran larvae being the predominant food item by number. Forty brown trout stomach contained 578 organisms or 14.5 per fish, while 53 rainbow trout consumed 1,337 organisms or 25.2 per fish. Yet the mean stomach volume for all brown trout was .29 cc, and for all rainbow trout was .28 cc. This difference in numbers of organisms consumed was accounted for by the greater percentage of larger organisms in the brown trout stomachs. The rainbow trout ingested many small midge and blackfly larvae while the browns consumed proportionately more caddisfly larvae. This would seem to indicate that lower Post Creek, with greater than 50% caddisflies, might be a more suitable habitat for brown trout or some other desired game fish species as opposed to rainbow trout.

CHAPTER VI

Summary

The investigation period, April through September 1973, attempted to relate changes in standing crop, productivity, and species diversity of benthic insects as a measure of ecological stress on the aquatic community of Post Creek with respect to changes in the physical and chemical nature of the environment brought about by man's activities along its lower reaches in the Mission Valley.

The main tool employed in this study was the basic, coarse-mesh Surber square foot bottom sampler. Four bottom samples were taken from four selected sites at approximately weekly intervals throughout the six-month study period. A composite sample was produced for each site on each sampling day from which standing crop and the Shannon index of diversity were calculated.

Site I had a low population density of resident species, productivity, and overall species diversity. The situation appeared to be directly related to the extreme and rapid fluctuations in discharge from McDonald Lake in response to agricultural demands in the valley. The causative agent for this drastic drop in standing crop was the greatly increased current velocity as a function of the increased discharge. This produced catastrophic increases

in the insect drift and extreme scouring as a result of increased suspended load and bed movement which effectively reduced the primary productivity of this section of Post Creek for the entire summer. Coupled with the increased discharge, riffles, the most productive sites for benthic insects in any stream, were for all practical purposes absent for the duration of the irrigative season. These factors work in combination to drastically reduce the standing crop, production, and species diversity of this section of Post Creek for the four most productive months of the year.

The increased population density, richness, productivity, and overall species diversity at Site II were undoubtedly related to the more homogeneous nature of this section of Post Creek, primarily in the form of a much more constant stream velocity and discharge. This stability increased the overall producitivity of the stream by allowing the establishment of a significant algal flora which increased the primary productivity of the ecosystem. Also as a result of a more constant discharge and velocity, there was a "normal" circadian cycle of active insect drift as opposed to the catastrophic drift characteristic of Site I. Finally, the relative stability inherent in this section of Post Creek allowed for the retention of riffle sites throughout the summer and greatly enhanced the efficiency of the filter-feeding and net-spinning forms of aquatic insects, especially the Trichoptera, allowing them to proliferate and diversity under a more constant set of ecological conditions.

Site III had a consistently high summer diversity, slightly higher than that of Site II. This was undoubtedly a function of the increased number of potential microhabitats available which is in turn a function of the more complex physical and chemical nature of the environment brought about by the drastic reduction in discharge and velocity as the result of agricultural use. Increased current velocity is largely responsible for any increase in the physical complexity of the substrate. Such increases in physical complexity should theoretically greatly increase the number of potential microhabitats available in the ecosystem. But, on the other hand, the current that is responsible for the increased complexity is simultaneously responsible for increased scouring from increased load, increased water friction, and increased substrate movement, all factors which tend to negate any increase in potential microhabitats as the result of increased physical complexity with respect to increased current velocity. This section of Post Creek retains the physical complexity of its fast water condition before man's intervention. But with the reduction in discharge and velocity as the result of agricultural use, there are none of the current factors which tend to negate such complexities as potential microhabitats. For example, the reduced discharge and velocity allowed for the accumulation of leaf litter and detritus which greatly increased the amount and size of food particles and substrate surface area available as this allochtonous material decomposed. This obviously greatly increased both the chemical and physical complexity of the ecosystem. Thus, the increase in potential microhabitats at this section of Post Creek appeared to be related to the increased stability of the existing complex substrate brought about by the reduction in discharge and velocity. Another important ecological factor peculiar to the lower sections of Post Creek was the amount of insolation received. With the absence of a dense forest canopy, the solar radiation is drastically increased. This coupled with the extreme stability and the substantial increase in bicarbonate alkalinity from agricultural runoff greatly increased the primary productivity which in combination with the enhanced physical and chemical complexity of the ecosystem greatly increased the density, distribution, and subsequent diversity indices of the members of the secondary trophic level, primarily the benthic insects.

This rather constant environment appeared to give a distinct reproductive advantage to the warm-water algal feeders, principally the Trichoptera, at the expense of the other orders, especially the Ephemeroptera. Although the overall diversity remained quite high at Site III, this trend in faunal composition change indicated the direction of community development beyond this point toward a condition of immaturity.

Site IV was characterized by a quite substantial increase in the productivity and standing crop of several species of Trichoptera (namely Hydropsyche, Glossoma, and Brachycentrus) and a corresponding decrease in overall species richness and diversity. This trend appeared to be directly related to the extreme stability in physical characteristics indigenous to this section of Post Creek and the greatly increased primary productivity as a result of increased insolation and bicarbonate alkalinity from agricultural runoff. An increase in species diversity expected in response to increased primary productivity appeared to be offset by one of the factors responsible for the increase in primary productivity -- the substantial increase in bicarbonate alkalinity. Alkalinity has a qualitative as well as quantitative influence on the benthic insects. The Trichoptera have a statistically significant positive correlation while the Ephemeroptera have a statistically significant negative correlation to alkalinity. This in effect intensifies the trend set at Site III by giving an even greater reproductive advantage to the Trichoptera at the expense of the Ephemeroptera. As the alkalinity increased from Site I to Site IV, the Trichoptera had a corresponding increase from 7 to 52% of the total bottom fauna while the Ephemeroptera had a corresponding reduction from 61 to 18% of the total bottom fauna. This phenomenon pushed the ecosystem back into a more immature state characterized by fewer resident species and a disporportionately large number of individuals within a few of the tolerant species groups. In other words, the increase in alkalinity and the extreme uniformity and stability of physical characteristics reduced the number of available microhabitats that could be occupied by many specialists and produced a community of a few prolific generalists best adapted for this particular set of environmental conditions.

In conclusion, the changes in average standing crop and diversity of benthic insects at the four selected sampling sites during the six-month study period appeared to be directly related to increased water temperature, insolation, physical stability, chemical complexity with respect to food material, and bicarbonate alkalinity. These factors undoubtedly work in combination to bring about the observed changed in biota.

This study demonstrated that the agricultural eutrophication of the lower Post Creek drainage produced a readily detectable change in the number and distribution of aquatic benthic insects and therefore in the consequent values in the Shannon diversity indices for the given sites. This establishes the Shannon index of diversity as an extremely valuable tool in the monitoring of eutrophication of running water systems.

What does this mean for man? These changes in community structure with increased pollution from whatever source can and do drastically alter the food webs for the entire aquatic ecosystem. For example, such changes could possibly mean the extinction or reduction of a desired species such as the rainbow trout, if important members of its food chain are substantially reduced or exterminated with the onset of the pollutant. This in fact appears to be precisely the problem with the trout fishery of the lower Post Creek drainage. The stream has changed from a Ephemeroptera-Plecoptera type stream in areas above the agricultural use to a very predominantly Trichopteran stream in the valley. Rainbow trout feed primarily on drift in running water. The types of Trichopteran collected which made up the biggest percentages of the total bottom fauna in lower Post Creek generally do not constitute any significant part of the drift in any stream and most certainly not in a stream characterized by the low and relatively constant discharge and velocity observed at Sites III and IV of Post Creek. This for the most part removed them as a potential source of food for the rainbow trout. It appears that in a stream superficially teeming with possible food stuff, it is indeed food availability that is the major limiting factor in the growth and reproduction of the rainbow trout in this section of Post Creek. It has been well documented in the literature than rainbow trout take proportionately more of the smaller type organisms such as mayfly and Diptera larvae as opposed to their cousin the brown trout which takes proportionately more of the larger Trichoptera when occupying the same habitat. If reviving the fishery of lower Post Creek is deemed advantageous by the public, possibly brown trout or some other suitable game fish species would be better adapted to this altered environment than is the rainbow trout.

APPENDIX A

TABLE 4

ALGAL FLORA OF POST CREEK SITE I

Phylum Chlorophyta
  Sub-Phylum Chlorophyceae
    Order Chaetophorales
      Family Chaetophoraceae
        Chaetophora

    Order Oedogoniales
      Family Oedogoniaceae
        Oedogonium

    Order Chlorococcales
      Family Entophysalidaceae
        Chlorogloea
      Family Hydrodictyaceae
        Pediastrum

Phylum Chrysophyta
  Sub-Phylum Bacillariophyceae
    Order Centrales
      Family Coscinodiscaceae
        Melosira
        Coscinodiscus
        Stephanodiscus

    Order Pennales
      Family Fragillariaceae
        Asterionella
        Fragillaria
        Meridion
        Synedra
        Ceratoneis
      Family Niviculaceae
        Nivicula
      Family Gomphonemaceae
        Gomphonema
      Family Cymbellaceae
        Cymbella
      Family Nitzschiaceae
        Hantzschia

  Sub-Phylum Zanthophyceae
    Order Vaucheriales
      Family Vaucheriaceae
        Vaucheria

Phylum Cyanophyta
    Order Chroococcales
      Family Chroococcaceae
        Aphanacapsa
        Microcystis
        Chroococcus

    Order Oscillatoriales
      Family Oscillatoraceae
        Oscillatoria

    Order Nostocales
      Family Nostocaceae
        Nostoc
        Anabaena
      Family Rivulariaceae
        Sacconema

TABLE 5

ALGAL FLORA OF POST CREEK SITE II

Phylum Chlorophyta
  Sub-Phylum Chlorophyceae
    Order Tetrasporales
      Family Tetrasporaceae
        Tetraspora
      Family Gloeocystaceae
        Gloeocystis

    Order Chlorococcales
      Family Palmelaceae
        Sphaerocystis

    Order Ulothrichales
      Family Ulothrichaceae
        Ulothrix

    Order Chaetophorales
      Family Chaetophoraceae
        Chaetophora

    Order Oedogoniales
      Family Oedogoniaceae
        Oedogonium

    Order Siphonales
      Family Cladophoraceae
        Rhizoclonium

    Order Zygnematales
      Family Zygnemataceae
        Zygnema
        Spirogyra 2sp.
      Family Desmidiaceae
        Staurastrum

Phylum Chrysophyta
  Sub-Phylum Bacillariophyceae
    Order Centrales
      Family Coscinodiscaceae
        Coscinodiscus
        Melosira
        Stephanodiscus

    Order Pennales
      Family Fragilariaceae
        Asterionella
        Fragillaria
        Meridion
        Synedra
      Family Achnanthaceae
        Cocconeis
      Family Niviculaceae
        Nivicula
        Gyrosigma
      Family Gomphonemaceae
        Gomphonema
      Family Cymbellaceae
        Cymbella
      Family Nitzschiaceae
        Hantzchia

  Sub-Phylum Xanthophyceae
    Order Mischococcales
      Family Characiopsidaceae
        Characiopsis

    Order Vaucheriales
      Family Vaucheriaceae
        Vaucheria

Phylum Cyanophyta
    Order Oscillatoriales
      Family Oscillatoriaceae
        Oscillatoria
        Spirulina
        Arthrospira

    Order Nostocales
      Family Nostocaceae
        Nostoc
        Anabaena
        Nodularia

TABLE 6

ALGAL FLORA OF POST CREEK SITE III

Phylum Chlorophyta
  Sub-Phylum Chlorophyceae
    Order Tetrasporales
      Family Gloeocystaceae
        Gloeocystis

    Order Chlorococcales
      Family Palmelaceae
        Sphaerocystis

    Order Ulothrichales
      Family Ulothrichaceae
        Ulothrix
      Family Microsporaceae
        Microspora

    Order Oedogoniales
      Family Oedogoniaceae
        Oedogonium

    Order Siphonales
      Family Cladophoraceae
        Rhizoclonium

    Order Zygnematales
      Family Zygnemataceae
        Mougeotia
        Spirogyra 3sp.
      Family Desmidiaceae
        Closterium
        Cosmarium
        Staurastrum

Phylum Chrysophyta
  Sub-Phylum Bacillariophyceae
    Order Centrales
      Family Coscinodiscaceae
        Melosira

    Order Pennales
      Family Fragilariaceae
        Ceratoneis
        Diatoma
        Fragilaria

    Order Pennales con't
      Family Fragilariaceae
        Meridion
        Opephora
        Synedra
        Tabellaria
        Frustulia
      Family Eunotiaceae
        Eunotia
      Family Achnanthaceae
        Cocconeis
        Rhoicosphenia
      Family Niviculaceae
        Nivicula
        Pinnularia
      Family Gomphonemaceae
        Gomphonema
      Family Cymbellaceae
        Cymbella
        Amphora
      Family Nitzschiaceae
        Nitzschia
        Hantzschia
      Family Surirellaceae
        Surirella

  Sub-Phylum Xanthophyceae
    Order Mischococcales
      Family Chariopsidaceae
        Chariopsis

    Order Vaucheriales
      Family Vaucheria

Phylum Cyanophyta
    Order Oscillatoriales
      Family Oscillatoriaceae
        Oscillatoria
        Spirulina
        Arthrospira

    Order Nostocales
      Family Nostocaceae
        Nostoc
        Anabaena

TABLE 7

ALGAL FLORA OF POST CREEK SITE IV

Phylum Chlorophyta
  Sub-Phylum Chlorophyceae
    Order Tetrasporales
      Family Gloeocystaceae
        Gloeocystis

    Order Chlorococcales
      Family Palmelaceae
        Sphaerocystis

    Order Ulothrichales
      Family Ulothrichaceae
        Ulothrix
      Family Microsporacea
        Microspora

    Order Oedogoniales
      Family Oedogoniaceae
        Oedogonium

    Order Siphonales
      Family Cladophoraceae
        Rhizoclonium

    Order Zygnematales
      Family Zygnemataceae
        Mougeotia
        Spirogyra 3sp.
      Family Mesotaeniaceae
        Gonatozygon
      Family Desmidiaceae
        Closterium
        Cosmarium
        Staurastrum

Phylum Chrysophyta
  Sub-Phylum Bacillariophyceae
    Order Centrales
      Family Coscinodiscaceae
        Melosira

    Order Pennales
      Family Fragilariaceae
        Ceratmneis
        Diatoma
        Fragilaria

    Order Pennales com't
      Family Fragilariaceae
        Meridion
        Opephora
        Synedra
        Tabellaria
      Family Eunotiaceae
        Eunotia
      Family Achnanthaceae
        Cocconeis
        Rhoicosphenia
      Family Niviculaceae
        Nivicula
        Pinnularia
      Family Gomphonemaceae
        Gomphonema
      Family Cymbellaceae
        Cymbella
        Amphora
      Family Nitzschiaceae
        Nitzschia
        Hantzschia
      Family Surirellaceae
        Surirella

  Sub-Phylum Xanthophyceae
    Order Mischococcales
      Family Characiopsidaceae
        Characiopsis

    Order Vaucheriales
      Family Vaucheriaceae
        Vaucheria

Phylum Cyanophyta
    Order Oscilatoriales
      Family Oscillatoriaceae
        Oscillatoria
        Spirulina
        Arthrospira

    Order Nostocales
      Family Nostocaceae
        Nostoc
        Anabaena

APPENDIX B

TABLE 8

PHYSICAL AND CHEMICAL ANALYSIS OF SITE I, POST CREEK, APRIL THROUGH SEPTEMBER 1973

Dates:	4-14	5-6	5-28	6-7	6-14	6-22	6-26	7-3	7-10	7-16	7-30	8-7	8-14	8-22	9-10	9-31
Temperature °C	4.5	5.0	6.0	8.0	11	12	12	12	12	13	14	15	16	16	13	13
Dissolved Oxygen (ppm)	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Carbon Dioxide (ppm)	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Total Alkalinity (ppm $CaCO_3$ & HCO_3^-)	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70
pH	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.6	7.4	7.4	7.4
Total Hardness	70	70	70	85	70	70	70	70	70	70	70	70	80	80	80	80
Phosphate	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrate & Nitrite	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Discharge Ft^3/sec	145	145	145	300	180	182	320	320	300	300	280	280	275	275	130	130
Velocity Ft/sec	2.8	2.8	2.8	3.5	2.8	2.9	3.5	3.5	3.5	3.5	3.4	3.4	3.2	3.2	2.7	2.7
Turbidity JTU	5	5	5	8	5	5	7	6	5	5	5	5	5	5	5	5

TABLE 9

PHYSICAL AND CHEMICAL ANALYSIS OF POST CREEK, SITE II, APRIL THROUGH SEPTEMBER 1973

Dates:	4-14	5-6	5-28	6-7	6-14	6-22	6-26	7-3	7-10	7-16	7-30	8-7	8-14	8-22	9-10	9-31
Temperature °C	5.0	6.0	6.0	8.5	11	12	12	12	12	13	14	15	17	16	13	12
Dissolved Oxygen (ppm)	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Carbon Dioxide (ppm)	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Total Alkalinity (ppm $CaCO_3$ & HCO_3^-)	60	60	60	70	60	60	60	60	60	60	60	60	60	60	60	60
pH	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.6	7.4	7.4	7.7	8.0	7.8	7.8	7.8
Total Hardness	65	65	65	80	70	70	70	70	70	70	70	70	70	70	70	70
Phosphate	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrate & Nitrite	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Discharge Ft^3/sec	50	50	50	135	60	58	140	140	90	80	61	62	60	60	48	48
Velocity Ft/sec	2.0	2.1	2.1	2.4	2.1	1.9	2.5	2.5	2.2	2.2	2.1	2.1	2.0	2.0	2.0	2.0
Turbidity JTU	5	5	5	8	5	5	7	6	5	5	5	5	5	5	5	5

TABLE 10

PHYSICAL AND CHEMICAL ANALYSIS OF POST CREEK, SITE III, APRIL THROUGH SEPTEMBER 1973

Dates:	4-14	5-6	5-28	6-7	6-14	6-22	6-26	7-3	7-10	7-16	7-30	8-7	8-14	8-22	9-10	9-31
Temperature °C	11	11	12.5	13	15	16	17	17	17	18	16	16	15	13	12	12
Dissolved Oxygen (ppm)	8	8	8	8	8	8	8	8	8	8	8	8	9	9	9	9
Carbon Dioxide (ppm)	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Total Alkalinity (ppm $CaCO_3$ & HCO_3^-)	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140
pH	7.8	7.8	7.8	7.8	7.8	7.8	8.0	8.0	8.0	8.2	8.2	8.2	8.2	8.2	8.2	8.2
Total Hardness	145	145	145	145	150	150	150	150	150	150	150	150	150	150	150	150
Phosphate	************************Trace***															
Nitrate & Nitrite (ppm)	.2	.2	.3	.3	.3	.3	.5	.5	.5	.5	.5	.5	.5	.5	.3	.3
Discharge Ft^3/sec	8.4	8.5	8.5	10	8.5	4.2	8.4	7.5	4.4	4.4	4.3	4.5	4.0	4.0	4.1	4.0
Velocity Ft/sec	1.2	1.3	1.3	1.4	1.2	.7	1.6	1.6	1.3	1.3	1.2	1.2	.9	.9	1.0	1.0
Turbidity JTU	8	8	8	14	10	10	14	13	10	10	10	8	6	6	6	6

TABLE 11

PHYSICAL AND CHEMICAL ANALYSIS OF POST CREEK, SITE IV, APRIL THROUGH SEPTEMBER 1973

Dates:	4-14	5-6	5-28	6-7	6-14	6-22	6-26	7-3	7-10	7-16	7-30	8-7	8-14	8-22	9-10	9-31
Temperature °C	12	12	13	14.5	16	17	18	18	17	18	16	16	15	14	10	10
Dissolved Oxygen (ppm)	8	8	8	8	8	7	7	8	8	8	8	8	9	9	9	9
Carbon Dioxide (ppm)	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Total Alkalinity (ppm $CaCO_3$ & HCO_3^-)	140	140	140	160	160	160	160	165	165	140	140	140	160	160	160	160
pH	8.0	8.0	8.0	8.0	8.0	8.0	8.2	8.2	8.2	8.4	8.4	8.4	8.4	8.4	8.4	8.4
Total Hardness	145	150	150	170	175	175	175	175	175	165	165	160	170	170	170	170
Phosphate	******************Trace**															
Nitrate & Nitrite (ppm)	.3	.3	.3	.3	.3	.3	.5	.5	.5	.5	.5	.5	.5	.5	.3	.3
Discharge Ft^3/sec	100	100	105	140	120	120	130	125	120	120	120	120	110	100	100	95
Velocity Ft/sec	2.0	2.0	2.1	2.2	2.0	2.2	2.2	2.2	2.0	2.0	2.0	2.0	1.8	1.8	1.8	1.8
Turbidity JTU	8	8	8	14	10	10	12	12	10	10	10	10	7	7	7	7

APPENDIX C

TABLE 12

NUMERICAL ANALYSIS OF THE BENTHIC INSECT FAUNA (ft^2), POST CREEK, APRIL THROUGH SEPTEMBER 1973

Date:	4-14	5-6	5-28	6-7	6-14	6-22	6-26	7-3	7-10	7-16	7-30	8-7	8-14	8-22	9-10	9-31
Site I	118*	132	158	164	160	161	98	70	75	55	65	68	61	62	87	131
Site II	152	156	169	146	137	140	125	127	109	62	105	77	83	69	207	171
Site III	230	249	255	235	273	242	262	298	271	202	257	229	238	257	279	212
Site IV	278	319	281	258	294	290	239	317	298	187	344	544	378	662	488	505

*Total number of insects per square foot bottom sample

APPENDIX D

TABLE 13

VOLUMETRIC ANALYSIS OF THE BENTHIC INSECT FAUNA (ft^2), POST CREEK, APRIL THROUGH SEPTEMBER 1973

Date:	4-14	5-6	5-28	6-7	6-14	6-22	6-26	7-3	7-10	7-16	7-30	8-7	8-14	8-22	9-10	9-31
Site I	.8*	.9	.9	.8	.7	.7	.4	.3	.8	.3	.5	.6	.4	.4	.4	.5
Site II	1.2	1.2	1.0	1.1	.8	.8	.5	1.6	1.8	.5	2.0	2.2	1.8	1.0	2.4	2.2
Site III	2.0	2.4	2.4	2.5	2.9	3.0	3.7	5.2	5.0	4.9	6.8	6.9	5.0	5.2	5.2	2.6
Site IV	5.8	6.2	6.0	6.0	3.8	4.0	4.6	5.7	5.8	4.5	6.2	5.0	5.4	5.2	5.2	5.1

*Measured in milliliters of alcohol

APPENDIX E

TABLE 14

AVERAGE NUMBER OF INDIVIDUAL SPECIES IN THE BOTTOM FAUNA OF POST CREEK, SITE I, APRIL THROUGH SEPTEMBER 1973

Date:	4-14	5-6	5-28	6-7	6-14	6-22	6-26	7-3	7-10	7-16	7-30	8-7	8-14	8-22	9-10	9-31
Rithrogena hageni	24	22	23	26	21	20	6	4	6	3	4	5	5	4	5	4
Cinygmula sp.	18	19	27	29	23	22	11	10	12	4	3	3	4	6	-	-
Cinygma integrum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Epeorus deceptivus	5	12	18	19	24	27	6	6	7	4	2	1	2	1	-	-
Epeorus albertae	-	-	-	-	-	4	3	3	2	3	4	5	4	4	-	-
Epeorus longimanus	-	-	-	-	4	5	7	7	6	4	6	10	7	4	2	-
Ephemerella doddsi	6	7	3	4	2	2	-	-	-	-	-	-	-	2	3	5
Ephemerella hystrix	3	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
Ephemerella inermis	2	3	1	1	1	2	1	-	-	-	-	-	-	-	-	-
Ephemerella infrequens	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ephemerella flavilinae	-	-	2	2	4	3	3	3	2	2	6	4	2	-	-	-
Ephemerella margarita	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ephemerella tibialis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ephemerella hecuba	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ephemerella micheneri	-	-	-	-	-	-	-	-	-	2	3	4	2	-	-	-
Baetis parvus	8	5	2	-	-	-	-	-	-	-	-	-	6	9	19	6
Baetis tricaudatus	7	8	9	10	8	11	4	3	5	4	5	6	7	7	13	15
Baetis bicaudatus	-	-	-	-	-	-	-	2	5	5	4	4	3	3	3	3
Ameletus oregonensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ameletus cooki	-	-	2	2	2	2	-	-	-	-	-	-	-	-	-	-
Paraleptophlebia debelis	1	4	4	7	8	10	5	2	3	-	-	3	5	9	10	23
Tricorythodes minuta	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Arcynopteryx cpc.	1	2	1	2	-	-	-	-	-	-	-	-	-	2	2	5
Diura knowltoni	3	3	2	3	-	-	-	-	-	-	-	-	-	-	-	-
Isoperla fulva	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Isoperla mormona	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Isogenus aestivalis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Acroneuria pacifica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	4

TABLE 14 - Continued

AVERAGE NUMBER OF INDIVIDUAL SPECIES IN THE BOTTOM FAUNA OF POST CREEK, SITE I, APRIL THROUGH SEPTEMBER 1973

Date:	4-14	5-6	5-28	6-7	6-14	6-22	6-26	7-3	7-10	7-16	7-30	8-7	8-14	8-22	9-10	9-31
Classenia sabulosa	-	-	-	-	-	-	-	1	-	-	-	-	-	-	3	4
Paraperla frontalis	1	2	2	1	1	1	1	-	-	-	-	-	-	-	-	-
Alloperla sp.	3	-	2	2	2	2	3	3	2	2	-	-	-	3	5	7
Hastaperla sp.	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pteronarcys californica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nemoura oregonensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nemoura californica	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
Capnia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rhyacophila acropedes	2	3	3	2	2	2	3	-	-	-	-	-	-	-	2	6
Glossoma sp.	4	4	6	6	4	5	5	-	2	-	-	-	-	-	3	6
Agapetus sp.	-	-	-	-	-	-	-	-	-	5	4	3	2	-	-	-
Hydropsyche sp.	2	2	1	3	2	1	2	-	1	-	-	-	-	-	1	3
Arctopsyche grandis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Parapsyche elsis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Parapsyche almota	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Brachycentrus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Limnephilus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Leptocella sp.	-	-	-	4	3	-	-	-	-	-	-	-	-	-	-	-
Oecetis cinerascens	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polycentrops sp.	2	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
Wormaldia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Helicopsyche borealis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cleptelmis sp.	10	9	22	20	24	23	19	15	11	13	16	17	14	8	5	4
Lara sp.	6	3	5	-	-	-	-	-	-	-	8	7	-	-	-	2
Narpus sp.	-	-	-	1	1	1	2	2	2	3	-	-	-	-	-	-
Haliplus sp.	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sialis sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hexatoma sp.	1	1	1	-	-	-	-	-	-	-	-	-	-	-	6	8
Tipula sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE 14 - Continued

AVERAGE NUMBER OF INDIVIDUAL SPECIES IN THE BOTTOM FAUNA OF POST CREEK, SITE I, APRIL THROUGH SEPTEMBER 1973

Date:	4-14	5-6	5-28	6-7	6-14	6-22	6-26	7-3	7-10	7-16	7-30	8-7	8-14	8-22	9-10	9-31
Antocha sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chironomus sp.	12	20	16	17	19	13	15	10	8	-	-	-	-	-	-	-
Calypsectra sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Simulium sp.	-	-	3	3	4	3	2	-	-	-	-	-	-	-	-	-
Culex sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Atherix variegata	-	-	-	-	1	1	1	-	-	-	-	-	-	-	-	-
Chrysops sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Blephlacerus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Paragyractes sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ophiogomphis montanus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE 15

AVERAGE NUMBER OF INDIVIDUAL SPECIES IN THE BOTTOM FAUNA OF POST CREEK, SITE II, APRIL THROUGH SEPTEMBER 1973

Date:	4-14	5-6	5-28	6-7	6-14	6-22	6-26	7-3	7-10	7-16	7-30	8-7	8-14	8-22	9-10	9-31
Rithrogena hageni	18	22	15	13	9	9	10	15	7	4	-	-	-	3	17	16
Cinygmula sp.	11	15	11	10	9	12	9	6	11	2	-	1	4	2	-	17
Cinygma integrum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Epeorus deceptivus	3	5	11	11	13	16	15	12	11	6	-	-	-	-	-	-
Epeorus albertae	-	-	-	-	-	-	-	6	3	4	12	5	-	-	-	-
Epeorus longimanus	-	-	-	-	-	-	-	-	11	6	-	-	-	-	-	-
Ephemerella doddsi	5	6	4	4	3	2	3	4	3	2	2	1	5	5	22	17
Ephemerella hystrix	2	-	-	-	-	-	-	-	-	-	-	-	-	-	2	2
Ephemerella inermis	5	3	2	2	1	2	2	-	-	-	-	-	-	-	-	-
Ephemerella infrequens	-	-	1	1	3	3	2	2	-	-	-	-	-	-	-	-
Ephemerella flavilinae	-	-	9	8	15	11	9	3	6	4	1	-	-	-	-	-
Ephemerella margarita	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ephemerella tibialis	-	-	-	-	-	-	-	-	-	-	2	-	2	-	-	-
Ephemerella hecuba	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ephemerella micheneri	-	-	-	-	-	-	-	3	2	2	-	-	-	-	-	-
Baetis parvus	7	2	3	2	2	1	2	2	2	-	-	-	-	-	-	-
Baetis tricaudatus	20	6	11	13	9	8	9	11	5	4	27	18	14	9	54	22
Baetis bicaudatus	-	3	6	5	7	-	5	7	5	3	4	5	19	6	7	4
Ameletus oregonensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ameletus cooki	-	-	-	-	-	-	-	1	2	2	2	2	-	-	-	-
Paraleptophlebia debelis	4	5	7	8	5	6	5	3	-	-	-	-	-	-	8	8
Tricorythodes minuta	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Arcynopteryx cpc.	1	1	-	-	-	-	-	-	-	-	-	-	2	3	4	3
Diura knowltoni	9	10	7	6	1	-	-	-	-	-	-	-	-	-	2	-
Isoperla fulva	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Isogenus mormona	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Isogenus aestivalis	4	5	4	4	2	-	-	-	-	-	-	-	-	-	-	-
Acroneuria pacifica	2	2	1	1	1	-	-	-	3	1	2	1	2	1	2	1

TABLE 15 - Continued

AVERAGE NUMBER OF INDIVIDUAL SPECIES IN THE BOTTOM FAUNA OF POST CREEK, SITE II, APRIL THROUGH SEPTEMBER 1973

Date:	4-14	5-6	5-28	6-7	6-14	6-22	6-26	7-3	7-10	7-16	7-30	8-7	8-14	8-22	9-10	9-31
Classenia sabulosa	4	3	3	2	2	2	2	2	3	2	8	3	5	3	2	1
Paraperla frontalis	1	2	2	2	1	-	-	-	-	-	-	-	-	-	-	1
Alloperla sp.	3	4	3	5	4	4	3	4	2	-	6	4	3	3	4	5
Hastaperla sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pteronarcys californica	2	2	1	1	-	-	-	1	1	-	-	1	-	-	-	-
Nemoura oregonensis	3	4	3	2	-	-	-	-	-	-	-	-	-	-	2	2
Nemoura californica	-	-	-	-	-	-	-	-	1	-	3	3	-	-	-	4
Capnia sp.	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rhyacophila acropedes	4	5	5	6	7	3	3	3	3	3	7	5	5	4	8	9
Glossoma sp.	4	5	7	8	7	7	8	7	12	8	5	6	3	4	13	11
Agapetus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hydropsyche sp.	4	3	2	-	1	1	2	4	3	1	2	-	-	-	22	11
Arctopsyche grandis	2	2	-	-	-	-	-	-	-	1	1	1	2	2	3	3
Parapsyche elsis	-	-	-	-	-	-	-	-	-	-	-	1	1	6	8	4
Parapsyche almota	-	-	-	-	-	-	-	-	-	-	-	-	-	2	5	2
Brachycentrus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Limnephilus sp.	2	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Leptocella sp.	1	-	-	-	-	-	-	-	1	-	-	-	-	-	2	-
Oecetis cinerascens	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
Polycentrops sp.	5	5	2	1	1	-	-	-	-	-	2	-	-	-	-	-
Wormaldia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Helicopsyche borealis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cleptelmis sp.	13	17	29	16	18	27	24	26	12	7	9	9	12	9	14	10
Lara sp.	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-
Narpus sp.	-	-	-	-	-	-	-	-	1	2	2	-	-	-	-	1
Haliplus sp.	2	2	-	-	-	-	-	-	-	-	3	3	2	4	3	-
Sialis sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hexatoma sp.	2	2	1	-	-	-	-	-	1	-	1	-	1	-	1	2
Tipula sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE 15 - Continued

AVERAGE NUMBER OF INDIVIDUAL SPECIES IN THE BOTTOM FAUNA OF POST CREEK, SITE II, APRIL THROUGH SEPTEMBER 1973

Date:	4-14	5-6	5-28	6-7	6-14	6-22	6-26	7-3	7-10	7-16	7-30	8-7	8-14	8-22	9-10	9-31
Antocha sp.	-	-	4	4	5	3	3	-	1	2	-	-	-	-	-	4
Chironomus sp.	11	17	15	11	10	13	9	5	-	-	-	7	6	4	5	10
Calypsectra sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	3
Simulium sp.	-	-	-	-	-	-	-	-	-	-	2	2	-	-	3	-
Culex sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Atherix variegata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	2
Chrysops sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Blephlacerus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pararagyractes sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ophiogomphis montanus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE 16

AVERAGE NUMBER OF INDIVIDUAL SPECIES IN THE BOTTOM FAUNA OF POST CREEK, SITE III, APRIL THROUGH SEPTEMBER 1973

Date:	4-14	5-6	5-28	6-7	6-14	6-22	6-26	7-3	7-10	7-16	7-30	8-7	8-14	8-22	9-10	9-31
Rithrogena hageni	4	3	3	3	2	2	5	4	2	2	-	-	-	-	-	3
Cinygmula sp.	4	6	6	4	-	-	-	-	-	-	-	-	-	-	5	5
Cinygma integrum	2	2	3	3	3	5	7	16	17	15	13	6	7	6	-	-
Epeorus deceptivus	2	3	5	3	3	3	-	-	-	-	-	-	-	-	-	-
Epeorus albertae	-	-	-	-	23	26	14	32	20	18	7	-	4	-	-	-
Epeorus longimanus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ephemerella doddsi	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ephemerella hystrix	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ephemerella inermis	12	11	7	6	2	2	-	-	-	-	-	-	-	-	-	-
Ephemerella infrequens	-	-	-	-	3	3	4	2	2	3	-	-	-	-	-	-
Ephemerella flavilinae	-	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-
Ephemerella margarita	-	-	-	-	-	-	-	-	-	5	4	-	-	-	-	3
Ephemerella tibialis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ephemerella hecuba	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-
Ephemerella micheneri	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Baetis parvus	-	-	-	2	4	5	6	4	4	4	-	17	27	44	64	47
Baetis tricaudatus	28	25	24	22	20	19	14	22	27	12	21	8	9	7	11	9
Baetis bicaudatus	-	-	-	-	5	6	-	2	3	2	-	-	-	-	-	-
Ameletus oregonensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ameletus cooki	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Paraleptophlebia debelis	22	28	25	21	19	25	47	26	29	10	33	29	14	23	15	17
Tricorythodes minuta	-	-	-	-	-	-	1	2	6	9	31	49	51	22	17	7
Arcynopteryx cpc.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Diura knowltoni	9	8	8	-	-	-	-	-	-	-	-	-	-	2	2	2
Isoperla fulva	4	5	6	5	2	2	-	-	-	-	-	-	-	-	-	-
Isoperla mormona	-	-	-	-	-	-	-	3	2	-	-	-	-	-	-	-
Isogenus aestivalis	2	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
Acroneuria pacifica	2	2	2	-	-	-	-	-	-	-	3	6	3	2	2	2

TABLE 16 - Continued

AVERAGE NUMBER OF INDIVIDUAL SPECIES IN THE BOTTOM FAUNA OF POST CREEK, SITE III, APRIL THROUGH SEPTEMBER 1973

Date:	4-14	5-6	5-28	6-7	6-14	6-22	6-26	7-3	7-10	7-16	7-30	8-7	8-14	8-22	9-10	9-31
Classenia sabulosa	3	3	3	3	5	-	3	3	3	3	4	4	3	2	4	4
Paraperla frontalis	2	1	2	1	2	1	-	-	-	-	-	-	-	-	-	-
Alloperla sp.	1	2	2	-	-	-	1	-	2	2	-	4	3	2	4	4
Hastaperla sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pteronarcys californica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nemouria oregonensis	2	3	3	3	-	-	-	-	-	-	-	-	-	-	-	-
Nemouria californica	-	-	-	-	-	-	1	3	4	5	8	6	6	7	6	5
Capnia sp.	1	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Rhyacophila acropedes	14	12	18	15	17	11	14	11	4	4	5	4	5	6	10	7
Glossoma sp.	28	31	30	29	25	21	23	12	16	13	16	7	6	7	18	12
Agapetus sp.	-	-	4	9	14	5	5	7	14	7	11	6	2	5	-	-
Hydropsyche sp.	17	19	23	28	33	23	20	49	45	18	9	11	6	7	13	12
Arctopsyche grandis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Parapsyche elsis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Parapsyche almota	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Brachycentrus sp.	9	7	8	11	9	8	13	7	5	12	6	5	-	6	-	-
Limnephilus sp.	7	8	6	5	4	3	2	4	5	4	10	3	1	3	3	2
Leptocella sp.	-	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-
Oecetis cinerascens	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polycentrops sp.	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wormaldia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Helicopsyche borealis	-	-	-	-	-	-	-	-	3	4	-	2	-	2	-	-
Cleptelmis sp.	18	21	31	33	35	34	19	48	26	14	39	24	31	61	62	43
Lara sp.	-	-	-	-	-	-	-	-	-	4	3	-	-	-	1	-
Narpus sp.	-	-	-	-	2	1	-	1	-	1	2	-	-	-	-	-
Haliplus sp.	1	2	2	2	-	-	-	-	-	-	-	-	-	-	-	-
Sialis sp.	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
Hexatoma sp.	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-
Tipula sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE 16 - Continued

AVERAGE NUMBER OF INDIVIDUAL SPECIES IN THE BOTTOM FAUNA OF POST CREEK, SITE III, APRIL THROUGH SEPTEMBER 1973

Date:	4-14	5-6	5-28	6-7	6-14	6-22	6-26	7-3	7-10	7-16	7-30	8-7	8-14	8-22	9-10	9-31
Antocha sp.	-	-	-	-	7	7	4	4	4	5	7	4	7	3	4	9
Chironomus sp.	12	18	24	19	18	17	14	22	15	9	14	29	33	22	19	12
Calypsectra sp.	4	6	6	8	7	5	10	7	6	6	9	4	4	17	13	12
Simulium sp.	5	5	10	6	7	8	-	2	4	10	-	-	7	-	5	-
Culex sp.	11	13	9	-	-	-	-	-	-	-	-	-	-	-	-	-
Atherix variegata	-	-	-	-	2	-	-	-	2	-	1	-	2	-	-	-
Chrysops sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	2
Blephlacera sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Parargyractes sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ophiogomphis montanus	1	-	-	-	-	-	-	-	1	-	1	1	-	1	-	-

TABLE 17

AVERAGE NUMBER OF INDIVIDUAL SPECIES IN THE BOTTOM FAUNA OF POST CREEK, SITE IV, APRIL THROUGH SEPTEMBER 1973

Date:	4-14	5-6	5-28	6-7	6-14	6-22	6-26	7-3	7-10	7-16	7-30	8-7	8-14	8-22	9-10	9-31
Rithrogena hageni	5	7	7	15	14	6	7	8	3	-	-	-	-	2	4	4
Cinygmula sp.	3	4	4	2	3	-	-	-	-	-	-	-	-	-	-	-
Cinygma integrum	1	1	2	2	2	4	7	6	-	9	11	7	5	4	-	7
Epeorus deceptivus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Epeorus albertae	-	-	-	8	11	14	8	10	21	17	6	5	4	2	-	-
Epeorus longimanus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ephemerella doddsi	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ephemerella hystrix	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ephemerella inermis	28	26	8	4	2	1	-	-	15	2	-	-	-	-	-	-
Ephemerella infrequens	-	-	-	14	24	12	14	23	15	4	7	2	-	-	-	-
Ephemerella flavilinae	-	-	-	-	2	2	3	2	-	-	-	-	-	-	-	-
Ephemerella margarita	-	-	-	-	-	-	-	-	3	5	31	3	14	6	-	5
Ephemerella tibialis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ephemerella hecuba	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ephemerella micheneri	-	-	-	-	-	-	-	2	3	2	-	-	-	-	-	-
Baetis parvus	-	-	-	2	3	2	-	-	2	-	3	-	-	-	-	-
Baetis tricaudatus	7	9	14	6	7	18	6	34	20	17	33	73	25	49	39	35
Baetis bicaudatus	-	-	-	-	2	-	2	2	3	3	9	-	-	-	-	-
Ameletus oregonensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ameletus cooki	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Paraleptophlebia debelis	6	13	17	13	10	24	7	8	11	7	5	-	-	-	-	-
Tricorythodes minuta	-	-	-	-	-	-	-	4	-	3	9	5	8	5	3	4
Arcynopteryx cpc.	-	-	-	-	-	-	-	-	-	-	-	-	3	4	3	3
Diura knowltoni	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Isoperla fulva	1	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-
Isoperla mormona	-	-	-	5	6	3	5	5	4	-	-	-	-	-	-	-
Isogenus aestivalis	-	-	4	7	9	-	-	-	-	-	-	-	-	-	-	-
Acroneuria pacifica	2	2	1	2	-	-	-	-	-	-	5	4	4	6	4	6

TABLE 17 - Continued

AVERAGE NUMBER OF INDIVIDUAL SPECIES IN THE BOTTOM FAUNA OF POST CREEK, SITE IV, APRIL THROUGH SEPTEMBER 1973

Date:	4-14	5-6	5-28	6-7	6-14	6-22	6-26	7-3	7-10	7-16	7-30	8-7	8-14	8-22	9-10	9-31
Classenia sabulosa	3	3	4	3	3	4	3	3	6	4	3	-	5	5	6	6
Paraperla frontalis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Alloperla sp.	-	-	-	2	2	1	-	-	-	-	-	-	3	-	-	-
Hastaperla sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pteronarcys californica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nemoura oregonensis	2	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
Nemoura californica	-	-	-	-	-	-	-	2	-	-	-	4	3	5	-	4
Capnia sp.	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rhyacophila acropedes	5	6	8	7	6	9	14	11	8	5	9	14	16	13	18	11
Glossoma sp.	42	44	30	27	29	24	19	30	23	25	47	37	27	42	41	53
Agapetus sp.	5	4	4	6	8	5	7	4	6	4	7	5	-	-	-	-
Hydropsyche sp.	74	89	62	49	52	33	42	18	16	10	44	165	129	377	264	273
Arctopsyche grandis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Parapsyche elsis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Parapsyche almota	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Brachycentrus sp.	32	33	22	11	8	18	9	31	47	20	24	-	28	15	11	2
Limnephilus sp.	2	3	3	1	-	2	2	2	3	1	2	-	1	1	2	-
Leptocella sp.	-	-	-	-	-	-	-	2	3	-	-	-	-	-	-	-
Oecetis cinerascens	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polycentrops sp.	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Wormaldia sp.	-	-	-	-	-	-	-	2	1	-	-	-	-	-	-	-
Helicopsyche borealis	-	-	-	-	-	-	-	-	3	-	3	-	2	-	-	-
Cleptelmis sp.	18	19	31	35	52	63	46	62	34	14	31	56	39	47	43	44
Lara sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Narpus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Haliplus sp.	2	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-
Sialis sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hexatoma sp.	2	1	1	-	-	-	1	-	3	-	1	-	-	-	-	-
Tipula sp.	-	-	-	-	-	-	-	2	-	-	-	-	2	-	2	-

TABLE 17 - Continued

AVERAGE NUMBER OF INDIVIDUAL SPECIES IN THE BOTTOM FAUNA OF POST CREEK, SITE IV, APRIL THROUGH SEPTEMBER 1973

Date:	4-14	5-6	5-28	6-7	6-14	6-22	6-26	7-3	7-10	7-16	7-30	8-7	8-14	8-22	9-10	9-31
Antocha sp.	8	8	11	13	14	12	9	11	9	12	26	13	14	24	7	12
Chironomus sp.	15	22	23	21	17	22	22	23	25	10	19	21	23	22	19	17
Calypsectra sp.	5	3	4	3	4	4	5	5	6	7	9	10	8	12	11	11
Simulium sp.	5	4	9	9	3	7	-	5	4	6	-	120	13	9	8	8
Culex sp.	13	14	10	-	-	-	-	-	-	-	-	-	-	-	-	-
Atherix variegata	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-
Chrysops sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Blephlacera sp.	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
Parargyractes sp.	-	-	-	-	-	-	-	-	-	-	-	-	2	2	3	-
Ophiogomphis montanus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

APPENDIX F

TABLE 18

PERCENTAGE COMPOSITION OF INDIVIDUAL SPECIES IN THE BOTTOM FAUNA OF POST CREEK, SITE I, APRIL THROUGH SEPTEMBER 1973

Date:	4-14	5-6	5-28	6-7	6-14	6-22	6-26	7-3	7-10	7-16	7-30	8-7	8-14	8-22	9-10	9-31
Rithrogena hageni	19.9	17.6	16.3	15.3	15.0	13.6	6.1	8.73	9.45	5.52	6.04	5.98	5.53	6.41	9.07	4.35
Cinygmula sp.	15.2	16.7	19.3	16.4	16.0	14.3	11.1	19.7	19.6	2.21	2.05	2.47	2.35	9.76	4.11	17.4
Epeorus deceptivus	4.02	8.73	13.5	17.6	17.0	16.2	15.1	11.6	10.7	1.59	1.84	1.55	1.74	1.81	-	-
Epeorus albertae	-	-	-	-	-	1.78	3.17	6.45	2.07	5.54	6.01	5.79	5.62	6.41	-	-
Epeorus longimanus	-	-	-	-	1.95	1.87	7.27	4.02	9.64	8.33	9.56	13.9	9.22	6.81	4.27	-
Ephemerella doddsi	5.21	4.28	2.11	1.36	1.39	1.40	-	-	-	-	-	-	-	3.20	5.06	4.68
Ephemerella hystrix	2.51	2.29	1.59	-	-	-	-	-	-	-	-	-	-	-	-	-
Ephemerella inermis	1.76	2.41	.99	.37	.39	.81	.72	-	-	-	-	-	-	-	-	-
Ephemerella flavilinae	-	-	1.00	2.64	2.68	2.05	3.61	5.09	2.47	6.65	9.77	7.59	3.37	-	-	-
Paraleptophlebia debelis	1.09	3.14	3.22	4.75	4.72	6.34	4.15	4.61	4.18	-	-	-	3.94	14.5	16.2	20.1
Baetis parvus	6.75	6.33	1.93	-	-	-	-	-	-	-	-	-	4.17	14.6	24.1	3.17
Baetis tricaudatus	5.23	6.89	6.91	6.23	6.17	7.05	15.1	5.13	6.07	7.99	9.69	10.3	8.21	11.3	11.5	12.3
Baetis bicaudatus	-	-	-	-	-	-	-	4.28	8.21	10.5	8.11	8.05	6.35	4.85	1.96	2.57
Arcynopteryx cpc.	.92	1.43	.59	-	-	-	-	-	-	-	-	-	-	3.09	2.07	4.31
Diura knowltoni	2.12	1.09	1.57	2.56	2.77	-	-	-	-	-	-	-	-	-	-	-
Hastaperla sp.	1.17	1.09	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Paraperla frontalis	1.07	1.19	.89	.79	.68	.88	.96	-	-	-	-	-	-	-	-	-
Rhyacophila acropedes	1.21	1.95	1.61	1.27	1.13	1.37	3.17	-	-	-	-	-	-	-	3.27	5.13
Glossoma sp.	2.41	2.97	4.43	1.88	2.41	3.09	5.13	6.09	1.61	-	-	-	-	-	2.14	5.13
Hydropsyche sp.	1.07	.94	.59	.73	.79	.59	2.16	-	1.23	-	-	-	-	-	1.09	3.76
Agapetus sp.	-	-	-	-	-	-	-	-	-	3.37	4.04	2.11	2.08	-	-	-
Polycentrops sp.	1.74	2.15	1.79	-	-	-	-	-	-	-	-	-	-	-	-	-
Leptocella sp.	-	-	-	.54	.76	-	-	-	-	-	-	-	-	-	-	-
Acroneuria pacifica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.23	3.17
Classenia sabulosa	-	-	-	-	-	-	-	1.79	-	-	-	-	-	-	1.51	1.72

TABLE 18 - Continued

PERCENTAGE COMPOSITION OF INDIVIDUAL SPECIES IN THE BOTTOM FAUNA OF POST CREEK, SITE I, APRIL THROUGH SEPTEMBER 1973

Date:	4-14	5-6	5-28	6-7	6-14	6-22	6-26	7-3	7-10	7-16	7-30	8-7	8-14	8-22	9-10	9-31
Alloperla sp.	2.46	2.31	1.39	.76	1.04	1.22	3.17	3.55	2.85	2.27	-	-	-	4.81	7.81	6.54
Nemouria californica	-	-	-	-	-	-	-	-	1.29	-	-	-	-	-	-	-
Cleptelmis sp.	8.20	13.7	15.3	14.0	14.5	15.8	19.0	33.7	20.4	26.6	30.1	19.8	12.7	12.9	6.78	3.75
Lara sp.	5.17	1.48	1.63	-	-	-	-	-	-	4.26	4.41	-	-	-	-	-
Narpus sp.	-	-	-	.22	.32	.24	.31	.67	.85	.76	-	-	-	-	-	-
Haliplus sp.	2.58	1.27	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hexatoma sp.	.80	1.17	.38	-	-	.53	-	-	-	-	-	-	-	-	-	7.51
Chironomus sp.	10.3	15.6	11.0	12.8	12.7	9.43	15.2	4.27	2.47	-	-	-	-	-	-	-
Simulium sp.	-	-	1.46	1.73	1.71	1.39	2.12	-	-	-	-	-	-	-	-	-
Atherix variegata	-	-	-	.44	.57	.49	1.15	-	-	-	-	-	-	-	-	-
Ameletus cooki	-	-	.59	.57	.61	1.62	-	-	-	-	-	-	-	-	-	-
Ephemerella micheneri	-	-	-	-	-	-	-	-	-	3.81	5.87	6.07	4.11	-	-	-

TABLE 19

PERCENTAGE COMPOSITION OF INDIVIDUAL SPECIES IN THE BOTTOM FAUNA OF POST CREEK, SITE II, APRIL THROUGH SEPTEMBER 1973

Date:	4-14	5-6	5-28	6-7	6-14	6-22	6-26	7-3	7-10	7-16	7-30	8-7	8-14	8-22	9-10	9-31
Rithrogena hageni	13.2	15.9	9.41	8.72	8.93	7.52	7.35	11.8	6.55	5.67	-	-	-	4.27	8.01	9.95
Cinygmula sp.	7.98	9.21	7.54	7.70	8.53	7.74	6.99	4.58	11.6	3.62	-	.76	5.58	3.11	-	9.83
Epeorus deceptivus	2.82	3.58	7.00	8.97	12.0	12.4	10.7	9.22	11.3	7.64	-	-	-	-	-	-
Epeorus albertae	-	-	-	-	-	-	-	5.13	1.29	5.67	11.3	7.38	-	-	-	-
Epeorus longimanus	-	-	-	-	-	-	3.86	8.02	10.3	8.49	-	-	-	-	-	-
Ephemerella doddsi	3.33	4.86	2.00	1.97	1.74	1.71	1.80	2.79	3.04	-	1.37	1.46	7.12	7.85	10.9	11.3
Ephemerella inermis	3.34	2.13	1.19	1.07	.49	1.00	.93	-	-	-	-	-	-	-	-	-
Ephemerella hystrix	1.35	3.72	-	-	-	-	-	-	-	-	-	-	-	-	1.76	1.83
Ephemerella flavilinae	-	-	5.86	7.99	12.5	8.55	8.49	2.58	6.08	2.01	.85	-	-	-	-	-
Ephemerella infrequens	-	-	.37	1.63	1.79	1.94	1.82	1.03	-	-	-	-	-	-	-	-
Ephemerella micheneri	-	-	-	-	-	-	-	2.31	1.74	6.48	-	-	-	-	-	-
Ephemerella tibialis	-	-	-	-	-	-	-	-	-	-	1.84	2.07	1.53	-	-	-
Baetis parvus	4.56	.54	1.41	1.62	.61	.54	.71	.83	.76	-	-	-	-	-	-	-
Baetis tricaudatus	1.31	5.30	6.35	6.99	7.24	5.38	5.56	8.69	5.88	7.83	28.9	29.2	16.6	12.9	24.0	13.2
Baetis bicaudatus	-	1.47	2.91	2.97	5.34	4.27	4.53	4.99	4.32	7.24	3.15	4.21	25.0	9.41	3.04	2.57
Paraleptophlebia debelis	2.75	5.77	3.79	3.46	3.65	1.73	1.84	2.11	-	-	-	-	-	-	3.79	4.33
Ameletus cooki	-	-	-	-	-	-	-	.45	.52	.61	-	-	1.31	1.52	-	-
Arcynopteryx cpc.	.62	.35	-	-	-	-	-	-	-	-	-	-	1.51	4.32	1.67	1.83
Diura knowltoni	6.03	6.71	3.99	2.02	.22	-	-	-	-	-	-	-	-	-	.97	-
Isogenus aestivalis	2.97	3.05	2.21	2.32	.43	-	-	-	-	-	-	-	-	-	-	-
Acroneuria pacifica	1.35	1.49	.64	.47	.41	-	-	-	1.95	1.88	1.72	1.66	2.03	3.98	3.93	2.70
Classenia sabulosa	2.99	2.34	1.87	1.72	.88	3.12	3.24	1.29	2.37	3.21	8.91	5.07	6.53	3.93	3.78	3.06
Paraperla frontalis	.55	1.89	1.20	1.07	.23	-	-	-	-	-	-	-	-	-	-	1.59
Alloperla sp.	1.89	2.37	1.46	1.52	1.76	3.51	2.98	2.27	1.02	-	5.07	5.06	3.72	4.68	1.93	2.74
Pteronarcys californica	1.39	.57	.55	.49	-	-	-	.28	.57	.68	2.11	1.56	-	-	-	-
Nemouria californica	-	-	-	-	-	-	-	-	.79	1.55	2.86	3.03	-	-	-	2.47
Nemouria oregonensis	1.74	1.97	1.95	-	-	-	-	-	-	-	-	-	-	-	.57	1.86

TABLE 19 - Continued

PERCENTAGE COMPOSITION OF INDIVIDUAL SPECIES IN THE BOTTOM FAUNA OF POST CREEK, SITE II, APRIL THROUGH SEPTEMBER 1973

Date:	4-14	5-6	5-28	6-7	6-14	6-22	6-26	7-3	7-10	7-16	7-30	8-7	8-14	8-22	9-10	9-31
Capnia sp.	.52	1.33	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rhyacophila acropedes	2.84	3.12	3.25	3.96	4.15	2.31	2.05	2.16	2.27	4.03	7.10	6.53	6.17	5.46	3.25	4.36
Glossoma sp.	2.92	3.27	4.01	2.33	2.47	6.22	9.76	6.09	12.6	11.3	4.73	4.22	4.05	5.85	5.43	5.27
Hydropsyche sp.	2.84	2.33	1.49	.97	.45	.47	.51	3.14	3.27	1.22	1.85	1.02	-	-	10.0	9.07
Arctopsyche grandis	1.38	1.79	-	-	-	-	-	-	-	3.22	1.53	1.79	1.64	1.85	2.05	1.99
Parapsyche elsis	-	-	-	-	-	-	-	-	-	-	-	.53	.77	8.92	4.06	2.74
Parapsyche almota	-	-	-	-	-	-	-	-	-	-	-	-	-	1.55	2.86	1.25
Limnephilus sp.	1.30	-	-	-	.24	-	-	-	-	-	-	-	-	-	-	-
Polycentrops sp.	3.70	3.48	1.29	.47	.31	-	-	-	-	-	2.38	-	-	-	-	-
Leptocella sp.	.54	-	-	-	-	-	-	-	.26	-	-	-	-	-	.57	-
Oecetis cinerascens	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.51	1.34
Cleptelmis sp.	8.7	12.5	17.4	13.1	25.4	11.3	19.1	16.7	10.6	8.86	8.41	14.2	12.6	14.6	6.00	6.31
Narpus sp.	-	-	-	-	-	-	-	-	1.52	1.44	1.74	-	-	-	-	1.38
Haliplus sp.	1.24	1.53	-	-	-	-	-	-	-	-	1.54	3.49	2.17	5.89	1.57	1.64
Hexatoma sp.	1.38	.79	.39	1.52	-	-	-	-	.25	1.65	.57	-	1.04	-	.28	4.61
Antocha sp.	-	-	2.00	3.04	3.89	2.74	1.35	-	.58	1.44	-	-	-	-	-	2.74
Chironomus sp.	7.11	9.28	8.95	8.47	8.05	9.77	5.32	3.75	-	-	-	9.64	6.27	6.05	1.30	6.21
Calypsectra sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	1.55	1.57	3.79
Simulium sp.	-	-	-	-	-	-	-	-	-	-	2.07	1.99	-	-	1.39	-
Atherix variegata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.03	1.29

TABLE 20

PERCENTAGE COMPOSITION OF INDIVIDUAL SPECIES IN THE BOTTOM FAUNA OF POST CREEK, SITE III, APRIL THROUGH SEPTEMBER 1973

Date:	4-14	5-6	5-28	6-7	6-14	6-22	6-26	7-3	7-10	7-16	7-30	8-7	8-14	8-22	9-10	9-31
Rithrogena hageni	1.24	1.22	1.13	.86	.49	.76	2.15	1.32	.48	.67	-	-	-	-	-	1.64
Cinygmula sp.	2.54	2.61	1.98	-	-	-	-	-	-	-	-	-	-	-	-	-
Cinygma integrum	.97	1.13	1.22	1.16	.79	1.92	2.81	7.03	7.15	8.97	5.09	2.44	2.57	2.67	-	-
Epeorus deceptivus	1.27	1.44	1.86	1.39	.76	.65	-	-	-	-	-	-	-	-	-	-
Epeorus albertae	-	-	-	-	11.1	11.8	17.7	10.5	8.19	9.23	3.69	-	1.68	-	-	-
Ephemerella inermis	4.97	5.08	2.95	1.02	.66	.57	-	-	-	-	-	-	-	-	-	-
Ephemerella infrequens	-	-	-	-	1.07	1.38	1.54	.57	.62	1.30	-	-	-	-	-	-
Ephemerella flavilinae	-	-	-	-	-	-	-	.49	.55	-	-	-	-	-	-	-
Ephemerella margarita	-	-	-	-	-	-	-	-	-	2.38	.79	-	-	-	-	1.49
Ephemerella hecuba	-	-	-	-	-	-	.64	.29	-	-	-	-	-	-	-	-
Baetis parvus	-	-	-	-	1.05	2.11	2.05	1.02	1.14	1.63	-	7.08	13.2	19.4	21.9	22.5
Baetis tricaudatus	9.97	10.7	9.96	1.03	6.05	7.54	5.65	6.57	10.2	6.11	8.38	3.44	3.69	2.74	4.33	3.76
Baetis bicaudatus	-	-	-	-	-	1.87	1.99	.49	.57	1.00	.96	-	-	-	-	-
Paraleptophlebia debelis	10.7	11.2	8.94	6.59	7.46	10.7	17.5	9.55	11.6	5.67	10.7	12.1	6.25	10.6	5.99	8.54
Tricorythodes minuta	-	-	-	-	-	-	.28	.56	2.07	4.54	13.8	22.8	23.1	8.73	6.68	2.83
Diura knowltoni	3.01	3.35	3.20	3.19	-	-	-	-	-	-	-	-	-	.79	.80	.84
Isoperla fulva	1.47	1.59	1.99	.96	.47	.87	-	-	-	-	-	-	-	-	-	-
Isoperla mormona	-	-	-	-	-	-	-	-	.58	.64	-	-	-	-	-	-
Isogenus aestivalis	.49	.51	.88	.75	-	-	-	-	-	-	-	-	-	-	-	-
Acroneuria pacifica	1.22	1.05	.79	.88	-	-	-	-	-	.97	2.01	1.55	1.09	1.76	1.26	1.09
Classenia sabulosa	1.55	1.47	1.38	1.61	1.57	-	1.02	1.05	1.14	1.87	1.80	1.93	1.34	.95	1.44	2.03
Paraperla frontalis	.32	.24	.47	.38	.55	.29	-	-	-	.56	-	-	-	-	-	-
Alloperla sp.	.66	.53	.68	.74	-	-	.11	-	.27	-	-	1.77	1.38	.86	1.55	1.97
Nemouria oregonensis	1.05	1.32	1.33	1.29	-	-	-	-	-	-	-	-	-	-	-	-
Nemouria californica	-	-	-	-	-	-	.27	1.04	1.36	2.34	2.88	2.61	2.58	2.64	2.22	2.41
Capnia sp.	.33	.35	.37	.41	-	-	-	-	-	-	-	-	-	-	-	-
Rhyacophila acropedes	6.05	5.49	7.55	5.09	5.48	4.69	6.01	3.94	1.45	1.87	1.95	1.72	2.56	2.45	4.30	4.14
Glossoma sp.	17.3	16.9	12.3	7.38	7.49	9.16	9.76	4.22	6.32	7.21	4.67	2.41	2.56	2.87	5.89	5.65

TABLE 20 - Continued

PERCENTAGE COMPOSITION OF INDIVIDUAL SPECIES IN THE BOTTOM FAUNA OF POST CREEK, SITE III, APRIL THROUGH SEPTEMBER 1973

Date:	4-14	5-6	5-28	6-7	6-14	6-22	6-26	7-3	7-10	7-16	7-30	8-7	8-14	8-22	9-10	9-31
Agapetus sp.	-	-	1.55	2.87	4.33	2.27	1.76	3.11	5.14	3.79	4.83	2.71	.96	2.45	-	-
Hydropsyche sp.	7.02	6.81	9.73	10.1	11.6	9.74	8.22	19.0	17.1	9.25	4.23	4.95	2.33	2.96	5.23	6.03
Brachycentrus sp.	3.23	3.01	2.66	2.84	3.44	2.97	5.36	2.32	2.17	5.77	2.06	2.07	2.11	2.04	-	-
Limnephilus sp.	3.56	3.68	1.79	1.82	1.27	1.25	.68	1.06	1.85	2.11	9.67	1.55	.52	1.47	1.21	6.38
Leptocella sp.	-	-	-	-	-	-	-	.66	.38	-	-	-	-	-	-	-
Polycentrops sp.	.33	.29	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Helicopsyche borealis	-	-	-	-	-	-	-	1.14	-	1.61	-	1.07	-	.59	-	-
Cleptelmis sp.	9.59	9.40	11.5	10.9	13.0	15.1	7.32	17.5	9.85	6.68	17.3	13.9	16.8	25.8	23.2	18.3
Lara sp.	.78	.85	-	-	-	-	-	-	-	-	.88	-	-	-	.49	-
Haliplus sp.	.69	.64	.75	.83	-	-	-	-	-	-	-	-	-	-	-	-
Chironomus sp.	8.12	7.99	9.34	8.79	6.64	7.71	6.77	7.54	5.94	4.38	6.19	14.4	13.8	8.91	9.22	6.07
Simulium sp.	1.66	1.74	4.23	3.98	2.35	3.27	-	2.67	1.24	5.61	-	.85	3.01	-	1.63	-
Hexatoma sp.	-	-	-	-	-	-	-	-	.18	.25	-	-	-	-	-	-
Culex sp.	4.87	4.41	2.02	-	-	-	-	-	-	-	-	-	-	-	-	-
Calypsectra sp.	1.67	1.79	1.92	2.06	2.11	2.04	3.11	2.57	2.66	3.07	3.21	3.05	3.15	5.89	4.12	6.03
Antocha sp.	-	-	-	-	2.55	3.18	1.22	1.59	1.64	2.53	2.66	1.57	2.54	1.04	1.68	4.11
Narpus sp.	-	-	-	-	.32	.37	-	.29	-	-	.47	-	-	-	-	-
Atherix variegata	-	-	-	-	.57	-	-	-	.62	-	.18	-	.55	-	-	-
Chrysops sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.87	.77
Sialis sp.	.14	-	-	-	-	-	.11	-	-	-	-	-	-	-	.18	-
Ophiogomphus montanus	.14	.17	-	-	-	-	-	-	.18	-	.13	.16	-	1.6	-	-

TABLE 21

PERCENTAGE COMPOSITION OF INDIVIDUAL SPECIES IN THE BOTTOM FAUNA OF POST CREEK, SITE IV, APRIL THROUGH SEPTEMBER 1973

Date:	4-14	5-6	5-28	6-7	6-14	6-22	6-26	7-3	7-10	7-16	7-30	8-7	8-14	8-22	9-10	9-31
Rithrogena hageni	2.91	2.20	2.61	5.34	5.50	2.06	3.22	2.41	1.15	-	-	-	-	.33	.81	.90
Cinygmula sp.	1.22	1.14	1.41	1.33	.41	-	-	-	-	-	-	-	-	-	-	-
Cinygma integrum	.22	.24	.71	.66	.72	1.3	3.01	1.86	-	4.88	2.54	1.36	1.11	.69	1.02	1.55
Epeorus albertae	-	-	-	1.97	2.48	5.22	3.68	3.13	6.47	10.4	7.15	.88	1.27	.33	-	-
Ephemerella infrequens	-	-	-	3.36	9.97	4.25	6.83	8.11	5.14	1.77	1.79	.36	-	-	-	-
Ephemerella inermis	8.92	8.88	2.73	1.98	.68	.28	-	-	5.77	1.18	-	-	-	-	-	-
Ephemerella micheneri	-	-	-	-	-	-	-	.44	1.06	.55	-	-	-	-	-	-
Ephemerella margarita	-	-	-	-	-	-	-	-	.79	3.01	9.36	.44	3.92	.97	.93	.95
Ephemerella flavilinae	-	-	-	-	.66	.74	1.22	.35	-	-	-	-	-	-	-	-
Baetis parvus	-	-	-	-	.28	.66	-	-	.59	-	.64	-	-	-	-	-
Baetis tricaudatus	3.22	3.00	5.15	2.23	2.16	6.10	2.73	10.5	7.49	9.86	9.22	13.3	7.89	7.91	8.99	6.77
Baetis bicaudatus	-	-	-	-	.28	-	.57	.49	.82	1.37	2.33	-	-	-	-	-
Paraleptophlebia debelis	4.22	4.00	6.01	8.23	3.88	8.12	2.90	2.37	3.88	3.34	1.09	-	-	-	-	-
Tricorythodes minuta	-	-	-	-	-	-	-	1.02	-	1.33	2.35	.75	2.16	.79	.55	.58
Arcynopteryx cpc.	-	-	-	-	-	-	-	-	-	-	-	-	.72	.47	.65	.72
Isogenus aestivalis	-	-	.75	.82	1.47	-	-	-	-	-	-	-	-	-	-	-
Isoperla fulva	.62	.54	.55	.63	-	-	-	-	-	-	-	-	-	-	-	-
Isoperla mormona	-	-	-	-	1.67	1.0	1.99	1.76	1.49	-	-	-	-	-	-	-
Acroneuria pacifica	.72	.46	.29	.78	-	-	-	-	-	-	1.97	2.01	2.22	2.45	2.00	2.31
Classenia sabulosa	1.35	1.04	1.47	1.44	.98	1.16	1.29	1.02	1.84	2.06	.88	1.02	1.30	1.52	1.88	1.97
Nemouria californica	-	-	-	-	-	-	-	.59	-	-	-	.68	.66	.69	.77	.86
Nemouria oregonensis	.88	1.75	.77	-	-	-	-	-	-	-	-	-	-	-	-	-
Capnia sp.	.24	.16	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Alloperla sp.	-	-	-	-	.43	.32	-	-	-	-	-	-	.55	-	-	-
Rhyacophila acropedes	2.33	2.02	2.68	2.73	2.67	4.26	5.29	3.52	2.74	3.00	2.41	2.50	4.61	2.09	4.16	2.17
Glossoma sp.	14.3	13.7	10.7	8.26	8.66	8.35	8.03	8.01	8.76	13.9	12.9	6.91	7.72	5.77	9.07	12.1
Agapetus sp.	1.82	1.77	1.14	1.87	1.90	1.73	2.92	1.05	6.11	2.08	1.84	.72	-	-	-	-
Hydropsyche sp.	30.2	29.5	23.3	20.7	18.0	12.6	1818	6.53	6.10	5.77	12.7	28.5	37.3	58.7	61.9	55.5

TABLE 21 - Continued

PERCENTAGE COMPOSITION OF INDIVIDUAL SPECIES IN THE BOTTOM FAUNA OF POST CREEK, SITE IV, APRIL THROUGH SEPTEMBER 1973

Date:	4-14	5-6	5-28	6-7	6-14	6-22	6-26	7-3	7-10	7-16	7-30	8-7	8-14	8-22	9-10	9-31
Brachycentrus sp.	11.3	10.4	8.35	4.17	2.97	6.53	3.11	10.9	15.2	11.4	7.44	2.26	6.38	.22	2.74	.20
Limnephilus sp.	.97	.99	1.14	.67	-	.88	.75	.54	.73	.55	.49	-	.14	.11	121	.29
Leptocella sp.	-	-	-	-	-	-	-	-	.70	-	-	-	-	-	-	-
Wormaldia sp.	-	-	-	-	-	-	-	3.53	.15	-	-	-	-	-	-	-
Polycentrops sp.	-	-	-	-	.14	-	-	.57	-	-	-	-	-	-	-	-
Helicopsyche borealis	-	-	-	-	-	-	-	-	1.06	-	.67	-	.39	-	-	-
Cleptelmis sp.	5.44	5.62	10.4	16.8	17.5	20.7	19.4	20.9	12.2	8.46	8.91	10.3	9.67	8.33	9.25	9.55
Haliplus sp.	.66	.57	.63	.72	-	-	-	-	-	-	-	-	-	-	-	-
Hexatoma sp.	.33	.25	.27	-	-	-	.20	-	.54	-	.23	-	-	.15	.22	-
Tipula sp.	-	-	-	-	-	-	-	.50	-	-	-	-	.13	-	.38	-
Antocha sp.	2.77	2.65	3.97	3.69	5.34	4.68	3.36	3.75	3.94	7.19	7.33	2.13	3.99	4.17	1.46	2.65
Chironomus sp.	6.15	6.02	8.94	8.20	7.47	7.44	10.6	8.94	7.39	5.60	4.94	3.61	6.33	3.22	4.17	3.78
Calypsectra sp.	1.05	1.12	.98	1.31	1.98	1.77	1.85	1.55	2.83	2.54	2.55	1.79	1.83	1.76	2.03	2.29
Simulium sp.	1.17	1.59	3.14	3.88	1.38	2.47	-	1.49	1.66	2.87	-	22.5	3.01	1.35	1.24	1.27
Culex sp.	6.02	5.18	3.44	2.89	-	-	-	-	-	-	-	-	-	-	-	-
Blephlacera sp.	-	-	-	-	-	-	.29	.40	-	-	-	-	-	-	-	-
Atherix variegata	-	-	-	-	-	-	-	-	.39	.42	-	-	-	-	-	-
Parargyractes sp.	-	-	-	-	-	-	-	-	-	-	-	-	.14	.22	.67	-

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