AN EXAMINATION OF THE AQUATIC INSECT POPULATIONS OF OAK CREEK, ARIZONA

A Thesis Presented to

The Graduate Faculty

Northern Arizona University

In Partial Fulfillment

of the Requirements for the Degree

Master of Science in Biology

by

Eric Bruce May

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TABLE OF CONTENTS

LIST OF TABLES

CHAPTER I

INTRODUCTION

Increasing interest in stream ecology has stimulated much research in the area of aquatic insect communities. Present knowledge of the distribution and abundance of stream insects has developed mainly from studies aimed at determining the nature and availability of fish food (Mackay and Kalff, 1969). Of the types of substrate compositions examined, the clear, swift-flowing riffle areas preferred by trout and salmon have been examined most thoroughly (Surber, 1937; Pennak and Van Gerpen, 1947; Armitage, 1958). Few accounts concerning the distribution of immature stages are available, and life history data are unavailable for aquatic insects of the southwest. Similarly literature concerning various aspects of larval and adult ecology is lacking, indicating the need for basic research dealing with the aquatic insect fauna.

It is probable that many factors affect the distribution of adult insects whose larval stages are spent in aquatic habitats. Insects whose life cycles are entirely in terrestrial habitats are well studied, however insects whose life cycles include aquatic environments remain largely unexamined. Data are needed concerning life cycles, spatial distribution of various species, the effects of certain stream characteristics on aquatic larvae, differences in aquatic communities between different substrates, and seasonal changes in abundancies of various aquatic insect species.

Of further concern to aquatic biologists is the continued advance of pollution in streams and rivers, and the need to chart community structures prior to the possible man-caused eutrophication of streams. The presence or absence of a single index species is probably not useful (Mackay, 1969). Taxonomic studies have not been useful, since such studies do not usually include a description of the community from which the organism came. Thus it is of particular value not only to chart the insect fauna of a stream, but also to examine the organisms' habitat preferences, and variations in community composition between different stream bottom substrate types.

The two most basic questions to be answered prior to other types of study are: what organisms are found in the stream, and with what types of habitats do they frequently associate. A survey provides future researchers with an understanding of what organisms frequent a given stream, and aids in identification of specimens collected during later studies. A gap exists in the knowledge concerning the ecology of many larvae. To understand community compositions it is important to understand in part the habitat preferences of those individuals that comprise a given community. It was with the intention of answering these two questions that the study of the West Fork of Oak Creek was initiated.

Percival and Whitehead (1929) and Janzen and Schoener (1969) utilized a spatial approach to their respective problems. Percival and Whitehead (1929) examined the variations in community structure between various sites in different stream bottom types. The particular study enabled them to examine differences in a great many substrate types during a short period of time. Janzen and Schoener (1969) examined the effects of drought by examining wetter and drier sites during a single tropical dry season. It is possible to reduce the effects of climate and seasonal variation by selecting short periods of the year for collection.

Examination of ninety-five sites covering a wide variety of habitat compositions provided me with: a survey of the aquatic insect fauna, knowledge of the habitat preferences of the aquatic larvae examined, and comparative data between three general types of substrate compositions and the communities that occupy them.

Forty-five genera were represented in this survey, with eight of the forty-five genera undetermined. Members of the Coleoptera, Diptera, Trichoptera, Ephemeroptera, Hemiptera, Neuroptera, Odonata, and Plecoptera were represented in this study. See Table 1, page 5, for a checklist of the aquatic insect genera of the West Fork.

Field sampling was carried out during two time periods. Summer sampling began August 11, 1971 and ended September 22, 1971, and winter sampling began December 11, 1971 and ended December 22, 1971. From papers by Mackay and Kalff (1969) and Mackay (1969) the choice of the two time periods was ideal. During the months of June, July, and August the greatest population densities occur, with the lowest population peaks during the months of November, December, and January.

The main body of this thesis is concerned with the survey of the genera and their habitat preferences, and comparisons of the insect communities found at various stream bottom types. Each order is listed with families indicated, and habitat compositions are included with each genus A discussion concerning the habitat preferences of each genus is also given.

Comparative studies that have been used extensively in the preparation of this thesis are: Percival and Whitehead (1929), Percival and Whitehead (1930), Stehr and Branson (1938), Pennak and Van Gerpen (1947), Armitage (1958), Mackay (1969), Mackay and Kalff (1969), and Elliot (1971).

TABLE 1

A CHECKLIST OF AQUATIC INSECTS OF THE WEST FORK

I = Immature forms A = Adult forms S = Collected during the summer W = Collected during the winter.

CLASS INSECTA	
ORDER DIPTERA	
Family Tabanidae	I, S, W
Family Rhagionidae	I, S, W
Family Simuliidae	I, S, W
Family Stratiomyidae	I, S, W
Family Muscidae	I, S, W
Family Chironomidae	I, S, W
Family Ceratopogonidae	I, S, W
Family Ephydridae	I, S, W
ORDER TRICHOPTERA	
Family Hydroptilidae	
Ochotrichia sp.	I, S, W
Family Helicopsychidae	
Helicopsyche sp.	I, S, W
Family Sericostomatidae	
Sericostoma sp.	I, S, W
Family Hydropsychidae	
Cheumatopsyche sp.	I, S
Hydropsyche sp.	I, S, W
Family Philopotamidae	
Chimarra sp.	I, S, W
Family Leptoceridae	
Oecetis sp.	I, S, W
Family Glossosomatidae	
Phylliocus sp.	I, S, W
Family Lepidostomatidae	
Lepidostoma sp.	I, S
Family Limnephilidae	
Hesperophylax sp.	I, S
Family Rhyacophilidae	
Atopsyche sp.	I, S, W
Glossosoma sp.	I, S
Family Psychomyiidae	
Polycentropus sp.	I, S, W

ORDER HEMIPTERA	
Family Belostomatidae	
Abedus sp.	I, A, S
Family Naucoridae	
Ambrysus buri	I, A, S, W
ORDER COLEOPTERA	
Family Dytiscidae	
Agabus minnesotensis	A, S
Family Elmidae	
Optioservus divergens	A, S
Optioservus sp.	I, S
Heterelmis glabra	A, S
Narpus sp.	I, S
Elsianus sp	I, S
Helichus suturalis	A, S
ORDER EPHEMEROPTERA	
Family Baetidae	
Baetis sp.	I, S, W
Callibaetis sp.	I, S
Paracloeodes sp.	I, S
Choroterpes sp.	I, S, W
Tricorythodes sp.	I, S, W
Family Heptageniidae	
Epeorus margarita	I, S
Heptagenia criddlei	I, S, W
ORDER ODONATA	
Family Gomphidae	
Ophiogomphus arizonicus	I, S
Family Aeshnidae	
Aeshna interrupta	I, S
Family Libellulidae	
Paltothemis lineatipes	I, S
Family Cordulegasteridae	
Cordulegaster diadema	I, S
Family Coenagrionidae	
Hyponeura sp	I, S
Family Lestidae	
Archilestestes grandis	I, S

ORDER PELCOPTERA	
Family Nemouridae	
Capnia sp.	I, W
ORDER NEUROPTERA	
Family Corydalidae	
Corydalis sp.	I, S

CHAPTER II

DESCRIPTION OF STUDY AREA

I. GENERAL DESCRIPTION

The mouth of West Fork of Oak Creek is approximately thirty-two kilometers south by southwest of Flagstaff, Arizona. It joins the main stream approximately twenty kilometers from the source of Oak Creek and was chosen for this study because it is a permanent stream with few disturbances by people. All sampling sites were located in the lower portion of the stream.

The total study area was 637 meters along the stream of West Fork beginning at the point where West Fork joins Oak Creek. The altitude at the point of entry to Oak Creek is 1602 meters (5270 feet) and at the uppermost region of the study area the altitude is 1614 meters (5310 feet). A low ledge borders the stream at an altitude of 1620 meters (5400 feet) with a much higher ledge rising to an altitude of 1824 meters (6000 feet). All altitudes are from the United States Geological Survey Munds Park Sectional Map, Arizona.

The portion of the stream that was the study area travels through red rock sandstone. Much of the area adjacent to the stream is composed of woodlands but some segments are lined by cliffs.

Vegetation of the woodland areas was composed chiefly of Ponderosa Pine (Pinus ponderosa). Numerous shrubs were found in the area but none were identified.

The stream bed was found to be quite diverse in microhabits with the basic composition of rocks, gravel, sand, and bedrock. The flora of the stream was very diverse with abundant moss and algae. Aggregations of grass were found growing directly in the stream. Of the algae, green algae were the most common, with some blue-green and red algae also being found in the area.

II. DESCRIPTION OF THE STREAM BED IN THE STUDY AREA

At the point where West Fork joins Oak Creek the stream bed was composed of sandstone bedrock with extensive moss and algae cover. The stream flow was rapid at this point, as there was a drop of about two meters to the main stream of Oak Creek. Upstream, a series of shallow pools dominated a large portion of the study area (approximately 200 meters). The stream bed composition of this region ranged from extensive rocks and gravel to sand to a combination of the two.

The stream bed then became a series of pockets with boulders and rocks strewn along the length of the stream bed. This condition extended for about fifty meters. There was a small length of the stream in the center of this segment of the study area that was rapid with a sandstone bedrock or sand substrate. Here there were no obstructions to the flow of water.

Upstream from this region the stream was wide and slow moving. The stream bed ranged from rocks to sand and silt substrate to a sandstone bedrock substrate with numerous sand and rock "islands." This region comprised about one-half of the study area extending approximately 300 meters upstream.

The final upstream section of the study area was a series of channels cutting through a wash of boulders, rocks, and sand. This portion was short, giving way to a shallow pool of ten meters long. The wash was created by a smaller stream that joins West Fork, which apparently had become dammed and later had broken loose, sending the rocks and boulders across the main stream. The substrate of the shallow pool was sand and rocks with the upper end of the pool changing to a fast moving stream with a sandstone bedrock substrate.

Average temperatures for the stream were 15° C during the summer sampling period and 0° C during the winter sampling period.

CHAPTER III

MATERIALS AND METHODS

I. STUDY AREA SELECTION

The study at West Fork, Oak Creek was initiated by taking several visual surveys of the entire length of the stream. Such surveys enabled me to view all regions along the length of the stream. Since the sampling was not to be random, the surveys proved to be of assistance when the segment of the stream to be sampled was chosen.

It was possible through the course of the surveys to categorize the possible alternatives in selection of the study area. First it would have been possible to analyze the total length of the stream. Such an approach would have made possible an analysis of a majority of the microhabitats, and allowed for a more complete survey of the immature insect fauna. The second alternative would have been to take a segment of either the lower or upper portion of the stream. Such an alternative would give more uniform external conditions.

For the purpose of this study I chose the lower portion of the stream and sampled a length of 637 meters beginning with the mouth and moving upstream. This was the more feasible alternative since the number of microhabitats was nearly the same as the number found in the upper portions of the stream, and this choice made it possible to collect the samples in a period of time when weather conditions were uniform.

II. SAMPLING PERIODS

Sample collections were made in two time periods. Initial samples were taken between August 6, 1971 and September 11, 1971; a period of over one month. The final collections were taken between December 11, 1971 and December 22, 1971; a period of eleven days. It was desirable to collect samples at a period of time when the biotic portions of the stream ecosystem were at a relatively high level of activity (August to September) and at a relatively low activity (December).

III. STATION SELECTION

The stream study area was divided into a series of stations. For the purpose of this study a station was defined as a unit of the stream which has a characteristic water flow, and relatively similar conditions external to the stream. When a site or a series of sites was selected in a given area that area was given a station number and a description. It is a valid assumption that a microhabitat is a set of biotic and abiotic characteristics that are different from all other small units of the total environment, and that these characteristics are a partial function of the surrounding area. Therefore it is important to analyze the region as well as the specific sites.

IV. SITE SELECTION

Sites were selected on the basis of certain characters that were to be analyzed in connection with the populations of adult and immature insects found. The characteristics used as parameters for this study were: the type of substrate (rocks, gravel, sand, silt, and/or bedrock), vegetation, detritus, and water speed (rapid or slow).

V. STATION-SITE DESCRIPTION

Station Description

The station was initially described giving overall characteristics of the stream within the unit. The amount of canopy, the speed of the water, and the possible microhabitats were discussed in the description The station was then mapped and the sites that were sampled were indicated on the map. The station was then described as to the individual components as one moves from the right bank to the left bank when facing upstream.

Site Description

Each site was described fully using the various characters discussed previously. Since each site was one of the components of the station, each was described during the station description.

Mapping

Diagrams were made of each station to note the massive characters of the station (rock piles, boulders, and logs), and to give the pattern of water flow over the station. Each site, as stated earlier, was positioned on the diagram to indicate position relative to the massive characters and to the water flow.

VI. SAMPLING METHOD

Samples were taken at the time of site selection using a Surber sampler. Dimensions of the sampler used for the collecting were:

Mesh size--10 threads per centimeter

Area encompassed--.0924 square meters

Bag length--.608 meters

The sampler was placed over the desired point and the area enclosed by the square of the sampler was stirred up causing the insects to be carried into the net. The collected material was then transferred to a large pan for removal of all organisms found in the sample. The specimens were stored in vials containing an alcohol, formalin, and acetic acid solution (AFA) until the organisms could be analyzed.

VII. METHOD OF ANALYSIS

Separation

Initial generic determinations were made utilizing available keys. The organisms were separated into individual vials for each genus. At this time a count was taken of the total number per genus.

Verification and Measurements

Each organism was then re-examined and a second generic determination was made. At this time I measured the length of the individuals in each vial (or length of the larval case, when present). A second determination was made so that I could be relatively sure of the identifications. The specimens in the best condition were selected to be sent to experts in the various fields to obtain a verification of the generic names that I applied. Care was taken to select all types from each genus, especially those that were possibly different species. Counts were taken of specimens sent so an accurate count of populations could be maintained.

VIII. EARLY AND LATE SAMPLING METHODS COMPARED

The procedures for the collections of August 6, 1971 through September 11, 1971 were carried out as above. The collections of December 11, 1971 through December 22, 1971 were handled essentially the same except for the method of describing the sites. Descriptions were not recorded for each station or site, instead notations were made of the changes within each site. The notations would indicate roughly the same information about each site, but would further indicate the changes that had taken place.

IX. NUMBERS OF SAMPLES

During the period of August 6, 1971 to September 11, 1971 samples were taken from a total of seventy-one sites representing thirty-six stations. During the period of December 11, 1971 to December 22, 1971 samples were taken at a total of twenty-nine sites representing seventeen stations. A total of one hundred samples were taken from the stream.

CHAPTER IV

DESCRIPTION OF STATIONS ESTABLISHED ALONG THE WEST FORK

In an attempt to sample a wide variety of microhabitats, thirty-six stations were established along the West Fork for this study. Station #1 was established at the mouth of the stream where the water of the West Fork empties into Oak Creek. Water currents passed over a sandstone bedrock substrate that was covered by moss and algae. On the right side of the creek facing upstream the water currents were slow moving A very swift current moved along the left bank of the stream. Three sites were established: site #1, near a slow current in algae; site #2, at the middle of the stream in a slow current, in algae; and site #3 in the fast current on the left side of the stream in algae. See map of station #1, page 159.

Station #2 was selected in clear, slow moving waters of varied depth. Bedrock comprised the majority of the station substrate, however, on the left side of the stream there was a rock-gravel pile. At the center of the stream there was a single boulder with a gravel pile on the upstream side. There was no vegetation at the station or immediately upstream from it. Two sites were established: site #1, on the upstream side of the boulder in the rock-gravel pile; and site #2, in the rock-gravel pile on the left side of the stream as you face upstream. See map of station #2, page 159.

Station #3 was selected in an area of swift water. At this station the water had two main currents: a slow current along the right bank and a fast current along the left bank. There was an eddy on the left side of the stream creating a slower current over some of the sample sites. The substrate consisted of a rock-gravel bar on the left side of the stream that tapered off into a bedrock substrate as one moved to the right. Two sites were established: site #1, in the rock-gravel bar near the fast current; and site #2, in the rock-gravel bar where there was an eddy. See map of station #3, page 160.

Station #4 was located along a portion of the stream having slow moving currents throughout. The left side of the stream had extensive rock and gravel and the right side of the stream had silt directly on bedrock. There was extensive detritus along both shores. Five sites were established: site #1a, directly on bedrock in silt near the right side; site #1b, directly downstream from a low ledge in sand; site #2a, in the main channel on rock and gravel; site #2b, on rock and gravel out of the main channel near the left shore; and site #3, on rock and gravel in a small pool near the left shore away from the main water currents. See map of station #4, page 160.

Station #5 was at the downstream end of a pool of 0.6 meter depth. From the right bank there was a bedrock ledge with silt and detritus cover. From the ledge moving to the left bank there was a 0.6 meter drop to a sandy substrate that gradually changed to rock and gravel approaching the left bank. The currents were slow throughout the station. Four sites were established: site #1, on the rock ledge in the silt and detritus; site #2, in deep water at the sand substrate; site #3, in rock and gravel bar near the left bank; and site #4, upstream to site #3 in rock and gravel near the left bank. See map of station #5, page 161.

Station #6 was placed at the base of a three meter drop of the stream bed. Throughout the station there was a very fast sheet of water only a few centimeters in depth. Vegetation covering bedrock prevails throughout the station with sandstone slabs covering part of the station substrate. Two sites were established: site #1, near the right bank in algae growing on bedrock; and site #2, near the left bank in moss that covered the bedrock. See map of station #6, page 161.

Station #7 was located just before the creek bed took a three meter drop. Vegetation was extensive throughout the station except in the channel along the right bank of the stream where there was a strong current. Water currents were slow at the station. Two sites were established: site #1, was placed on a sand substrate directly in the channel along the right side of the stream; and site #2, placed in moss in the middle of the stream. See map of station #7, page 162.

Station #8 was established in a region where the substrate was chiefly bedrock with scattered piles of rock and gravel. The water currents were slow and uniform over the station. No aquatic vegetation or detritus was noted at the station. One site was established: site #1, placed on a rock-gravel pile near the left bank of the stream. See map of station #8, page 162.

Station #9 was situated downstream from a system of channels that have cut into the existing substrate of rock and gravel. At this region of the stream the currents had washed down to the bedrock with scattered piles of rock and gravel remaining. The water currents were slow over the station. No aquatic vegetation or detritus was found at this station. One site was established: site #1, placed at a pile of rock and gravel set on bedrock. See map of station #9, page 163.

Station #10 encompassed the series of channels previously discussed. The substrate was a uniform combination of large rocks with smaller rocks and gravel filled in between them. The water currents were rapid along the left side of the stream and slow along the right side. Three sites were established: site #1, in the main current along the right side of the stream on a rock pile that was set directly on bedrock; site #2, set on rocks and gravel in a small channel that joins the right channel; and site #3, set in a deep pool in rock and gravel. See map of station #10, page 163.

Station #11 was placed at the uppermost portion of the channels discussed for station #10 and station #9. All other factors are identical to station #10 at site #3. One site was established for the station: site #1, set on rocks and gravel in a deep pool. See map of station #11, page 164.

Station #12 was established in a pool approximately eight meters wide. A sand and silt substrate prevailed over the station, however, a pile of detritus existed along the right side of the stream extending for three meters across the stream and ten meters along the length of the pool. Slow currents existed at the station. No vegetation was found at the station. One site was established: site #1, placed in the detritus pile. See map of station #12, page 164.

Station #13 was positioned at the upper end of the pool discussed for station #12. All characteristics were similar to station #12 except for a large rock-gravel bar that extended along the right side of the stream producing a semi-stagnant pool on the right side of the bar as one faces upstream. One site was established: site #1, placed in the semi-stagnant pool. See map of station #13, page 165.

Station #14 was chosen at a point in the stream where the water moved over a bedrock stream bed. There was a pile of rocks and gravel with litter extending out from the right bank of the stream. Water currents were rapid along the left side of the stream, with slower currents passing along the right side. No vegetation existed at this station. One site was established: site #1, placed near the right bank of the stream in the rock pile. See map of station #14, page 165.

Station #15 was established at a very narrow part of the stream where the water currents were extremely rapid. The entire station had a bedrock substrate with a low bush growing over the left side of the stream occupying half of the width of the stream. No detritus was encountered at the station. One site was established: site #1, placed under the bush near the center of the stream. See map of station #15, page 166.

Station #16 was located at a portion of the stream where the stream narrowed and where the water currents accelerated rapidly. The substrate was bedrock with a pile of rock and gravel along the right bank. An eddy was present over the pile. No vegetation was encountered at the station. One site was established: site #1, placed in the pile of rock and gravel where the eddy was present. See map of station #16, page 166.

Station #17 was located at a point where a group of boulders extended across the stream. The substrate was comprised of rock-gravel and sand in around the boulders. No detritus was encountered at the station. Water currents were swift throughout the station. Two sites were established: site #1, placed between two boulders directly in the path of the currents; and site #2, placed behind the boulders out of the main current. See map of station #17, page 167.

Station #18 encompassed a series of gravel bars of uniform rock, gravel, and sand composition. There was a swift current moving near and parallel to the left bank, and a slow current moving along the right side of the stream setting up eddies over two of the gravel bars. No vegetation was encountered and very little detritus existed at the station. Three sites were established: site #1, at a downstream gravel bar in slow currents; site #2, at a gravel bar directly upstream from site #1 near the right side of the stream; and site #3, in a gravel bar along the left side of the stream directly in the main current that runs parallel to the left side. See map of station #18, page 167.

Station #19 was fixed in a region of the stream similar to station #17. Water currents were much slower than at station #17 and detritus was found at the station. One site was established: site #1, directly upstream from the boulders in the main currents. See map of station #19, page 168.

Station #20 was very similar to station #19 except that this station was at a region where the river narrowed causing a slight acceleration of the water currents. No vegetation or detritus was noted for this station. One site was established: site #1, placed in front of the boulders in the path of the main currents. See map of station #20, page 168.

Station #21 was fixed at that part of the stream where a United States Forest Service trail crossed the stream. This was one of the widest portions of the stream with a width of twelve meters. Near the left bank there was a small pool with a substrate of extensive sand and silt on rocks, while the majority of the substrate was rock, gravel, and sand. There was a rock overhang that extended two meters over the stream. The water currents were slow and uniform in all regions of the stream. No vegetation and very little detritus was found at the station. Two sites were established: site #1, near the right bank on sand and gravel; and site #2, in the small pool. See map of station #21, page 169.

Station #22 was identical to station #21, except that more silt was found. The pool had a substrate identical to that of station #21. Two sites were established: site #1, near the right bank of the stream on rock and sand; site #2, in the pool on the left side of the stream. See map of station #22, page 169.

Station #23 was selected at a gravel bar that rested on bedrock. The substrate at the bar was rock, gravel, and sand with the edges being almost pure sand. No vegetation or detritus was located at the station. The rest of the substrate was bedrock. All water currents were slow and uniform throughout the station. One site was established: site #1, placed on the gravel bar near the edges. See map of station #23, page 170.

Station #24 was located at a part of the stream which had extensive bedrock substrate with numerous small pateches of gravel and sand. Detritus was lacking at the station. One site was established: site #1, placed on one of the rock-gravel patches where an eddy existed. See map of station #24, page 170.

Station #25 encompassed a bend in the stream. The stream was wide with an average water depth of five centimeters. An area of rock and silt extended along the left side of the stream, while the right side of the stream had algae growing over a bedrock substrate.

Water currents were rapid and constantly eroded the silt on the right side of the stream. Two sites were established: site #1, placed in the rock and silt substrate; and site #2, placed in the algae growing on the bedrock. See map of station #25, page 171.

Station #26 was similar to site one of station #25 except that the water currents were very slow. One site was established: site #1, on rock in the main channel. See map of station #26, page 171.

Station #27 was situated at a log placed across the stream as a footbridge. A large pile of detritus was formed by the log blocking the surface currents of the stream. Water currents were slow and uniform throughout the station. No vegetation was found at the station. One site was established: site #1, placed in the approximate center of the detritus pile. See map of station #27, page 172.

Station #28 and station #29 were identical in that both had a bedrock substrate extending throughout each site. A large boulder extended from the right bank of each with a build-up of rock, gravel and sand on bedrock on the upstream side of each boulder. Currents at both stations were slow and uniform. No vegetation was located at either station. One site was established for each station: site #1 for each, placed directly on the rock-gravel build-up upstream from the boulder. See map of station #28, page 172.

Station #30 and station #31 encompassed a region where boulders, rocks, gravel, and sand spilled across the stream from a smaller stream that joins the West Fork. The main stream had split into two channels which were uniform in substrate having rock, gravel, and sand. Station #30 extended across the downstream portion of the channels, and station #31 extended across the upper portion of the channels. The water currents were rapid along the channel on the right and slower along the left channel. Three sites were established for station #30: site #1, placed in the right channel on rock and sand on bedrock; site #2, placed in the left channel on rock, gravel and sand; and site #3, placed in the left channel where it spilled into a large pool. Three sites were established for station #31: site #1, placed in the right channel on rock and gravel; site #2, placed in the left channel on rock and gravel; and site #3, placed in the upstream end of the large pool where water currents were slow. See map of stations #30 and #31, page 173.

Station #32 was placed at a section where the stream widens causing a deceleration of the currents. The stream substrate was comprised of rock and gravel with sand. Stream currents were split with a rapid current near the left bank of the stream and a slower current near the right bank. Three sites were established: site #1, placed near the right bank in slow currents; site #2 placed in the center of the stream in the main currents; and site #3, placed in the most rapid current near the left bank. See map of station #32, page 174.

Station #33 was placed in a slow moving current. The sub-strate was chiefly bedrock with sand and piles of detritus at several points in the station. No vegetation was found at the station. One site was established: site #1, placed at one of the sand and detritus piles. See map of station #32, page 174.

Station #34 was situated on a portion of the stream where extensive sand and silt occurred in piles. A large patch of gravel and sand extended out from the right bank. Detritus was found at the station but no vegetation was noted. The water currents were slow and uniform with an eddy over the gravel and sand extension out from the right bank. Two sites were established: site #1, placed in the gravel and sand extension of the right bank; and site #2, set on one of the sand and silt piles near the main currents of the stream. See map of station #34, page 174.

Station #35 was established where a series of large boulders extended across the stream laying directly on bedrock. Along the right side of the stream there was a build-up of sand and gravel behind a projection of the shore. There were build-ups of sand and gravel on the upstream side of the boulders. Near the shore of the left side of the stream and in the middle of the stream there was a bedrock substrate. Water currents were slow throughout the upstream portion of the station but were accelerated as the currents were forced between the boulders. The main current of the stream passed along the left side of the stream. Four sites were established: site #1, placed in the rock and gravel pile behind the projection of the right bank; site #2, placed behind boulders in the middle of the stream; site #3, placed on bedrock in the main current of the stream; and site #4, placed behind a large boulder on the left side of the stream on rock and gravel. See map of station #35, page 175.

Station #36 encompassed two pools, one on the left side of the stream and one on the right. The pools were split by a shallow current passing between them. Both pools had a rock and gravel substrate with extensive algae and detritus in each. The currents were slow throughout the station. Three sites were established as follows: site #1, placed in the pool at the right side of the stream behind boulders; site #2, placed in the pool at the left side of the stream near the main current; and site #3, placed in the pool on the left side of the stream away from the main currents. See map of station #36, page 176.

Table #2 lists the characters that were sampled and indicates the sites that possessed the various character combinations.

Abbreviations used in this table and throughout the thesis are as follows: R, Rock-Gravel; S, Sand; St, Silt; B, Bedrock; V, Vegetation; D, Detritus; SW, Slow water; and FW, Fast water. The number code for each site is set so that the first number indicates the station number and the second number indicates the site number in that particular station.

TABLE 2

SUBSTRATE COMPOSITION OF SITES DURING

SUMMER SAMPLING PERIOD

R-S-St-V-D-SW
31-2
36-1

R-S-St-V-D-FW
10-2

R-S-St-V-SW
5-4

R-S-St-D-SW
7-1
10-3
11-1
21-2
30-3
32-1
35-1

R-S-St-B-SW
8-1

R-S-B-D-SW
5-2
28-1
29-1

R-St-V-D-SW
36-3

R-S-St-SW
4-3
5-3
13-1
18-1
18-2
22-2

R-S-D-SW
2-2
12-1
19-1

R-S-D-FW
30-2

R-S-V-SW
35-2

R-S-V-FW
17-2

R-S-B-SW
22-1
34-2

R-S-B-FW
9-1
10-1
24-1

R-St-B-SW
14-1
35-4

R-St-B-SW
14-1
35-4

R-B-V-FW
6-2
32-3

R-B-D-SW
26-1

R-S-SW
2-1
3-2
4-2b
16-1
20-1
21-1

R-S-FW
3-1
4-2a
17-1
18-3
30-1
31-1
32-2

S-St-D-SW
4-1b
34-1

S-B-D-SW
33-1

S-B-SW
23-1

St-B-V-SW
1-2
1-3
7-2
15-1

St-B-V-FW
25-2

St-B-D-SW
4-1a
5-1

St-V-D-SW
36-2

B-V-FW
1-4

B-FW
35-3

D-SW
27-1

CHAPTER V

CHANGES IN HABITAT COMPOSITION BETWEEN SUMMER AND WINTER

The stations sampled during the winter period were the same as those sampled during the summer. During the winter sampling period there was snow and ice in the region of West Fork. Ice covered almost the entire length of the 637 meters of the study area and varied in thickness from .3 meters to a thin layer of less than a centimeter.

Station #1 was entirely covered with ice along the right side of the stream. Much of the algae had disappeared. The water currents were very rapid throughout due to melting of snow. Sites #1, #2, and #3 were resampled.

Station #2 was covered with ice. At some sites I was unable to break the ice to take samples. Water currents and substrate composition remained the same. Site #1 was resampled.

Station #3 had ice covering the middle of the stream, however, at the edges only a thin layer existed. The area was denuded of the sand that had previously existed here and much of the bedrock was now uncovered. Water currents remained the same. Sites #1 and #2 were resampled.

Station #4 had ice throughout the station All of the silt had been washed from the station and the sand was partially removed. The water currents had become more rapid. Sites #1a, #1b, #2a, #2b, and #3 were resampled.

Station #5 was covered with ice which prevented sampling the left side of the stream. On the right the ice extended vertically down to the substrate allowing only a slow flow of water over the substrate. There was a marked denuded appearance to the ledge on the right side of the stream. Sites #1 and #2 were resampled.

Station #6 was ice covered with ice down to the substrate along the left side of the stream. All detritus had been lost from the station and some of the rocks also had washed away. Currents appeared the same as before. Sites #1 and #2 were resampled.

Station #7 had a sparse layer of ice over the area. There was a build-up of detritus at the station. Vegetation was missing from the station. The water currents were the same as previous records indicate. Sites #1 and #2 were resampled.

Station #8 was without ice. The area was denuded leaving only rock-gravel on bedrock. The current was essentially the same. Site #1 was resampled.

Station #9 had no ice at the station. All sand was gone. Currents remained unchanged. Site #1 was resampled.

Station #10 remained unchanged. Sites #1 and #2 were resampled.

Station #11 had a rapid current running through it. There has been a loss of all silt, sand and detritus leaving only rock-gravel in the region. Site #1 was resampled.

Station #12 had been covered by a pile of gravel, sand and detritus leaving the station out of the stream. No samples could be taken.

Station #13 had ice covering the entire station. No other changes had occurred to either the water currents or substrate composition. Site #1 was resampled.

Station #14 had ice extending partially over the station. There had been a loss of silt at the region. A large pile of leaves had lodged at the station. Water currents remained the same. Site #1 was resampled.

Station #15 had an ice covering over the left side of the stream. The bush that was recorded during the summer was torn away leaving only silt on bedrock. The currents remained unchanged. Site #1 was resampled.

Station #16 was covered by ice but was otherwise unchanged. Site #1 was resampled.

Station #17 was unchanged with no ice over the region.

Site #1 was resampled.

It was apparent that there had been a great deal of runoff in the West Fork during the time between the two sampling periods. Weather conditions during the time between the two sampling periods account for this, as there was a period of heavy snow with rain following. Such conditions would tend to give a great deal of water coming from available watersheds.

Table 3 lists the characteristics existing at each site. The sites collected during this time were placed near, but not on, the previous site.

TABLE 3

SUBSTRATE COMPOSITION OF SITES DURING WINTER SAMPLING PERIOD

R-S-B-D-FW	R-S-D-SW	R-B-FW	S-B-D-SW
7-1	2-1	9-1	4-1a
R-S-St-SW	4-3	R-B-SW	St-B-V-D-SW
13-1	R-S-FW	8-1	5-1
R-S-B-FW	4-2b	R-V-SW	St-B-V-FW
3-1	R-S-FW	6-1	5-1
4-1b	5-2	R-D-SW	St-B-V-FW
4-2a	10-1	7-2	1-3
R-S-B-SW	16-1	14-1	1-4
3-2	17-1	R-FW	St-B-SW
		10-2	15-1
		11-1	B-D-FW
			1-2
			B-V-SW
			6-2

CHAPTER VI

A SURVEY OF THE DIPTERA OF THE WEST FORK

The Diptera collected from the West Fork were exclusively larvae. During the summer sampling 1668 were collected from sixty-seven sites. During the winter sampling 209 larvae were collected from seventeen sites. Among the 1877 specimens collected, eight families were represented.

Information is lacking concerning the ecology of dipterous larvae that inhabit freshwater streams. In addition, verifications that were made of the dipteran specimens could only be made to family. As many of the families are diverse I am unable to fully discuss their ecology here. Lists are provided in Tables 4 through 11 giving the sites from which the various families of Diptera were collected with information concerning the habitat.

ORDER DIPTERA

TABLE 4

TABANIDAE COLLECTION DATA

Site collected	Number of individuals	Type of habitat
	Summer	
Tabanidae		
7-1	1	R-S-St-D-SW
9-1	1	R-S-B-FW
10-1	4	R-S-B-FW
10-2	4	R-S-St-D-V-FW
10-3	1	R-S-St-D-SW
14-1	4	R-St-B-SW
18-1	1	R-S-St-SW
18-2	1	R-S-St-SW
18-3	5	R-S-FW
19-1	2	R-S-D-SW
20-1	4	R-S-SW
21-1	8	R-S-SW
23-1	2	S-B-SW
24-1	15	R-S-B-FW
25-1	1	R-St-FW
26-1	2	R-B-D-SW
28-1	6	R-S-B-D-SW
29-1	1	R-S-B-D-SW
30-1	6	R-S-FW
30-2	2	R-S-D-FW
31-1	3	R-S-FW
35-2	2	R-S-V-SW
	Winter	
Tabanidae		
4-2a	2	R-S-B-FW

TABLE 5

RHAGIONIDAE COLLECTION DATA

Site collected	Number of individuals	Type of habitat
	Summer	
Rhagionidae		
7-1	1	R-S-St-D-SW
7-2	2	St-B-V-SW
10-1	3	R-S-B-FW
10-2	9	R-S-St-D-V-FW
15-1	2	S-St-V-SW
18-3	1	R-S-FW
25-1	1	R-St-FW
30-3	3	R-S-St-D-SW
31-1	2	R-S-FW
35-2	3	R-S-V-SW
	Winter	
4-1b	1	R-S-B-FW

TABLE 6

SIMULIIDAE COLLECTION DATA

Site collected	Number of individuals	Type of habitat
	Summer	
Simuliidae		
1-2	20	St-B-V-SW
1-3	57	St-B-V-SW
1-4	1	B-V-FW
3-2	10	R-S-SW

TABLE 6 (Continued)

Site collected	Number of individuals	Type of habitat
	Summer	
Simuliidae		
6-2	2	R-B-V-FW
7-2	4	St-B-V-SW
10-1	6	R-S-St-D-V-FW
10-2	15	R-S-St-D-V-FW
15-1	1	S-St-V-SW
16-1	1	R-S-SW
17-2	9	R-S-SW
20-1	1	R-S-SW
25-1	2	R-St-FW
26-1	2	R-B-D-SW
	Winter	
Simuliidae		
1-2	1	B-D-FW
1-3	54	St-B-V-FW
1-4	17	St-B-V-FW

TABLE 7

STRATIOMYIDAE COLLECTION DATA

Site collection	Number of individuals	Type of habitat
	Summer	
Stratiomyidae		
1-2	50	St-B-V-SW
1-3	40	St-B-V-SW
3-2	26	R-S-SW
4-1b	1	S-St-D-SW

TABLE 7 (Continued)

Site collected	Number of individuals	Type of habitat
	Summer	
Stratiomyidae		
6-1	1	S-St-D-SW
7-2	4	B-St-V-SW
10-2	1	B-S-St-V-D-FW
	Winter	
Stratiomyidae		
1-2	1	B-D-FW

TABLE 8

MUSCIDAE COLLECTION DATA

Site collected	Number of individuals	Type of habitat
	Summer	
Muscidae		
1-2	1	St-B-V-SW
8-1	1	R-S-St-B-SW
	Winter	
Muscidae		
1-3	4	St-B-D-FW

TABLE 9

CHIRONOMIDAE COLLECTION DATA

Site collected	Number of individuals	Type of habitat
	Summer	
Chironomidae		
1-2	7	St-B-V-SW
1-3	29	St-B-V-SW
2-1	62	R-S-SW
2-2	33	R-S-D-SW
3-2	10	R-S-SW
4-1a	25	St-B-D-SW
4-1b	15	S-St-D-SW
4-2a	4	R-S-FW
4-2b	103	R-S-SW
4-3	11	R-S-St-SW
5-1	60	St-B-D-SW
5-2	14	R-S-B-D-SW
5-3	11	R-S-St-SW
5-4	34	R-S-St-V-SW
6-1	1	B-V-D-FW
7-1	41	R-S-St-D-SW
7-2	16	St-B-V-SW
8-1	30	R-S-St-B-SW
9-1	4	R-S-B-FW
10-1	2	R-S-B-FW
10-2	14	R-S-St-D-V-FW
10-3	7	R-S-St-D-V-FW
11-1	42	R-S-St-D-SW
12-1	9	R-S-D-SW
13-1	17	R-S-St-SW
14-1	50	R-St-B-SW
16-1	5	R-S-SW
17-1	87	R-S-FW
17-2	6	R-S-V-FW
18-1	3	R-S-St-SW
18-3	4	R-S-FW
20-1	3	R-S-SW
21-1	9	R-S-SW
21-2	1	R-S-St-D-SW

TABLE 9 (Continued)

Site collected	Number of individuals	Type of habitat
	Summer	
Chironomidae		
22-1	39	R-S-B-SW
22-2	24	R-S-St-SW
24-1	46	R-S-B-FW
25-1	30	R-S-FW
25-2	53	St-B-V-FW
26-1	42	R-B-D-SW
27-1	3	D-SW
28-1	50	R-S-B-D-SW
29-1	20	R-S-B-D-SW
30-2	5	R-S-D-FW
30-3	3	R-S-St-D-SW
31-1	4	R-S-FW
31-2	1	R-S-St-V-D-SW
31-3	6	R-S-St-D-SW
32-1	5	R-S-St-D-SW
32-2	15	R-S-FW
32-3	6	R-B-V-FW
33-1	60	S-B-D-SW
34-1	14	S-St-D-SW
34-2	27	R-S-B-SW
35-1	13	R-S-St-D-SW
35-2	3	R-S-V-SW
35-4	12	R-St-B-SW
36-1	5	R-S-St-D-V-SW
36-2	6	St-V-D-SW
36-3	12	R-St-D-V-SW
	Winter	
Chironomidae		
1-2	4	B-D-FW
1-3	22	St-B-V-FW
1-4	17	St-B-V-FW
2-1	2	R-S-D-SW

TABLE 9 (Continued)

Site collected	Number of individuals	Type of habitat
	Winter	
Chironomidae		
3-2	3	R-S-B-SW
4-1a	6	S-B-D-SW
4-1b	5	R-S-B-FW
4-2a	1	R-S-B-FW
5-1	22	St-B-V-D-SW
5-2	10	R-S-SW
6-2	1	B-V-SW
7-1	7	R-S-B-D-FW
7-2	1	R-D-SW
10-1	2	R-S-SW
13-1	15	R-S-St-SW
14-1	3	R-D-SW

TABLE 10

CERATOPOGONIDAE COLLECTION DATA

Site collected	Number of individuals	Type of habitat
	Summer	
Ceratopogonidae		
2-1	3	R-S-SW
4-2b	2	R-S-SW
7-2	2	St-B-V-SW
25-2	2	St-B-V-SW
34-2	2	R-S-B-SW
35-1	1	R-S-St-D-SW
36-3	2	R-St-V-D-SW

TABLE 10 (Continued)

Site collected	Number of individuals	Type of habitat
	Winter	
Ceratopogonidae		
4-2a	1	R-S-B-FW
4-2b	1	R-S-FW
13-1	1	R-S-St-SW

TABLE 11

EPHYDRIDAE COLLECTION DATA

Site collected	Number of individuals	Type of habitat
	Summer	
Ephydridae		
4-3	1	R-S-St-SW
16-1	1	R-S-SW
31-1	2	R-S-FW
	Winter	
Ephydridae		
4-2b	2	R-S-FW

CHAPTER VII

A SURVEY OF THE TRICHOPTERA OF THE WEST FORK

The Trichoptera collected from the West Fork were exclusively larvae. During the summer sampling 2820 larvae were collected from sixty-seven sites along the stream. During the winter sampling 225 larvae were collected from twenty-one sites along the stream. It was found that the Trichoptera was the largest group encountered during the summer sampling and the second largest group during the winter sampling. Among the 3045 specimens collected thirteen genera are represented.

Tables 12 through 23 list those genera collected during this study, with information concerning the habitats in which they were collected.

ORDER TRICHOPTERA
Family Hydroptilidae

TABLE 12

<u>OCHOTRICHIA</u> SP. COLLECTION DATA

Site collected	Number of individuals	Type of habitat
	Summer	
<u>Ochotrichia</u> sp.		
1-2	4	St-B-V-SW
1-3	8	St-B-V-SW

TABLE 12 (Continued)

Site collected	Number of individuals	Type of habitat
	Winter	
Ochotrichia sp.		
1-3	15	St-B-V-FW
4-1b	1	R-S-B-FW

Denning (1956) states that members of the genus Ochotrichia are found in clear cold swift streams. No other information was located concerning the habitat of this particular genus.

Data of this study is inconclusive. However, in two of the three sites sampled, very similar conditions prevailed. Since the two sites are adjacent there is no way to state that this may be significant.

Family Helicopsychidae

TABLE 13

HELICOPSYCHE SP. COLLECTION DATA

Site collected	Number of individuals	Type of habitat
	Summer	
Helicopsyche sp.		
1-2	1	St-B-V-SW
2-1	7	R-S-SW

TABLE 13 (Continued)

Site collected	Number of individuals	Type of habitat
	Summer	
<u>Helicopsyche</u> sp.		
2-2	2	R-S-SW
3-1	11	R-S-FW
4-1a	2	St-B-D-SW
4-1b	37	S-St-D-SW
4-2a	22	R-S-FW
4-2b	23	R-S-SW
4-3	4	R-S-St-SW
5-1	1	St-B-D-SW
5-2	4	R-S-B-D-SW
5-3	10	R-S-St-SW
5-4	5	R-S-St-V-SW
6-1	3	B-D-V-FW
6-2	32	R-B-V-FW
7-1	26	R-S-St-D-SW
8-1	2	R-S-St-B-SW
9-1	13	R-S-B-FW
10-1	1	R-S-B-FW
10-2	4	R-S-St-D-V-FW
10-3	12	R-S-St-D-SW
11-1	14	R-S-St-D-SW
12-1	2	R-S-D-SW
14-1	42	R-St-B-SW
15-1	1	St-B-V-SW
16-1	5	R-S-SW
17-1	51	R-S-FW
17-2	5	R-S-V-FW
18-1	8	R-S-St-SW
18-2	2	R-S-St-SW
18-3	46	R-S-FW
19-1	4	R-S-D-SW
20-1	46	R-S-SW
21-1	8	R-S-SW
21-2	8	R-S-St-D-SW
22-1	15	R-S-B-SW

TABLE 13 (Continued)

Site collected	Number of individuals	Type of habitat
	Summer	
Helicopsyche sp.		
23-1	4	S-B-SW
24-1	82	R-S-B-FW
25-1	38	R-St-FW
25-2	22	St-B-V-FW
26-1	15	R-B-D-SW
28-1	43	R-S-B-D-SW
29-1	43	R-S-B-D-SW
30-1	12	R-S-FW
30-2	21	R-S-D-FW
30-3	34	R-S-St-D-SW
31-1	19	R-S-FW
31-2	13	R-S-St-V-D-SW
32-1	2	R-S-St-D-SW
32-2	5	R-S-FW
32-3	11	R-B-V-FW
33-1	90	S-B-D-SW
34-1	12	S-St-D-SW
34-2	28	R-S-B-SW
35-1	76	R-S-St-D-SW
35-2	182	R-S-V-SW
35-3	112	B-FW
35-4	67	R-St-B-SW
36-1	5	R-S-St-V-D-SW
36-2	121	St-V-D-SW
36-3	45	R-St-D-V-SW
	Winter	
Helicopsyche sp.		
7-2	1	R-D-SW
10-1	7	R-S-SW
14-1	3	R-D-SW
16-1	5	R-S-SW
17-1	3	R-S-SW

Denning (1956) notes that clear, moving streams provide the preferred habitats for the genus Helicopsyche. Minkley (1963) found Helicopsyche in beds of algae and also found Helicopsyche among rocks and gravel. Avery (1970) lists Helicopsyche sp. as part of the components of gravel bottoms during a study of pollution in the East Gallatin River, Montana.

This genus was the most common genus found at the West Fork. Seventeen hundred individuals of this genus have been recorded at this area. Generally, the highest population densities were noted at sites where a rock-gravel stubstrate existed. At site 35-3 Helicopsyche sp. was uniformly spaced over a bedrock substrate in fast water. Data collected from both summer and winter indicate that they prefer a rock-gravel substrate. Helicopsyche is found at low densitiies when silt is part of the substrate, however if the silt is not extensive they will inhabit the site in moderate to high densities This preference is especially apparent when rocks and gravel are present.

Family Sericostomatidae

TABLE 14

SERICOSTOMA SP. COLLECTION DATA

Site collected	Number of individuals	Type of habitat
	Summer	
Sericostoma sp.		
1-2	3	St-B-V-SW
2-1	14	R-S-SW
2-2	1	R-S-D-SW
4-1b	9	S-St-D-SW
4-2b	1	R-S-SW
4-3	3	R-S-St-SW
5-1	9	St-B-D-SW
5-2	10	R-S-B-D-SW
5-3	4	R-S-St-SW
5-4	30	R-S-St-V-SW
6-1	1	R-D-V-FW
7-1	7	R-S-St-D-SW
8-1	5	R-S-St-B-SW
9-1	13	R-S-B-FW
10-1	5	R-S-B-FW
10-3	1	R-S-St-D-SW
11-1	4	R-S-St-D-SW
12-1	39	R-S-D-SW
13-1	2	R-S-St-SW
14-1	3	R-St-B-SW
17-1	6	R-S-FW
17-2	1	R-S-FW
18-1	3	R-S-St-SW
18-2	16	R-S-St-SW
18-3	7	R-S-FW
20-1	5	R-S-SW
21-1	10	R-S-SW
21-2	10	R-S-St-D-SW
22-1	19	R-S-B-SW
22-2	1	R-S-St-SW
24-1	4	R-S-B-FW
25-2	14	St-B-V-FW

TABLE 14 (Continued)

Site collected	Number of individuals	Type of habitat
	Summer	
Sericostoma sp.		
28-1	19	R-S-B-D-SW
29-1	77	R-S-B-D-SW
30-1	5	R-S-FW
30-2	1	R-S-D-FW
30-3	2	R-S-St-D-SW
31-1	3	R-S-FW
31-2	20	R-S-St-V-D-SW
31-3	4	R-S-St-D-S
32-1	2	R-S-St-D-SW
32-3	5	R-B-V-FW
33-1	45	S-B-D-SW
34-1	65	S-St-D-SW
34-2	36	R-S-B-SW
35-1	8	R-S-St-D-SW
35-2	8	R-S-V-SW
35-3	2	R-St-B-SW
36-1	2	R-S-St-D-V-SW
36-2	2	St-V-D-SW
36-3	73	R-St-V-D-SW
	Winter	
Sericostoma sp.		
1-3	1	St-B-V-FW
3-2	2	R-S-B-SW
4-1b	8	R-S-B-FW
5-2	7	R-S-SW
9-1	3	R-B-FW
13-1	1	R-S-St-SW
14-1	8	R-D-SW
16-1	1	R-S-SW

Jones (1941) located Sericostoma personatum on substrates ranging from bedrocks with irregular stones, to rocks, and to gravel and sand. In some cases Jones located S. personatum in dense aquatic vegetation. Hanna (1956) noted S. personatum on a sandy bottom underneath stones. Flint and Wiggins (1961) located a similar genus, Lepidostoma, in association with stones where the pupae would attach. Elliot (1971) found Sericostoma sp. at moderate densities at a station in which the substrate was gravel and mud with extensive macrophytes.

Sericostoma sp. is very common in the West Fork with 671 individuals collected during the summer and winter periods. Habitat preferences indicated by the data of this study are rocks, gravel and sand. When sand was present without rock or gravel the densities ranged higher than with rocks or gravel. This species of Sericostoma has a preference for slower waters, and seems to be found in habitats more frequently when the substrate is less diverse or has a simpler composition.

Family Hydropsychidae

TABLE 15

CHEUMATOPSYCHE SP. COLLECTION DATA

Site collected	Number of individuals	Type of habitat
	Summer	
Cheumatopsyche sp.		
10-3	1	R-S-St-D-SW
18-3	1	R-S-FW

Avery (1970) collected Cheumatopsyche sp. from the East Gallatin River, Montana, at sites of rocks, gravel and sand. Denning (1956) indicates that Cheumatopsyche sp. prefer stones in swift moving streams where they spin a nest to trap food.

Data from this study is too limited to allow for any conclusions concerning the Cheumatopsyche sp. Members of the genus were found among rocks, which is consistent with the literature.

TABLE 16

HYDROPSYCHE SP. COLLECTION DATA

Site collected	Number of individuals	Type of habitat
	Summer	
Hydropsyche sp.		
3-1	2	R-S-FW
3-2	8	R-S-SW

TABLE 16 (Continued)

Site collected	Number of individuals	Type of habitat
	Summer	
Hydropsyche sp.		
6-1	2	B-D-V-FW
6-2	2	R-B-V-FW
7-2	6	St-B-V-SW
10-1	4	R-S-B-FW
10-2	24	R-S-St-D-V-FW
10-3	1	R-S-St-D-SW
15-1	1	St-B-V-SW
16-1	5	R-S-SW
17-2	8	R-S-V-FW
24-1	15	R-S-B-FW
25-1	22	R-St-FW
26-1	5	R-B-D-SW
28-1	1	R-S-B-D-SW
30-1	1	R-S-FW
30-2	15	R-S-D-FW
30-3	1	R-S-St-D-SW
35-2	4	R-S-V-SW
	Winter	
Hydropsyche sp.		
1-3	1	St-B-V-FW
3-1	2	R-S-B-FW
4-2b	4	R-S-FW
4-3	2	R-S-D-SW
5-1	1	R-S-SW
7-1	2	R-S-B-D-FW
7-2	1	R-D-SW
8-1	1	R-B-SW
9-1	2	R-B-FW
10-1	1	R-S-SW
10-2	4	R-FW
15-1	1	St-B-SW
16-1	4	R-S-SW

Percival and Whitehead (1929) noted Hydropsyche sp. on stones with and without vegetation; however, they noted that the densities were slightly higher with vegetation at the site. Jones (1941) indicated that Hydropsyche sp. is found on rocks and gravel with and without vegetation. Here, again, the densities were higher in vegetation. Pennak and Van Gerpen (1947) recorded higher population densities of Hydropsyche sp. among stones than in gravel or sand. Avery (1970) found Hydropsyche sp. in the East Gallatin River, Montana, on a rock and gravel substrate. Elliot (1971) indicated that Hydropsyche instabilis was found at great densities among large stones and gravel devoid of macrophytes.

Data concerning the species of Hydropsyche collected during this study leads one to conclude that a rock-gravel substrate is the preferred habitat type. Denning (1956) indicated that Hydropsyche sp. prefers faster water. This is not fully supported by my data. Densities were higher for Hydropsyche sp. in sites with fast currents passing over them. The association of Hydropsyche with vegetation cannot be made from the data of this study.

Family Philopotamidae

TABLE 17

CHIMARRA SP. COLLECTION DATA

Site collected	Number of individuals	Type of habitat
	Summer	
Chimarra sp.		
3-2	1	R-S-SW
10-1	12	R-S-B-FW
10-2	149	R-S-St-D-V-FW
15-1	18	St-B-V-SW
16-1	1	R-S-SW
17-2	19	R-S-V-SW
18-3	1	R-S-FW
19-1	5	R-S-D-SW
20-1	2	R-S-SW
24-1	1	R-S-B-FW
25-1	4	R-St-FW
25-2	1	St-B-V-FW
26-1	2	R-B-D-SW
30-2	13	R-S-D-FW
	Winter	
Chimarra sp.		
1-3	1	St-B-V-FW
1-4	2	St-B-V-FW
8-1	2	R-B-SW
10-2	2	R-FW
11-1	1	R-FW
13-1	1	R-S-St-SW
14-1	1	R-D-SW

Palmer (1938) states that the larvae of Chimarrha albomacula prefer more moderate current speeds, and that they are found among stones that have vegetation associated with them. Denning (1956) notes that Chimarra sp. are found in clear, cold streams. Denning (1949) also noted that members of the genus Chimarra can be found as far north as Montana.

The species of Chimarra found at the West Fork seemed to prefer rocks and gravel and was found at high densities when vegetation was found over the substrate. There was no indication that this species prefers certain water speeds.

Family Leptoceridae

TABLE 18

OECETIS SP. COLLECTION DATA

Site collected	Number of individuals	Type of habitat
	Summer	
Oecetis sp.		
4-1b	6	S-St-D-SW
4-2a	1	R-S-FW
4-2b	1	R-S-SW
14-1	1	R-St-B-SW
17-1	3	R-S-FW
18-1	1	R-S-St-SW
22-1	1	R-S-B-SW
28-1	3	R-S-B-D-SW
34-2	2	R-S-B-SW
35-2	1	R-S-V-SW

TABLE 18 (Continued)

Site collected	Number of individuals	Type of habitat
	Winter	
Oecetis sp.		
4-1a	1	S-B-D-SW
4-1b	1	R-S-B-FW
5-2	1	R-S-SW
7-1	1	R-S-B-D-FW
8-1	1	R-B-SW
9-1	1	R-B-FW
10-1	1	R-S-SW
14-1	1	R-D-SW

Pennak and Van Gerpen (1947) associated this genus with rocks and gravel and indicated very low densities in substrates other than rock and gravel. No other information is available.

It is apparent from the data of this study that this species of Oecetis prefers rock and gravel with sand. This is consistent with the information provided by Pennak and Van Gerpen (1947).

Family Glossosomatidae

TABLE 19

PHYLLIOCUS SP. COLLECTION DATA

Site collected	Number of individuals	Type of habitat
	Summer	
Phylliocus sp.		
4-1b	1	S-St-D-SW
4-3	6	R-S-St-SW
7-1	2	R-S-St-D-SW
9-1	1	R-S-B-FW
12-1	1	R-S-D-SW
16-1	2	R-S-SW
17-1	4	R-S-FW
17-2	2	R-S-V-FW
18-1	1	R-S-St-SW
18-2	2	R-S-St-SW
18-3	1	R-S-FW
19-1	2	R-S-D-SW
21-2	8	R-S-St-D-SW
22-1	1	R-S-B-SW
24-1	1	R-S-B-FW
25-1	3	R-St-FW
25-2	2	St-B-V-FW
28-1	8	R-S-B-D-SW
29-1	35	R-S-B-D-SW
30-2	11	R-S-D-FW
30-3	1	R-S-St-D-SW
31-1	4	R-S-FW
31-2	9	R-S-St-V-D-SW
32-1	2	R-S-St-D-SW
32-3	2	R-B-V-FW
33-1	12	S-B-D-SW
34-1	21	S-St-D-SW
34-2	3	R-S-B-SW
35-1	9	R-S-St-D-SW
35-2	4	R-S-V-SW
36-3	9	R-St-V-D-SW

TABLE 19 (Continued)

Site collected	Number of individuals	Type of habitat
	Winter	
Phylliocus sp.		
4-1b	2	R-S-B-FW
14-1	2	R-D-SW

No information is available concerning Phylliocus sp. ecology. Data from this study indicates that rocks and gravel are the preferred types. It may be significant that high densities were recorded for sand and slower water in two sites.

Family Lepidostomatidae

TABLE 20

LEPIDOSTOMA SP. COLLECTION DATA

Site collected	Number of individuals	Type of habitat
	Summer	
Lepidostoma sp.		
4-1b	1	S-St-D-SW
5-3	2	R0S-St-SW
17-1	2	R-S-FW
22-1	1	R-S-B-SW
29-1	2	R-S-B-D-SW
32-3	1	R-B-V-FW

Denning (1949) described a new species of Lepidostoma from Oak Creek, Arizona, and suggested that it may be found near rocks.

Flint and Wiggins (1961) indicate that larvae of the genus Lepidostoma are found in clear, cold streams. Jones (1941) has found Lepidostoma sp. associated with vegetation among stones and rocks. MacKay (1969) noted Lepidostoma sp. at high densities in rock, gravel, and sand substrates. Avery (1970) has recorded the same findings.

Data from this study, concerning Lepidostoma sp., indicates that the genus prefers rock, gravel, and sand, which is consistent with the available literature.

Family Limnephilidae

TABLE 21

HESPEROPHYLAX SP. COLLECTION DATA

Site collected	Number of individuals	Type of habitat
	Summer	
Hesperophylax sp.		
8-1	1	R-S-St-B-SW
12-1	1	R-S-D-SW
17-1	2	R-S-FW

There is a lack of information concerning Hesperophylax. Denning (1956) suggests that members of the genus are probably abundant in clear, swift waters.

Only four specimens were found during this study, all in rocks, gravel, and sand. It is possible that this may be the preferred habitat.

Family Rhyacophilidae

TABLE 22

<u>ATOPSYCHE</u> SP. COLLECTION DATA

Site collected	Number of individuals	Type of habitat
	Summer	
Atopsyche sp.		
9-1	1	R-S-B-FW
10-2	6	R-S-St-D-V-FW
10-3	1	R-S-St-D-SW
	Winter	
Atopsyche sp.		
1-4	1	St-B-V-FW
6-1	1	V-R-SW
8-1	1	R-B-SW

No ecological information was available concerning this genus. Data from this study is too variable to allow for any conclusions concerning the ecology of *Atopsyche* sp.

TABLE 23

GLOSSOSOMA SP. COLLECTION DATA

Site collected	Number of individuals	Type of habitat
	Summer	
Glossosoma sp.		
28-1	1	R-S-B-D-SW

Mackay (1969) collected Glossosoma sp. in a rock, gravel, and sand substrate. I am unable to discuss this genus since only a single specimen was collected during this study.

Family Psychomyiidae

TABLE 24

POLYCENTROPUS SP. COLLECTION DATA

Site collected	Number of individuals	Type of habitat
	Summer	
Polycentropus sp.		
11-1	3	R-S-St-D-SW
14-1	1	R-St-B-SW
16-1	3	R-S-SW
17-2	2	R-S-V-FW
18-1	1	R-S-St-SW
20-1	3	R-S-SW
22-1	1	R-S-B-SW
24-1	1	R-S-B-FW
26-1	3	R-B-D-SW

TABLE 24 (Continued)

Site collected	Number of individuals	Type of habitat
	Winter	
Polycentropus sp.		
1-2	2	B-D-FW

Percival and Whitehead (1929) collected *Polycentropus* sp. in great densities among rocks and loose gravel. Jones (1941) recorded *Polycentropus* sp. among stones with extensive algal growth, in rock and gravel, and even in mud and silt. All sites collected by Jones had very low densities of *Polycentropus* sp. Mackay (1969) noted *Polycentropus* sp. among rocks, gravel, and sand in moderate numbers.

Data from this study indicates that *Polycentropus* sp. prefers rocks and gravel with sand. In addition, *Polycentropus* sp. prefers the slower waters of a stream.

CHAPTER VIII

A SURVEY OF THE HEMIPTERA OF THE WEST FORK

The Hemiptera collected from the West Fork included both nymphs and adults. During the summer sampling 574 adults and nymphs were collected from fifty-six sites along the stream. During the winter sampling ten specimens were collected from seven sites. Of the 584 specimens collected two genera were represented. Usinger (1956) notes that members of the Naucoridae and Belostomatidae lay their eggs during the spring, and hatch and mature during the summer. Both families are highly predaceous and will range over the stream in search of prey.

Tables 25 through 26 list those specimens that have been collected in this study with information concerning the site of collection.

ORDER HEMIPTERA

Family Belostomatidae

TABLE 25

ABEDUS SP. COLLECTION DATA

Site collected	Number of individuals	Type of habitat
	Summer	
Abedus sp.		
2-2	1	R-S-D-SW
4-1a	1	St-B-D-SW
4-1b	1	S-St-D-SW
6-2	1	R-B-V-FW
15-1	1	St-B-V-FW
25-1	1	St-B-V-SW
26-1	3	R-B-D-SW
27-1	3	D-SW
35-1	1	R-S-St-D-SW

Usinger (1956) writes that the genus Abedus is a very predaceous form, such that it is difficult to give any specific habitat with which they would be associated. Data from this study indicates that Abedus is not confined to any particular substrate. Observations in the study area have indicated that this species is very motile and would be found in a variety of habitats.

Family Naucoridae

TABLE 26

AMBRYSUS BURI COLLECTION DATA

Site collected	Number of individuals	Type of habitat
	Summer	
Ambrysus buri		
1-3	5	St-B-V-SW
2-1	14	R-S-SW
2-2	1	R-S-D-SW
3-1	2	R-S-FW
3-2	33	R-S-SW
4-1a	4	St-B-D-SW
4-1b	1	S-St-D-SW
5-2	2	R-S-B-D-SW
5-4	2	R-S-St-V-SW
6-1	5	B-V-D-FW
6-2	12	R-B-V-FW
7-1	9	R-S-St-D-SW
7-2	54	S5-B-V-SW
8-1	1	R-S-St-B-SW
9-1	7	R-S-B-FW
10-1	6	R-S-B-FW
10-2	35	R-S-St-D-V-FW
10-3	3	R-S-St-D-SW
11-1	3	R-S-St-D-SW
12-1	5	R-S-D-SW
14-1	3	R-St-B-SW
15-1	8	St-B-V-SW
16-1	18	R-S-SW
17-1	9	R-S-FW
17-2	12	R-S-V-FW
18-1	3	R-S-St-SW
18-2	4	R-S-St-SW
18-3	10	R-S-FW
19-1	15	R-S-D-SW
20-1	11	R-S-SW
21-1	3	R-S-SW

TABLE 26 (Continued)

Site collected	Number of individuals	Type of habitat
	Summer	
Ambrysus buri		
22-1	7	R-S-B-SW
24-1	11	R-S-B-FW
25-1	22	R-St-FW
25-2	6	St-B-V-FW
26-1	45	R-B-D-SW
27-1	1	D-SW
28-1	23	R-S-B-D-SW
29-1	3	R-S-B-D-SW
30-1	4	R-S-FW
30-2	14	R-S-D-FW
30-3	34	R-S-St-D-SW
31-2	6	R-S-FW
31-2	1	R-S-FW
31-3	4	R-S-St-D-SW
32-1	2	R-S-St-D-SW
32-3	2	R-B-V-FW
33-1	3	S-B-D-SW
35-1	4	R-S-St-D-SW
35-2	9	R-S-V-SW
36-1	5	R-S-St-D-V-SW
36-2	7	St-V-D-SW
36-3	12	R-St-V-D-SW
	Winter	
Ambrysus buri		
1-4	3	St-B-V-FW
2-1	2	R-S-D-SW
3-1	1	R-S-B-FW
4-1b	1	R-S-B-FW
4-2a	1	R-S-B-FW
4-3	1	R-S-D-SW
13-1	1	R-S-St-SW

Usinger (1956) states that the preferred habitat of this genus seems to be well oxygenated water, especially those streams with a "pebbly" bottom. Usinger further notes that this genus is a widespread group occupying lakes as well as streams. La Rivers (1950) noted in a paper concerning an overlap in the ranges of the genus Ambrysus and the genus Plecoris, that Ambrysus was usually in swifter water avoiding mud bottoms that were present in the region. Rapp (1963) has found that Ambrysus mormon prefers well aereated waters of a stream in debris and, also noted that A. mormon avoided heavily silted areas

Data from this study indicates that Ambrysus buri prefers those habitats having rocks and gravel as the main substrate type. A. buri was not frequently found at sites where rocks and gravel did not exist. Sand seems to also be a preferred substrate as forty out of fifty sites in which Ambrysus buri was collected had sand as part of the substrate composition. The winter sampling data supports these findings. However, it is significant that the highest populations during both sampling periods were found in silt, bedrock, and vegetation.

CHAPTER IX

A SURVEY OF THE COLEOPTERA OF THE WEST FORK

The Coleoptera collected during this study included both larvae and adults. During the summer sampling 153 adults and larvae were collected from twenty-six sites along the stream. Among the 153 specimens collected six genera are represented. It was found that the Coleoptera comprised only a small portion of the total fauna gathered during the summer sampling (153 specimens out of 6576 specimens). No members of the Coleoptera were found during the winter sampling.

Tables 27 through 32 list those species that have been collected with information concerning the site of collection.

ORDER COLEOPTERA
SUBORDER ADEPHAGA
Family Dytiscidae

TABLE 27

AGABUS MINNESOTENSIS COLLECTION DATA

Site collected	Number of individuals	Type of habitat
Agabus minnesotensis (Adults)		
15-1	2	S-St-V-SW

Leech and Chandler (1956) discuss many of the aquatic Coleoptera that inhabit streams, with the genus Agabus being included in that group. Concerning the aquatic forms, they state that these forms crawl among stones or remain in slack water behind the more rapid water. Young (1960) reports that specimens of the species Agabus moestus have been located in ponds and lakes. He has two adult specimens of Agabus solus that were found in a river near Coral Harbor, Indiana. LaRivers (1951) reports that specimens of Agabus have been taken from some lakes in Nevada. Leech (1942) described a new species of Agabus that came from the Sacramento River, California, and indicated that the habitat of Agabus griseipennis is brackish water, especially, "shallow weedy shores of lakes."

I was able to collect only two specimens of A. griseipennis during the winter sampling, thus I am unable to come to any conclusions concerning the habitat preference of this species. From the literature it is apparent that the genus Agabus is a widely distributed form.

SUBORDER POLYPHAGA
Family Elmidae

TABLE 28

OPTIOSERVUS DIVERGENS COLLECTION DATA

Site collected	Numbers of individuals	Type of habitat
Optioservus divergens (Adults)		
16-1	1	R-S-SW
Optioservus sp. (Larvae)		
4-2a	1	R-S-FW
9-1	2	R-S-B-FW
25-1	1	S-St-FW

Leech and Chandler (1956) grouped together members of the family Elmidae that inhabit streams and have placed the genus Optioservus in the group. Sanderson and Brown (1959) report finding Optioservus ovalis in a small creek with many stones and small pebbles. Brown and Shoemake (1964b) have collected Optioservus in great numbers in gravel in riffles, and beneath stones in turbid water near or at the margin of the stream.

From data of this study it is not possible to draw any conclusions concerning the habitat preferences of adults of this species of Optioservus. The larvae were collected in three widely separated sites and show very similar preferences of habitats. Data suggests that the larvae prefer habitats of rocks, gravel, and sand in or near fast moving currents. This is consistent with the literature.

TABLE 29

HETERELMIS GLABRA COLLECTION DATA

Site found	Number of individuals	Type of habitat
Heterelmis glabra (Adults)		
30-2	1	R-S-D-FW
30-3	1	R-S-St-D-SW

Brown (1966) found members of the genus Heterelmis consistently in clear, cold fast moving streams. Sanderson and Brown (1959) found this genus in regions of calcium deposits in travertine streams. The calcium had the shape of stones on the bed of the stream. Sanderson and Brown indicate that Heterelmis is highly restricted in a watershed even to the extent of a few square meters. Brown and Shoemake (1964b) found specimens of Heterelmis in debris, sticks, and leaves which had been caught in an obstruction in the stream. They have also gathered specimens from water-logged wood in a flowing stream.

I am unable to draw any conclusions as to the habitat preferences of Heterelmis glabra from my data. It is important to note that those specimens that I have taken were found in detritus material that included sticks and other decaying woody matter.

TABLE 30

NARPUS SP. COLLECTION DATA

Site found	Number of individuals	Type of habitat
Narpus sp. (Larvae)		
1-2	4	St-B-V-SW
10-3	2	R-S-St-D-SW
17-2	1	R-S-V-FW
24-1	1	R-S-B-FW
24-2	1	R-S-B-SW

Leech and Chandler (1956) associate Narpus sp. with the riffle beetles (Superfamily Dryopoidea) that are found in fast moving streams. Other than this there is no information in the literature concerning the microhabitat preference of this genus.

During the summer sampling period I was able to collect nine larvae of Narpus in widely separated sites. From the data of this study it is possible to state that members of this unidentified species associate with a rock, gravel, and sand substrate. However, it may be significant that in two of the sites there was silt in the area. At those sites where silt was present I found the greatest numbers of Narpus specimens.

TABLE 31

ELSIANUS SP. COLLECTION DATA

Site found	Number of individuals	Type of habitat
Elsianus sp. (Larvae)		
7-1	1	R-S-St-D-SW
10-1	5	R-S-B-FW
10-2	25	R-S-St-V-D-FW
10-3	4	R-S-St-D-SW
11-1	2	R-S-St-D-SW
30-2	27	R-S-D-FW
30-3	1	R-S-St-D-SW

Literature is lacking on collection records, stream descriptions, and habitat preferences for the genus Elsianus. Burke (1963) has collected Elsianus texanus under rocks in the Devils River, Texas. Brown (1971) described a new species of Elsianus and indicated that it was found in streams of high calcium content.

I was able to collect sixty-five immature specimens of Elsianus from the West Fork. In all cases they were associated with rock, gravel, and sand. In six out of seven sites they were found associated with detritus. It is valid to conclude, from my data, that they are commonly associated with rocks, gravel, and sand; and that in most cases the larvae prefer sites with detritus in the habitat.

Family Dryopidae

TABLE 32

HELICHUS SUTURALIS COLLECTION DATA

Site found	Number of individuals	Type of habitat
Helichus suturalis (Adults)		
4-2a	3	R-S-FW
4-3	4	R-S-St-SW
6-1	7	B-V-D-FW
7-2	2	St-B-V-FW
10-1	1	R-S-B-FW
10-2	7	R-S-St-V-D-FW
15-1	3	St-B-V-FW
17-1	1	R-S-FW
17-2	3	R-S-V-FW
20-1	3	R-S-SW
25-1	5	R-St-FW
26-1	6	R-B-D-SW
28-1	1	R-S-V-D-SW
30-2	2	R-S-D-FW
30-3	1	R-St-D-SW
31-1	10	R-S-FW
32-3	1	R-B-V-FW
35-1	1	R-S-St-D-SW
35-2	9	R-S-V-SW

Brown (1966) mentions that the genus Helichus can be expected wherever permanent streams occur in the state of Oklahoma. Brown and Shoemake (1964) have collected Helichus sp. among: sticks and leaves, water-logged sticks in flowing water, stones in riffles, and miscellaneous objects in flowing water (paper, cardboard, rusted metal, and tires). Musgrave (1935) collected

Helichus sp. in roots of willow that were under water. Brown and Shoemake (1964a) indicate that *Helichus* is the most widespread genus of the dryopid fauna in Oklahoma.

I was able to collect seventy adult specimens of *Helichus suturalis* from the West Fork. In all instances, except for one, all specimens were found among rocks and gravel. However, those *H. suturalis* specimens collected were found most commonly with submerged vegetation or detritus that was over rocks and gravel.

CHAPTER X

A SURVEY OF THE EPHEMEROPTERA OF THE WEST FORK

The Ephemeroptera specimens collected from the West Fork were exclusively nymphs. During the summer sampling, 1232 nymphs were collected from sixty-two sites along the stream. During the winter sampling, 524 nymphs were collected from twenty-six sites. Of the 1756 specimens collected, seven genera are represented.

Tables 33 through 39 list those genera and species collected and give information concerning the sites of collection.

ORDER EPHEMEROPTERA
Family Baetidae

TABLE 33

BAETIS SP. COLLECTION DATA

Site collected	Number of individuals	Type of habitat
	Summer	
Baetis sp.		
1-3	7	St-B-V-SW
3-1	21	R-S-SW
6-1	2	B-D-V-FW
7-1	1	R-S-St-D-SW
7-2	12	St-B-V-SW
15-1	2	St-B-V-SW
16-1	1	R-S-SW
20-1	1	R-S-SW
26-1	1	R-S-SW

TABLE 33 (Continued)

Site collected	Number of individuals	Type of habitat
	Summer	
Baetis sp.		
29-1	2	R-B-D-SW
35-1	2	R-S-St-D-SW
	Winter	
Baetis sp.		
1-2	1	B-D-FW
1-3	171	St-B-V-FW
1-4	39	St-B-V-FW
4-2b	1	R-S-FW

Ide (1930) found Baetis sp. on rocks with loose moss, in algae, and in shallow rapids. Ide (1937) notes that many Baetis specimens can be collected in head waters of streams among stones. Jones (1941) associated Baetis with extensive vegetation. Linduska (1942) recorded the habitat of Baetis intermedus as at the edge of streams among silt covered rocks; also, he noted that B. vagans nymphs range freely over rocks. Harker (1953) recorded two species of Baetis in cold, clear streams among stones. Elliot (1967) associated Baetis with moss. Pearson and Franklin (1968) located Baetis sp. in regions of turbidity, and in silt. They further noted that Baetis sp. was at low densities in the regions of silt or where rubble existed with algae.

Data indicates that Baetis sp. shows a slight preference for rocks over other habitat types; however, it is found in highest densities in silt on bedrock, in the winter and summer collections. During the summer it was found generally in slower currents.

TABLE 34

CALLIBAETIS SP. COLLECTION DATA

Site collected	Number of individuals	Type of habitat
	Summer	
Callibaetis sp.		
4-1	2	St-B-D-SW
5-4	18	R-S-St-SW

Ide (1930) notes that members of this genus frequent lakes and that this is probably the normal habitat. Day (1956) states that Callibaetis is a widespread form in lakes and streams.

There were few sites in which specimens of Callibaetis were collected during this study, thus no conclusions can be drawn concerning their habitat preferences.

TABLE 35

PARACLOEODES SP. COLLECTION DATA

Site collected	Number of individuals	Type of habitat
	Summer	
Paracloeodes sp.		
2-2	3	R-S-D-SW
4-2a	2	R-S-FW
4-3	4	R-S-St-SW
5-1	10	S5-B-D-SW
5-3	4	R-S-St-SW
5-4	6	R-S-St-V-SW
6-2	4	R-B-V-FW
8-1	1	R-S-St-B-SW
9-1	4	R-S-B-FW
13-1	5	R-S-St-SW
15-1	1	St-B-V-SW
17-2	4	R-S-V-FW
19-1	4	R-S-D-FW
22-1	3	R-S-B-SW
24-1	5	R-S-B-FW
25-1	6	R-St-FW
30-1	2	R-S-FW
30-2	1	R-S-D-FW
30-3	1	R-S-St-D-SW
32-2	1	R-S-FW
32-3	3	R-B-V-FW
35-1	2	R-S-St-D-SW
35-2	3	R-S-V-SW
36-1	1	R-S-St-D-V-SW
36-2	12	St-V-D-SW

No information is available concerning the ecology of *Paracloeodes* sp. From the data of this study it is apparent that this species prefers a rock-gravel substrate. Higher population densities were noted for regions in which silt and detritus occurred as part of the substrate.

TABLE 36

CHOROTERPES SP. COLLECTION DATA

Site collected	Number of individuals	Type of habitat
	Summer	
Choroterpes sp.		
2-1	2	R-S-SW
3-1	3	R-S-FW
4-2a	28	R-S-FW
4-2b	19	R-S-SW
4-3	6	R-S-St-SW
5-4	2	R-S-St-V-SW
6-1	1	D-V-B-FW
6-2	1	R-B-V-FW
7-1	10	R-S-St-D-SW
7-2	2	St-B-V-SW
9-1	4	R-S-B-FW
10-1	2	R-S-B-FW
10-2	7	R-S-St-V-D-FW
10-3	11	R-S-St-D-SW
14-1	21	R-St-B-SW
16-1	65	R-S-SW
17-1	16	R-S-FW
17-2	20	R-S-V-FW
18-1	3	R-S-St-SW
18-2	2	R-S-St-SW
18-3	24	R-S-FW
19-1	1	R-S-D-SW
20-1	23	R-S-SW
21-1	56	R-S-SW
21-2	3	R-S-St-D-SW
22-1	19	R-S-B-SW
22-2	1	R-S-St-SW
24-1	10	R-S-B-FW

TABLE 36 (Continued)

Site collected	Number of individuals	Type of habitat
	Summer	
Choroterpes sp.		
25-1	11	R-St-FW
25-2	1	St-B-V-FW
26-1	8	R-B-D-SW
27-1	1	D-SW
28-1	2	R-S-B-D-SW
29-1	1	R-S-B-D-SW
30-1	20	R-S-FW
30-2	17	R-S-D-FW
30-3	124	R-S-St-D-SW
31-1	18	R-S-FW
31-3	1	R-S-St-D-SW
32-2	1	R-S-FW
32-3	3	R-B-V-FW
34-1	1	S-St-D-SW
34-2	3	R-S-B-SW
35-1	3	R-S-St-D-SW
35-2	18	R-S-V-SW
35-4	4	R-St-B-SW
36-2	15	St-V-D-SW
36-3	80	R-St-D-V-SW
	Winter	
Choroterpes sp.		
1-3	2	St-B-V-FW
1-4	2	St-B-V-FW
2-1	36	R-S-D-SW
3-1	11	R-S-B-FW
3-2	15	R-S-B-SW
4-1a	2	S-B-D-SW
4-1b	21	R-S-B-FW
4-2a	2	R-S-B-FW
4-2b	8	R-S-FW
4-3	11	R-S-D-SW
5-1	2	St-B-V-D-SW
6-1	1	R-V-SW

TABLE 36 (Continued)

Site collected	Number of individuals	Type of habitat
	Winter	
Choroterpes sp.		
7-1	13	R-S-B-D-FW
8-1	21	R-B-SW
9-1	1	R-B-FW
10-1	12	R-S-SW
10-2	9	R-FW
13-1	6	R-S-St-SW
14-1	6	R-S-St-SW
16-1	10	R-S-SW
17-1	2	R-S-SW

No information exists concerning the habitat preferences of the genus Choroterpes. Data from this study indicate that Choroterpes prefers a rock and gravel substrate that has sand mixed with the rock and gravel. Choroterpes is associated with sand, having high population densities in sand. The highest densities were found in slow currents passing over silt.

TABLE 37

TRICORYTHODES SP. COLLECTION DATA

Site collected	Number of individuals	Type of habitat
	Summer	
Tricorythodes sp.		
2-2	3	R-S-D-SW
4-1b	23	S-St-D-S
4-3	1	R-S-St-SW

TABLE 37 (Continued)

Site collected	Number of individuals	Type of habitat
	Summer	
Tricorythodes sp.		
5-2	1	R-S-B-D-SW
5-3	5	R-S-St-SW
5-4	8	R-S-St-V-SW
6-2	1	R-B-V-FW
7-2	1	St-B-V-SW
8-1	2	R-S-St-B-SW
10-2	1	R-S-St-V-D-FW
11-1	2	R-S-St-D-SW
12-1	8	R-S-D-SW
14-1	1	R-St-B-SW
15-1	2	St-B-V-SW
16-1	21	R-S-SW
17-1	1	R-S-FW
20-1	1	R-S-SW
22-1	8	R-S-B-SW
22-2	7	R-S-St-SW
24-1	1	R-S-B-FW
25-2	1	St-B-V-FW
26-1	3	R-B-D-SW
27-1	1	D-SW
28-1	2	R-S-B-D-SW
30-3	3	R-S-St-D-SW
31-3	2	R-S-St-D-SW
32-2	3	R-S-FW
32-3	13	R-B-V-FW
33-1	1	S-B-D-SW
34-1	14	S-St-D-SW
35-1	1	R-S-St-D-SW
36-2	2	St-V-D-SW
36-3	6	R-St-V-D-SW
	Winter	
Tricorythodes sp.		
1-3	1	St-B-V-FW
1-4	2	St-B-V-FW
3-2	1	R-S-B-SW

TABLE 37 (Continued)

Site collected	Number of individuals	Type of habitat
	Winter	
Tricorythodes sp.		
4-1b	4	R-S-B-FW
7-1	3	R-S-B-D-FW
7-2	1	R-D-SW
8-1	15	R-B-SW
10-1	2	R-S-SW
10-2	4	R-FW
11-1	1	R-FW
13-1	8	R-S-St-SW
14-1	9	R-D-SW
15-1	5	St-B-SW
16-1	8	R-S-SW

Avery (1970) located Tricorythodes sp. in the East Gallatin River, Montana, in rock and gravel. Day (1956) notes that they are usually found in quiet waters on the bottom of the stream.

Data collected during the study indicate that Tricorythodes sp. usually prefers a sand substrate with rock and gravel. Higher population densities have been recorded in slower currents, which is consistent with the literature.

Family Heptageniidae

TABLE 38

EPEORUS MARGARITA COLLECTION DATA

Site collected	Number of individuals	Type of habitat
	Summer	
Epeorus margarita		
10-2	1	R-S-St-V-D-FW
30-1	2	R-S-FW
30-2	1	R-S-D-FW
35-2	6	R-S-V-SW

Lehmkuhl (1968) notes that Epeorus nitidus nymphs feed on detritus, and that they have a great affinity for objects in the stream. Radford and Hartland-Rowe (1971) noted that Epeorus deceptivus and E. longimanus have fast seasonal life cycles that correspond to the spring growing season of the algae. They found that Epeorus species are algal feeders which are regulated by the standing crop.

It is possible that due to the sampling in the middle and late summer months Epeorus margarita was almost missed as indicated by other species discussed by Radford and Hartland-Rowe (1971). Data indicate that they do associate with both vegetation and detritus, but it is not conclusive.

TABLE 39

HEPTAGENIA CRIDDLEI COLLECTION DATA

Site collected	Number of individuals	Type of habitat
	Summer	
Heptagenia criddlei		
3-1	8	R-S-FW
4-2a	10	R-S-FW
4-2b	2	R-S-SW
6-1	1	D-V-V-FW
6-2	3	R-B-V-FW
7-1	5	R-S-St-D-SW
9-1	2	R-S-B-FW
10-1	10	R-S-B-FW
10-2	10	R-S-St-V-D-SW
10-3	15	R-S-St-D-SW
11-1	2	R-S-St-D-SW
14-1	2	R-S-St-D-SW
17-1	4	R-S-FW
17-2	10	R-S-V-FW
18-3	10	R-S-FW
19-1	7	R-S-D-SW
20-1	25	R-S-SW
24-1	3	R-S-B-FW
25-1	6	R-St-FW
25-2	1	S5-B-V-FW
26-1	3	R-B-D-SW
28-1	9	R-S-B-D-SW
30-1	12	R-S-FW
30-2	6	R-S-D-FW
30-3	4	R-S-St-D-SW
31-1	1	R-S-FW
35-1	2	R-S-St-D-SW
35-2	12	R-S-V-SW
	Winter	
Heptagenia criddlei		
2-1	9	R-S-D-SW
3-1	7	R-S-B-FW
3-2	4	R-S-B-SW

TABLE 39 (Continued)

Site collected	Number of individuals	Type of habitat
	Winter	
Heptagenia criddlei		
4-1a	1	S-B-D-SW
4-1b	1	R-S-B-FW
4-2b	2	R-S-FW
4-3	1	R-S-D-SW
5-1	7	R-S-SW
6-1	2	R-V-SW
7-1	2	R-S-St-D-SW
8-1	5	R-B-SW
9-1	1	R-B-FW
10-1	2	R-S-SW
10-2	2	R-FW
15-1	1	St-B-SW
17-1	3	R-S-SW

Dodds and Hisaw (1924) noted Heptagenia sp. as an inhabitant along swift streams. Mackay (1969) located Heptagenia sp. at a station with a rock and gravel bottom in patches of sand. Elliot (1971) found Heptagenia lateralis at a station with a rock and gravel substrate with no macrophytes.

Data for this study indicate that Heptagenia criddlei prefers a rock-gravel substrate. These findings are consistent with the literature. Higher densities were noted in simpler habitats. There is no preference for water speed.

CHAPTER XI

A SURVEY OF THE ODONATA OF THE WEST FORK

The Odonata collected from West Fork, Oak Creek were exclusively naiads. During the summer sampling (August 6, 1971 to September 11, 1971) sixty-five naiads were collected from twenty-seven sites along the stream. The sixty-five specimens of Odonata collected comprised only a small portion of the total fauna gathered during the summer sampling (sixty-five specimens out of 6576). Pritchard and Smith (1956) report that the naiads hatch during the late spring and should be present throughout the summer. If this is the case, then it is apparent that there are few members of the Odonata that frequent this portion of the stream. No naiads were found during the winter sampling.

There is a lack of information concerning the ecology of Odonata naiads. Information is available concerning the taxonomy of the naiads and adults, or about the ecology of the adults.

Tables 40 through 45 list those species that have been collected in this study, with the information concerning the site of collection.

ORDER ODONATA
SUBORDER ANISOPTERA

Family Gomphidae

TABLE 40

OPHIOGOMPHUS ARIZONICUS COLLECTION DATA

Site collected	Number of individuals	Type of habitat
Ophiogomphus arizonicus		
4-1b	1	S-St-D-SW
5-4	1	R-S-St-V-SW
10-2	1	R-S-St-V-D-FW
12-1	5	R-S-D-SW
17-1	2	R-S-FW
22-2	3	R-S-St-SW
25-2	2	St-B-V-FW
29-1	3	R-S-B-D-SW
34-1	1	S-St-D-SW
36-1	3	R-S-St-D-V-SW

Walker (1933) reports that O. rupinsulensis has been found in streams with considerable silt and has been found to be correspondingly darker than those found in regions of no silt. Whitehouse (1941) notes, that other members of the genus have been found to occupy fish hatchery ponds. The hatchery grounds that I have examined have ponds with gravel and silt as the substrate. Pritchard and Smith (1956) state that naiads of the genus

Ophiogomphus are commonly found in gravel beds of mountain streams and lakes.

Data from this study indicate that members of this species have been found to inhabit microhabitats that offer some cover and protection. The majority of the specimens have been associated with rock, sand, and vegetation.

Family Aeshnidae

TABLE 41

AESHNA INTERRUPTA COLLECTION DATA

Site collected	Number of individuals	Type of habitat
Aeshna interrupta		
21-2	1	R-S-St-D-SW
31-2	1	R-S-St-V-D-SW

Pritchard and Smith (1956) state that the adults of the genus Aeshna are found near marshes, sluggish streams, shallow lakes and ponds, or bays containing vegetation. This is consistent with my findings since the stream bed of West Fork has a great deal of vegetation during the summer and late fall. They further state that the naiads are located in freshwater that is shallow and harbors vegetation. Whitehouse (1941) reports that members of the species A. coerulea are separated into several races all of which inhabit mountainous regions of British Columbia, and the Rocky Mountains. However, he does not indicate the habitat preferences of the race or species. In general, Whitehouse (1941) associates members of the genus Aeshna with some form of submerged vegetation. Bick (1950) has found A. umbrosa in small woodland streams which generally have a great deal of submerged vegetation. Walker (1950) has found A. interrupta, A. ermita, A. canadensis, and A. sitchensis in a region of marshes and duck ponds. He again does not state the exact nature of the habitat in which each was found. I would assume that the nature of the area is that of extensive submerged and terrestrial vegetation. Moore (1953) has found A. cyanea adults in a region of heavy vegetation, however his paper did not deal with the locality of the naiads.

Since the number of specimens collected in this study is small, it is difficult to draw any conclusions on the nature of the habitat that they prefer. I can only state that both specimens were taken from habitats that were extremely diverse. A major component of both habitats was the extensive detritus found in each. However, A. interrupta was not a major part of the odonate fauna of the stream.

Family Libellulidae

TABLE 42

PALTOTHEMIS LINEATIPES COLLECTION DATA

Site collected	Number of individuals	Type of habitat
Paltothemis lineatipes		
18-2	1	R-S-St-SW
33-2	3	S-B-D-SW
34-1	4	S-St-D-SW
35-1	1	R-S-St-D-SW
35-4	2	R-St-B-SW

Ahrens (1938) collected adults of this species along Bright Angel Creek in the Grand Canyon, Arizona. I have seen this creek and it is predominantly of a rock and silt substrate.

Information concerning the genus *Paltothemis* is lacking. From data obtained during this study it is apparent that this species of *Paltothemis* is associated with a substrate of rocks, sand, or silt, or a combination of these. All were found in slow water, and three of the collections were made in detritus.

Family Cordulegasteridae

TABLE 43

CORDULEGASTER DIADEMA COLLECTION DATA

Site collected	Number of individuals	Type of habitat
Cordulegaster diadema		
27-1	1	D-SW

Pritchard and Smith (1956) write that *Cordulegaster dorsalis* has been found in ovipost on coarse sand in streams, and that the naiads are found in mud of slowly moving woodland streams. Whitehouse (1941) indicated that *C. dorsalis* has been found to deposit eggs in algae along slow moving streams.

Since only one specimen was collected I am unable to give any information on the type of habitat that *C. diadema* occupies. Further, the habitat of that single specimen was detritus caught on a log bridge placed across the stream. The bridge caused an extensive build-up of pine needles and leaves approximately one foot in depth.

SUBORDER ZYGOPTERA

Family Coenagrionidae

TABLE 44

HYPONEURA SP. COLLECTION DATA

Site collected	Number of individuals	Type of habitat
Hyponeura sp.		
5-4	1	R-S-St-V-SW
11-1	1	R-S-St-D-SW
18-1	1	R-S-St-SW
18-2	1	R-S-St-SW
22-1	2	R-S-St-SW
30-3	2	R-S-St-D-SW
31-1	1	R-S-FW
31-2	3	R-S-St-V-D-SW
32-3	7	S-B-D-SW
35-1	1	R-S-St-D-SW
35-2	3	R-St-B-SW

Pritchard and Smith (1956) state that Hyponeura is prominent in permanent streams of desert regions. Permanent streams tend to have a preponderance of sand and silt as substrate characters.

From samples I have collected it would appear that members of this species of Hyponeura associate with habitats having rocks, sand, and silt as characteristic components. My data further indicate that this species prefers habitats in slow moving water.

Family Lestidae

TABLE 45

ARCHILESTES GRANDIS COLLECTION DATA

Site collected	Number of individuals	Type of habitat
Archilestes grandis		
5-1	1	St-B-D-SW
5-4	1	R-S-St-V-SW
22-2	1	R-S-St-SW

Pritchard and Smith (1956) state that naiads of the genus Archilestes have been found crawling over vegetation in still water. From specimens I collected, it would appear that they associate with rocks, sand, and silt near aquatic vegetation. However, since I collected only three, I am unable to draw any firm conclusions as to the habitat they prefer.

CHAPTER XII

A SURVEY OF THE PLECOPTERA OF THE WEST FORK

The Plecoptera collected from the West Fork were exclusively nymphs. During the winter sampling 207 specimens were collected, all belonging to the genus Capnia. No nymphs of the Plecoptera were found during the summer sampling period.

Table 46 lists the sites at which Capnia sp. nymphs were collected with information concerning the site of collection.

ORDER PLECOPTERA

Family Nemouridae

TABLE 46

CAPNIA SP. COLLECTION DATA

Site collected	Number of individuals	Type of habitat
	Winter	
Capnia sp.		
1-3	1	St-B-V-FW
4-1b	1	R-S-B-FW
6-1	2	R-V-SW
7-1	8	R-S-B-D-FW
7-2	89	R-D-SW
8-1	14	R-B-SW
9-1	24	R-B-FW
10-1	8	R-S-SW
10-2	15	R-FW
11-1	3	R-FW
13-1	3	R-S-St-SW

TABLE 46 (Continued)

Site collected	Number of individuals	Type of habitat
	Winter	
Capnia sp.		
14-1	4	R-D-SW
15-1	3	St-B-SW
16-1	11	R-S-SW
17-1	20	R-S-SW

Stehr and Branson (1938) have noted that members of the family Capniidae (now Subfamily Capniinae) were abundant among rocks, gravel, and sand. They found that there is a sharp rise in numbers during the months of October and December. Radford and Hartland-Rowe (1971) have concurred with these findings. Hynes (1963) described several species in the family Nemouridae which have habitats associated with stones.

From the data on the genus Capnia of this study it is possible to conclude that this species prefers a rock substrate. It seems to be especially prominent in detritus as eighty-nine individuals were located in a rock, gravel, and detritus habitat composition.

CHAPTER XIII

A SURVEY OF THE NEUROPTERA OF THE WEST FORK

The Neuroptera collected from the West Fork were exclusively larvae. During the summer sampling seven larvae were collected, all belonging to the genus *Corydalis*. The Neuroptera were the least abundant group found during the sampling periods. No larvae of the Neuroptera were found during the winter sampling. Chandler (1956) states that the larval period of the Neuroptera is from one to three years long, thus it is apparent that few members of the Neuroptera frequent this stream.

Table 47 lists the sites at which *Corydalis* sp. larvae were located. Information concerning the ecology of the members of the Neuroptera is lacking, and too few members of the group were located to make any comments concerning their habitat preferences.

ORDER NEUROPTERA

Family Corydalidae

TABLE 47

CORYDALIS SP. COLLECTION DATA

Site collected	Number of individuals	Type of habitat
Corydalis sp.		
10-1	3	R-S-B-FW
10-2	2	R-S-St-V-D-FW
17-2	2	R-S-V- FW

Chandler (1956) notes that members of the genus *Corydalis* are highly voracious, and are usually inhabitants of clear, cold streams. Maddux (1954) states that the larvae prefer areas in which large stones are present.

Data collected for the genus *Corydalis* during this study are inconclusive. It is significant that *Corydalis* sp. was discovered in all sites under large stones and in gravel. Generally the nature of the habitat was a narrow channel with fast water moving over the surface of large stones and gravel, with some silt or vegetation in the area.

CHAPTER XIV

RESULTS

I. SUMMER SUBSTRATE ASSOCIATIONS

Fauna of the Rock and Gravel Habitat

The rock and gravel substrate was the most common substrate found at the study area. Insect diversity was notably greater in the gravel habitat than in other types of habitats. Table 2 indicates the number of sites associated with the rock-gravel substrate. I have broken this type of habitat into twenty combinations that have been examined and will consider the results from each type of composition separately.

Generic preferences point to the conclusion that there is a great abundance of dipteran, ephemeropteran, and trichopteran fauna to be found inhabiting the rock-gravel habitats. In addition, densities are the greatest in regions containing the rock and gravel association. Chironomid larvae, *Tricorythodes* sp. nymphs, and *Ambrysus buri* nymphs and adults are found in the greatest densities in this type of habitat.

Rock-gravel, sand, silt, vegetation, and detritus. This is the most complex of all the habitat types. Surprisingly, it contains a low number of species in comparison to less complex sites. Species appearing to have a broad range of preferences in substrate composition are common. Choroterpes sp. was found to have a high population density of 880 individuals per square meter in slower water, which may indicate reasons for a lower ephemeropteran diversity. However, Choroterpes sp. had a very low population density in a similar habitat in fast water. Choroterpes sp. made up the highest proportion of the total fauna in slower waters with 47.9% of the total population. Helicopsyche sp. a very common trichopterous larvae and Sericostoma sp., somewhat common also, were found to comprise a large percentage of the total fauna in slower waters. However, in faster waters of identical habitat composition they occur in much smaller proportions. Chimarra sp. was found in extremely high population densities at this habitat, 1689 individuals per square meter in fast water, which may account for the lack in trichopteran diversity. Ambrysus buri, a hemipteran, was in moderate densities in both fast and slow currents, and was found to be a very common hemipteran in this stream.

Rock-gravel, sand, silt, and vegetation. A single site was collected at this type of habitat in slow currents. Chironomid larvae were the most common larvae at this site. Sericostoma sp. was a very common larvae also. There was a great diversity in the larval ephemeropterans with up to four genera being found in a single square meter. However, the densities of the ephemeropterans were quite low.

Rock-gravel, sand, silt, and detritus. All samples in this type of habitat were taken from slow currents. Helicopsyche sp. and Choroterpes sp. were noted to be the most common members of this type of habitat. Chironomids were also very common and comprised 18% of the fauna from this type of habitat. Ambrysus buri was also frequently found in samples at this habitat type, comprising 9% of the total fauna.

Rock-gravel, sand, silt, and bedrock. A single site was collected in this type of habitat in slow currents. This particular substrate was limited in the amount of substrate present with patches of bare bedorck exposed. The diversity is low with the family Chironomidae being represented at a high density of 385 individuals per square meter. The chironomid larvae represented 73% of the total fauna sampled at this type of habitat composition.

Rock-gravel, sand, bedrock, and detritus. All samples from habitats of this composition were taken from slower currents. This habitat composition is very thin, lying on a bedrock base such that the bedrock becomes a major part of the habitat. Sericostoma sp. comprised 27% of the insect fauna in this habitat type and also was at the highest densities compared to other sites where Sericostoma sp. was found. Helicopsyche sp., and chironomids were very common at 23% and 22% respectively. Phylliocus sp. was frequently found, comprising 11% of the fauna. The trichopterans were a very diverse group and comprised the greatest percentage of the total fauna. Ambrysus buri was the only hemipteran occasionally found at this habitat type.

Rock-gravel, silt, vegetation, and detritus. A single site in slow currents was found of this habitat type. Extensive rocks with gravel was the major component of the site with a layer of silt covering the area. Sericostoma sp. comprised 51% of the total insect population at this habitat at a density of 816 individuals per square meter. Helicopsyche sp. was recorded as 31% of the total insect population with a density of 485 individuals per square meter.

Rock-gravel, sand, and silt. All sites having this particular substrate type were located in slow currents, generally at gravel bars or in piles of rock upstream from some form of projection of the shoreline. Generally the rock-gravel was the major component with sand and silt being minor components. Members of the Chironomidae were common to this habitat type, comprising 32% of the insect populations. Sericostoma sp. and Choroterpes sp. were frequent members of this habitat, comprising 23% of the total insect fauna. Paracloeodes sp. was an ephemeropteran comprising 11% of the total insect fauna. The area had a diverse Odonata population with four out of the six genera represented. Ambrysus buri was frequently found in habitats of this composition.

Rock-gravel, sand, and detritus. Detritus was a major component of the substrate composition in slower water, however it was a minor component in fast currents. Chironomid larvae and Sericostoma sp. larvae comprised 53% of the total fauna of habitats in slow water, however they comprised only 4% of the total fauna in fast water. Ambrysus buri, a common species in slow water, was not found in fast water passing over identical substrates. Elsianus sp. were the most abundant larvae in fast currents, comprising 18% of the total insect fauna in fast waters. Elsianus sp. were not found in slow currents. There was a diversity of trichopterous and ephemeropterous genera in this substrate in both fast and slow currents. No coleopterous fauna was found in slower waters, however, three species: Optioservus sp., Elsianus sp., and Helichus suturalis, were collected in fast water.

Rock-gravel, sand, and vegetation. Vegetation was a minor component in sites having this substrate composition. Highest densities for Helicopsyche sp. were found in this habitat in slow water. One density was as high as 2020 individuals per square meter. Helicopsyche comprised 69% of the total insect fauna in slow currents passing over this type of substrate, however, in fast waters it was an infrequent type, comprising only 4% of the insect fauna. Ambrysus buri, Choroterpes sp., and Heptagenia criddlei were frequently present in immature stages in both slow and fast waters. They did comprise a greater percentage of the insect populations in faster water.

Rock-gravel, sand, and bedrock. This particular substrate is generally found in piles that are surrounded by exposed bedrock. Chironomid larvae are the most common insect associated with this type of substrate in slower currents, constituting 31% of the total insect fauna. In faster currents they only comprise 16% of the total insect fauna, and were rarely found at some sites. Helicopsyche sp. were the most common insect larvae of faster currents, comprising 30% of the fauna, however, in slow currents they are less frequent, comprising 18% of the insect fauna. Sericostoma sp. larvae make up 23% of the fauna in slow water, but only 7% of the fauna in faster currents. Ambrysus buri is a frequent member of this substrate in both fast and slow currents at 8% of the populations in both. Overall diversity seems to be high in this substrate with twenty-five species being found in this habitat type.

Rock-gravel, silt, and bedrock. Helicopsyche sp. were the most commonly found larvae of this particular substrate with densities up to 727 individuals per square meter, comprising 48% of the total fauna. Chironomid larvae were very abundant constituting 32% of the total fauna examined. Choroterpes sp. was a frequent larvae comprising 11% of the insect population in this habitat type. All samples of this substrate were made in slow currents.

Rock-gravel, bedrock, and vegetation. Rock and gravel were minor components of this particular habitat with vegetation in great abundance in the form of moss. Currents were fast over all sites collected in this substrate. Helicopsyche sp. comprised the greatest proportion of the population at 3890 individuals per square meter. Ambrysus buri was a common form comprising 12% of the total fauna, as was Tricorythodes sp. at 13% of the total fauna.

Rock-gravel, bedrock, and detritus. Population densities were low in this substrate type with chirononomid larvae and Ambrysus buri in adult and immature stages comprising 87% of the fauna. Ambrysus buri was at one of the highest densities found for this species at 499 individuals per square meter. All collections were made in slow currents.

Rock-gravel and sand. Chironomid larvae were common in this type of substrate having densities of 1206 individuals per square meter in slow water and 957 individuals per square meter in slow water and 957 individuals per square meter in fast water, and comprising 27% and 20% of the total fauna in slow and fast water respectively. Helicopsyche sp. was very common in fast water (29% of the population), however, in slow water it comprised only 13% of the total fauna. Choroterpes sp. nymphs were common in both slow and fast water comprising, on the average, 20% of the fauna in both currents. Ambrysus buri was frequent in slow water.

Rock-gravel and silt. Rock and gravel were the major components of this substrate. The silt was constantly being eroded and replenished due to the fast currents over the site sampled. Helicopsyche sp. was the most frequent larvae located in this substrate at 25% of the total population. Chironomid larvae were also common at 20% of the total insect fauna. Hydropsyche sp. and Ambrysus buri were frequent at this substrate type.

Fauna of the Sand Habitat

The sand habitat type was a relatively uncommon form of habitat since in most instances rocks were either at the site or immediately adjacent to it, so that it became difficult to find pure sand without rocks or gravel. The insect diversity in this habitat when compared to the rock-gravel fauna, appears to be lower. Table 2 indicates the number of sites associated with sand. The substrate has been broken down into three combinations.

Sand, silt, and detritus habitats. Collections were taken in slow water at sites in this type of habitat. Sericostoma sp. larvae were the most common at 32% of the total insect fauna. Tricorythodes sp. was a frequent species at 16% of the population. Chironomid larvae were found at lower numbers.

Sand, bedrock, and detritus habitats. Overall diversity was very low in this substrate type. One site was sampled in slow water. Helicopsyche was recorded at 999 individuals per square meter and comprised 43% of the total fauna. Chironomid larvae were very common with 666 individuals per square meter, forming 28% of the total fauna. Sericostoma was abundant, comprising 26% of the total insect fauna.

Sand, and bedrock habitats. Six larvae were collected in slow water at this habitat type: four larvae of Helicopsyche sp. and two larvae of Tabanidae.

Fauna of the Silt Habitat

The silt substrate sampled was consistently a thin layer of silt on bedrock, associated with vegetation or detritus. Insect fauna located in this substrate was diverse, however, population densities were very low. Table 2 indicates the number of sites associated with the silt substrate. I have broken this type into four combinations.

Silt, bedrock, and vegetation habitats. Stratiomyidae larvae are the most common form at this substrate type in slower currents, comprising 25% of the total population. None were found in identical substrates in fast currents. Simuliid larvae were found to comprise 22% of the populations in slow water, however, none were found in habitats associated with fast water. *Ambrysus buri* was a frequent form and the highest density of *Ambrysus buri* was recorded at 599 individuals per square meter in slow currents. In habitats of faster currents, *A. buri* comprised only 6% of the population. Chironomid larvae were the most common form in habitats of the same substrate composition in fast water, comprising 50% of the total populations examined. Chironomid larvae only comprised 14% of the fauna in identical substrates in slow currents. *Helicopsyche* sp. comprised 21% of the fauna in habitats of fast currents, however, in slow currents they comprised less than 1% of the total fauna.

Silt, bedrock, and detritus habitats. Chironomid larvae comprised 80% of the total insect population at this substrate. *Paracloeodes* was frequently found and comprised 9% of the total population.

Silt, vegetation, and detritus habitats. A single site was sampled at this type of substrate in which detritus was the major component. The sample was taken in fast water. Helicopsyche sp. larvae constituted 13% of the insect population with a surprising density of 1343 individuals per square meter. Tricorythodes sp. was a frequent larvae at 9% of the total population.

Fauna of the Bedrock Habitat

Bedrock was a relatively common substrate, however, few samples were taken from this substrate. Insect diversities are very low as are the population densities, which was to be expected. Table 2 indicates the number of sites collected in bedrock. Three combinations were examined, all were in fast currents.

Bedrock, vegetation, and detritus habitats. Population densities were extremely low at the single site examined. Helichus suturalis was the most common species, comprising 29% of the population; only seventy-seven individuals per square meter were noted. Ambrysus buri comprised 21% of the population at a density of fifty-five individuals per square meter.

Bedrock and vegetation habitats. Only one simuliid larvae and two stratiomyid larvae were found at this particular substrate.

Helicopsyche sp. were the only larvae located at this substrate. It was surprising to note 1243 individuals per square meter at this substrate. Individual larvae were evenly spaced over the entire substrate. Simuliid larvae were not sampled in this substrate, however, a count was made of a population on bedrock, outside of the study sites, and it was determined to have fifty-four larvae per 6.25 square centimeters. This is to be expected since the habitat for the larval Simuliidae is generally attached to a bedrock substrate where the water is a thin, fast-moving sheet.

Fauna of the Detritus Habitat

The detritus substrate sampled was an uncommon habitat, created by a log foot-bridge across the stream. Three chironomid larvae and three *Abedus* sp. adults were collected at the site. One *Ambrysus buri* adult, one *Choroterpes* sp. larvae, one *Tricorythodes* sp. nymph, and one *Heptagenia criddlei* nymph were found at the site.

Table 48 on pages 135 through 139 provides the percentage that each genus or family comprised of the total community populations collected during the summer sampling period. The numbers refer to the percentage composition of the genus or family.

CHAPTER XV

COMPARATIVE RESULTS OF WINTER AND SUMMER SAMPLING

I. A COMPARISON OF WINTER AND SUMMER SAMPLING RECORDS AT SITES SAMPLED DURING BOTH SUMMER AND WINTER

During the winter a series of twenty-six sites were sampled at seventeen stations. The overall diversity during the winter sampling was a great deal less than was found during the summer. Of forty-three genera present during the summer only twenty-two were found during the winter. Capnia, a plecopteran not found during the summer, was found during the winter. Densities were much less during the winter than in the summer. This portion of the discussion will concentrate on species composition of the insect populations, as densities are too low to provide valuable comparative data.

Rock-gravel, Sand, Bedrock, and Detritus Habitats

A single site was sampled in fast water. Choroterpes sp. was a frequent member of the community comprising 36% of the total insect population. Chironomid larvae were occasionally found and comprised 19% of the population. Capnia sp. a plecopteran not found during the summer sampling, comprised 22% of the total population. In previous records Choroterpes sp. represented less than 1% of the total fauna. Helicopsyche sp. and Sericostoma sp. previously occupied 50% of the populations, but were not found at this substrate in the winter collection. The station at which the habitat was located had lost a great deal of silt and the particular site was denuded, exposing bedrock at several spots in the station.

Rock-gravel, Sand, and Silt Habitats

Chironomid larvae comprised 32% of the population during the summer sample, and 42% of the winter population. Tricorythodes sp. was 22% of the fauna as compared to 6% of the population in previous records. Choroterpes sp. comprised 17% of the population during the winter but only 6% during the summer. The collections were in slow water at a site previously having identical characters.

Rock-gravel, Sand, and Bedrock Habitats

Helicopsyche sp. and Choroterpes sp. were recorded at 25% and 33% of the winter populations respectively (collections in fast water). However, in slow water Choroterpes sp. were at 52% in winter. Heptagenia criddlei ranged from 1% to 14% of the total winter populations in faster currents of identical substrates.

During the summer samples the ephemeropterans were a very minor group at this particular substrate. During the winter sampling, chironomid larvae occupied only a minor part of the population, however, they comprised 31% of the population in substrates with slow currents and 16% of the population in substrates with fast currents during the summer.

Rock-gravel, Sand, and Detritus Habitats

All sites collected were in slower water. A single genus, Chproterpes sp., dominated at 72% of the winter population. During the summer Choroterpes sp. was at only .64% of the population. Sericostoma sp. and chrionomid larvae dominated during the summer at 26% and 27% of the total population respectively.

Rock-gravel and Sand Habitats

Choroterpes sp., frequently found at this substrate type in slow and fast currents, comprised 17% and 20% of the fauna respectively during the winter. Helicopsyche sp. was the most frequent form in fast water comprising 48% of the total population. However, in similar substrate types in slow water it comprised only 17% of the total insect population. Capnia sp. was not found in fast currents in similar substrate types but comprised 28% of the total insect population at rock and gravel in slow water. During the summer sampling the dominant larvae were Chironomidae, and Helicopsyche sp., and the dominant nymphs were Choroterpes sp.

Rock-gravel and Vegetation Habitats

Only seven larvae were collected at this particular substrate: one larvae of Atopsyche sp., one nymph of Choroterpes sp., two nymphs of Heptagenia criddlei, and three nymphs of Capnia sp.

Rock-gravel and Detritus Habitats

No summer samples were obtained from similar habitats, possibly since this was a build-up of extensive detritus caught in the rocks, caused by heavy currents. Capnia sp. was the most common form found at the substrate, accounting for 69% of the total insect population. Tricorythodes sp. and Choroterpes sp. were occasionally found and respectively constituted 7% and 8% of the total population.

Rock-gravel Habitats

Again no summer habitats were sampled, since this particular habitat is the result of rapid waters that have denuded the stream bed of all but rocks and gravel. Capnia nymphs were common, comprising 45% of the total insect population. Choroterpes sp. larvae was frequently found, and comprised 23% of the population.

Sand, Bedrock, and Detritus Habitats

Seventeen immature forms were collected during the winter; six Chironomidae larvae, seven Helicopsyche sp. larvae, one Oecetis sp. larvae, two Choroterpes sp. nymphs, and one Tricorythodes sp. nymph.

Silt, Bedrock, Vegetation, and Detritus Habitats

Only two larval types were found: twenty-two chironomid larvae, and two Choroterpes sp. larvae.

Silt, Bedrock, and Vegetation Habitats

Sites sampled during the winter were in fast currents. Baetis sp. nymphs were the most common at 55% of the total insect population, at a density of 1898 individuals per square meter. This was the largest density I have recorded for the winter samples and the largest density for Baetis sp. in both winter and summer. Simuliid larvae were very common and comprised 23% of the populations.

During the summer samples in like habitats chironomid larvae comprised 50% of the insect fauna and Helicopsyche sp. were 21% of the total insect population.

Silt and Bedrock, Bedrock and Vegetation, and Bedrock and Detritus Habitats

Only four larval types were found in the silt and bedrock habitat: one Hydropsyche sp. larvae, five Tricorythodes sp. nymphs, one Heptagenia criddlei nymph, and three Capnia sp. nymphs. Two larval types were found in the bedrock vegetation habitat: one chironomid larvae, and one Capnia sp. nymph. Five larval types were found at the bedrock and detritus habitat: one simuliid larvae, one stratiomyid larvae, four chironomid larvae, two Polycentropus sp. larvae, and one Baetis sp. nymph.

Table 49 on pages 140 through 141 provides the percentage composition of each genus or family collected during the winter sampling period.

CHAPTER XVI

DISCUSSION

The relative importance of habitat compositions has been emphasized with respect to the habitat preferences of the various genera studied. Such knowledge is necessary when one begins to examine the community compositions at different substrates. Ulfstrand (1968) states: "The substrate is an especially important determinant of the life conditions of the fauna; besides other functions it has to provide food for the animals." Ulfstrand further indicated that benthic species select habitats on the basis of factor combinations rather than on the basis of isolated factors. Allee and Torvick (1927) in an examination of different distribution of animals in a small stream noted that pH, stream flow and substrate conditions greatly influence the distribution of stream invertebrates. Possibly the effect of pH can be interpreted as a direct result of the physical nature of the stream (Allee and Torvick, 1927). Experimental modification of the stream bed has been found to alter population densities. In many cases, by increasing available surface area (addition of stones to sandy substrates) population densities of aquatic invertebrates subsequently increased (Wene and Wickliff, 1940). Linduska (1942) recorded differences between species abundancies relative to the type of substrate composition. Certain substrates are either limited in their productive capacities or have great productive capacities based on factors such as rock, gravel, or rubble, or whether the factors were nonexistent (Pennak and Van Gerpin, 1947). Lyman (1958) found that in the ephemeropterous nymphs assume patterns that are a natural result of the bottom type more than any other factor.

Probably the aquatic fauna of any stream is an indirect result of the adjacent terrestrial habitats. Though the effects of terrestrial conditions on aquatic habitats was not measured it is possible to indicate some of the relationships. Mackay (1969) suggests that the species composition of the West Creek, Quebec, is probably greatly influenced by the woodlands surrounding the creek. Fauna of aquatic habitats could be influenced by woodlands in several ways. First, woodlands are responsible in part for shielding the stream from radiation. Second, woodlands supply the detritus that is an important component of streams. Third, woodlands supply many of the habitats necessary for adult insects whose larval stages are spent in streams. Other terrestrial habitats may provide other necessary components to the stream. Terrestrial habitats with few plants may weather easily, providing stones and silt to the stream. Though the effect of terrestrial habitats was not measured during this study, it is possible to understand the possible sources of suitable habitats for the aquatic genera that inhabit the West Fork.

I have utilized the spatial approach for this study. By spatial approach it is meant that a great many habitats were sampled in a restricted period of time. The spatial approach allows one to examine communities with respect to the composition of the substrates, rather than examining the seasonal distribution of the organisms, although samples were taken during two time periods which gave me seasonal data as well. Janzen and Schoener (1969) examined the effects of drought by examining localities in wetter and drier sites in a tropical drought. Percival and Whitehead (1929), Gersbacher (1937), Linduska (1942), Lyman (1958), and Vincent (1967), utilized the spatial approach to the problem of comparing differences in animal populations. It is interesting that Gersbacher (1937) examined succession in stream communities by comparing various streams at different successional stages during one period of time. Needham and Usinger (1956) examined the variability of fauna at a single riffle utilizing a spatial approach.

The use of the Surber sampler in this study was ideal since substrates can be both quantitatively and qualitatively sampled utilizing the same instrument. Needham and Usinger (1956) indicate that the Surber sampler can be utilized under a great many conditions with excellent results.

A certain amount of bias has been noted in the study due to the availability of substrate types. Rock and gravel bottom types were the most common type found and subsequently were sampled at fifty-three out of sixty-nine sites during the summer sampling, and at nineteen out of twenty-six sites during the winter sampling. However, as other types of substrates were lacking in the stream I was unable to sample a wide variety of those combinations not in rock and gravel.

I. THE ROCK-GRAVEL FAUNA

The Diptera

Chironomid larvae were found to be the most common type of dipteran in the rock-gravel substrate with high densities of midges noted at sites which included silt or detritus. Chironomid larvae showed an affinity for habitats in slower currents, possibly due to a greater tolerance to lower oxygen levels. Tabanid larvae were frequently encountered at low densities at sites when sand was present, and were notably missing or at very low densities when sand was not present. The rhagionid larvae followed a pattern similar to the tabanid larvae, however, they were far less frequent, and at very low population densities. Simuliid larvae are highly restricted in this type of substrate, being associated with vegetation and fast currents of the stream. The ceratopogonid larvae were restricted to gravel and sand substrates in slow currents. The Ephydridae and Muscidae were exceptionally rare.

Percival and Whitehead (1929) reported that the midges are by far the most important of the aquatic Diptera. Indications are that the nature of the detritus and the speed of the water may be important determinants affecting the distribution of midges in streams (Percival and Whitehead, 1929). Jones (1941) has recorded that the chironomid larvae are quite abundant in the late summer months, and become decreasingly abundant as winter approaches. Davies and Smith (1958) have shown that Prosimulium sp. are restricted to sites with no rooted vegetation. Pennak and Van Gerpen (1947) indicated extensive numbers of chironomid larvae in all types of habitats, however, they were quite scarce in rock with coarse gravel and coarse sand. They further have found that the ceratopogonid larvae are rarer forms in rocks and gravel, the rhagionid larvae are rare in coarse gravel, and that the simuliid larvae are very abundant but restricted to bedrock. Mackay (1969) discovered that the blackfly larvae are very abundant through the summer months. Stehr and Branson (1938) found that riffles with a rock substrate were ideal for the chironomid larvae, however, they were not the preferred habitats of simuliid larvae or stratiomyid larvae.

The Trichoptera

The most common larvae of the Trichoptera was Helicopsyche sp., being found in all sites of a rock-gravel nature. Higher percentages were found in vegetation, detritus, and silt. Also, higher densities of Helicopsyche sp. were recorded at the above mentioned substrate types. Helicopsyche sp. larvae were more abundant at sites with faster currents passing over them. Sericostoma sp. larvae were very common at the rock-gravel habitats having vegetation or silt as part of the composition. The highest densities were recorded when both vegetation and detritus were present at the habitat. Phylliocus sp. and Hydropsyche sp. are frequently encountered at low densities at many of the sites, however, highest densities were located in vegetation or silt. Chimarra sp. was occasionally encountered in varied substrates, however, densities are noted to be highest in vegetation and detritus. Oecetis sp. and Polycentropus sp. were occasionally found at very low densities. Lepidostoma sp., Hesperophylax sp., Atopsyche sp., and Glossosoma sp. were rarely encountered and comprised a minor part of the trichopteran fauna.

Percival and Whitehead (1929) found Hydropsyche sp. to be more prevalent among rocks and stones with vegetation. Glossosoma sp. they found more frequently on rocks and stones devoid of vegetation. Data from this study is consistent with these findings. Stehr and Branson (1938) report finding Hydropsyche to be rare on stones of a rock riffle devoid of vegetation. Pennak and Van Gerpen (1947) recorded low densities of Lepidostoma sp. and Oecetis sp. in rock and gravel and slightly higher densities of Hydropsyche sp. in the same habitat. Mackay (1969) and Mackay and Kalff (1969) indicate Lepidostoma sp. as part of the rock and gravel fauna at very low densities. Minkley (1963) noted Hydropsyche sp., common in vegetation, especially moss.

Trichoptera found at the West Fork are the most diverse group and comprise the majority of the insect fauna found at the stream. This is consistent with previously cited authors.

The Coleoptera

A single species, Helichus suturalis, commonly occupied the rock-gravel substrates as adults. Optioservus divergens adults, Optioservus larvae, Heterelmis glabra adults, Narpus sp. larvae, and Elsianus sp. larvae were infrequent at the stream at low densities.

Helichus suturalis adapted to a wide variety of habitats at the West Fork. Brown and Shoemake (1964b) have found that members of the genus Helichus are very widespread over many habitat types. Percival and Whitehead (1929) note that the Coleoptera is a minor group in streams. These findings have been also recorded by Pennak and Van Gerpen (1947), Armitage (1958), and Mackay (1969). Mackay (1969) found Helichus striatus in several sites in rock, gravel, detritus, and vegetation.

The Hemiptera

Only two genera, Ambrysus and Abedus were located as adults and nymphs in rock and gravel. Abedus was frequently found, however, it is not associated with any single habitat type. Ambrysus buri was very common at the rock-gravel habitats. Highest densities of Ambrysus buri were found in vegetation and detritus. Few authors have reported Ambrysus sp. or Abedus sp. associated with any particular substrate. This is possibly due to the predaceous nature of the two genera.

The Ephemeroptera

Choroterpes sp. and Tricorythodes sp. have been found as the most common genera in the rock and gravel substrates. Higher densities are found for Choroterpes sp. than for Tricorythodes sp. This is especially true in habitats of vegetation and detritus, however, Choroterpes sp. which was noted in highest densities at sites with both vegetation and detritus, was also found in rock, gravel, and sand. Tricorythodes sp. was recorded at varied rock and gravel substrates, yet densities were again higher with vegetation comprising part of the substrate composition. Heptagenia criddlei was frequently found at this substrate type in low densities. Paracloeodes sp. was frequent also, however, densities were low. Callibaetis sp., Baetis, and Epeorus margarita were rare in rock and gravel.

Percival and Whitehead (1929) recorded high densities of Baetis sp. associated with vegetation, however, Baetis sp. were noted as only a small percentage of the total population. Linduska (1942) found Baetis sp. in stones, however, he found the populations to be quite low. Harker (1953) noted that Heptagenia sp. utilized stones for protection from physical damage caused by flooding. Little information is available concerning the ecology of Tricorythodes sp. and Choroterpes sp.

The Odonata

The Odonata were found to comprise a very small percentage of the total insect fauna collected at the West Fork. Ophiogomphus arizonicus, Paltothemis linetips, Aeshna interrupta, Cordulegaster diadema, Archilestes grandis and Hyponeura sp. were recorded only rarely at substrates of rock and gravel.

The Neuroptera

A single genus, Corydalis sp., was located at the West Fork. The total number of individuals collected was only fifteen. As there is no ecological information concerning this genus, it is not possible to discuss it.

II. THE SAND FAUNA

Overall diversity of genera was lower at sand substrates, as were the population densities. Mackay (1969) notes that in sand substrates the numbers of all larvae are generally lower. From information concerning the rock-gravel substrate it is apparent that the sand substrates offer very limited protection from predators or sunlight. Also, protection from physical damage is low. This substrate was very ephemeral, and was changed with any marked increase in water flow. The Coleoptera and Odonata were distinctly absent from this substrate. Due to case building requirements both *Helicopsyche* sp. and *Sericostoma* sp. occurred frequently at this substrate. The Ephemeroptera requiring shade from the sun and protection were found at low densities and low generic diversities at this type of substrate. The burrowing forms represented by the Diptera were found at low densities and low generic diversities due to lack of sufficient protection.

III. THE SILT FAUNA

Generic diversity at the silt substrates was higher than that of the sand substrates, however, one notable exception was the Diptera. Simuliids, stratiomyids, and chironomids were found at the highest densities in the silt fauna. The chironomid larvae are noted to have high hemoglobin contents which would allow for high densities in heavily silted areas of low oxygen content. The chironomid larvae were the most prevalent group in this type of substrate.

IV. THE BEDROCK AND DETRITUS FAUNA

Probably due to lack of protection, lack of food material, and lack of case building material, few genera can find adequate habitats at these respective substrates. *Helicopsyche* sp. was found at over 1000 individuals per square meter evenly spread over the substrate. Simuliid larvae were located in high numbers where the currents were very rapid and the water a thin sheet. It was probably due to the selectivity of simuliid larvae for thin sheets of water that these larvae occurred in isolated patches. I was unable to locate any information concerning habits of Helicopsyche sp. Mackay (1969) found that the oxygen concentration was less than 50% saturation which may add to the undesirable nature of the detritus habitats.

V. LIFE CYCLE CONSIDERATIONS

Any considerations of population differences between the winter and summer samples must be centered around a discussion of the life cycles of the various genera. Information is lacking concerning many of the life cycles. Notably, the Odonata and Coleoptera were not present at the West Fork during the winter periods. At the West Fork this may be as a result of the freezing conditions prevailing during the winter sampling. Also it is possible that the naiads move toward the stream banks and burrow into the soil at the stream's edge during the winter. Mackay (1969) followed the life histories of the trichopterans and determined that odonate populations do exist during the winter, however, the populations are at a very low density. Similar results were indicated for the Diptera, Ephemeroptera, Coleoptera, and Odonata. Harker (1953) found that among mayflies emergence from the nymphal stage occurs in June, with only small numbers of nymphs remaining during the winter months. Elliot (1967) noted similar results with his study on mayflies (Mackay and Kalff, 1969). It is possible that due to a lower survival of eggs and newly hatched larvae in colder water the populations are much lower, with only the more cold adapted genomes surviving during the winter to emerge in the spring.

Larvae of an order not collected during the summer was found during the winter. A plecopteran, in the genus Capnia was found in relatively high abundance during the winter period in substrates with vegetation as part of the habitat composition. Mackay and Kalff (1969) and Elliot (1967) have found that the Plecoptera larvae are at peaks in their densities in June and July and also in October and December. It is possible that due to the plecopterans being a more cold water form, they have a single hatching period in the late summer and early winter and emerge in the spring, Such a pattern would enable the plecopteran larvae to avoid the higher water temperatures of the summer.

CHAPTER XVII

SUMMARY

A total of ninety-five sites at the West Fork of Oak Creek were examined during two time periods for insect larvae and adult communities. The sites represent thirty-two microhabitat compositions during the summer and eighteen microhabitat compositions during the winter.

Thirty-six genera and thirteen species were identified from a total of 7699 specimens collected. Eight families of Diptera larvae were represented but generic determinations were unable to be made. Habitat preferences were discussed concerning each of the genera represented.

The Diptera, Trichoptera, and Ephemeroptera were found to be the most diverse groups having the highest densities in both winter and summer collections. The Odonata and Coleoptera were found to be absent from the winter collections. Plecoptera larvae were found to be common during the winter but absent during the summer.

Chironomid larvae, Helicopsyche sp. larvae, Sericostoma sp. larvae, Choroterpes sp. nymphs, and Tricorythodes sp. nymphs comprised the bulk of the specimens collected during the summer.

Chironomid larvae and Capnia sp. nymphs were found to comprise the bulk of the winter samples.

Rock-gravel substrates were found to have the greatest variety of genera, and the greatest densities in both the winter and summer samples.

TABLE 48

PERCENTAGE COMPOSITION OF GENERA IN EACH MICROHABITAT EXAMINED DURING THE SUMMER

Diptera	Tabanidae	Rhagionidae	Simuliidae	Stratiomyidae	Muscidae	Chironomidae	Ephydridae	Ceratoponidae
R-S-St-V-D-SW						7.78		1.19
R-S-St-V-D-FW	1.23	2.76	4.61	.30		4.3		
R-S-St-V-SW						31.48		
R-S-St-D-SW	.30	.60				17.79	.60	.15
R-S-St-B-SW					2.08	72.91		
R-S-B-SW	1.81					21.76		
R-St-V-D-SW						3.47		
R-S-St-SW	.94					32.22	.47	
R-S-D-SW	1.29					27.27		
R-S-D-FW	1.39			4.19		3.49		
R-S-V-SW	.75	1.13				1.13		
R-S-V-FW			8.03			5.35		
R-S-B-SW						31.38		
R-S-B-FW	6.26	.94	1.88			16.30		
R-St-B-SW	1.77					32.00		
R-B-V-FW			1.78			5.35		
R-B-D-SW	1.41		1.41			29.78		
R-S-SW	1.25		.41	3.62		26.88	.13	.83
R-S-FW	2.46	.52				20.10	.35	
R-St-FW	.65	.65	1.30			19.60		
S-St-D-SW				.43		11.20		1.29
S-B-D-SW						28.43		
S-B-SW	33.33							
St-B-V-SW		1.04	22.25	24.86		13.87		.52
St-B-V-FW						50.0		1.88
St-B-D-SW						79.98		
St-V-D-SW						3.63		
B-V-D-FW			4.16			4.16		
B-V-FW			33.33	66.66				
B-FW						30.0		
D-SW								

TABLE 48 (Continued)

	Trichoptera Ochotrichia	Helicopsyche	Sericostoma	Cheumatopsyche	Hydropsyche	Chimarra	Oecetis	Phylliocus
R-S-St-V-D-SW		10.77	13.17					5.38
R-S-St-V-D-FW		1.23			7.38	45.89		
R-S-St-V-SW		4.62	27.77					
R-S-St-D-SW		25.94	5.88		.30			3.31
R-S-St-B-SW		4.16	10.41					
R-S- B -D-SW		23.31	27.46		.25		.77	11.39
R-St-V-D-SW		31.25	50.69					1.44
R-S-St-SW		11.37	13.74				.47	4.26
R-S-D-SW		5.19	25.97			3.24		1.94
R-S-D-FW		14.68	.69		10.48	9.09		7.67
R-S-V-SW		68.67	3.01		1.50		.37	1.50
R-S-V-FW		4.46	.89		7.14	16.96		1.78
R-S-B-SW		17.99	23.01				1.25	1.67
R-S-B-FW		30.40	6.89		5.45	5.45		.62
R-St-B-SW		48.44	2.22				.44	
R-B-V-FW		38.39	4.46		1.78			1.78
R-B-D-SW		10.63			3.54	1.41		
R-S-SW		13.37	3.20		.41	.55	.13	.27
R-S-FW		29.27	2.99	.17	.52	.17	.70	1.23
R-St-FW		24.83			14.37	2.61		1.96
S-St-D-SW		21.12	31.89				2.55	9.91
S-B-D-SW		42.65	26.32					5.68
S-B-SW		66.66						
St-B-V-SW	3.14	.78	.78		1.83	4.71		
St-B-V-FW		20.75	13.20			.94		1.88
St-B-D-SW		1.80	.93			.93		
St-V-D-SW		73.33	1.21					
B-V-D-FW		12.50	4.16		8.33			
B-V-FW								
B-FW		100						
D-SW								

TABLE 48 (Continued)

	Trichoptera	Lepidostoma	Hesperophylax	Atopsyche	Glossosoma	Polycentropus	Coleoptera Agabus	Optioservus	Heterelmis
R-S-St-V-D-SW									
R-S-St-V-D-FW				1.84					
R-S-St-V- SW									
R-S-St-D-SW				.15		.45			.15
R-S-St-B-SW			2.08						
R-S-B-D-SW		.25			.25				
R-St-V-D-SW									
R-S-St-SW		.94				.47			
R-S-D-SW			.64						
R-S-D-FW								.69	
R-S-V-SW									
R-S-V-FW						1.78			
R-S-B-SW		.41				.41			
R-S-B-FW				.31		.31		.62	
R-St-B-SW						.44			
R-B-V-FW		.89							
R-B-D-SW						2.12			
R-S-SW						.83		.13	
R-S-FW		.35	.35					.17	
R-St-FW									
S-St-D-SW		.43						.43	
S-B-D-SW									
S-B-SW									
St-B-V-SW							.52	.26	
St-B-V-SW									
St-B-V-FW									
St-B-D-SW									
St-V-D-SW									
B-V-D-FW									
B-V-FW									
B-FW									
D-SW									

TABLE 48 (Continued)

	Coleoptera *Narpus*	*Elsianus*	*Helichus*	Hemiptera *Abedus*	*Ambrysus*	Neuroptera *Corydalis*	Ephemeroptera *Baetis*	*Callibaetis*	*Paracloeodes*
R-S-St-V-D-SW					7.78				
R-S-St-V-D-FW		7.69	2.15		10.87	.61			
R-S-St-V-SW					1.85			16.66	5.55
R-S-St-D-SW		1.20	1.35	.15	8.89		.45		.45
R-S-St-B-SW					2.08				2.08
R-S-B-D-SW			.25		7.25		.25		
R-St-V-D-SW					5.55				.69
R-S-St-SW			1.89		11.37				11.37
R-S-D-SW				.64	13.63				1.94
R-S-D-FW		18.88	1.39		9.79				.69
R-S-V-SW			2.26		3.39				1.13
R-S-V-FW	.89		2.67		10.11	8.92			3.57
R-S-B-SW	.41				7.53			1.25	1.25
R-S-B-FW	.31	1.56	.31		7.52	7.94			2.82
R-St-B-SW					1.33				
R-B-V-FW			.89	.89	12.30				6.25
R-B-D-SW			4.25	2.12	31.91		1.41		
R-S-SW			.41		11.83			3.20	
R-S-FW			2.46		7.76				.52
R-St-FW		1.30	3.26		14.37				3.92
S-St-D-SW				.43	.43				
S-B-D-SW					1.42				
S-B-SW									
St-B-V-SW			.78	.26	17.53		3.66		.26
St-B-V-FW				.94	5.66				.94
St-B-D-SW				.93	3.73		1.86		9.34
St-V-D-SW					4.24				7.27
B-V-D-FW			29.16		20.83		8.33		4.16
B-V-FW									
B-FW									
D-SW									

TABLE 48 (Continued)

	Ephemeroptera Choroterpes	Tricorythodes	Epeorus	Heptagenia	Odonata Ophiogomphus	Aeshna	Paltothemis	Cordulegester	Hyponeura	Archilestes
R-S-St-V-D-SW	47.9	3.59							2.39	
R-S-St-V-D-FW	2.46	.30	.30		5.84	.30				
R-S-St-V-SW	1.85	7.40			.92				.92	.92
R-S-St-D-SW	25.49	1.50		4.22		.15	.15		.75	
R-S-St-B-SW		4.16								
R-S-B-D-SW	.77	.77		2.33	.77					
R-St-V-D-SW					2.8					
R-S-St-SW	5.67	6.16			1.42		.47		1.42	.47
R-S-D-SW	.64	7.14		4.54	3.24					
R-S-D-FW	11.88		.69	4.19						
R-S-V-SW	6.79		2.26	4.90					1.13	
R-S-V-FW	17.85			8.92						
R-S-B-SW	7.94	3.34					1.25		.83	
R-S-B-FW	5.01	.31		4.70						
R-St-B-SW	11.11	.44		.88			.88			
R-B-V-FW	3.57	12.50		2.07					6.25	
R-B-D-SW	5.67	2.12		2.12						
R-S-SW	22.98	3.06		3.76						
R-S-FW	14.40	.70	.35	7.93					.17	
B-St-FW	7.18			3.92						
S-St-D-SW	.86	15.94			.86		1.72			
S-B-D-SW		.47								
S-B-SW										
St-B-V-SW	.52	.78								
St-B-V-FW	.94	.94		.94	1.88					
St-B-D-SW										.93
St-V-D-SW	9.09	1.21								
B-V-D-FW				4.16						
B-V-FW										
B-FW										
D-SW	10.0	10.0						10.0		

TABLE 49

PERCENTAGE COMPOSITION OF GENERA IN EACH MICROHABITAT EXAMINED DURING THE WINTER

	R-S-B-D-FW	R-S-St-SW	R-S-B-FW	R-S-B-SW	R-S-D-SW	R-S-FW	R-S-SW	R-B-FW	R-B-SW	R-V-SW
Diptera										
Tabanidae			2.89							
Rhagionidae			1.44							
Simuliidae										
Stratiomyidae										
Muscidae										
Chironomidae	19.44	41.66	8.69	10.34	3.07	7.50	8.63			
Ephydridae						5.00				
Ceratopogonidae		2.77				2.50				
Trichoptera										
Ochotrichia			1.44							
Helicopsyche			24.63	6.89	1.53	47.50	16.54			
Sericostoma		2.77	11.59	6.89			5.75	3.33		
Hydropsyche	5.55			6.89	3.07	10.00	4.31	6.66	1.66	
Chimarra		2.77							3.33	
Oecetis	2.77		1.44				3.59	3.33	1.66	
Phylliocus			2.89							
Atopsyche									1.66	14.28
Polycentropus										
Hemiptera										
Ambrysus		2.77	2.89		4.61					
Ephemeroptera										
Baetis						2.50				
Choroterpes	36.11	16.66	33.33	51.72	72.30	20.00	17.26	3.33	35.00	14.28
Tricorythodes	8.36	22.22	5.19	3.44			7.19		25.00	
Heptagenia	5.55		1.44	13.79	15.38	5.00	8.63	3.33		28.57
Plecoptera										
Capnia	22.22	8.33	1.44				28.05	80.00	23.33	42.85

TABLE 49 (Continued)

	R-D-SW	R-FW	S-B-D-SW	St-B-V-D-SW	St-B-V FW	St-B-SW	B-V-SW	B-D-:W
Diptera								
Tabanidae								
Rhagionidae								
Simuliidae					22.90			11.11
Stratiomyidae								11.11
Muscidae					1.29			
Chironomidae	2.96		35.29	91.66	12.58		50.00	44.44
Ephydridae								
Ceratopogonidae								
Trichoptera								
Ochotrichia					4.83			
Helicopsyche	2.96		41.17					
Sericostoma	5.92				.32			
Hydropsyche	.74	10.00			.32	10.00		
Chimarra	.74	7.50			.96			
Oecetis	.74		5.88					
Phylli ocus	1.48							
Atopsyche					.32			
Polycentropus								22.22
Hemiptera								
Ambrysus								
Ephemeroptera								
Baetis					55.16			1.11
Choroterpes	8.14	22.50	11.76	8.33	.64			
Tricorythodes	7.40	12.50	5.88		.32	50.00		
Heptagenia		2.50				10.00		
Plecoptera								
Capnia	68.88	45.00			.32	30.00	50.00	

TABLE 50

SPECIES ABUNDANCE AT EACH SITE DURING THE SUMMER SAMPLING

Station #1
- Site #2
  - Diptera
    - Simuliidae 20 individuals
    - Stratiomyidae 50 individuals
    - Chironomidae 7 individuals
  - Trichoptera
    - Ochotricha 4 individuals
    - Sericostoma 3 individuals
    - Helicopsyche 1 individual
  - Coleoptera
    - Narpus 4 individuals
- Site #3
  - Diptera
    - Simuliidae 57 individuals
    - Stratiomyidae 40 individuals
    - Chironomidae 30 individuals
  - Trichoptera
    - Ochotricha 8 individuals
    - Helicopsyche 1 individual
  - Coleoptera
    - Optioservus 1 individual
  - Hemiptera
    - Ambrysus 5 individuals
- Site #4
  - Diptera
    - Simuliidae 1 individual
    - Stratiomyidae 2 individuals

Station #2
- Site #1
  - Diptera
    - Chironomidae 61 individuals
    - Ceratopogonidae 4 individuals
  - Trichoptera
    - Sericostoma 15 individuals
    - Helicopsyche 7 individuals
  - Hemiptera
    - Ambrysus 14 individuals
  - Ephemeroptera
    - Choroterpes 2 individuals
- Site #2
  - Diptera
    - Chironomidae 33 individuals
  - Trichoptera
    - Sericostoma 1 individual
    - Helicopsyche 2 individuals
  - Hemiptera
    - Ambrysus 1 individual
    - Abedus 1 individual
  - Ephemeroptera
    - Paracloeodes 3 individuals
    - Tricorythodes 3 individuals

Station #3
- Site #1
  - Trichoptera
    - Helicopsyche 11 individuals
    - Hydropsyche 2 individuals
  - Hemiptera
    - Ambrysus 2 individuals
  - Ephemeroptera
    - Choroterpes 3 individuals
    - Heptagenia 8 individuals
- Site #2
  - Diptera
    - Simuliidae 10 individuals
    - Stratiomyidae 26 individuals
    - Chironomidae 12 individuals
  - Trichoptera
    - Hydropsyche 7 individuals
    - Chimarra 1 individual
  - Hemiptera
    - Ambrysus 33 individuals
  - Ephemeroptera
    - Baetis 21 individuals

TABLE 50 (Continued)

Station #4
- Site #1a
  - Diptera
    - Chironomidae 25 individuals
  - Trichoptera
    - Helicopsyche 2 individuals
  - Hemiptera
    - Ambrysus 4 individuals
    - Abedus 1 individual
  - Ephemeroptera
    - Baetis 2 individuals
- Site #1b
  - Diptera
    - Stratiomyidae 1 individual
    - Chironomidae 12 individuals
  - Trichoptera
    - Sericostoma 9 individuals
    - Helicopsyche 37 individuals
    - Oecetis 6 individuals
    - Phylliocus 1 individual
    - Lepidosoma 1 individual
  - Coleoptera
    - Optioservus 1 individual
  - Hemiptera
    - Ambrysus 1 individual
    - Abedus 1 individual
  - Ephemeroptera
    - Choroterpes 1 individual
    - Tricorythodes 23 individuals
  - Odonata
    - Ophiogomphus 1 individual
- Site #2a
  - Diptera
    - Chironomidae 4 individuals
  - Trichoptera
    - Helicopsyche 22 individuals
    - Oecetis 1 individual
    - Helichus 3 individuals
  - Hemiptera
    - Ambrysus 13 individuals
  - Ephemeroptera
    - Choroterpes 27 individuals
    - Heptagenia 10 individuals
    - Choroterpes 1 individual
    - Paracloeodes 1 individual
- Site #2b
  - Diptera
    - Chironomidae 103 individuals
    - Ceratopogonidae 2 individuals
  - Trichoptera
    - Sericostoma 3 individuals
    - Helicopsyche 23 individuals
    - Oecetis 1 individual
  - Hemiptera
    - Ambrysus 6 individuals
  - Ephemeroptera
    - Choroterpes 19 individuals
    - Heptagenia 2 individuals
- Site #3
  - Diptera
    - Chironomidae 11 individuals
    - Ephydridae 1 individual
  - Trichoptera
    - Phylliocus 6 individuals
    - Sericostoma 3 individuals
    - Helicopsyche 4 individuals
  - Coleoptera
    - Helichus 4 individuals
  - Hemiptera
    - Ambrysus 17 individuals
  - Ephemeroptera
    - Paracloeodes 4 individuals
    - Tricorythodes 1 individual
    - Choroterpes 6 individuals

Station #5
- Site #1
  - Diptera
    - Chironomidae 60 individuals
  - Trichoptera
    - Helicopsyche 1 individual
    - Sericostoma 9 individuals
  - Ephemeroptera
    - Paracloeodes 10 individuals
  - Odonata
    - Archilestes 1 individual

TABLE 50 (Continued)

Site #2
- Diptera
  - Chironomidae 14 individuals
- Trichoptera
  - Sericostoma 10 individuals
  - Helicopsyche 4 individuals
- Hemiptera
  - Ambrysus 2 individuals
- Ephemeroptera
  - Tricorythodes 1 individual

Site #3
- Diptera
  - Chironomidae 11 individuals
- Trichoptera
  - Helicopsyche 10 individuals
  - Sericostoma 4 individuals
  - Lepidostoma 2 individuals
- Ephemeropteraa
  - Paracloeodes 4 individuals
  - Tricorythodes 5 individuals

Site #4
- Diptera
  - Chironomidae 34 individuals
- Trichoptera
  - Sericostoma 30 individuals
  - Helicopsyche 5 individuals
- Hemiptera
  - Ambrysus 2 individuals
- Ephemeroptera
  - Callibaetis 18 individuals
  - Tricorythodes 8 individuals
  - Choroterpes 2 individuals
  - Paracloeodes 6 individuals
- Odonata
  - Archilestes 1 individual
  - Hyponeura 1 individual
  - Ophiogomphus 1 individual

Station #6

Site #1
- Diptera
  - Chironomidae 1 individual
  - Stratiomyidae 1 individual
- Trichoptera
  - Sericostoma 1 individual
  - Hydropsyche 2 individuals
  - Helicopsyche 3 individuals
- Coleoptera
  - Helichus 7 individuals
- Hemiptera
  - Ambrysus 5 individuals
- Ephemeroptera
  - Choroterpes 1 individual
  - Heptagenia 1 individual
  - Baetis 2 individuals

Site #2
- Diptera
  - Simuliidae 2 individuals
- Tirchoptera
  - Helicopsyche 32 individuals
  - Hydropsyche 2 individuals
- Hemiptera
  - Abedus 1 individual
  - Ambrysus 12 individuals
- Ephemeroptera
  - Tricorythodes 1 individual
  - Choroterpes 1 individual
  - Heptagenia 3 individuals
  - Paracloeodes 4 individuals

Station #7

Site #1
- Diptera
  - Chironomidae 41 individuals
  - Tabanidae 1 individual
  - Rhagionidae 1 individual
- Trichoptera
  - Helicopsyche 26 individuals
  - Phylliocus 2 individuals
  - Sericostoma 7 individuals
- Coleoptera
  - Helichus 7 individuals
  - Elsianus 1 individual
- Hemiptera
  - Ambrysus 9 individuals
- Ephemeroptera
  - Heptagenia 5 individuals
  - Choroterpes 10 individuals
  - Baetis 1 individual

Site #2
- Diptera
  - Chironomidae 16 individuals
  - Stratiomyidae 4 individuals
  - Simuliidae 4 individuals

TABLE 50 (Continued)

- Rhagionidae 2 individuals
- Ceratopogonidae 2 individuals

Trichoptera
- Hydropsyche 6 individuals

Coleoptera
- Helichus 2 individuals

Hemiptera
- Ambrysus 54 individuals

Ephemeroptera
- Baetis 12 individuals
- Tricorythodes 1 individual
- Choroterpes 2 individuals

Station #8
- Site #1
  - Diptera
    - Chironomidae 35 individuals
    - Muscidae 1 individual
  - Trichoptera
    - Sericostoma 5 individuals
    - Helicopsyche 2 individuals
    - Hesperophylax 1 individual
  - Hemiptera
    - Ambrysus 1 individual
  - Ephemeroptera
    - Tricorythodes 2 individuals
    - Paracloeodes 1 individual

Station #9
- Site #1
  - Diptera
    - Chironomidae 4 individuals
    - Tabanidae 1 individual
  - Trichoptera
    - Sericostoma 13 individuals
    - Helicopsyche 13 individuals
    - Phylliocus 1 individual
    - Atopsyche 1 individual
  - Coleoptera
    - Optioservus 2 individuals
  - Hemiptera
    - Ambrysus 7 individuals
  - Ephemeroptera
    - Paracloeodes 4 individuals
    - Heptagenia 2 individuals
    - Choroterpes 4 individuals

Station #10
- Site #1
  - Diptera
    - Tabanidae 4 individuals
    - Chironomidae 2 individuals
    - Simulidae 6 individuals
    - Rhagionidae 3 individuals
  - Trichoptera
    - Sericostoma 5 individuals
    - Chimarra 18 individuals
    - Hydropsyche 4 individuals
    - Helicopsyche 2 individuals
  - Coleoptera
    - Elsianus 5 individuals
    - Helichus 1 individual
  - Hemiptera
    - Ambrysus 6 individuals
  - Ephemeroptera
    - Choroterpes 2 individual
    - Heptagenia 10 individuals
  - Neuroptera
    - Corydalis 3 individuals
- Site #2
  - Diptera
    - Simuliidae 15 individuals
    - Chironomidae 14 individuals
    - Rhagionidae 9 individuals
    - Tabanidae 4 individuals
    - Stratiomyidae 1 individual
  - Trichoptera
    - Chimarra 149 individuals
    - Helicopsyche 4 individuals
    - Hydropsyche 24 individuals
    - Atopsyche 6 individuals
  - Coleoptera
    - Elsianus 25 individuals
    - Helichus 7 individuals
  - Hemiptera
    - Ambrysus 35 individuals
  - Ephemeroptera
    - Heptagenia 19 individuals
    - Choroterpes 6 individuals
    - Tricorythodes 1 individual
    - Epeorus 1 individual
    - Choroterpes 2 individuals

TABLE 50 (Continued)

Odonata
Ophiogomphus 1 individual
Neuroptera
Corydalis 2 individuals
Site #3
Diptera
Chironomidae 7 individuals
Tabanidae 1 individual
Trichoptera
Helicopsyche 12 individuals
Atopsyche 1 individual
Hydropsyche 1 individual
Sericostoma 1 individual
Cheumatostoma 1 individual
Coleoptera
Elsianus 4 individuals
Hemiptera
Ambrysus 3 individuals
Ephemeroptera
Choroterpes 12 individuals
Heptagenia 15 individuals
Odonata
Hyponeura 1 individual

Station #11
Site #1
Diptera
Chironomidae 42 individuals
Trichoptera
Helicopsyche 14 individuals
Sericostoma 4 individuals
Polycentropus 3 individuals
Coleoptera
Elsianus 2 individuals
Hemiptera
Ambrysus 3 individuals
Ephemeroptera
Choroterpes 17 individuals
Heptagenia 2 individuals
Tricorythodes 2 individuals
Odonata
Hyponeura 1 individual

Station #12
Site #1
Diptera
Chironomidae 9 individuals
Trichoptera
Sericostoma 39 individuals
Hesperophylax 1 individual
Phylliocus 1 individual
Helicopsyche 2 individuals
Hemiptera
Ambrysus 5 individuals
Ephemeroptera
Tricorythodes 8 individuals
Odonata
Ophiogomphus 5 individuals

Station #13
Site #1
Diptera
Chironomidae 17 individuals
Trichoptera
Sericostoma 2 individuals
Ephemeroptera
Paracloeodes 5 individuals

Station #14
Site #1
Diptera
Chironomidae 60 individuals
Tabanidae 4 individuals
Trichoptera
Helicopsyche 42 individuals
Sericostoma 3 individuals
Polycentropus 1 individual
Oecetis 1 individual
Hemiptera
Ambrysus 3 individuals
Ephemeroptera
Choroterpes 21 individuals
Tricorythodes 1 individual
Heptagenia 2 individuals

Station #15
Site #1
Diptera
Simuliidae 4 individuals
Stratiomyidae 1 individual
Rhagionidae 2 individuals
Trichoptera
Chimarra 18 individuals
Hydropsyche 1 individual
Helicopsyche 1 individual

TABLE 50 (Continued)

Coleoptera
- Belichus 3 individuals
- Agabus 2 individuals

Hemiptera
- Ambrysus 8 individuals
- Abedus 1 individual

Ephemeroptera
- Baetis 2 individuals
- Tricorythodes 2 individuals
- Paracloeodes 1 individual

Station #16

Site #1

Diptera
- Chironomidae 5 individuals
- Simuliidae 1 individual
- Ephydridae 1 individual

Trichoptera
- Phylliocus 2 individuals
- Helicopsyche 5 individuals
- Hydropsyche 3 individuals
- Polycentropus 3 individuals
- Chimarra 1 individual

Coleoptera
- Optioservus 1 individual

Hemiptera
- Ambrysus 18 individuals

Ephemeroptera
- Choroterpes 65 individuals
- Tricorythodes 21 individuals
- Baetis 1 individual

Station #17

Site #1

Diptera
- Chironomidae 87 individuals

Trichoptera
- Lepidostoma 2 individuals
- Hesperophylax 2 individuals
- Phylliocus 4 individuals
- Sericostoma 6 individuals
- Helicopsyche 51 individuals
- Oecetis 3 individuals

Coleoptera
- Helichus 1 individual

Hemiptera
- Ambrysus 9 individuals

Ephemeroptera
- Heptagenia 4 individuals
- Choroterpes 16 individuals
- Tricorythodes 1 individual

Site #2

Diptera
- Chironomidae 6 individuals
- Simuliidae 9 individuals

Trichoptera
- Chimarra 19 individuals
- Helicopsyche 5 individuals
- Hydropsyche 8 individuals
- Phylliocus 2 individuals
- Sericostoma 1 individual
- Polycentropus 2 individuals

Coleoptera
- Helichus 3 individuals
- Narpus 1 individual

Hemiptera
- Ambrysus 12 individuals

Ephemeroptera
- Choroterpes 20 individuals
- Paracloeodes 4 individuals
- Heptagenia 10 individuals

Neuroptera
- Corydalis 2 individuals

Station #18

Site #1

Diptera
- Tabanidae 1 individual
- Chironomidae 3 individuals

Trichoptera
- Helicopsyche 8 individuals
- Phylliocus 1 individual
- Sericostoma 3 individuals
- Oecetis 1 individual
- Polycentropus 1 individual

Hemiptera
- Ambrysus 3 individuals

Ephemeroptera
- Choroterpes 3 individuals

Odonata
- Hyponeura 2 individuals

Site #2

Diptera
- Tabanidae 1 individual

TABLE 50 (Continued)

Trichoptera
- Helicopsyche 2 individuals
- Phylliocus 2 individuals
- Sericostoma 16 individuals

Hemiptera
- Ambrysus 4 individuals

Ephemeroptera
- Choroterpes 2 individuals

Odonata
- Hyponeura 1 individual
- Paltothemis 1 individual

Site #3

Diptera
- Tabanidae 5 individuals
- Chironomidae 4 individuals
- Rhagionidae 1 individual

Trichoptera
- Helicopsyche 46 individuals
- Phylliocus 1 individual
- Sericostoma 7 individuals
- Chimarra 1 individual
- Cheumatopsyche 1 individual

Hemiptera
- Ambrysus 10 individuals

Ephemeroptera
- Choroterpes 24 individuals
- Heptagenia 10 individuals

Station #19

Site #1

Diptera
- Tabanidae 2 individuals

Trichoptera
- Helicopsyche 4 individuals
- Phylliocus 2 individuals
- Chimarra 5 individuals

Hemiptera
- Ambrysus 15 individuals

Ephemeroptera
- Choroterpes 1 individual
- Heptagenia 7 individuals
- Paracloeodes 4 individuals

Station #20

Site #1

Diptera
- Tabanidae 4 individuals
- Chironomidae 3 individuals
- Simuliidae 1 individual

Trichoptera
- Helicopsyche 46 individuals
- Sericostoma 5 individuals
- Polycentropus 3 individuals
- Chamarra 2 individuals

Coleoptera
- Helichus 3 individuals

Hemiptera
- Ambrysus 11 individuals

Ephemeroptera
- Heptagenia 25 individuals
- Choroterpes 23 individuals
- Tricorythodes 1 individual
- Baetis 1 individual

Station #21

Site #1

Diptera
- Chironomidae 9 individuals
- Tabanidae 5 individuals

Trichoptera
- Helicopsyche 8 individuals
- Sericostoma 10 individuals

Hemiptera
- Ambrysus 3 individuals

Ephemeroptera
- Choroterpes 56 individuals

Site #2

Diptera
- Chironomidae 1 individual

Trichoptera
- Sericostoma 10 individuals
- Phylliocus 8 individuals
- Helicopsyche 8 individuals

Ephemeroptera
- Choroterpes 2 individuals

Odonata
- Aeshna 1 individual

TABLE 50 (Continued)

Station #22
  Site #1
    Diptera
      Chironomidae 48 individuals
    Trichoptera
      Sericostoma 19 individuals
      Helicopsyche 15 individuals
      Polycentropus 1 individual
      Lepidostoma 1 individual
      Oecetis 1 individual
      Phylliocus 1 individual
    Hemiptera
      Ambrysus 7 individuals
    Ephemeroptera
      Choroterpes 10 individuals
      Tricorythodes 8 individuals
      Paracloeodes 3 individuals
    Odonata
      Hyponeura 2 individuals
  Site #2
    Diptera
      Chironomidae 26 individuals
    Trichoptera
      Sericostoma 1 individual
    Ephemeroptera
      Tricorythodes 7 individuals
      Choroterpes 1 individual
    Odonata
      Ophiogomphus 3 individuals
      Archelesties 1 individual

Station #23
  Site #1
    Diptera
      Tabanidae 2 individuals
    Trichoptera
      Helicopsyche 4 individuals

Station #24
  Site #1
    Diptera
      Chironomidae 46 individuals
      Tabanidae 15 individuals
    Trichoptera
      Helicopsyche 82 individuals
      Phylliocus 1 individual
      Hydropsyche 15 individuals
      Sericostoma 4 individuals
      Polycentropus 1 individual
      Chimarra 1 individual
    Coleoptera
      Narpus 1 individual
    Hemiptera
      Ambrysus 11 individuals
    Ephemeroptera
      Heptagenia 3 individuals
      Tricorythodes 1 individual
      Choroterpes 10 individuals
      Paracloeodes 5 individuals

Station #25
  Site #1
    Diptera
      Chironomidae 30 individuals
      Simuliidae 2 individuals
      Tabanidae 1 individual
      Rhagionidae 1 individual
    Trichoptera
      Helicopsyche 38 individuals
      Hydropsyche 22 individuals
      Phylliocus 3 individuals
      Chimarra 4 individuals
    Coleoptera
      Helichus 5 individuals
      Elsianus 2 individuals
    Hemiptera
      Ambrysus 22 individuals
    Ephemeroptera
      Choroterpes 11 individuals
      Heptagenia 6 individuals
      Paracloeodes 6 individuals
  Site #2
    Diptera
      Chironomidae 53 individuals
      Ceratopogonidae 2 individuals
    Trichoptera
      Helicopsyche 22 individuals
      Phylliocus 2 individuals
      Chimarra 1 individual
      Sericostoma 14 individuals
    Hemiptera
      Ambrysus 6 individuals
      Abedus 1 individual

TABLE 50 (Continued)

Ephemeroptera
- Choroterpes 1 individual
- Heptagenia 1 individual
- Tricorythodes 1 individual

Odonata
- Ophiogomphus 2 individuals

Station #26
Site #1
Diptera
- Chironomidae 42 individuals
- Simuliidae 2 individuals
- Tabanidae 2 individuals

Trichoptera
- Helicopsyche 15 individuals
- Hydropsyche 5 individuals
- Polycentropus 3 individuals
- Chimarra 2 individuals

Coleoptera
- Helichus 6 individuals

Hemiptera
- Ambrysus 45 individuals
- Abedus 3 individuals

Ephemeroptera
- Heptagenia 3 individuals
- Baetis 2 individuals
- Choroterpes 8 individuals
- Tricorythodes 3 individuals

Station #27
Site #1
Diptera
- Chironomidae 3 individuals

Hemiptera
- Ambrysus 1 individual
- Abedus 3 individuals

Ephemeroptera
- Tricorythodes 1 individual
- Choroterpes 1 individual

Odonata
- Cordulegaster 1 individual

Station #28
Site #1
Diptera
- Tabanidae 6 individuals
- Chironomidae 50 individuals

Trichoptera
- Phylliocus 9 individuals
- Sericostomas 19 individuals
- Helicopsyche 43 individuals
- Hydropsyche 1 individual
- Oecetis 3 individuals
- Glossosoma 1 individual

Coleoptera
- Helichus 1 individual

Hemiptera
- Ambrysus 23 individuals

Ephemeroptera
- Tricorythodes 2 individuals
- Heptagenia 9 individuals
- Choroterpes 2 individuals

Station #29
Site #1
Diptera
- Chironomidae 20 individuals
- Tabanidae 1 individual

Trichoptera
- Phylliocus 35 individuals
- Sericostoma 77 individuals
- Helicopsyche 43 individuals
- Lepidostoma 2 individuals

Hemiptera
- Ambrysus 3 individuals

Ephemeroptera
- Choroterpes 1 individual
- Baetis 1 individual

Odonata
- Ophiogomphus 3 individuals

Station #30
Site #1
Diptera
- Tabanidae 6 individuals

Trichoptera
- Sericostoma 5 individuals
- Helicopsyche 12 individuals
- Hydropsyche 1 individual

Hemiptera
- Ambrysus 4 individuals

Ephemeroptera
- Choroterpes 20 individuals
- Heptagenia 12 individuals

TABLE 50 (Continued)

Parecloeodes 2 individuals
Epeorus 2 individuals
Site #2
Diptera
Tabanidae 2 individuals
Simuliidae 6 individuals
Chironomidae 5 individuals
Trichoptera
Phylliocus 11 individuals
Sericostoma 1 individual
Helicopsyche 21 individuals
Hydropsyche 15 individuals
Chimarra 13 individuals
Coleoptera
Elsianus 27 individuals
Helichus 2 individuals
Heterelmis 1 individual
Hemiptera
Ambrysus 14 individuals
Ephemeroptera
Choroterpes 17 individuals
Heptagenia 6 individuals
Paracloeodes 1 individual
Epeorus 1 individual
Site #3
Diptera
Chironomidae 3 individuals
Rhagionidae 3 individuals
Ephydridae 4 individuals
Trichoptera
Sericostoma 3 individuals
Helicopsyche 34 individuals
Hydropsyche 1 individual
Phylliocus 1 individual
Hemiptera
Ambrysus 34 individuals
Ephemeroptera
Choroterpes 124 individuals
Heptagenia 4 individuals
Tricorythodes 3 individuals
Paracloeodes 1 individual
Coleoptera
Elsianus 1 individual
Helichus 1 individual
Heterelmis 1 individual
Odonata
Hyponeura 2 individuals

Station #31
Site #1
Diptera
Chironomidae 4 individuals
Rhagionidae 2 individuals
Tabanidae 3 individuals
Ephydridae 2 individuals
Trichoptera
Phylliocus 4 individuals
Helicopsyche 19 individuals
Sericostoma 3 individuals
Coleoptera
Helichus 10 individuals
Hemiptera
Ambrysus 6 individuals
Ephemeroptera
Choroterpes 18 individuals
Heptagenia 1 individual
Odonata
Hyponeura 1 individual
Site #2
Diptera
Chironomidae 1 individual
Trichoptera
Phylliocus 9 individuals
Helicopsyche 13 individuals
Sericostoma 20 individuals
Hemiptera
Ambrysus 1 individual
Odonata
Hyponeura 4 individuals
Site #3
Diptera
Chironomidae 6 individuals
Trichoptera
Sericostoma 4 individuals
Hemiptera
Ambrysus 4 individuals
Ephemeroptera
Choroterpes 1 individual
Tricorythodes 2 individuals

Station #32
Site #1
Diptera
Chironimidae 5 individuals

TABLE 50 (Continued)

- Trichoptera
  - Phylliocus 2 individuals
  - Sericostoma 2 individuals
  - Helicopsyche 2 individuals
- Hemiptera
  - Ambrysus 2 individuals
- Ephemeroptera
  - Tricorythodes 2 individuals

Site #2

- Diptera
  - Chironomidae 15 indiviausls
- Trichoptera
  - Helicopsyche 5 individuals
- Ephemeroptera
  - Tricorythodes 3 individuals
  - Choroterpes 1 individual
  - Paracloeodes 1 individual

Site #3

- Diptera
  - Chironomidae 6 individuals
- Trichoptera
  - Phylliocus 2 individuals
  - Sericostoma 5 individuals
  - Helicopsyche 11 individuals
  - Lepidostoma 1 individual
- Coleoptera
  - Helichus 1 individual
- Hemiptera
  - Ambrysus 2 individuals
- Ephemeroptera
  - Tricorythodes 13 individuals
  - Choroterpes 3 individuals
  - Paracloeodes 3 individuals
- Odonata
  - Hyponeura 7 individuals

Station #33

Site #1

- Diptera
  - Chironomidae 60 individuals
- Trichoptera
  - Phylliocus 12 individuals
  - Sericostoma 45 individuals
  - Helicopsyche 90 individuals
- Hemiptera
  - Ambrysus 3 individuals
- Ephemeroptera
  - Tricorythodes 1 individual

Station #34

Site #1

- Diptera
  - Chironomidae 14 individuals
  - Ceratopogonidae 3 individuals
- Trichoptera
  - Phylliocus 22 individuals
  - Sericostoma 65 individuals
  - Helicopsyche 12 individuals
- Ephemeroptera
  - Choroterpes 1 individual
  - Tricorythodes 14 individuals
- Odonata
  - Ophiogomphus 1 individual
  - Paltothemis 4 individuals
- Coleoptera
  - (1 unidentifiable individual due to crushing)

Site #2

- Diptera
  - Chironomidae 27 individuals
- Trichoptera
  - Phylliocus 3 individuals
  - Sericostoma 36 individuals
  - Helicopsyche 28 individuals
  - Oecetis 2 individuals
- Coleoptera
  - Narpus 1 individual
- Hemiptera
  - Ambrysus 11 individuals
- Ephemeroptera
  - Choroterpes 3 individuals
- Odonata
  - Paltothemis 3 individuals

Station #35

Site # 1

- Diptera
  - Chironomidae 13 individuals
  - Ceratopogonidae 1 individual
- Trichoptera
  - Phylliocus 9 individuals
  - Helicopsyche 76 individuals
  - Sericostoma 8 individuals
- Coleoptera
  - Helichus 1 individual

TABLE 50 (Continued)

Hemiptera
- Ambrysus 4 individuals
- Abedus 1 individual

Ephemeroptera
- Choroterpes 3 individuals
- Heptagenia 2 individuals
- Baetis 2 individuals
- Tricorythodes 1 individual
- Paracloeodes 2 individuals

Odonata
- Hyponeura 1 individual
- Paltothemis 1 individual

Site #2
- Diptera
  - Chironomidae 3 individuals
  - Tabanidae 2 individuals
  - Rhagionidae 3 individuals
- Trichoptera
  - Phylliocus 4 individuals
  - Helicopsyche 182 individuals
  - Sericostoma 8 individuals
  - Hydropsyche 4 individuals
  - Oecetis 1 individual
- Coleoptera
  - Helichus 6 individuals
- Hemiptera
  - Ambrysus 9 individuals
- Ephemeroptera
  - Choroterpes 18 individuals
  - Heptagenea 13 individuals
  - Paracloeodes 3 individuals
  - Epeorus 6 individuals
- Odonata
  - Hyponeura 3 individuals

Site #3
- Trichoptera
  - Helicopsyche 112 individuals

Site #4
- Diptera
  - Chironomidae 12 individuals
- Trichoptera
  - Helicopsyche 67 individuals
  - Sericostoma 2 individuals
- Ephemeroptera
  - Choroterpes 4 individuals
- Odonata
  - Paltothemis 2 individuals

Station #36

Site #1
- Diptera
  - Chironomidae 12 individuals
  - Ceratopogonidae 2 individuals
- Trichoptera
  - Sericostoma 2 individuals
  - Helicopsyche 5 individuals
- Hemiptera
  - Ambrysus 12 individuals
- Ephemeroptera
  - Choroterpes 80 individuals
  - Tricorythodes 6 individuals

Site #2
- Diptera
  - Chironomidae 6 individuals
- Trichoptera
  - Sericostoma 2 individuals
  - Helicopsyche 121 individuals
- Hemiptera
  - Ambrysus 7 individuals
- Ephemeroptera
  - Paracloeodes 12 individuals
  - Choroterpes 15 individuals
  - Tricorythodes 2 individuals

Site #3
- Diptera
  - Chironomidae 5 individuals
- Trichoptera
  - Sericostoma 73 individuals
  - Helicopsyche 45 individuals
  - Phylliocus 9 individuals
- Hemiptera
  - Ambrysus 8 individuals
- Ephemeroptera
  - Paracloeodes 1 individual
- Odonata
  - Ophiogomphus 3 individuals

TABLE 51

SPECIES ABUNDANCE AT EACH SITE DURING THE WINTER SAMPLING

Station #1
- Site #2
  - Diptera
    - Chironomidae 4 individuals
    - Simuliidae 1 individual
    - Stratiomyidae 1 individual
  - Trichoptera
    - Polycentropus 2 individuals
  - Ephemeroptera
    - Baetis 1 individual
- Site #3
  - Diptera
    - Chironomidae 22 individuals
    - Simuliidae 54 individuals
    - Muscidae 4 individuals
  - Trichoptera
    - Hydropsyche 1 individual
    - Ochotricha 15 individuals
    - Chimarra 1 individual
    - Sericostoma 1 individual
  - Ephemeroptera
    - Choroterpes 2 individuals
    - Baetis 171 individuals
    - Tricorythodes 1 individual
  - Plecoptera
    - Capnia 1 individual
- Site #4
  - Diptera
    - Simuliidae 17 individuals
    - Chironomidae 17 individuals
  - Trichoptera
    - Chimarra 2 individuals
    - Atopsyche 1 individual

Station #2
- Site #1
  - Diptera
    - Chironomidae 2 individuals
  - Trichoptera
    - Helicopsyche 1 individual
  - Hemiptera
    - Ambrysus 2 individuals
  - Ephemeroptera
    - Choroterpes 36 individuals
    - Heptagenia 9 individuals

Station #3
- Site #1
  - Trichoptera
    - Helicopsyche 46 individuals
    - Hydropsyche 2 individuals
  - Hemiptera
    - Ambrysus 1 individual
  - Ephemeroptera
    - Choroterpes 11 individuals
    - Heptagenia 7 individuals
- Site #2
  - Diptera
    - Chironomidae 3 individuals
  - Trichoptera
    - Hydropsyche 2 individuals
    - Sericostoma 2 individuals
    - Helicopsyche 2 individuals
  - Ephemeroptera
    - Choroterpes 15 individuals
    - Heptagenia 4 individuals
    - Tricorythodes 1 individual

Station #4
- Site #1a
  - Diptera
    - Chironomidae 6 individuals
  - Trichoptera
    - Helicopsyche 7 individuals
    - Oecetis 1 individual
  - Ephemeroptera
    - Choroterpes 2 individuals
    - Heptagenia 1 individual
- Site #1b
  - Diptera
    - Rhagionidae 1 individual
    - Chironomidae 5 individuals
  - Trichoptera
    - Helicopsyche 11 individuals
    - Sericostoma 8 individuals
    - Oecetis 1 individual
    - Phylliocus 2 individuals
    - Ochotrichia 1 individual
  - Hemiptera
    - Ambrysus 1 individual

TABLE 51 (Continued)

- Ephemeroptera
  - Tricorythodes 4 individuals
  - Choroterpes 21 individuals
  - Heptagenia 1 individual
- Plecoptera
  - Capnia 1 individual

Site #2a
- Diptera
  - Chironomidae 1 individual
  - Tabanidae 2 individuals
- Trichoptera
  - Helicopsyche 6 individuals
- Hemiptera
  - Ambrysus 1 individual
- Ephemeroptera
  - Choroterpes 2 individuals

Site #2b
- Diptera
  - Ephydridae 2 individuals
  - Chironomidae 3 individuals
  - Ceratopogonidae 1 individual
- Trichoptera
  - Hydropsyche 4 individuals
  - Helicopsyche 19 individuals
- Ephemeroptera
  - Choroterpes 8 individuals
  - Baetis 1 individual
  - Heptagenia 2 individuals

Site #3
- Trichoptera
  - Hydropsyche 2 individuals
- Hemiptera
  - Ambrysus 1 individual
- Ephemeroptera
  - Choroterpes 11 individuals
  - Heptagenia 1 individual

Station #5

Site #1
- Diptera
  - Chironomidae 22 individuals
- Ephemeroptera
  - Choroterpes 2 individuals

Site #2
- Diptera
  - Chironomidae 10 individuals
- Trichoptera
  - Sericostoma 7 individuals
  - Oecetis 1 individual
  - Helicopsyche 8 individuals
  - Hydropsyche 1 individual
- Ephemeroptera
  - Heptagenia 7 individuals

Station #6

Site #1
- Trichoptera
  - Atopsyche 1 individual
- Ephemeroptera
  - Heptagenia 2 individuals
  - Choroterpes 1 individual
- Plecoptera
  - Capnia 3 individuals

Site #2
- Diptera
  - Chironomidae 1 individual
- Plecoptera
  - Capnia 1 individual

Station #7

Site #1
- Diptera
  - Chironomidae 7 individuals
- Trichoptera
  - Oecetis 1 individual
  - Hydropsyche 2 individuals
- Ephemeroptera
  - Choroterpes 13 individuals
  - Tricorythodes 3 individuals
  - Heptagenia 2 individuals
- Plecoptera
  - Capnia 8 individuals

Site #2
- Diptera
  - Chironomidae 1 individual
- Trichoptera
  - Hydropsyche 1 individual
  - Helicopsyche 1 individual
- Ephemeroptera
  - Tricorythodes 1 individual
- Plecoptera
  - Capnia 89 individuals

TABLE 51 (Continued)

Station #8
Site #1
Trichoptera
Chimarra 2 individuals
Oecetis 1 individual
Hydropsyche 1 individual
Atopsyche 1 individual
Ephemeroptera
Tricorythodes 15 individuals
Choroterpes 21 individuals
Heptagenia 5 individuals
Plecoptera
Capnia 14 individuals

Station #9
Site #1
Trichoptera
Hydropsyche 2 individuals
Oecetis 1 individual
Sericostoma 1 individual
Ephemeroptera
Choroterpes 1 individual
Heptagenia 1 individual
Plecoptera
Capnia 24 individuals

Station #10
Site #1
Diptera
Chironomidae 2 individuals
Trichoptera
Oecetis 1 individual
Helicopsyche 7 individuals
Hydropsyche 1 individual
Ephemeroptera
Choroterpes 12 individuals
Heptagenia 2 individuals
Tricorythodes 2 individuals
Plecoptera
Capnia 8 individuals
Site #2
Trichoptera
Hydropsyche 4 individuals
Chimarra 2 individuals
Ephemeroptera
Choroterpes 9 individuals
Heptagenia 1 individual
Tricorythodes 4 individuals
Plecoptera
Capnia 15 individuals

Station #11
Site #1
Trichoptera
Chimarra 1 individual
Ephemeroptera
Tricorythodes 1 individual
Plecoptera
Capnia 3 individuals

Station #12 No collection

Station #13
Site #1
Diptera
Chironomidae 15 individuals
Ceratopogonidae 1 individual
Trichoptera
Sericostoma 1 individual
Chimarra 1 individual
Hemiptera
Ambrysus 1 individual
Ephemeroptera
Choroterpes 6 individuals
Tricorythodes 8 individuals
Plecoptera
Capnia 3 individuals

Station #14
Site #1
Diptera
Chironomidae 3 individuals
Trichoptera
Sericostoma 8 individuals
Phylliocus 2 individuals
Oecetis 1 individual
Helicopsyche 3 individuals
Chimarra 1 individual
Ephemeroptera
Choroterpes 11 individuals
Tricorythodes 9 individuals
Plecoptera
Capnia 4 individuals

TABLE 51 (Continued)

Station #15
- Site #1
  - Trichoptera
    - *Hydropsyche* 1 individual
  - Ephemeroptera
    - *Tricorythodes* 5 individuals
    - *Heptagenia* 1 individual
  - Plecoptera
    - *Capnia* 3 individuals

Station #16
- Site #1
  - Trichoptera
    - *Helicopsyche* 5 individuals
    - *Sericostoma* 1 individual
    - *Hydropsyche* 4 individuals
    - *Oecetis* 3 individuals
  - Ephemeroptera
    - *Choroterpes* 10 individuals
    - *Tricorythodes* 8 individuals
  - Plecoptera
    - *Capnia* 11 individuals

Station #17
- Site #1
  - Trichoptera
    - *Helicopsyche* 3 individuals
  - Ephemeroptera
    - *Choroterpes* 2 individuals
    - *Heptagenia* 3 individuals
  - Plecoptera
    - *Capnia* 20 individuals

MAPS OF SUMMER SAMPLING STATIONS, SHOWING POSITION OF SITES IN EACH STATION. GRAPHS SHOW POPULATION NUMBERS PER SQUARE METER AT EACH SITE SAMPLED.

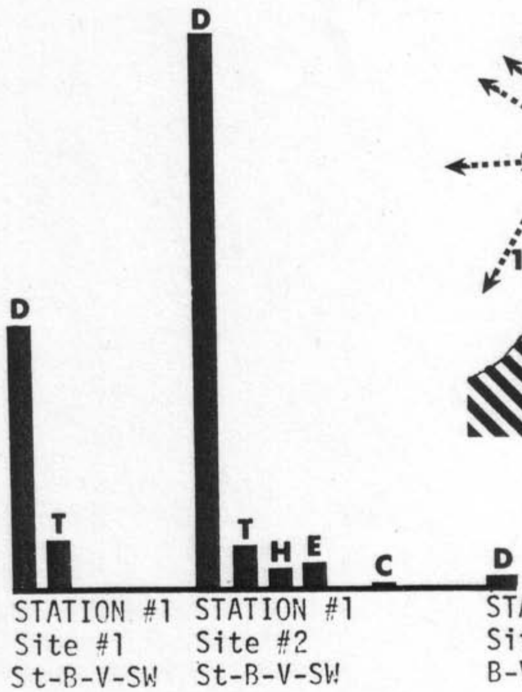
Explanation of Plates

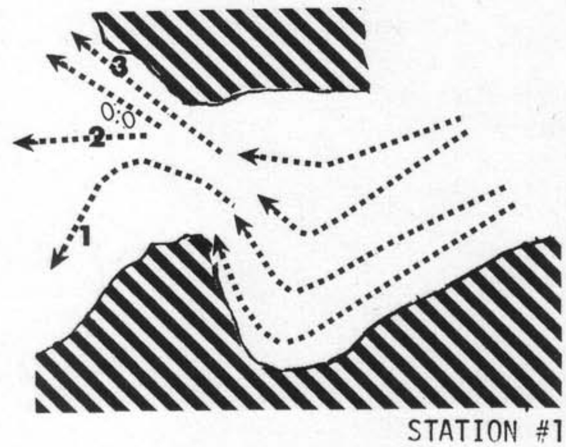
Abbreviations

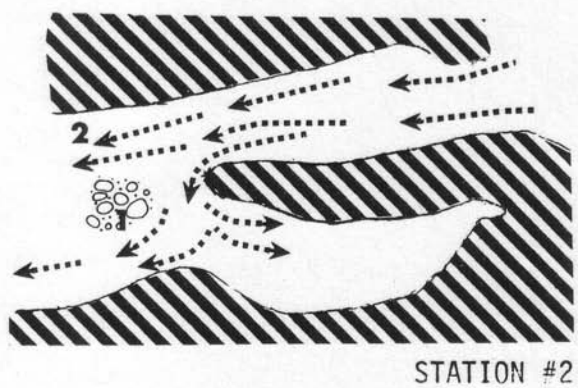
R	= Rock-gravel	D	= Diptera
S	= Sand	T	= Trichoptera
St	= Silt	H	= Hemiptera
B	= Bedrock	E	= Ephemeroptera
V	= Vegetation	O	= Odonata
D	= Detritus	C	= Coleoptera
FW	= Fast Water	P	= Plecoptera
SW	= Slow Water		

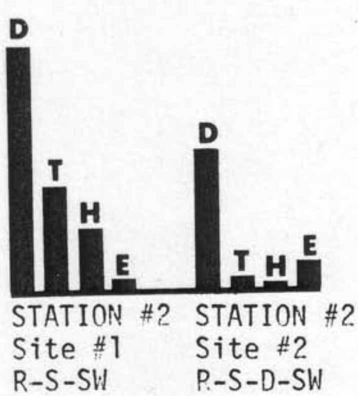
The bar graphs are constructed so that each millimeter equals 20 individuals.

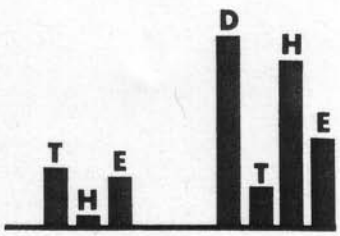
Adjacent to each station map on pages 159 through 176 are bar graphs indicating the population density of orders collected at each site. The graphs, though not discussed in the body of this thesis, are provided to indicate the variations in population densities between sites, to show the community structure, and to demonstrate the quantitative effect each order has on the overall population density of each community. To explain these graphs fully would require an entire paper separate from this thesis, however, it is important to supply this information.


D
T
D
T
H
E
C
D
STATION #1
Site #1
St-B-V-SW
STATION #1
Site #2
St-B-V-SW
STATION #1
Site #3
B-V-FW


3
2
1
STATION #1

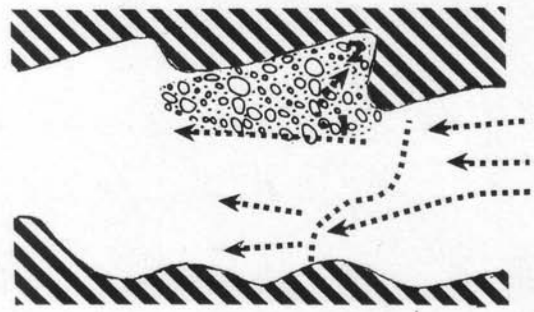

2
1
STATION #2


D
T
H
E
D
T
H
E
STATION #2
Site #1
R-S-SW
STATION #2
Site #2
R-S-D-SW

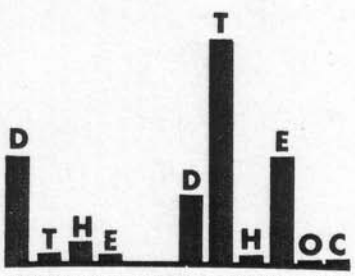


STATION #3 Site #1 S-R-FW

STATION #3 Site #2 S-R-FW

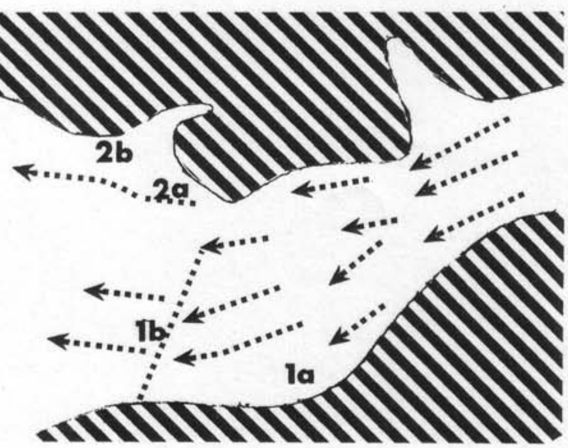


STATION #3



STATION #4 Site #1a St-B-D-SW

STATION #4 Site #1b S-St-D-SW



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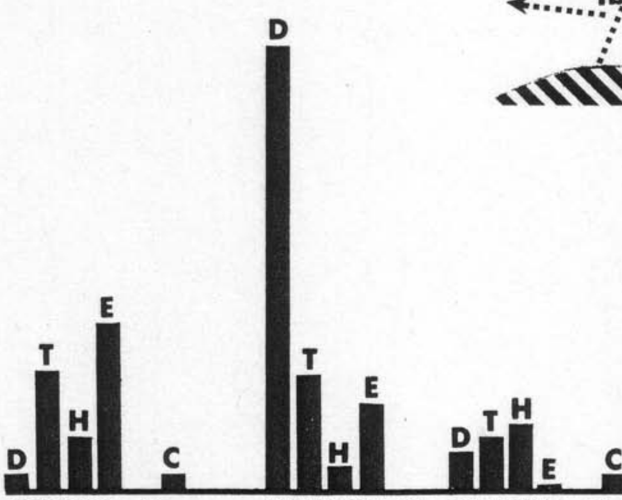
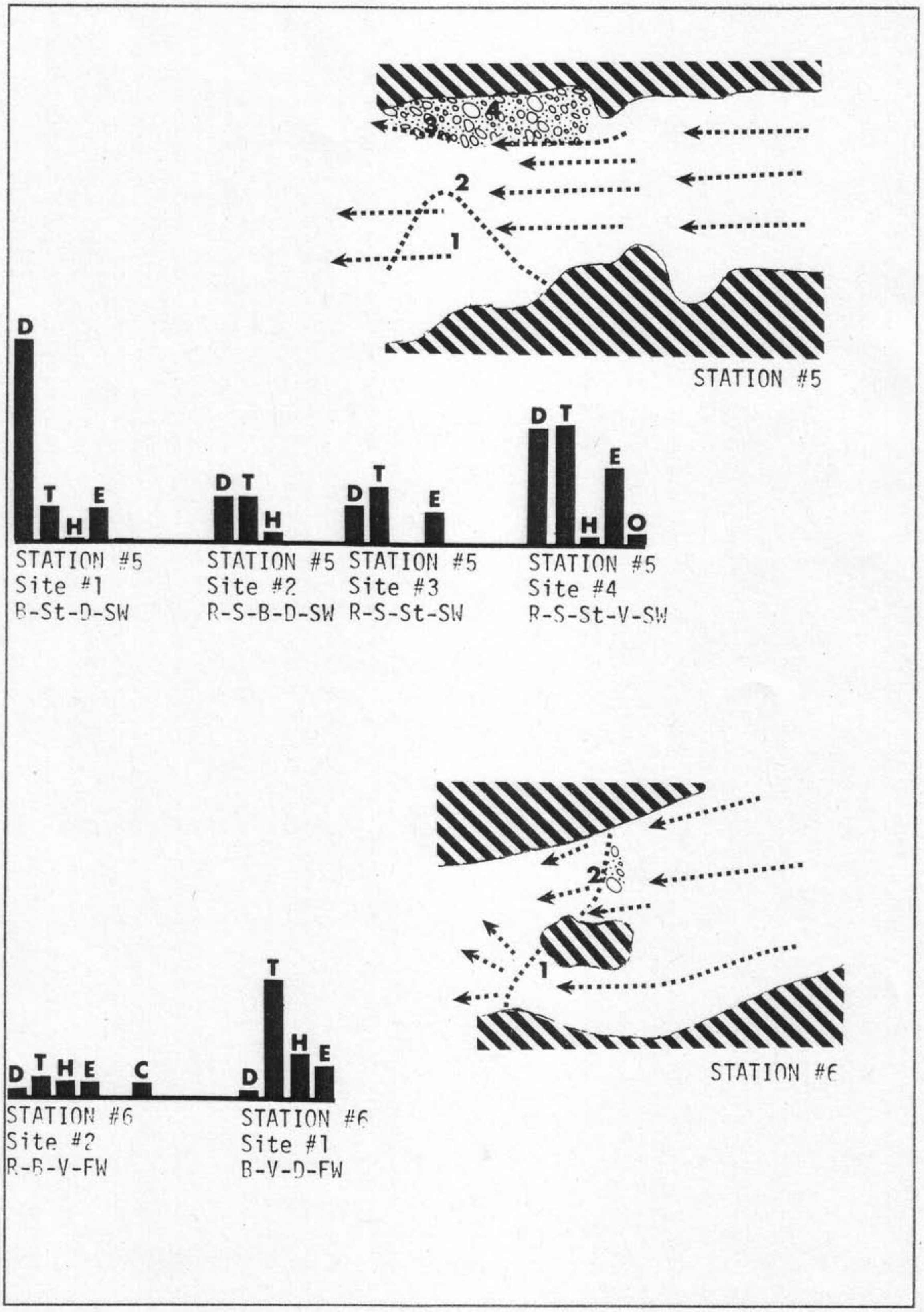


STATION #4 Site #2a R-S-FW

STATION #4 Site #2b R-S-SW

STATION #4 Site #3 R-S-St-SW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STATION #5
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Site #1
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Site #2
R-S-B-D-SW
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STATION #5
Site #3
R-S-St-SW
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STATION #5
Site #4
R-S-St-V-SW
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Site #2
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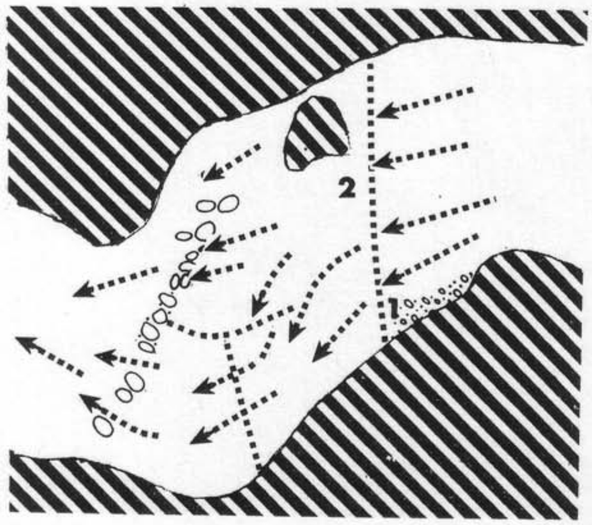
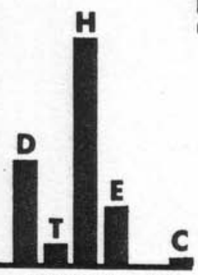
STATION #6
Site #1
B-V-D-FW

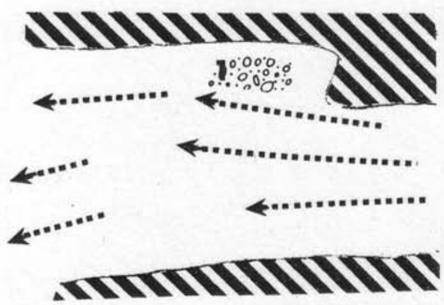


STATION #7

STATION #7
Site #1
R-S-St-D-SW

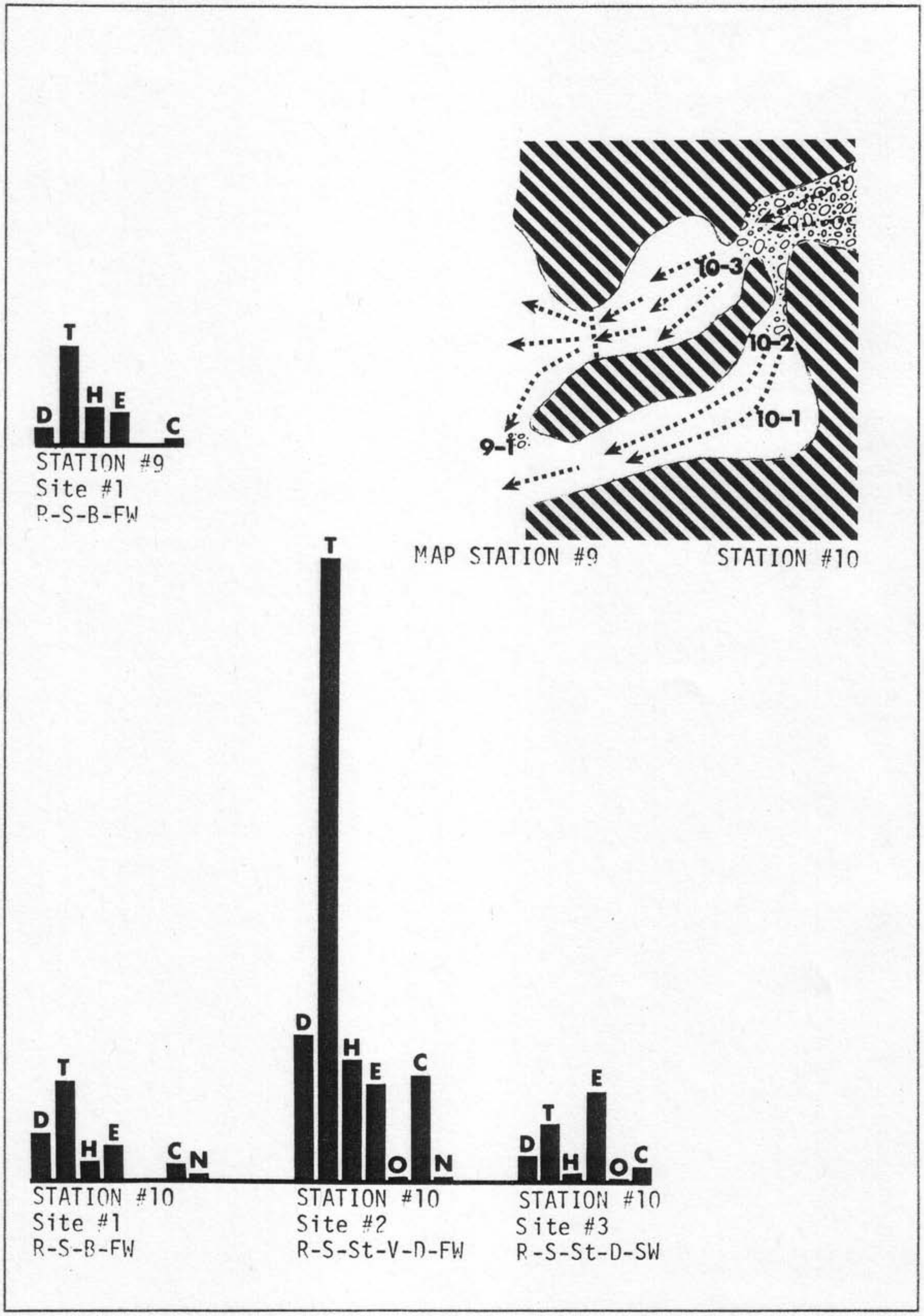


STATION #7
Site #2
St-B-V-SW



STATION #8

STATION #8
Site #1
R-S-St-B-SW


T
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C
STATION #9
Site #1
R-S-B-FW
10-3
10-2
10-1
9-1
MAP STATION #9
STATION #10
T
D
T
H
E
C
N
STATION #10
Site #1
R-S-B-FW
D
H
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C
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STATION #10
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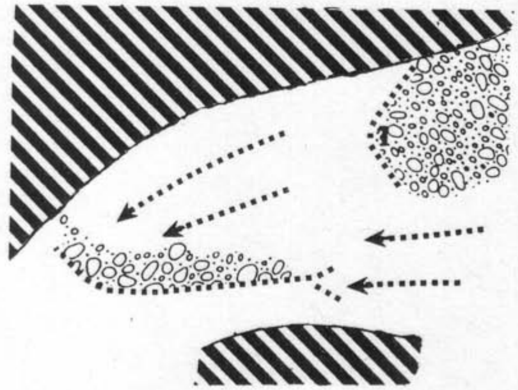
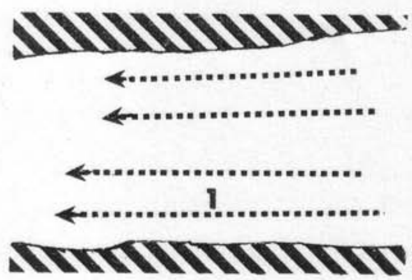
C
STATION #10
Site #3
R-S-St-D-SW

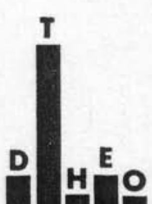


STATION #11

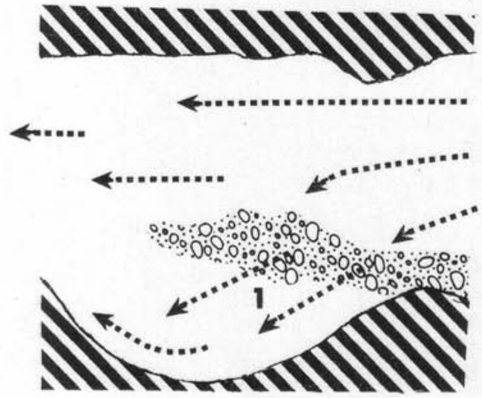
STATION #11
Site #1
R-S-St-D-SW



STATION #12

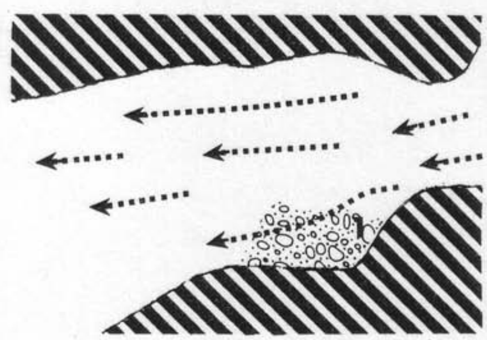


STATION #12
Site #1
R-S-D-SW

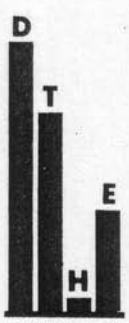


STATION #13

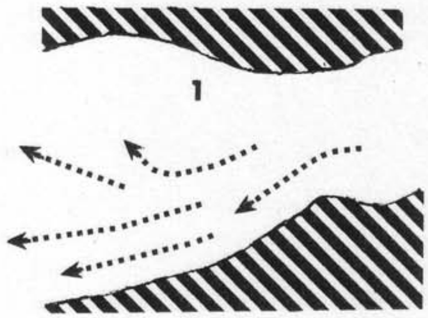
STATION #13
Site #1
R-S-St-SW



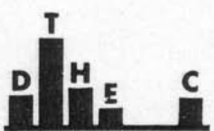
STATION #14



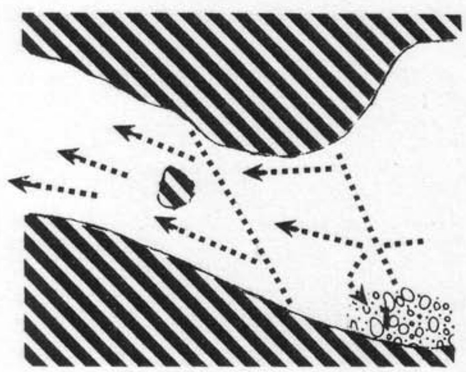
STATION #14
Site #1
R-St-B-SW



STATION #15

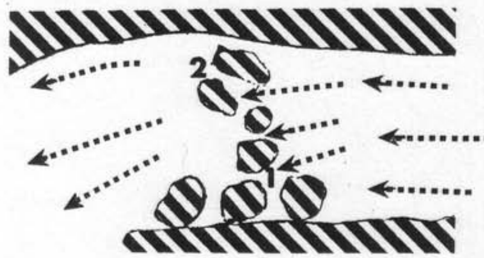


STATION #15
Site #1
St-B-V-SW

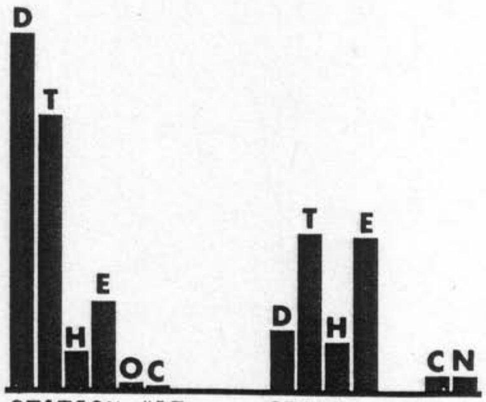


STATION #16

STATION #16
Site #1
R-S-SW

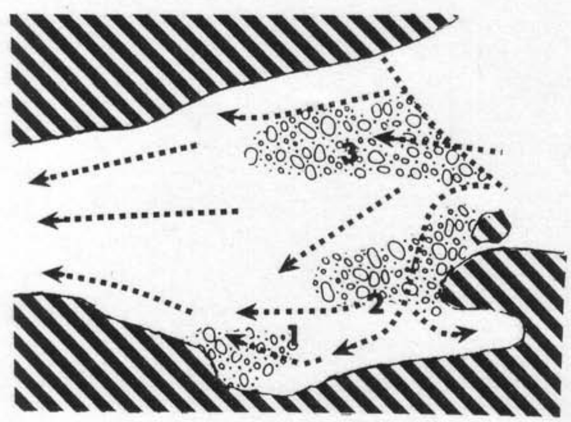


STATION #17



STATION #17
Site #1
R-S-FW

STATION #17
Site #2
S-R-V-FW

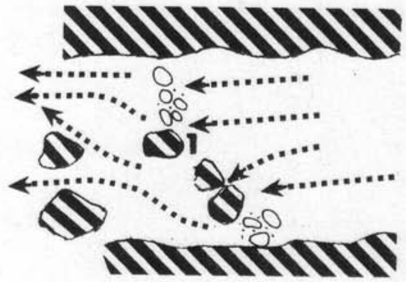


STATION #18

STATION #18
Site #1
R-S-St-SW

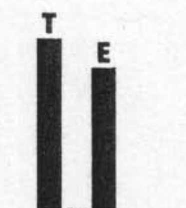
STATION #18
Site #2
R-S-St-SW

STATION #18
Site #3
R-S-FW

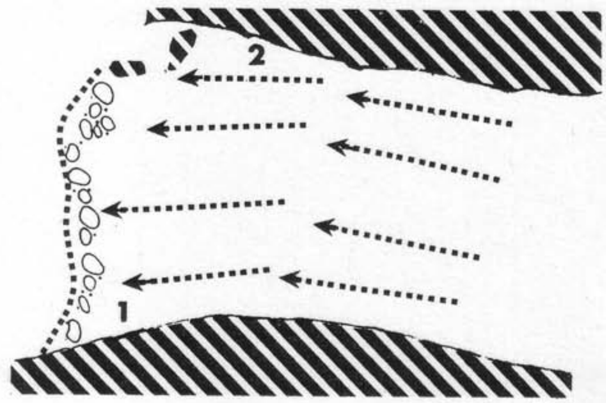


STATION #19
Site #1
R-S-D-SW

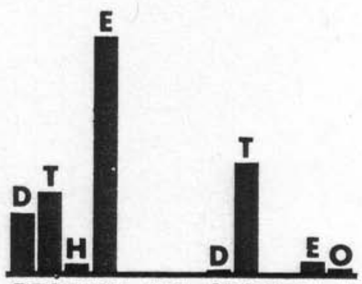
STATION #20



STATION #20
Site #1
R-S-SW

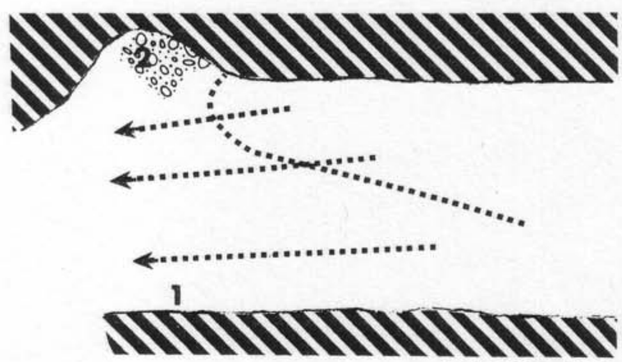


STATION #21

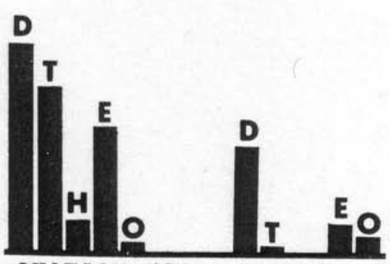


STATION #21 Site #1 R-S-SW

STATION #21 Site #2 R-S-St-D-SW

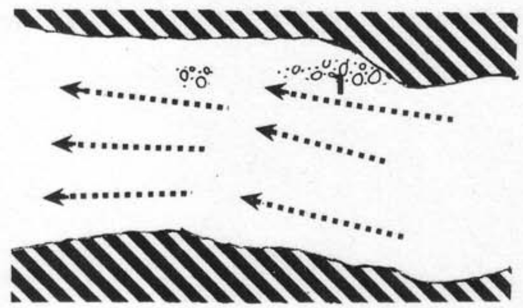


STATION #22



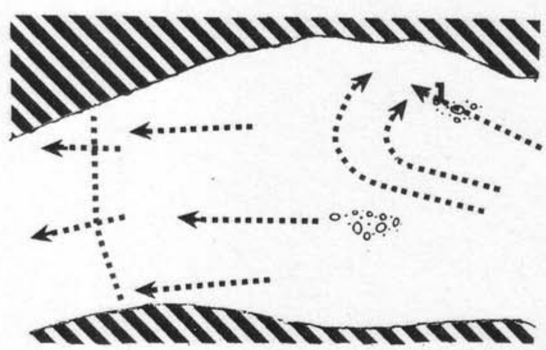
STATION #22 Site #1 R-S-B-SW

STATION #22 Site #2 R-S-St-SW



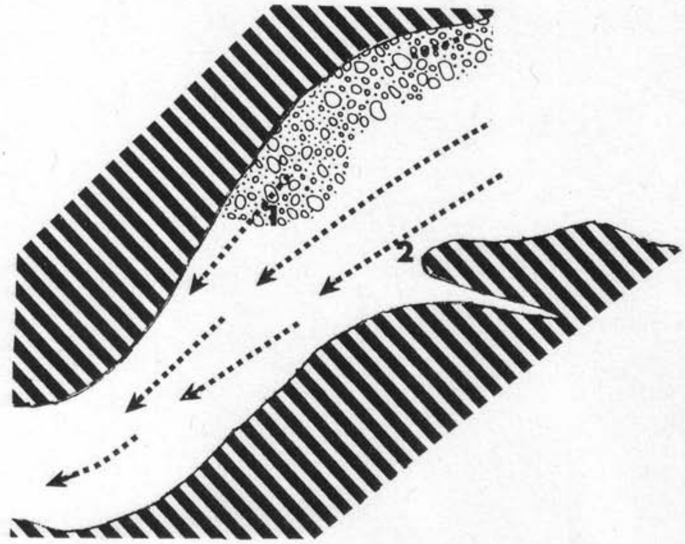
STATION #23

STATION #23
Site #1
S-B-SW



STATION #24

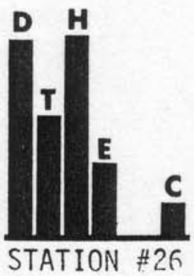
STATION #24
Site #1
R-S-B-FW



STATION #25

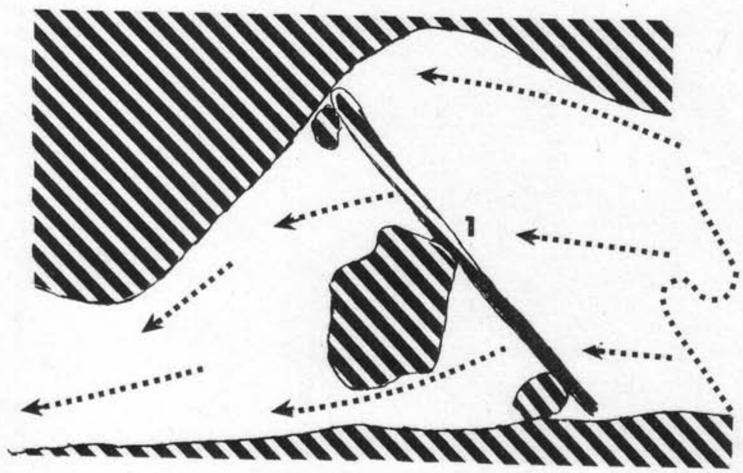
STATION #25
Site #1
R-St-FW

STATION #25
Site #2
St-B-V-FW



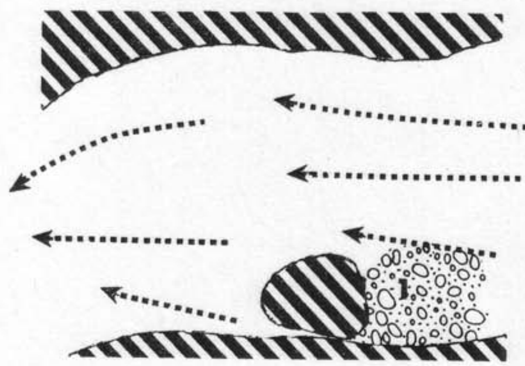
STATION #26
Site #1
R-B-D-SW

FOR MAP SEE MAP, STATION 25; Site 25-1

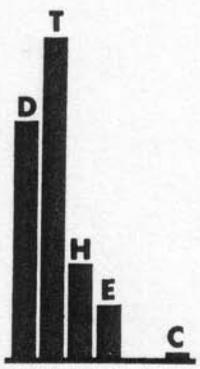


STATION #27

STATION #27
Site #1
D-SW



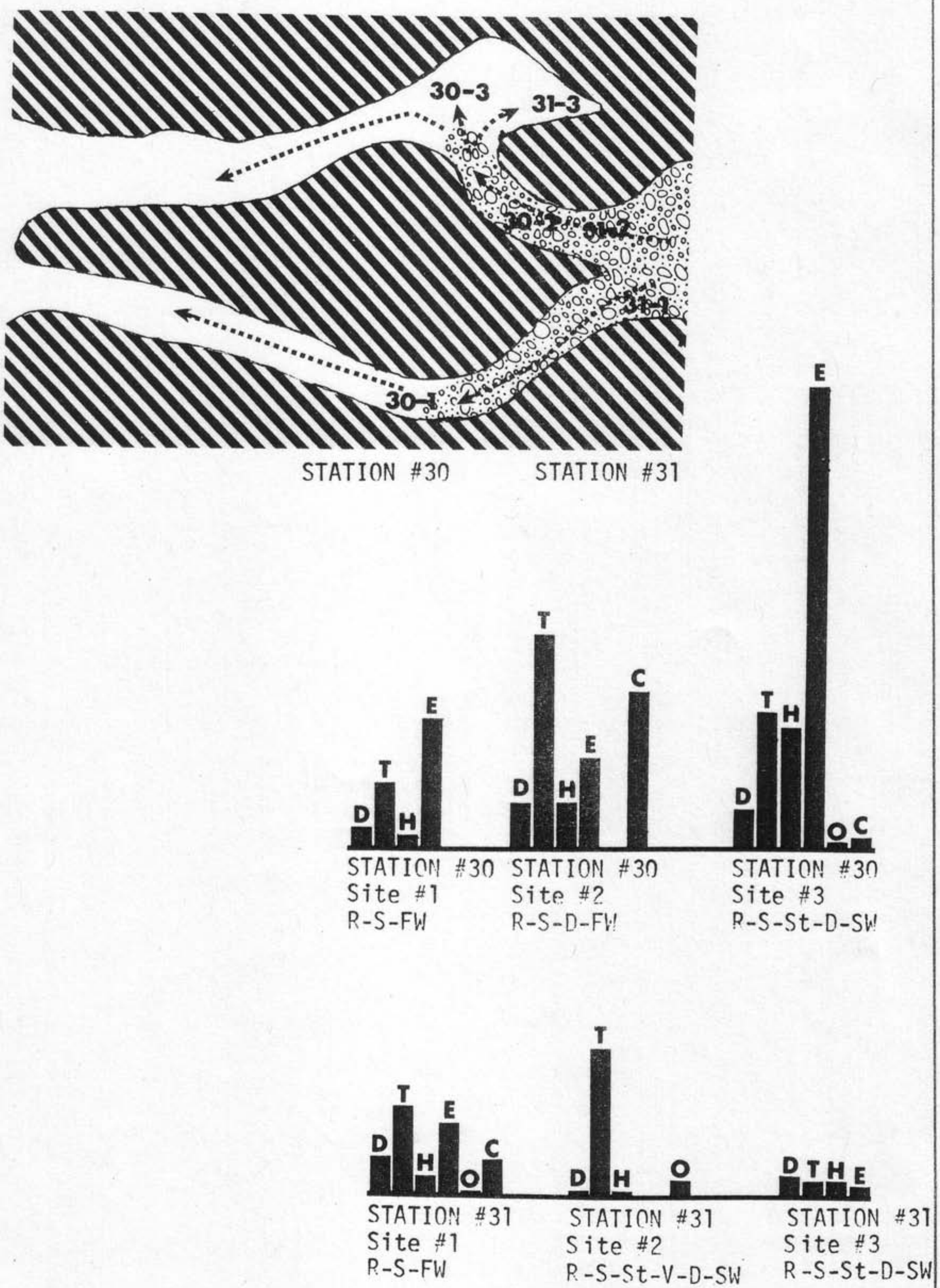
STATION #28

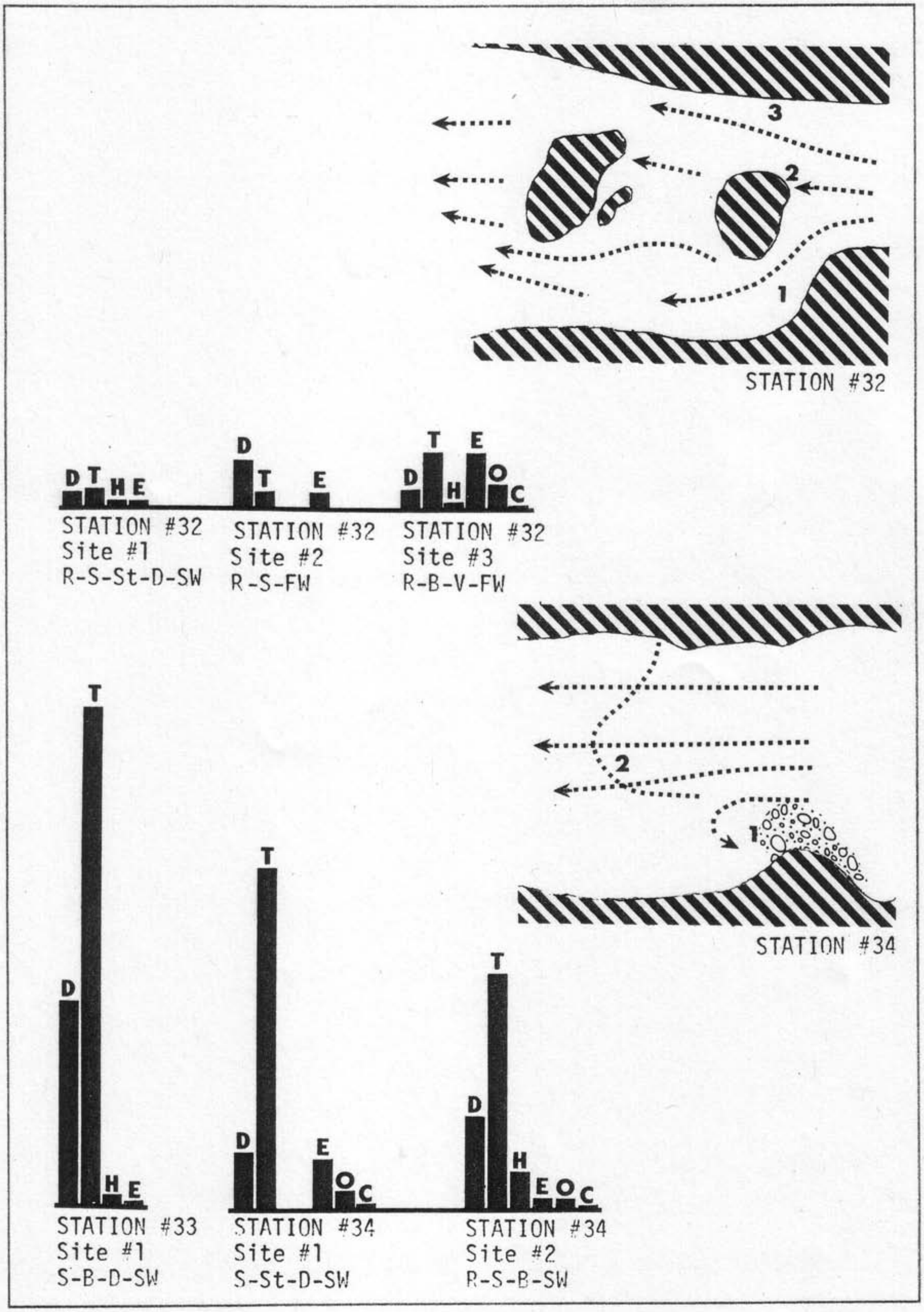


STATION #28
Site #1
R-S-B-D-SW

STATION #29
Site #1
R-S-B-D-SW

FOR MAP OF STATION #29
SEE MAP, STATION #28;
Site 28-1


30-3
31-3
30-2
31-2
31-1
30-1
STATION #30
STATION #31
D T H E
STATION #30
Site #1
R-S-FW
D T H E C
STATION #30
Site #2
R-S-D-FW
D T H E O C
STATION #30
Site #3
R-S-St-D-SW
D T H E O C
STATION #31
Site #1
R-S-FW
D T H O
STATION #31
Site #2
R-S-St-V-D-SW
D T H E
STATION #31
Site #3
R-S-St-D-SW


3
2
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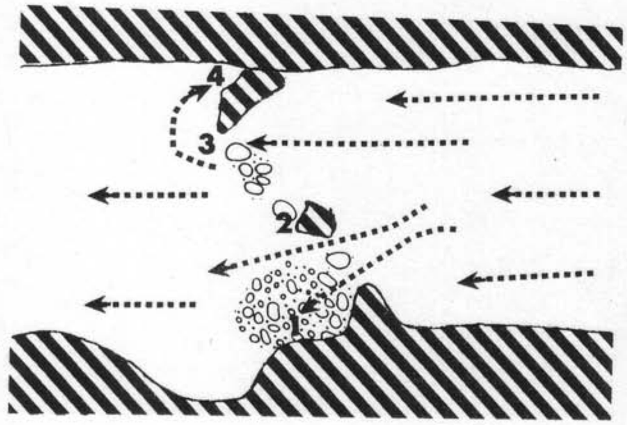
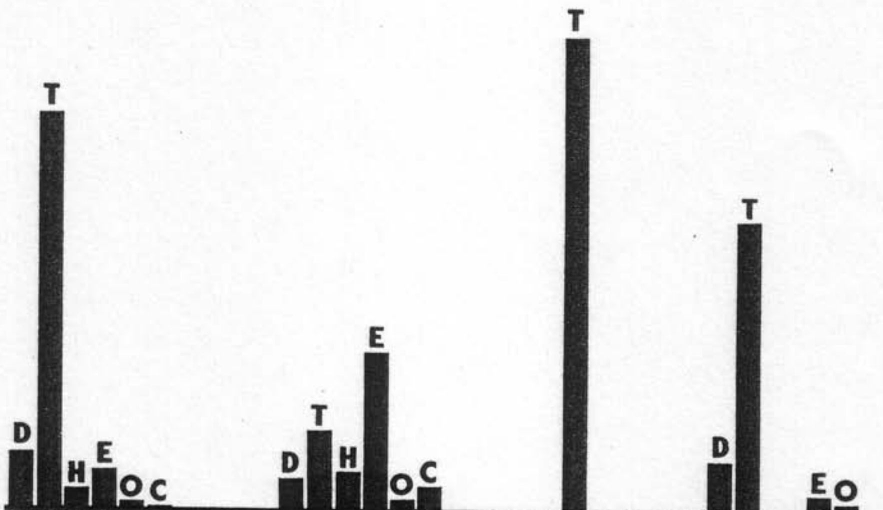
STATION #32
D T H E
STATION #32
Site #1
R-S-St-D-SW
D T E
STATION #32
Site #2
R-S-FW
D T H E O C
STATION #32
Site #3
R-B-V-FW
2
1
STATION #34
T D H E
STATION #33
Site #1
S-B-D-SW
T D E O C
STATION #34
Site #1
S-St-D-SW
T D H E O C
STATION #34
Site #2
R-S-B-SW



STATION #35

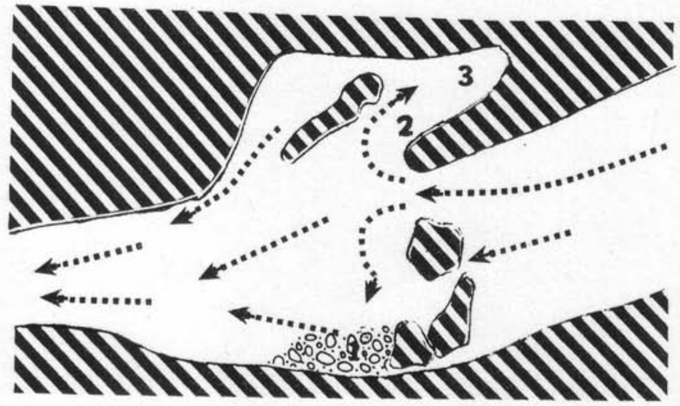


STATION #35
Site #1
R-S-St-D-SW

STATION #35
Site #2
R-S-V-SW

STATION #35
Site #3
B-FW

STATION #35
Site #4
R-St-B-SW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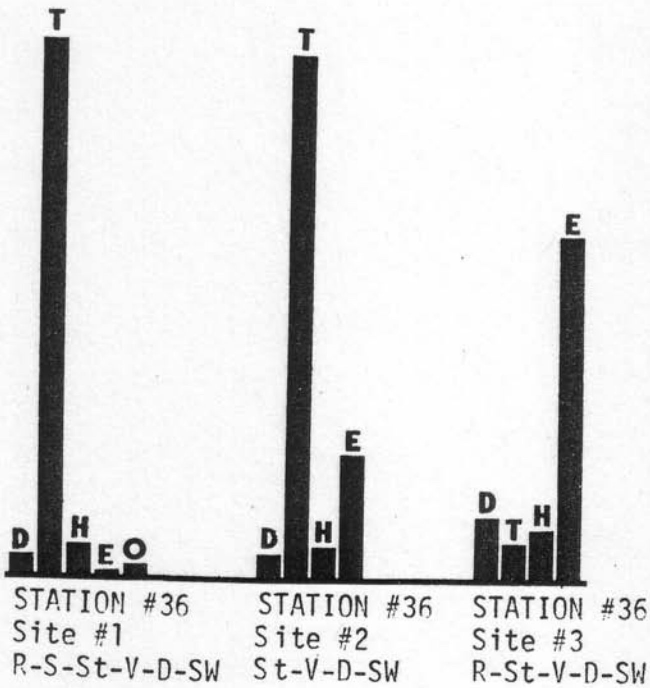
STATION #36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STATION #36
Site #1
R-S-St-V-D-SW
STATION #36
Site #2
St-V-D-SW
STATION #36
Site #3
R-St-V-D-SW

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APPENDIX

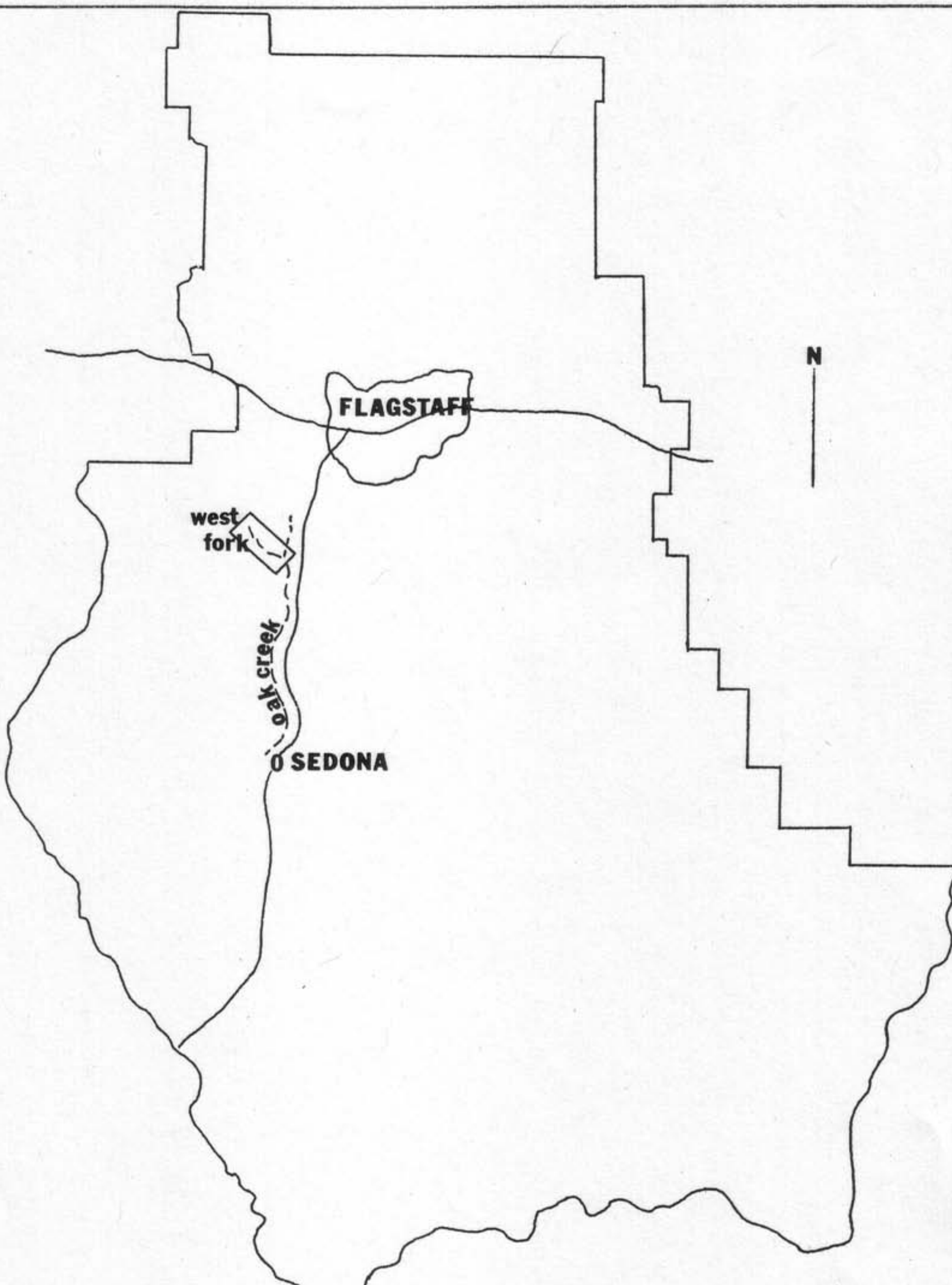

DIAGRAM OF COCONINO NATIONAL FOREST INDICATING THE POSITION OF THE WEST FORK OF OAK CREEK RELATIVE TO FLAGSTAFF, ARIZONA.

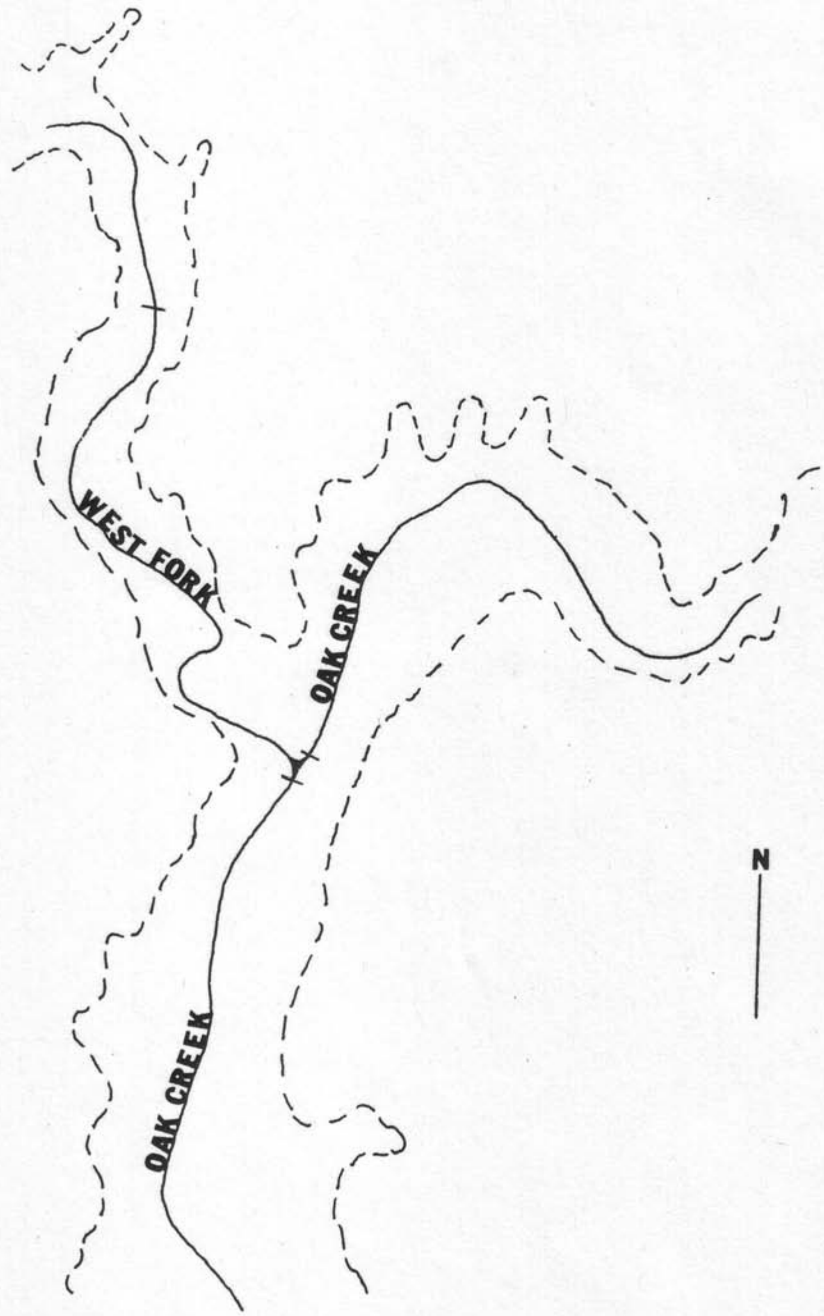

DIAGRAM OF THE WEST FORK AS IT JOINS THE MAIN STREAM OF OAK CREEK, AND SAMPLE AREA.