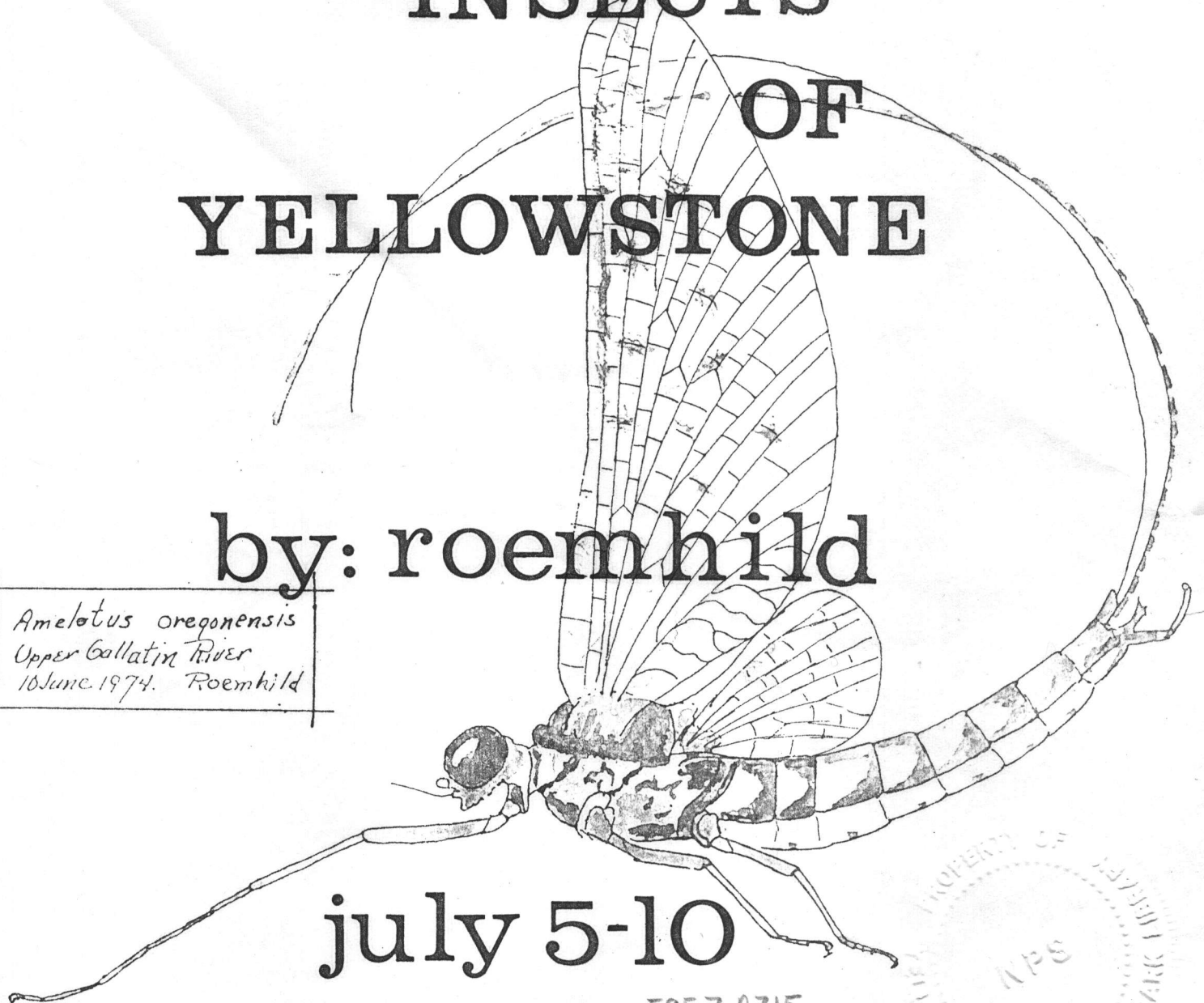
FRESH-WATER INSECTS OF YELLOWSTONE



by: roemhild

Amelotus oregonensis
Upper Gallatin River
10 June 1974. Roemhild

july 5-10

1982

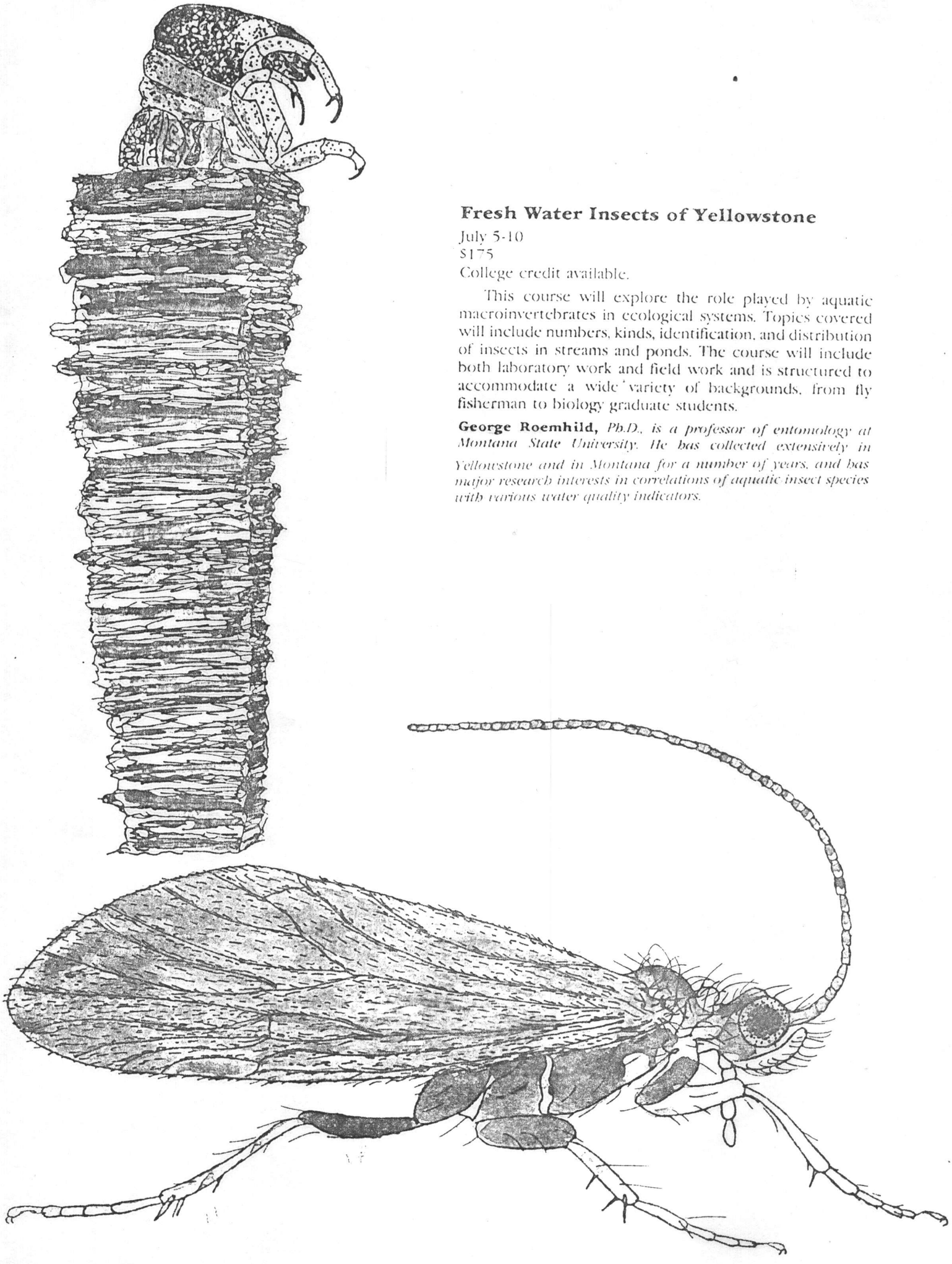
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Roemhild

Table of Contents

Frontspiece	1.
Introduction	2.
Food web	7.
Gastropoda	8.
Pelecypoda	12.
Amphipoda	15.
Insecta	17.
Hemiptera	27.
Odonata	30.
Trichoptera	35.
Ephemeroptera	44
Diptera	56.
Plecoptera	66.
Other insects	72.
References	73.



Fresh Water Insects of Yellowstone

July 5-10
$175
College credit available.

This course will explore the role played by aquatic macroinvertebrates in ecological systems. Topics covered will include numbers, kinds, identification, and distribution of insects in streams and ponds. The course will include both laboratory work and field work and is structured to accommodate a wide variety of backgrounds, from fly fisherman to biology graduate students.

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Introduction

In order for any ecological system to operate it must have an orderly path of organisms through which nutrition and energy flow can occur. Such systems can be quite simple but in nature they are usually very complicated - each of the organisms performing his part of the overall scheme and depending on other types of plants and animals while many other organisms, in turn, depend on him.

Upsets and perturbations at any level in these systems have wide ranging effects. A knowledge of the working order of such systems allows us to identify problems if we know the system well enough - even if we don't know it well we may, at least, be able to make some intelligent guesses about where to start looking for the problem.

Aquatic insects are a vital part of freshwater ecosystems and can be used as indicators of the well-being of the pond or stream in which we are interested. Insects have some advantages for this: First, they are large enough to be recognized without a microscope to a useful level of identification so that we may place them into their proper place in the trophic scheme. Second, they are abundant enough so that a representative sample should have little or no effect on the total population. And third, keys and other aids are readily available to aid the worker in his identification.

Although our main emphasis in this short period of time will be to learn to identify the various kinds of aquatic insects found in this area, please keep in mind the broader implications of the presence of particular species in any area and think about why a certain species is not found in all areas.

Distributional factors:

Animals and plants are not distributed at random. They exist in an area because their needs can be met there and they can withstand the conditions there. These needs and limiting conditions are called distributional factors.

Distributional factors are usually divided into two categories: abiotic (literally non-livibg) factors, and biotic (livirg) factors. In an aquatic environment, the abiotic factors are such things as; temperature, type of substrate, dissolved oxygen, dissolved minerals, salinity, flow rates, light penetration, permanence, turbidity, sedimentation, presence of toxic materials and size and shape of the system. None of these factors are 'alive'.

The biotic or living factors encompass all the other 'living' stuff in the system or around the system which influences the organisms in which we are interested. The living organisms depend on energy to survive - that energy flow may be used to trace and analyse the system to see how well it is doing.

Primary production, the making of new organic material (and therefore energy), is carried out in the aquatic community by numerous species of one-celled plants called algae and diatoms as well as multi-celled algae and, of course, true plants which are called macrophytes. All of these plants contain chlorophyll and are able to convert sunlight energy, carbon dioxide and water into new organic compounds which become part of the living plant. All other organisms in the ecosystem depend on these 'primary producers' for their source of organic compounds and energy. In some cases organic matter may be introduced from

external sources into the water - leaves and stems from plants and trees near the water's edge. The kind and size of organic matter available is an important factor in determining how many and what kinds of organisms are present in an ecosystem.

Oxygen is a very important factor for most organisms - trout and stoneflies need a lot of oxygen. Many midges need very little and some bacteria don't need any. Oxygen dissolves in water and turbulance will help it penetrate more deeply. Oxygen is added to the water by plants as a by-product of photosynthesis. Since plants need sunlight to do this, they produce oxygen only during daylight hours and will use oxygen at night. Water which has a large number of plants may show a great diurnal fluctuation in oxygen level.

Temperature is related to oygen in at least two ways. First, the lower the temperature, the greater the soluability of oxygen in water. About 40°C (105°F) is the upper limit at which insects can survive in a water habitat. The second reason is that all cold-blooded animals such as insects use more oxygen as temperature increases - thus, the same level of oxygen may support an organism at a low temperature but not at a higher one.

Phosphorus, nitrogen and potassium are the usual limiting factors for plant growth and primary production. Addition of these materials will usually increase plant growth. If too much is added, increased plant growth will eventually result in overcrowding and death to both plants and animals. Other minerals such as sodium, potassium, chloride and sulfate, when present in large quantities, can increase osmotic pressure to the point where normal metabolic processes are interfered with and

plants and animals die.

Obviously ponds which dry up or streams which are intermittant cannot support aquatic forms which require constant water. Some animals have the ability to burrow into the mud and survive in a comatose condition until the next flooding. Some insects (certain mosquitos) lay their eggs in depressions which later become flooded at which time the eggs hatch and develop rapidly into adults.

Flow affects the amount of oxygen in the water by providing for better mixing in riffle areas. It also moves water and dissolved oxygen over the insects so that gills operate more efficiently and food is more readily available. Some insects require this rapid water movement and are greatly adapted to it - others are adapted to still water environments.

Light penetration is extremely important in its effect on photosynthesis. When water is turbid primary production is decreased and consumers, which depend on this food source, will be reduced accordingly. Each level in the food chain can pass on about 10% of the energy which it contains so that large primary production is necessary for upper trophic levels (fish for instance) to prosper.

Silt, sand, gravel, boulders - each has its community of organisms adapted to that particular life. Substrate is very important in limiting the kinds of life that can exist in an area. Most trout stream insects are adapted to gravel habitats but practically few or no streams exist which do not have small amounts of several kinds of substrate. Many kinds of habitats produce many kinds of species.

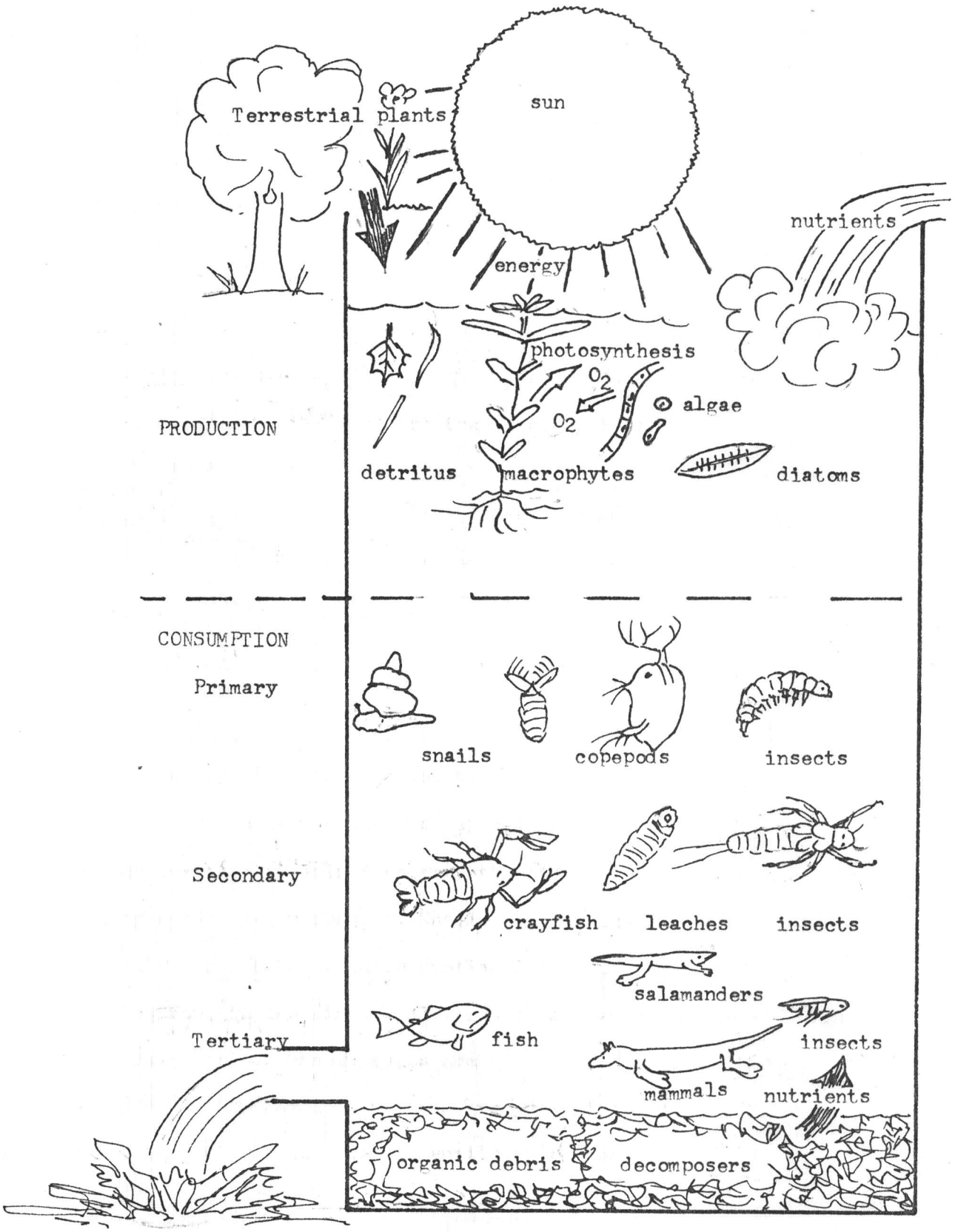
Toxic or poisonous materials may originate from natural or man-made

sources. Some waters have enough naturally occuring sulfides and selenium, for instance, to make them sterile. Almost any soluable salt in high enough concentration is toxic. Many of our problems today result from the introduction of exotic chemicals and wastes into the aquatic environment. Most of these problems, along with excess sewage and mining effluents, are being corrected

Sedimentation of streams is a natural occurrance - all of the geological features which we see are a result of erosion - substrate being moved by water. This is a natural everlasting process which cannot be stopped. Building, farming, overgrazing by domestic and wild animals, may lay bare the soil and increase erosion to the point where stream organisms can be severly effected by the smothering action of silt and dirt.

The size, shape and depth of ponds and streams do effect the kinds of animals which live there. Some aquatic insects are not found in streams under a certain size, but why this is so, we don't know. In some cases we can suggest reasons - shallow ponds and streams will heat more rapidly than deep ones and temperature is thus involved.

The biotic factors influencing the success of an organism in a specific environment are complex. Such things as predation, commensalism, presence or absence of a certain type of food, competition, and many other things are factors of moment. The general biotic picture which exists in most productive aquatic environments is illustrated very simply on the next page. The players may change, the importance of various processes may be different, but the general organization and results will remain essentially correct.


Terrestrial plants
sun
nutrients
energy
photosynthesis
O_2
O_2
algae
PRODUCTION
detritus
macrophytes
diatoms
CONSUMPTION
Primary
snails
copepods
insects
Secondary
crayfish
leaches
insects
salamanders
Tertiary
fish
insects
mammals
nutrients
organic debris
decomposers

Gastropoda - Snails and limpets

Based on general appearance there are three natural groups within the gastropods: the snails with spiral shells, the limpets which have a flattened non-spiral shell and the slugs which have an internal invisible shell.

Snails comprise the largest group of gastropods and there are about 300 families world-wide. Only about a dozen families are found in fresh water and only five families are found in our area. The snails can be divided into two groups - those with lungs and those with gills. Those which have gills are not found on land but those with lungs may be found either on land or in water. In some cases lung-snails may come to the water surface for air but in many cases air requirements can be met by using the air dissolved in water.

Snails are grazers for which they have a well developed set of teeth called a radula. The size, shape, and number of teeth making up the radula is used in some determinations of species. Diatoms, algae, and other green microscopic material is rasped from the surface of the substrate as the snail proceeds slowly forward. Snails are, in turn, fed upon by fish - especially pond fishes such as sunfish and perch. In Yellowstone National Park the trout in the Firehole River utilize large numbers of snails as food during periods when insects are not abundant. Shore birds and waterfowl also utilize snails for food. Even waterfowl species which normally feed on vegetation will turn to snails and other invertebrates during

periods when they need a high protein food source. This occurs during egg development in the female and during the rapid growth period of ducklings and goslings.

Fifty to 100 years ago snail shell collecting was a favorite pastime in this area of the country and we have extensive 'species' lists from that era. Many of the species described from shells collected during that period are now considered invalid because the differences used to describe a new species are now recognized as normal variations which one can expect in snail populations of the same species.

Limpets are found in our rivers and streams clinging closely to rocks over which they slowly travel as they graze on periphyton. Limpets usually do not occur in large numbers and are often not seen or noticed because their appearance is somewhat like some sort of debris on the rocks.

Slugs are land dwellers in our area and do not inhabit fresh water. However some very large ones are found in marine habitats.

The families of gastropods which we encounter in freshwater in this area are:

Ancylidae - fresh water limpets. About a half dozen genera occur in United States but we have found only one genus and species in our area- Ferrissia rivularis. Limpets are not common and are found in larger rivers.

Planorbidae. There are about 10 genera in this family and about half of these may be found in the northern Rockies. Gyraulus and Planorbula species are found in the park and we expect to find Heliosoma species here too.

Physidae - pouch snails. Although there are only 2 genera in this family

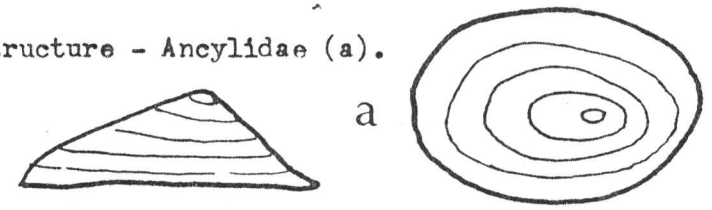
there are numerous species which are widespread and abundant in our area. Physa species are the most abundant ones in the park and we expect to find Aplexa species here also.

Valvatidae - round-mouthed snails. There is only one genus in this family- Valvata. These snails live in larger ponds as well as lakes and rivers. V. humeralis has been taken in the Madison River in the Park and several other species are known to occur in near-by Montana.

Lymneidae - pond snails. The one genus in this family, Lymnea, is abundant and widely distributed in our area. Several species are known to live in the park.

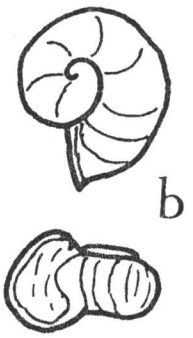
Key to the common freshwater Gastropoda (snails) of this area.

1. Shell without a spiral structure - Ancylidae (a).



Shell with a spiral structure - - - - - - - - - - - - - - - 2.

2. Spiral in one plane - Planorbidae (b).



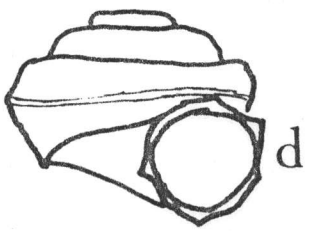
Spiral of shell upward as well as outward - - - - - - - - - 3.

3. Shell sinstral (aperture on left when shell is held with spire up) - Physidae (c)

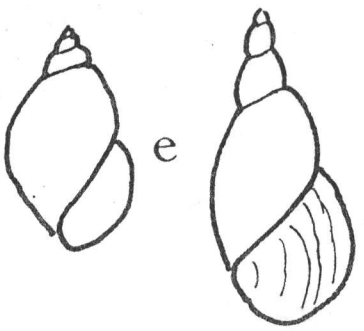


Shell dextral (aperature on right when shell is held upright). - 4.

4. Spiral of shell very low - Valvatidae (d)



Sriral of shell normal - Lymnaeidae (e)



Pelecypoda - clams and mussels.

Clams and mussels are widespread throughout United States and a number of species are found in our area. Their food consists of microscopic algae and zooplankton which they strain from water as they pump it through their siphons. Some families, such as the Spheridae, also consume large quantities of dead organic matter. Immature forms of clams are free-swimming and are often found hitch-hiking on fish, a means by which they become dispersed through their habitat.

The families Spheridae and Unionidae contain most of the species found in the United States while the family Margaretiferidae has only a few species. There are also a few representatives of other families which have been introduced from foreign areas into American waters.

Spheridae - pill clams., finger-nail clams. There are about 40 species of spherids in United States and few bodies of water exist which do not have at least one of these. In Montana we have identified about 20 species and at least a dozen species should occur in the park. There are three genera in the family: Sphaerium, Pisidium and Eupera. The first two genera are found commonly in our area but the last named is found only in south-eastern United States. The genera are separated by teeth characteristics which are found in the hinge of the shell and by the position of the umbo or hump on the exterior of the shell. Finger nail clams are reported to live 1 to 2 years.

Unionidae - pearl mussels or naids. As the name implies, this group has been utilized for their pearly shells from which buttons are made. The Mississippi River and its tributaries in the plains states, along with

some southern rivers, supports a fairly large industry based on collecting 'shell' for buttons. We have taken no Unionids in the park but one species, Anodonta grandis, occurs in eastern Montana so there is a slight possibility that some discoveries may be made in this area. The proliferation of many species in the Mississippi River valley indicates that this is an area where fresh-water clams have been actively evolving. Members of this family are reported to live 10 to 15 years.

Margaretiferidae. There are two genera and four species in this family. The most widely distributed species is Margaretifera margaretifera which is found, so far, in the Madison River in the park. This species varies greatly in appearance over its range: our drawing is of a specimen from the park but in slower flowing waters the size is often larger and the shape is convex rather than concave on the bottom. M. margaretifera is often found in colonies numbering hundreds in slow flowing rivers. Growth is apparently slow - the average age of individuals in a colony in the Madison River was found to be 48 years with the youngest being 10 years and the oldest 67 years.

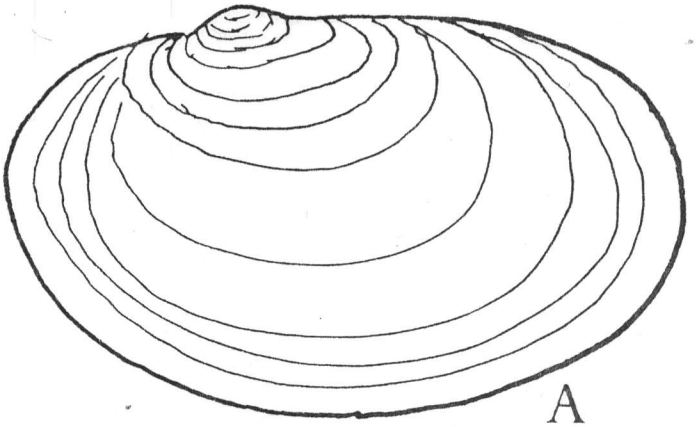
Key to the common freshwater Pelecypoda (clams) of this area.

1. Shell large, more than an inch long (mature forms are more than 2 inches long) A and B - 2.

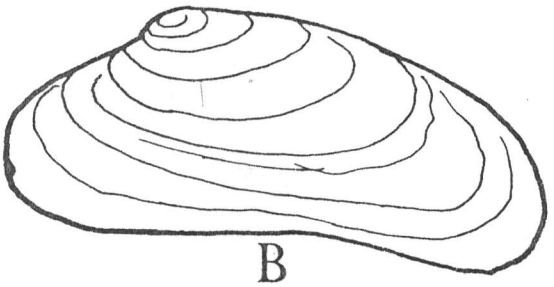
   Shell small, mature forms less than an inch long - Sphaeridae C.

2. Shell elongate and laterally compressed, nacre purpulish - B. Margaritiferidae

   Shell oval or oblong, nacre white - - - - - - - - Unionidae A.



A



B



C

Amphipoda - scuds or side-swimmers.

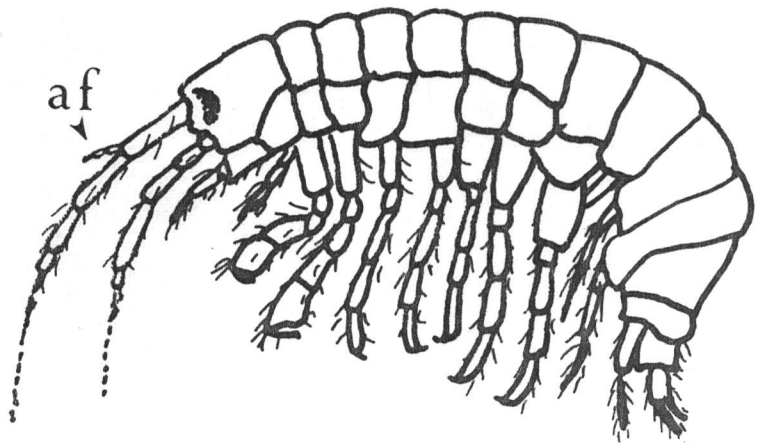
Some fishermen call them "shrimp" but, technically, they are not. There are about 90 species of amphipods known from fresh water in the United States. Many of these are known only from caves or other subteranean situations where specially adapted species are found. Most of the North American species belong to the family Gammaridae. Scuds feed on many kinds of food including dead organic matter, algae, diatoms, and debris. They are found in abundance in aquatic vegetational mats where they are protected and where abundant grazing is present. They are voraciously preyed upon by fish and are quickly consumed in ponds or streams where there is little vegetative cover. We have taken two species in Yellowstone National Park. They are Gammarus laucustris from the family Gammaridae and Hyalella azteca which is in the family Talitridae. Hyalella is the smaller of the two, 4-5mm long, while Gammarus is 10mm or more in length as an adult. Sometimes the two species will be found inhabiting the same weed bed.

Freshwater Amphipoda of this area.

Key:

First antenna with accessory flagellum (af), both pairs of antennae long and slender - Gammaridae

First antenna without accessory flagellum, first antennae shorter than second - Talitridae



A typical freshwater anphipod showing the accessory flagellum.

Insecta - insects.

In most ponds and streams there will be a very large number of living organisms; there will be several kinds of algae, many species of diatoms, and a large number of rooted plants. Many kinds of one-celled organisms will be present including bacteria and protozoa; water-fleas, wheel-animicules, worms of various kinds and other forms of small animals abound. Microscopes and special techniques of mounting are needed if we are to study this group.They are too small to be easily handled.
The next sized group upward is the group with which we will be concerned - insects and other invertebrates which we can readily see and are therefore easier to work with, study, and get to know. We will not spend time on the larger vertebrate animals - mammals and fish - which are at the top of the heap both in size and in trophic (eating) relationships.

In freshwater habitats, insects are usually the most abundant group in the intermediate size range, both in numbers of species and total numbers. They are therefore usually the most important in the trophic relationships in that environment.

There are many kinds (species) of aquatic insects in an area such as Yellowstone Park and each of these species has its own requirements of the system in which it lives. If the system is changed - the species will change. This sensitivity to change is a major reason why we are interested in aquatic insects- they tell us when changes occur and something about the magnitude and kinds of changes. Other reasons why we are interested in them are; they are food for fish and their presence, absence, kinds

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and numbers tell us much about the chances of fish to survive and the kinds of fish we can expect in an area. In high mountain lakes, the limiting factor for fish is often the insect complex present. In addition, fishermen want to know more about aquatic insects so that they can imitate them to catch fish. Still another reason - we always need more basic knowledge about our world - there are still many more species, right here in Yellowstone National Park, which are unknown to science today.

Insects are arthropods which means they have jointed legs and an exoskeleton. Arthropods also include crayfish, spiders and several other groups. Insects can be differentiated from the others in this group because only they have three pairs of legs and three body regions (head, thorax, and abdomen).

The life cycles of insects are all essentially the same; the egg, the immature form and the adult. Adults lay eggs to start the cycle over again. Most aquatic insects have one cycle (generation) per year but some species will have several generations produced in season. A few species need several years to produce a single generation. There are many variations on the basic plan of insect life cycles. Some insects do not change much in appearance from the immature stage to the adult stage - this is called incomplete metamorphosis. Others change drastically in appearance and go through a special stage (pupa) which entirely remakes them into different-looking creatures - this is complete metamorphosis.

Among the many species of 'aquatic' insects there are all degrees of dependence on free water. For instance, some species live in muck or

mud and do not require 'free' water to develop. Some require water for only a week or two and then become independent; most spend their immature stages in the water and then emerge as air-flying adults; some spend their entire life in water.

Examples:

Near water - shore bugs

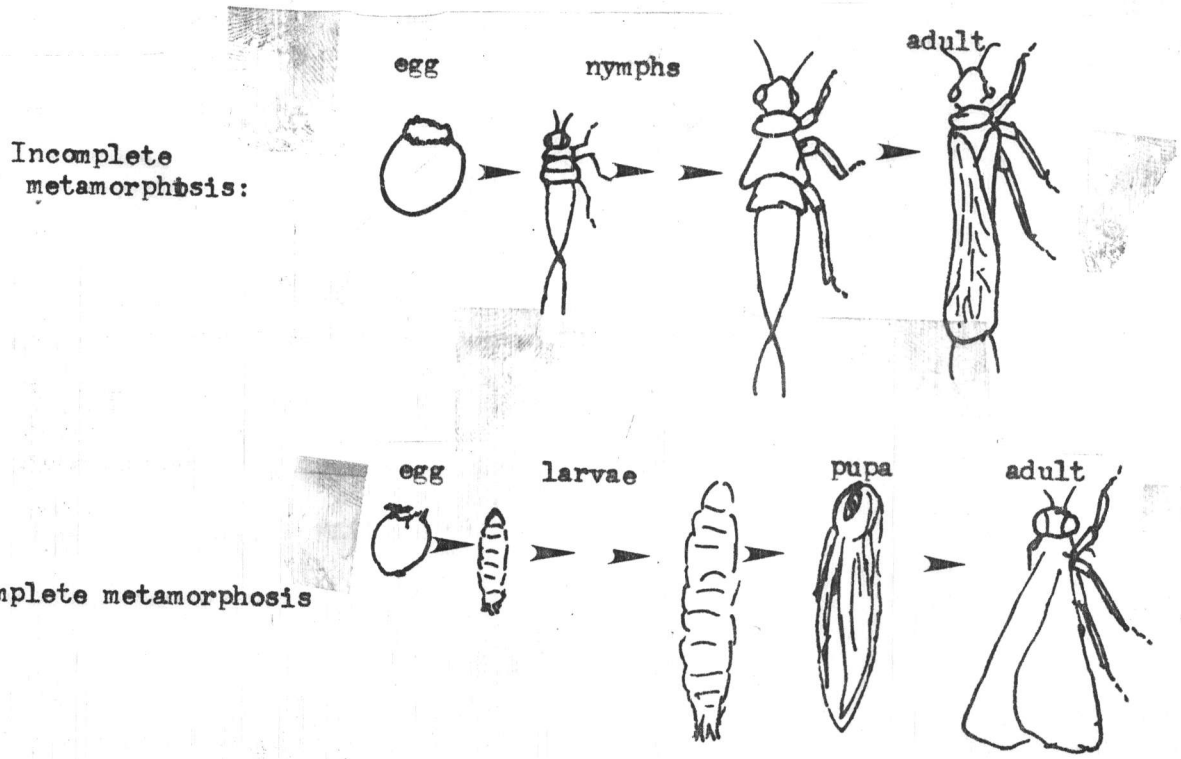
In mud - toad bugs, horse fly larvae, crane fly larvae

Few days in water - mosquitos

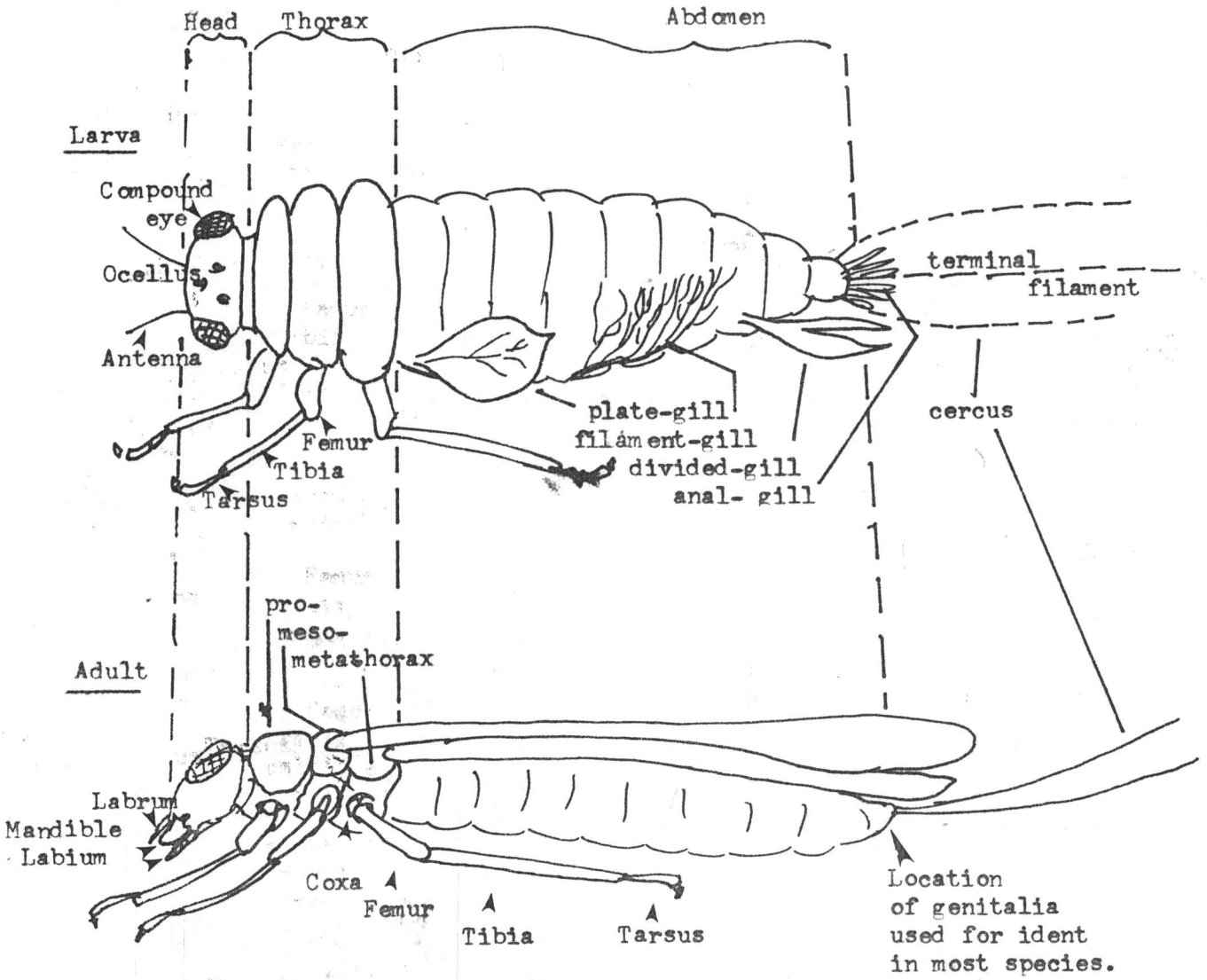
Immature stages in water for months - caddisflies, mayflies, stoneflies

All stages in water - water boatmen, backswimmers

Types Of Metamorphosis

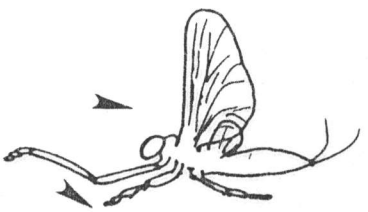


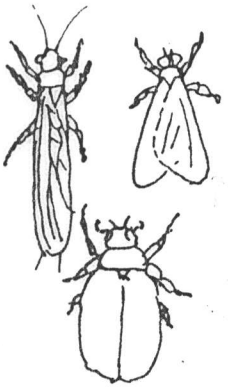
Simple anatomy of an Insect,



Key to the Aquatic Insects:

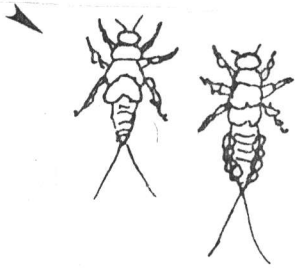
1. Wings present, usually large and conspicuous Adults 2.

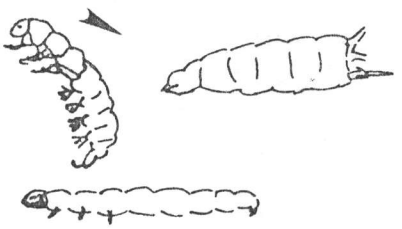




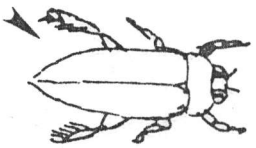
Wings adsent, wing pads are often present but wings are not large and extensible. Nymphs and Larvae 12.

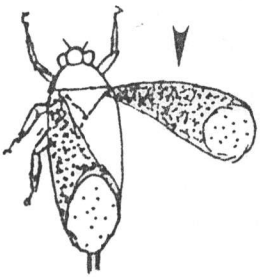






2. Forewings entirely or partly hard and leathery 3.





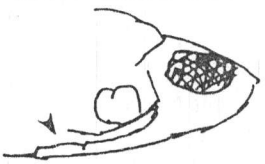
Forewings membranous and resembling hind wings if present 4.

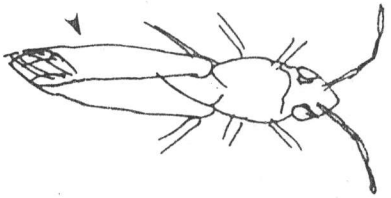
3. Chewing mouthparts, mandibles visible, front wings entirely hard Coleoptera, beetles



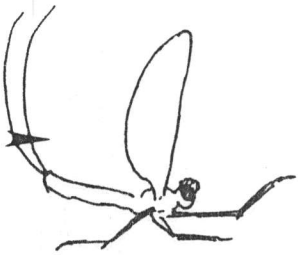


Sucking mouthparts of single jointed, peircing structure, Front wings partly leathery. Hemiptera, true bugs.



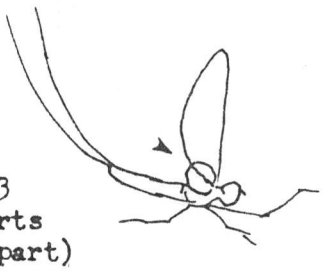


4. One pair of wings 5.

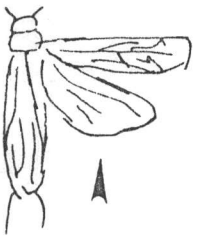




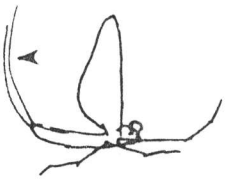
Two pairs of wings 6.



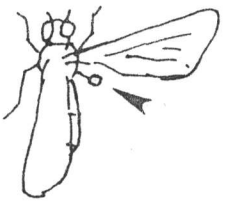




5. Abdomen ending in 2 or 3 long filaments, mouthparts useless. Ephemeroptera (part) mayflies



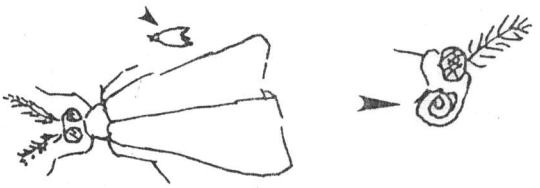
No long filaments at end of abdomen mouthparts functional, halteres present Diptera true flies.



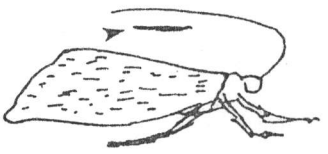
6. Wings with scales or hairs 7.

Wings clear, without scales or hairs 8.

7. Wings scaled, mouthparts a coiled sucking tube Lepidoptera - moths



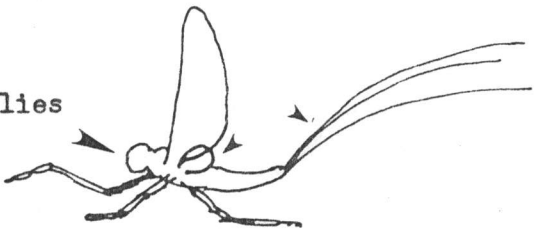
Wings haired, mouthparts not a tube Trichoptera -caddisflies



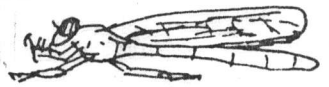
8. Antennae short and inconspicuous 9.

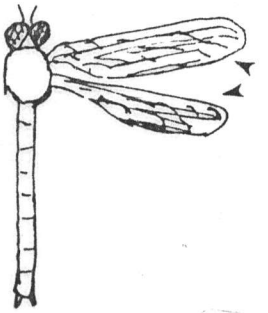
Antennae long and conspicuous 10.

9. Abdomen ending in 2 or 3 long filaments, hind wings much smaller than forewings. Ephemeroptera, mayflies



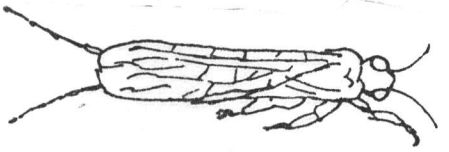
Abdomen without long filaments, wings about equal.
Odonata dragonflies/damselflies





10. Tarsi 2 or 3 segmented; usually with 2 conspicuous caudal filaments.
Plecoptera stoneflies

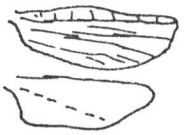




Tarsi 5 segmented:; without long caudal filaments 11.

11. Hindwings folded lengthwise, more than 25 mm long. Megaloptera
alderflies, fishflies



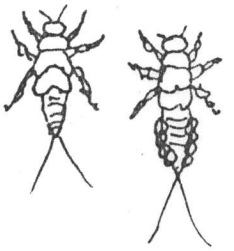


Hindwings not folded, less than 25 mm long. Neuroptera spongillaflies

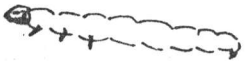




12. With wingpads which contain developing wings. 13.



Wingpads absent, no sign of developing wings 16.



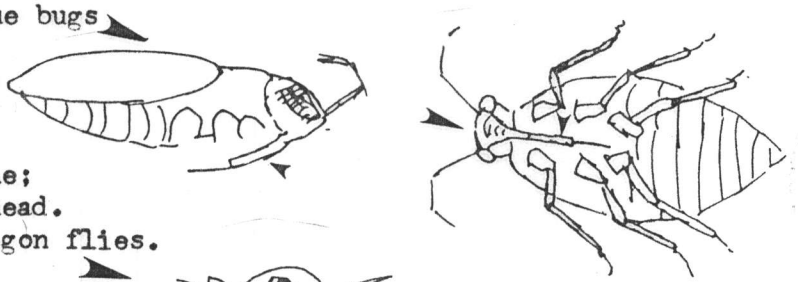




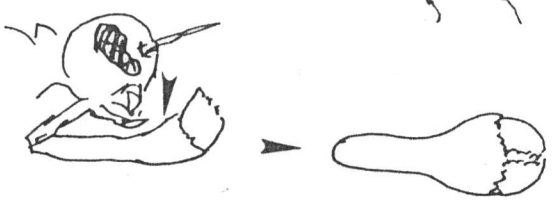
13. Chewing mouthparts (mandibles) present 14.



Sucking mouthparts present, no mandibles Hemiptera true bugs



14. Labium (lower lip) extensible; when extented, longer than head.
Odonata damsel/dragon flies.

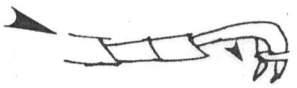


Labium not extensible 15.

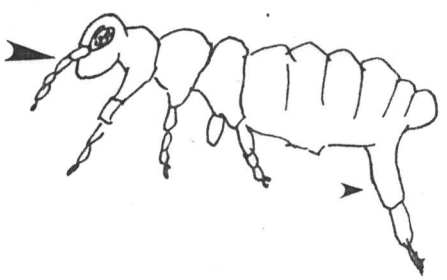
15 Tarsi with 1 claw; gills ont top or sides of abdomen
Ephemeroptera mayflies



Tarsi with 2 claws, if gills are present on abdomen, they occur only on the bottom of the first 2 or 3 abdominal segments. Plecoptera stoneflies

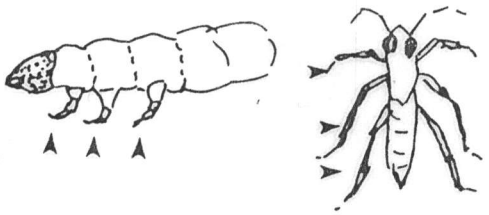


16, Abdomen with 6 or fewersegments; jumping organ on bottom of abdomen; total length less than 5 mm.
Collembola springtails



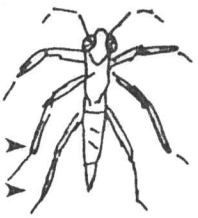
Abdomen with more than 6 segments; no jumping organ present and more than 5 mm long 17.

17. Three pairs of jointed (true) legs on thorax 18.



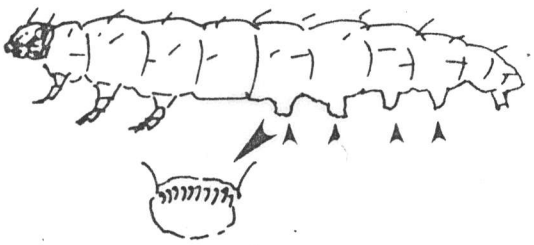
True jointed legs absent from thorax 23.

18. Middle and hind legs long and slender; compound eyes present Hemiptera true bugs



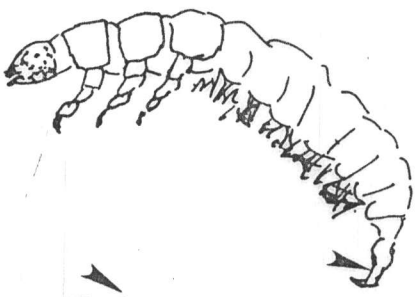
Legs not longer than abdomen; compound eyes absent 19.

19. Abdomen with at least 2 pairs of fleshy prolegs present which are armed with small hooks Lepidoptera moths



Abdomen without fleshy prolegs usually, but if present no small hooks in rows at end 20.

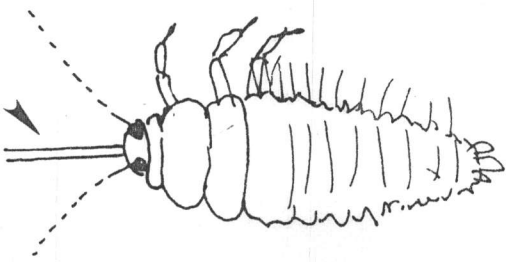
20. Last andominal segment with pair of prolegs bearing hook(s); antennae small and of 1 segment; eyes of 1 facet; free living or in cases Trichoptera caddisflies



Last abdominal segment without hook(s); if hooks are present then antennae is of more than 1 segment; eyes of more than 1 facet 21.

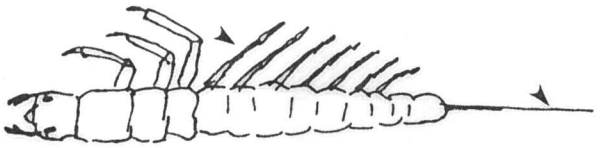


21. Mandibles in form of sucking tube; less than 5 mm long; found in fresh water sponges Neuroptera

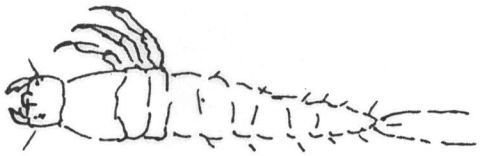


Mandibles not as above and not found in spenges 22.

22. Abdomen with 7 or 8 pairs of segmented lateral protruberances; long filament present on 9th segment Megaloptera alderflies

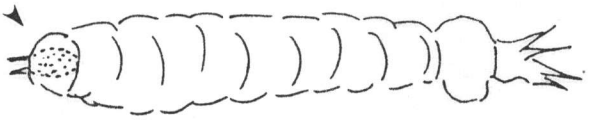


Abdomen with or without unsegmanted lateral protruberances and without a long anal filament Coleoptera beetles

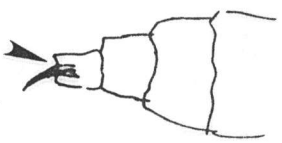


23. Head capsule hard and blackened, may be readily seen or may be withdrawn into first thoracic segment 24.

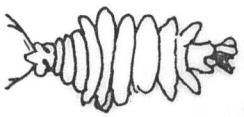


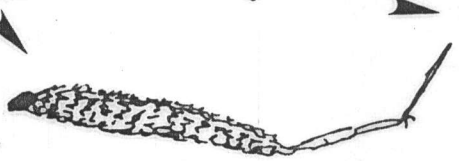


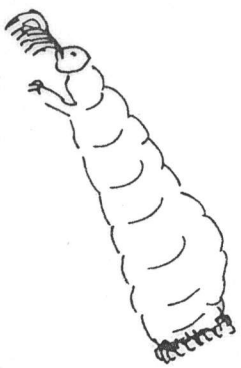
Head capsule virtually absent - may consist of only a few darkened rods
Diptera true flies



24. Posterior end of body with one or more of the following: gills, hair brush, sucker, breathing tube
Diptera true flies







Posterior end of body without any of the above structures
Coleoptera beetles



Hemiptera - True bugs.

Most of the Hemiptera are terrestrial but about 16 families are found in, on, or near the water. At least 6 families are known from Yellowstone National Park and 2 or 3 more may eventually be found here. All of the Hemiptera have piercing-sucking mouthparts and all except the corixids are predacious in other invertebrates. Corixids suck the juice from algal filaments. A summary of the known families in the park follows:

Corixidae. Commonly called water-boatmen, Ten genera and 36 species are known from Montana ; 4 genera and six species have been taken in the park. Corixids are found in ponds, lakes, and slow-flowing streams with lots of weeds and algae. As we collect these habitats more will undoubtedly increase the known number of species. There are more species in this family than in any other hemipteran family

Notonectidae. These are probably the second most abundant hemipteran form (aquatic) in the park. Although there is only one genus, Notonecta, there are 3 species which are well distributed throughout most of the ponds, sloughs and slow streams in the park. Notonectids are known as back-swimmers and will bite the hand that handles them carelessly.

Gerridae. Water striders, as members of this family are known, skate around on top of the water instead of living beneath the surface as do the majority of aquatic hemipterans. Gerris is the only genus in our area and we have found 4 species, to date, in the eddies of streams and in ponds and sloughs.

Naucoridae. Naucorids are called creeping water bugs. Ambrysus is our single genus and the park harbors 1 and possibly 2 species. Ambrysus heidemanni was first discovered and named from specimens collected in the thermal

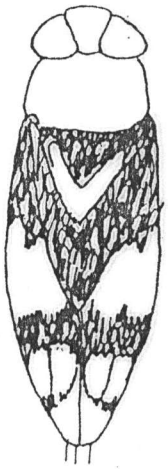
waters of the park. A. mormon may also be found here.

Veliidae. These insects are called broad-shouldered water striders. Rhagovelia distincta is the only species we have found to date in the park. It has been taken in the Madison River drainage and is often associated with thermally influenced streams.

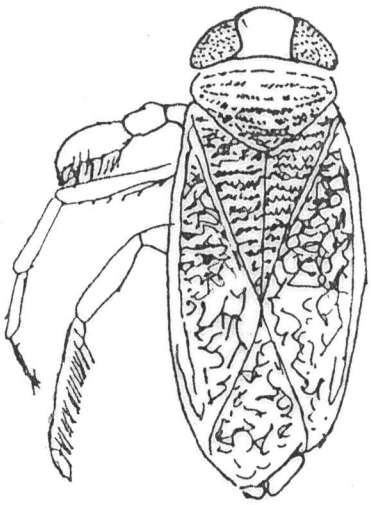
Saldidae. Saldids are shore bugs - always found near water but not in it. Although we havecollected some of these insects in the park, we have not identified them or made a special effort to collect more. On the basis of outside collections we would expect half a dozen species to be found in the park.

Others; Hebridae are also shore bugs and are quite small - they are undoubtedly found in the park. Belastomatidae are large predacious bugs which have been taken close to the park but none from within that we know of. They are called giant water bugs, electric light bugs, and fish killers - all good descriptions of their activities. They should be found in the park. Gelastorcoridae are called toad-bugs and live in mud along shorelines. They may occur in the park.

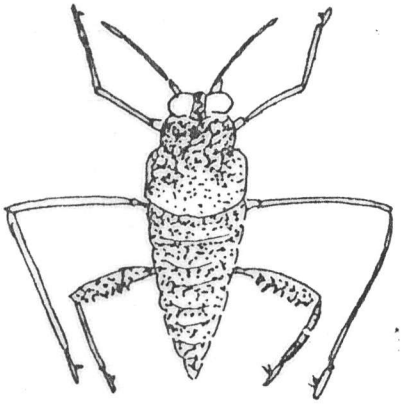
Some Aquatic Hemiptera from Yellowstone National Park



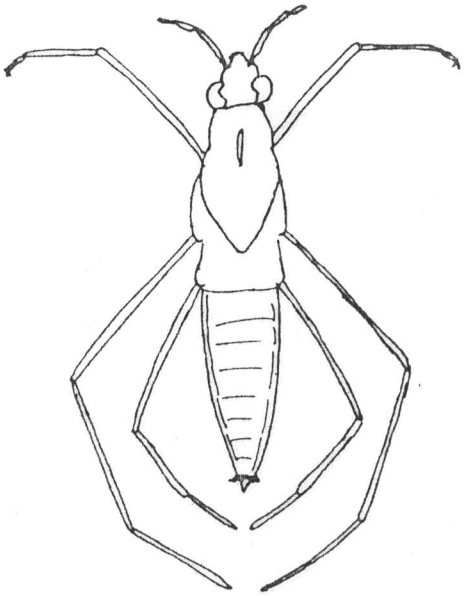
Notonectidae



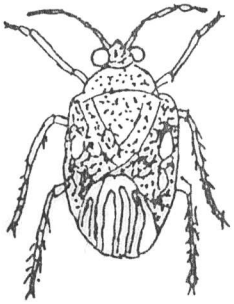
Corixidae



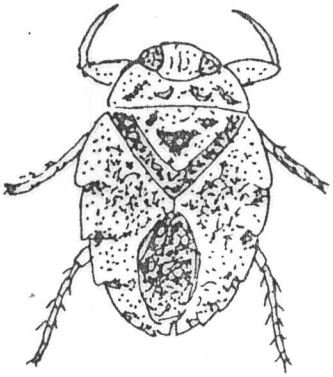
Veliidae



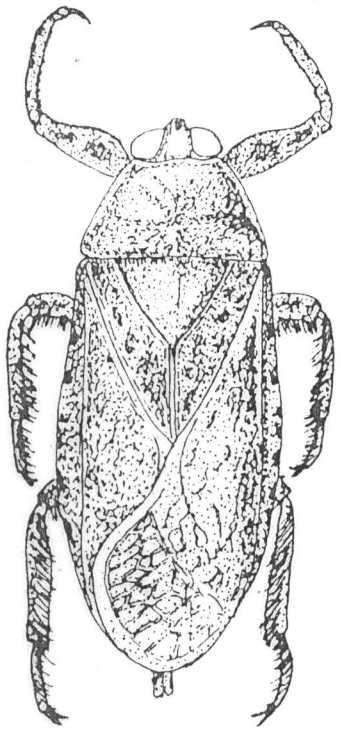
Gerridae



Saldidae



Naucoridae



Belastomatidae

Odonata - damselflies and dragonflies.

Members of this order are carnivorous, both as nymphs and adults, and prey on other invertebrates - even small fish- which they can catch. Odonata are well represented in the park - the spring creeks, ponds and mildly thermal waters are especially favored by these insects.

The two major suborders in the order are; Zygoptera - the damselflies, and Anisoptera - the dragonflies. Damselflies are weaker fliers and are not as robust as are dragonflies. Damselflies hold their wings parallel to the body when at rest and are always found near water. Dragonflies hold their wings straight out from their bodies when at rest and may wander several miles from thier home water hole.

The families of the two suborders - in this area - are;

Zygoptera - damselflies:

Calopterygidae. There are two genera and three species of this family in neighboring areas but so farnone have been found in the park.

Lestidae. There is a single genus in our fauna - Lestes. Three of the five species known from this area have been found in the park. These are our largest damselflies and are metallic green or bronze in color.

Coenagrionidae. Six genera and 21 species of this family occur in this region. Five genera and eight species have been taken in the park. Members of this family especially like the thermal flows - if they aren't too warm. They include the blue and greenish species most often seen here. The most common genera are: Enallagma, Ishnura, Coenagrion and Amphagrion.

Anisoptera - dragonflies.

Dragonflies are very strong fliers and are difficult to capture and our

collections, therefore, probably do not represent the fauna as well as do our damselfly collections. There are five families which may be represented in the park;

Cordulegasteridae. Only one collection from this family is known from Montana and none from the park.

Gomphidae. Two genera with several species are known from this region but only two species of ophiogomphus have been taken from the park to date.

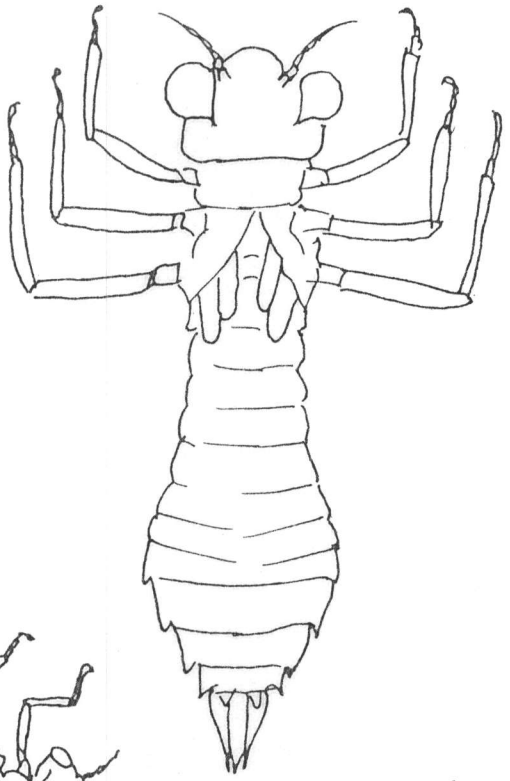
Aeschnidae. About a dozen species have been found in our area - Anax junius and 11 species of Aeschna. These are common, large, dark-colored dragonflies seen in most areas of the park. We have identified seven species from the park.

Libellulidae. The largest number of genera (6) and species (25) in our fauna belong to this family. There is much diversity in the family - the large red dragonflies seen near thermal features, various golden ones intermediate in size and the small black ones all belong to this family. Seventeen species have been named to date from the park and we expect to find more.

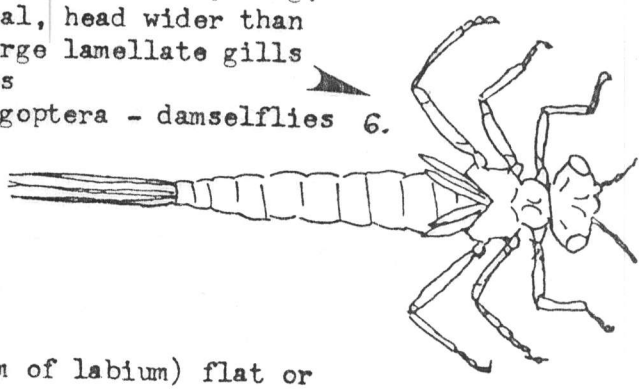
Cordulidae. One member of this family has been taken from within the park and we another from just outside. There are three genera and six species in this area.

Key to the nymphs of the Odonata

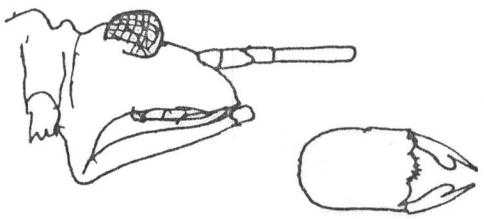
1. Body relatively stout, abdomen wider in middle or beyond, head usually smaller than abdomen, no large leaf-like anal gills, three stiff anal valves present - Anisoptera - dragonflies 2.



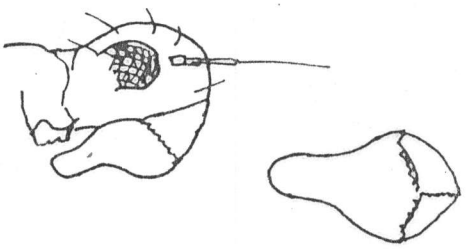
Body relatively slender and tapering, abdomen cylindrical, head wider than abdomen, three large lamellate gills as anal appendages
Zygoptera - damselflies 6.



2. Under lip (mentum of labium) flat or nearly so 3.



Under lip (mentum of labium) spoon- or mask-shaped covering face up to eyes 5.



3. Antennae 6 or 7 jointed; all tarsi with 3 segments 4.



Antennae 4-jointed; tarsi 2-2-3 segments - Gomphidae



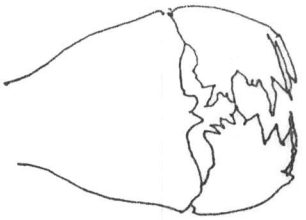
4. Joints of antannae short, thick, hairy
Petularidae ➤



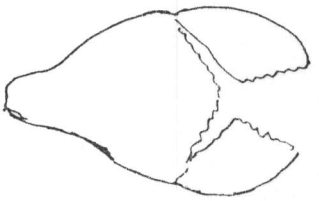
Joints of antannae slender and bristle-like Aeschnidae ➤



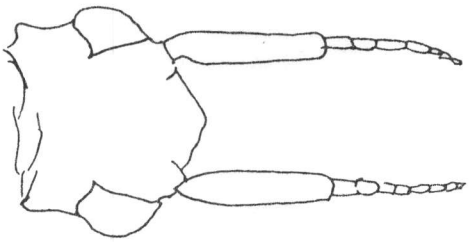
5. Lateral lobes of labium deeply and irregularly cut and forming large irregular teeth Cordulegasteridae ➤



Lateral lobes of labium more regularly and evenly cut to form even teeth
Libellulidae ➤

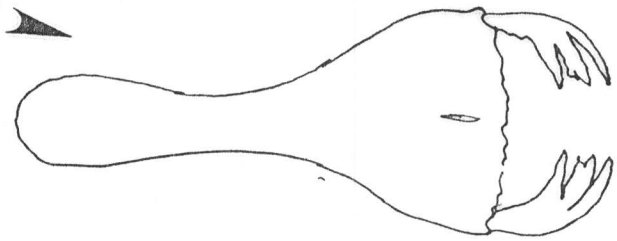


6. First antennal segment longer than other segments combined, mentum with deep open cleft, lateral anal gills triangular in cross section Calopterygidae ➤

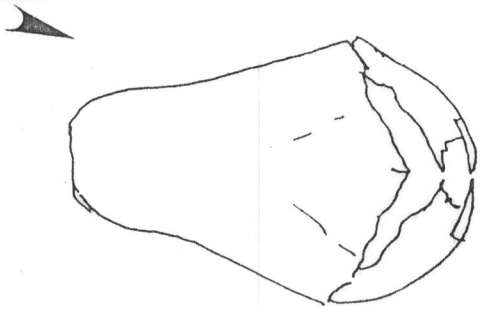


Antennal segments about all equal, mentum entire or with a closed median cleft, lateral anal gills flat 7.

7. Basal part of labial mask narrowed to a slender stalk, median cleft present but closed, lateral lobes of mentum with 2 to 3 deep incisions Lestidae



Basal part of labrum not greatly narrowed; no median cleft in labrum; lateral lobes not deeply incised Coenagrionidae



Trichoptera - caddisflies.

Caddisflies are important in the economy of streams because of their large numbers and their role in maintaining energy and food flow. Most caddisflies get their food from grazing on diatoms and algae, from dead organic matter or a combination of the two. Some groups use nets to strain any organic matter from the current for food. Members of the family Rhyacophilidae and a few genera in other families are carnivorous and feed on other invertebrates which they can catch. Generally the grazers and detritus feeders are cased - they make portable shelters which are used for protection and anchoring. As they grow larger, they add to the size of their case. Those who use nets spin them from silk and place them in the current while the predators are free-living and readily roam about in search of prey.

In the past few years fly-fishermen have become aware of the major role of caddisflies in stream biology and there is much new information about larval, pupal and adult behavior from this source.

Well over a thousand species of caddisflies are found in North America and we have collected 12 families and 73 species within Yellowstone National Park. We expect that there will be about 100 species on the park list when we have finished collecting.

The life cycle of caddisflies follows the general pattern; egg, larva, (five stages), pupa and adult. Most species have one generation per year but in thermal waters, such as those found in the park, emergence dates and number of generations per year may be changed considerably. For, instance, Brachycentrus occidentalis emerges during late April and

early May in normal streams but on the Firehole River it emerges from May into November - its normal developmental pattern is entirely changed.

The families and some of their members in the park are as follows: Hydroptilidae. Members of this family are minute - from 2 to 5 mm long - and are known as micro-caddisflies. In Yellowstone Park members of this family are found in great abundance in thermally influenced waters and reach great numbers in the Firehole, Gibbon, Madison and Gardner Rivers where thermal influence is found. Hydroptila, Leucotrichia, Mayatrichia and Ochrotrichia are all found in warmed water and two species of Agraylea are taken from cold streams. Emergence of those species inhabiting warm streams is greatly extended in time from normal patterns. Hydroptilids are mostly grazers, feeding on periphyton on the substrate.

Helicopsychidae. As the name implys, this caddisfly builds a helix-shaped case which greatly resembles a snail shell. We have but one species in in this area - Helicopsych borealis. This species is common in many spring creeks and slow streams where temperature does not get extremely low. H. borealis is about as large as the largest hydroptilids.

Hydropsychidae. Hydropsychids may be our most common caddisflies and are found in practically all streams. They make nets which are placed in the current to capture diatoms, algae, and detritus upon which they feed. Five genera and about 25 species are found in this area. We have taken the following in the park and expect that a number of other species will be found: Arctopsyche grandis, Cheumatopsyche pettiti, C. enonis, Hydropsyche bronta, H. cockerelli, and H. occidentalis.

Glossosomatidae. Six genera and about 80 species of this family are known from North America. Five genera and 10 species have been found in

the park. Larvae graze on exposed rocks to get the diatoms and algae growing there. Several species are very small and may be mistaken for hydroptilids so size alone should not be used for identification. Agapetus montanus, Anagapetus debilis, five species of Glossosoma and Protoptila coloma are found in streams and rivers with normal temperatures. Culoptila cantha and Protoptila erotica are found more commonly in heated streams.

Rhyacophilidae. The single genus in our area, Rhyacophila, has about 100 species in North America. We have collected 31 species from Montana and 9 species from the park. We expect to find several more species. Rhyacophilid larvae are free-living - they have no case- and are predators mainly on other insects. They are found only in cold mountain streams - not in thermal waters.

Phryganeidae. Members of this family live in spring creeks, ponds, marshes, and lakes. Phryganea cinera has been collected from park lakes and is on the wing in late June. It is a large dark species most often seen at dusk.

Polycentropidae. There are 6 North American genera in this family. Our collecting in the park has yielded only one species but there are certainly several more to be found. The larvae are net spinners and are found in ponds and lakes where wave action washes food to their nets.

Psychomyiidae. Two genera are known from western United States but only Psychomyia flavida is found in the park. This is a small species widely distributed and very abundant in the park.

Molannidae. Two genera and seven species are found in North America. Molanna flavicornis is the most widespread and occurs in lakes in Yellowstone National Park. The larvae feed on various kinds of organic matter which they collect from the lake bottoms.

Leptoceridae. We have captured four genera and seven species of this family in park waters. Oecetis is the common genus with three species, Mysticides has two species, while Nectopsyche and Ceraclea each are represented by a single species. Six genera with over 20 species have been identified from neighboring Montana. Leptocerid adults are beautifully patterned, have extremely long graceful antannae and are often found in abundance in warmer trout waters. Fishermen love them.

Philopotamidae. These caddisflies are net-spinners. All three North American genera are found in park waters. Chimarra, Dolophilodes and Wormaldia are all found in cold creeks.

Brachycentridae. Larvae of this family build 'log cabin' type cases and graze on periphyton and organic debris. Brachycentrus occidentalis occurs in a wide variety of habitats in the park while Amiocentrus aspilus and Micrasema sp. are more restricted and rare.

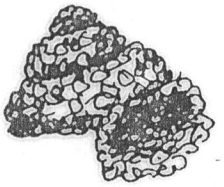
Lepidostomatidae. Of the two genera in this family, only one, Lepidostoma, occurs in the west. Larval cases vary from species to species, Food is periphyton and debris. Two species, L. aporna and L. rayneri, are presently known from the park and others probably will be found.

Limnephilidae. There are more genera (52) and more species (300) in this family than in any other family in North America. There are also more

kinds in the park than from any other family. Five species of Limnephilus have been found, 3 species of Oligophlebodes, 2 species of Apatania and one each of Amphicosmoecus, Farula, Glyphopsyche, Hesperophylax, Psychoglyphy, and Neophylax. The various species are adapted to a wide variety of habitats and are often the dominant caddisflies in alpine areas, swamps and sloughs.

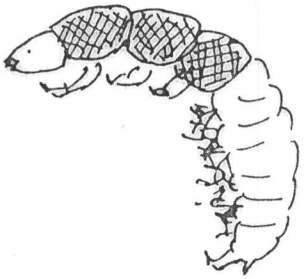
Key to the larvae of Trichoptera to family.

1. Case spiral in structure, similar to snail shell — Helicopsychidae



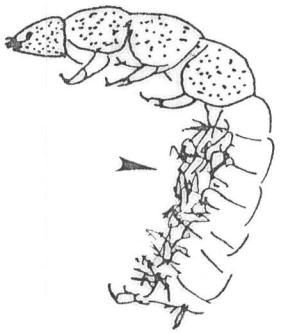
Case of different structure or absent — 2.

2. Large sclerotized plate on each of the three thoracic segments — 3.

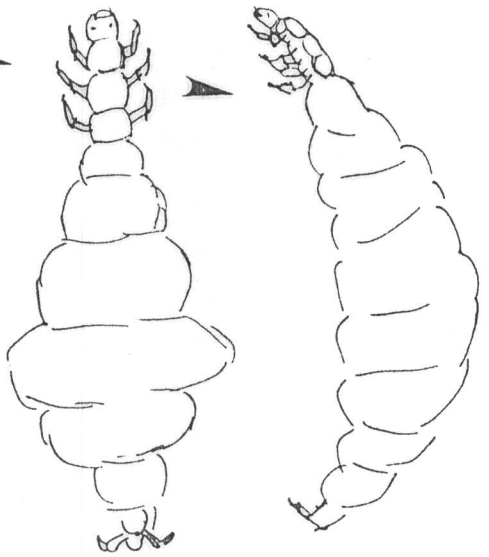


First two thoracic segments with sclerotized plates but last segment with plate absent or in several separated pieces — 4.

3. Abdomen with conspicuous gills on lateral and/or ventral surface; no case present; usually more than 5 mm long. — Hydropsychidae

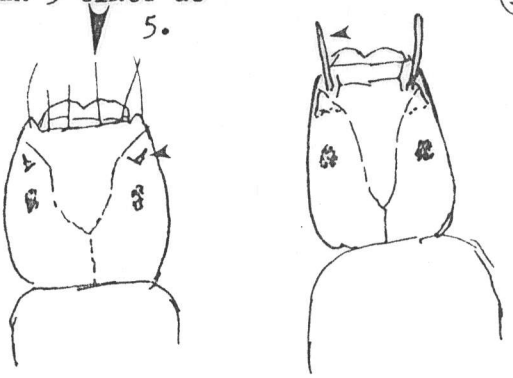


Abdomen without gills; case present in later instars; smaller than 5 mm; late stage larvae with enlarged abdominal segments — Hydroptilidae

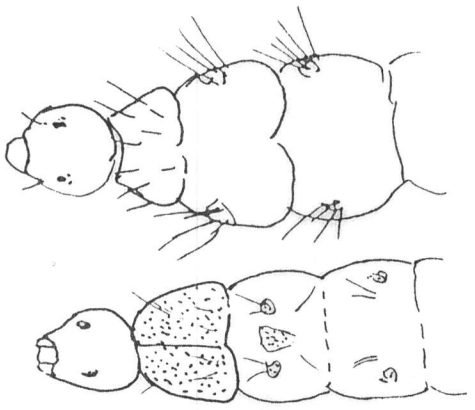


4. Antennae seven or more times longer than thick; case slender, made of sand or vegetable matter; in standing or running water — Leptoceridae

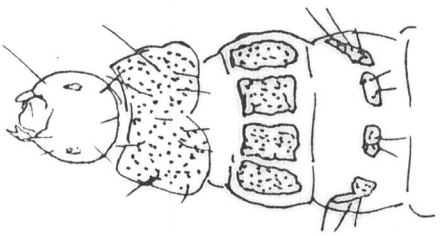
Antennae very short, often difficult to find, less than 3 times as long as thick. — 5.



5. Second thoracic segment without sclerotized plates or with only small scattered plates 6.

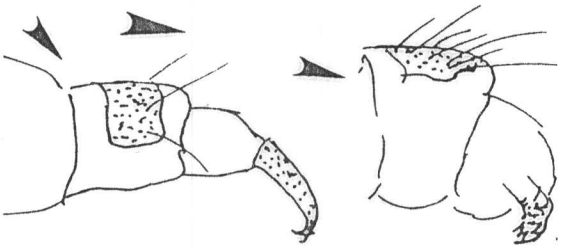


Second thoracic segment almost completely covered with sclerotozed plates 11.

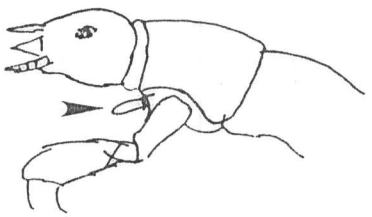


6. Last abdominal segment with a dorsal sclerotized plate 7.

Last abdominal segment without a dorsal sclerotized plate 9.



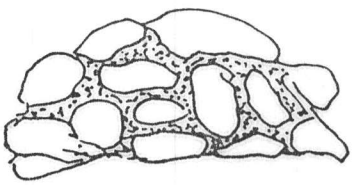
7. With large ventral prosternal horn; case of vegetation arranged in spiral; in lakes or slow streams Phryganeidae



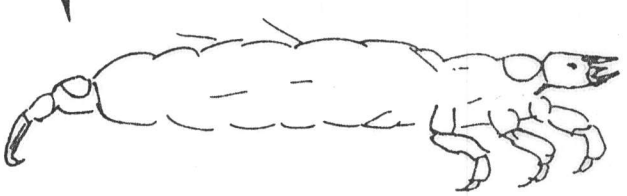


Prosternal horn absent; case absent or tortoise shell shaped; in streams and rivers. 8.

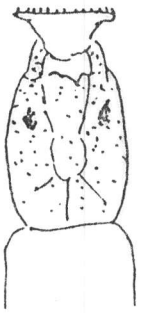
8. Tortoise shell shaped case, composed of sand or fine gravel Glossosomatidae



Case absent: mouthparts protruding in front Rhyacophilidae



9. Labrum soft and extended ~~to~~ on the sides; in slender silk nets under rocks in swift streams Philopotamidae



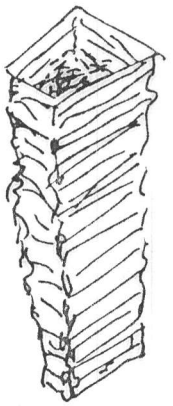
Labrum sclerotized; not laterally extended 10.

10. Larvae in flimsey silken nets; trochantin of foreleg hatchet-shaped; lake margins and streams Psychomyiidae



Larvae in funnel-shaped net; anal prolegs divergent and long; trochantin of foreleg pointed Polycentropidae

11. First abdominal segment without dorsal and lateral humps; case square and composed of vegetable matter; case round in a few. Brachycentridae



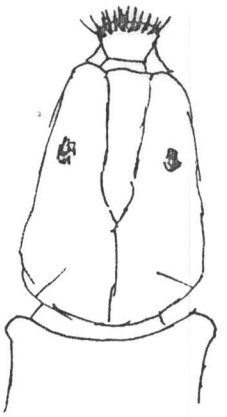
First abdominal segment with humps on top, side or both; case variable 12.

12. Claws of 3rd set of legs different from those of 1st and 2nd pair; case of sand with wings; streams or ponds Molannidae



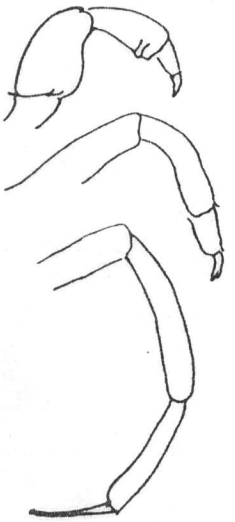
Claws of all legs similar 13.

13. Labrum with row of 15 to 20 stout seta across middle; rare (not in YNP) Calamatoceridae



Labrum with only a few seta 14.

14. Anal proleg with brush of fine seta; hind tarsal claw 2X as long as that of 2nd proleg; (not in YNP) Beraeidae



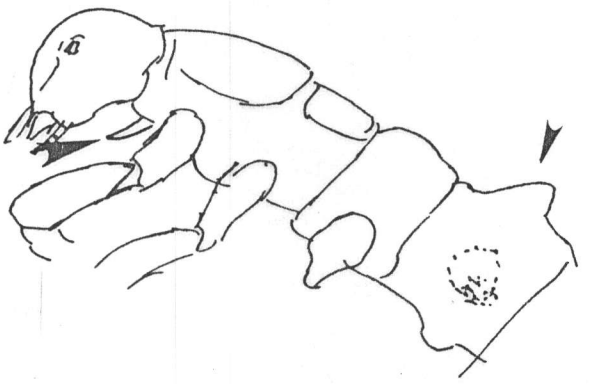
No brush on anal proleg; claws about equal in size 15.

15. Dorsal tubercle of first abdominal segment absent; case of sand grains bark or leaf bits Lepidostomatidae



Dorsal tubercle present on first abdominal segment 16.

16. Prosternal horn present; cases of many kinds. Limnephilidae



Prosternal horn absent; case of sand or fine gravel 17.

17. Sericostomatidae and Odontoceridae have not been taken in this area

Ephemeroptera - mayflies.

Mayflies are often the most abundant insects in streams and are found to some extent in about all streams. Some species also occur commonly in ponds and a few are found in lakes or along the shores of lakes. I have taken about 30 species in the park and estimate that there may be another dozen species to be tabulated.

Mayflies are of special interest to flyfishermen because of the historical association between the development of fly fishing and the commonness of mayflies on the streams where this type of fishing originated.

Mayflies may not be easy to identify because, more often than not, the form in hand is the sudimago (dun of fishermen) with which it is difficult and sometimes impossible to detect the characteristics needed for species separation. When collecting adults it is best to first examine the specimens while they are still alive and if they are duns - greyish wings and dull colors - place them in a plastic box or other container so that they can moult to the true adult (spinner) in which stage they are capable of being accurately classified. Since the males are needed for diagnosis to species in most cases, large numbers are usually collected so that there is better chance of attaining some males. Usually swarming mayflies are males so that is a good place to collect.

As noted, mayflies are unique in that they have two adult stages divided by a moult. Their life cycle is: egg, nymph (up to 22 stages in some species) subimago (dun), and imago (spinner).

In some families the nymphs, when large, are easier to classify to species than are the adults. This is especially true in the families Ephemerellidae, Baetidae, and Tricorythodidae. Shed skins or 'shucks'

may therefore be of value in diagnosis of species - especially if duns or females are the only adult forms at hand.

The known representatives of the mayflies in our area are as follows:

Baetiscidae. This family contains only one genus - Baetisca. I know of no reports of this genus in the park. In Montana one species is known and some nymphs have been taken in Wyoming so we may eventually find Baetisca in the park. Most species in the family are found in the southern and eastern parts of the country.

Leptophlebiidae. There are 13 North American genera in this family with a total of about 100 species. The major genera and species in this area are: Choroterpes albiannulata is found in the Yellowstone River and some of its tributaries in Montana but not in the park. Leptophlebia contains 9 species in North America but only L. gravestella is found in the park. Paraleptophlebia debilis and P. heteronea are park natives and P. vaciva should be found at higher altitudes in cold streams. P. bicornuta and P. memorialis could possibly be found at lower elevations in warmer waters.

Ephemeridae. This family is comprised of four genera, two of which are found in the west: Hexagenia and Ephemera. These are burrowing mayflies whose nymphs live in tunnels in the bottoms of silty streams. Ephemera simulans is the only species known from the park and was once common in the Firehole-Madison river system but is now extinct or extremely rare. We have good collections of this species from the Firehole in 1955 and a few specimens from the Madison River in 1961. Fishermen say that this species dissapeared as a result of the earthquake in 1959.

Polymitarcidae. There are three North American genera in this family.

Ephoron album is the only species which occurs in our area where it lives as a burrowing larva in silted stream bottoms. It has not been taken in the park but is found in areas both to the north and the south.

Oligoneuridae. The two genera and several species of this family are mostly from warmer climates. One species, Lachlania powelli, might be found in this area.

Siphlonuridae. This family is well represented in our fauna. Ameletus has several species which occur in Yellowstone National Park: cooki, oregonensis, validus, velox, and similor. These are early season mayflies of large size and with striking patterns. Siphlonurus occidentalis is a late season species found in various areas of the park. Isonychia and Analetris have been found in neighboring areas but not in the park. The other three genera in this family are not likely to be found here.

Tricorythodidae. Of the three genera in this family only Tricorythodes has been found in the park. T. minutus has been found in the Madison River but probably occurs elsewhere.

Caenidae. A recent collection of a species of this family near the park indicates that it will probably be taken within the park. These are so similar to Tricorythodes species that that they may have been mistaken for that species many times.

Ephemerellidae. Until a few years ago all members of this family were placed in the single genus Ephemerella. Since there were over 80 species in this genus it was a welcome change when the subgenera were elevated to genus level. The new genera are: Attenella, Caudatella, Dannella, Drunella, Ephemerella, Eurypophella, Serratella, and Timpanoga.

At least 14 species from this family have been found in the park. In fact, several species were first found and described from specimens collected in the park. Among the most common species are: Ephemerella inermis/infrequens a complex of two species which inhabits most of the larger streams including the Yellowstone, Madison, Snake, Lewis, Firehole, and Gibbon Rivers and numerous small streams. Ephemerella laucustris was described from the shores of Yellowstone Lake where it is still found. Caudatella heterocaudata was first described from the Firehole and also is found in the Yellowstone River. Drunella doddsi is found in large numbers in the Lamar River and other streams and may be confused with Drunella grandis ingens which also occurs in larger streams and is known to western fishermen as the 'green drake'. Also within the Drunella genus are: coloradensis, flavilinea and spinifera - each found in its preferred habitat. Timpanoga hecuba hecuba is common in the lower Yellowstone River in the park and Attenella margarita is also found in the Yellowstone both in and out of the park. Seratella tibialis occurs in small cold streams.

The ephemerellas are some of the most widely imitated mayflies tied by fishermen. Sizes range from 5 mm for inermis to 15 mm for large egg-laden grandis-ingens. All ephemerells have two pairs of wings and three tails.

Heptageniidae. This family, along with Ephemerellidae and Baetidae, provide most of the species of mayflies in our area. Cinygmula is represented by two species - reticulata and tarda and we can expect to find more species later. Cinygma a close rare relative has not been taken in the park but it occurs close by so it should be found here. The genus Epeorus is

divided into two subgenera; Iron and Irinopsis. Iron albertae is common in some of the larger rivers in the park while Iron deceptivus occurs in some of the smaller colder streams. Ironopsis grandis is occasionally taken in cold streams. Heptagenia simplicoides has been found in the park.

Rithrogena species are probably the most common members of this family in the park area. Futilis, hageni, robusta and reticulata are well documented and we expect to find several other species. Stenonema reesi has been taken nearby in Montana and should be found in similar habitats in the park. There are several other genera in the family but they do not occur in our area.

Ametropodidae and Metropodidae. The members of the latter family are all found in warmer climes. At least one species of Ametropus might be found here since it has been collect to both the north and south.

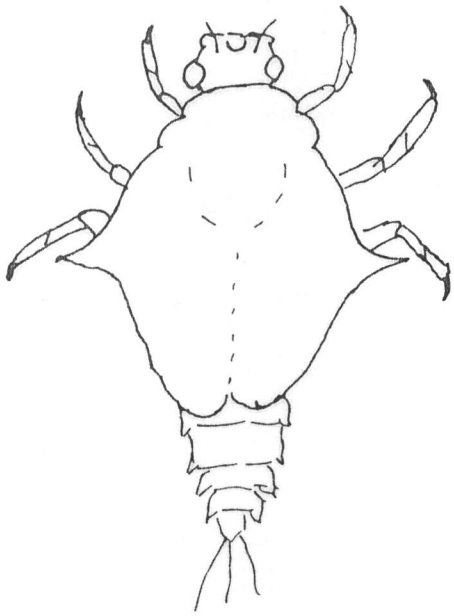
Baetidae. Baetis is one of the most common genera in the park as it is from the surrounding areas. Recent work on this genus has relieved a lot of confusion in identification of species. The main changes which have occurred in our local species are: B. parvus is now B. hageni, B. intermedius and B. vagans are now B. tricaudatus, The species which we have taken in the park are: B. bicaudatus found in small cold mountain streams, B. insignificans found in larger rivers but quite rare, B. propinquis from several areas, B. tricaudatus found in warm and cold streams throughout the park and the earliest and latest to emerge. On the Firehole River this species can be found emerging all months of the year. On cold streams it begins emergence in April. B. thermophilus was first described by McDunnough from the Firehole at Old Faithful.

Callibaetis species are found in ponds, lakes and eddies of streams.

C. coloradensis and C. doddsi are the two species we have found in the park. Centroptilum has occasionally been collected near the park so it may eventually be found here. Pseudocloeon edmundsi is found in abundance in the Firehole River and it, together with B. tricaudatus, makes up most of the mayfly hatch on that and other thermal streams. It emerges from April through October.

Key to families of mayflies (nymphs).

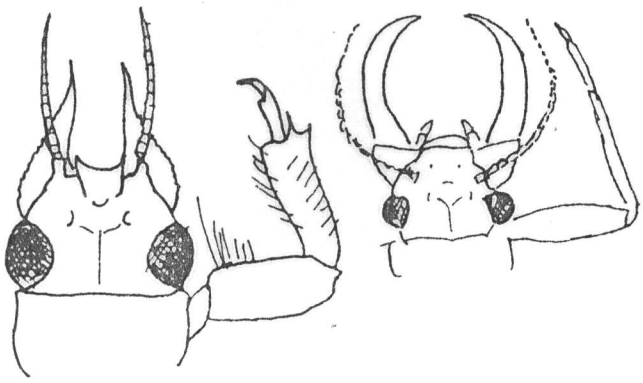
1. Top of thorax greatly enlarged and extending back over abdomen so that gills are concealed. ➤



Baetiscidae

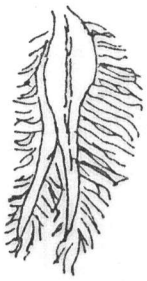
Top of thorax not so extended, gills visible 2.

2. Large tusks extending forward from front of head, visible from above. ➤ 3.

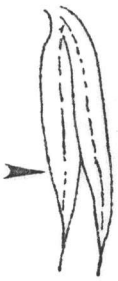


No such tusks extending from front of head 6.

3. Gills on abdominal segments 2 to 7 divided and with fringed margins ➤ 4.

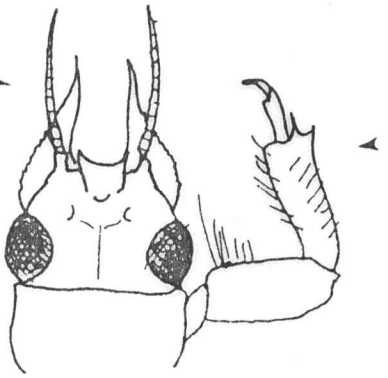


Gills on abdominal segments 2 to 7 divided but without fringed gills ➤

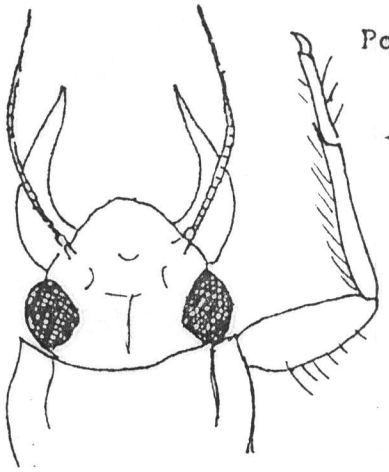


Leptophlebiidae

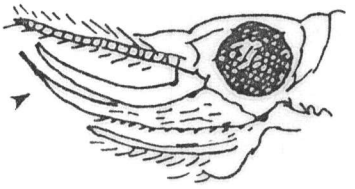
4. Forelegs flattened , adapted for burrowing; gills held over back. 5.



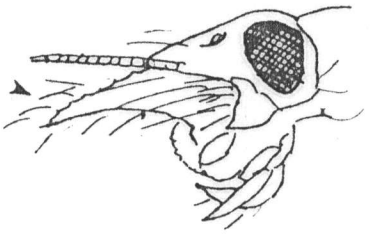
Forelegs cylindrical in cross-section; gills held at the side Potamanthidae



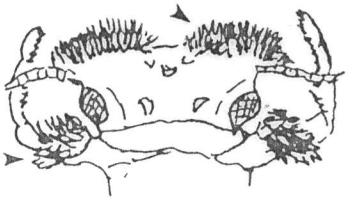
5. Tusks curved upward when viewed from the side. Ephemeridae



Tusks curved downward at tip when viewed from the side Polymitarcidae

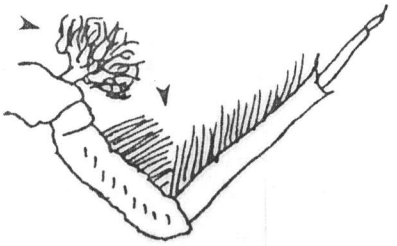


6. Head and thorax with dorsal pads of spines; gills on segments 2 to 7 held beneath belly and with fringed margins Behningiidae



Head and thorax without pads; gills not held beneath belly 7.

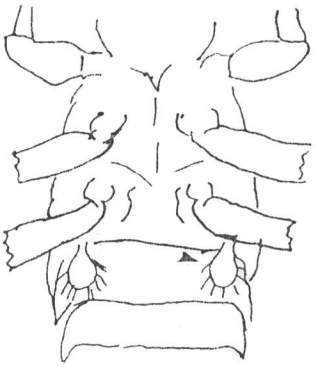
7. Front legs with double row of long hairs on front surface; gills on neck and sometimes at base of front leg 8.

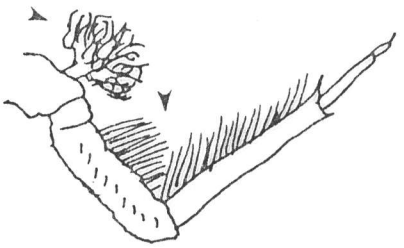


No rows of hairs or gill tufts 9.

8. Gills ventral on abdominal segment 1; no gill tufts at base of forelegs Oligoneuridae ➤

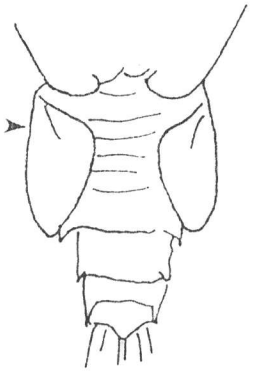
Gills dorsal on abdominal segment 1; gill tufts at base of forelegs Siphlonuridae (Isonychia) ➤





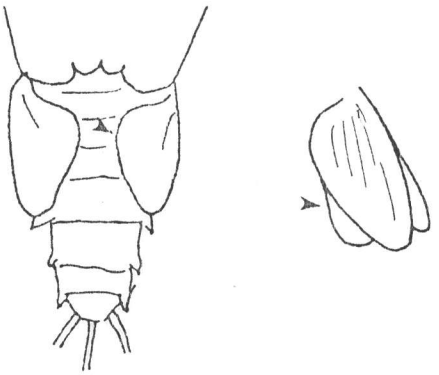
9. Gills on abdominal segment 2 enlarged so that they cover the gills on the suceeding segments 10.

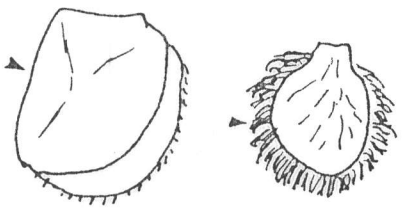
Gills on segment 2 not covering the rest of the gills 11.



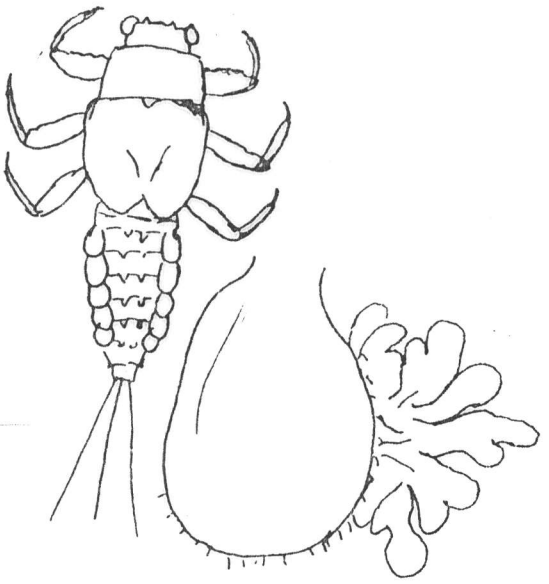
10. Enlarged gills on segment 2 triangular in shape and not meeting on the mid-line; gills on segments 6 to 3 without fringed margins Tricorythodidae

Gills on segment 2 squarish and meeting on the mid-line; gills on segments 3 to 6 with fringed edges Caenidae ➤



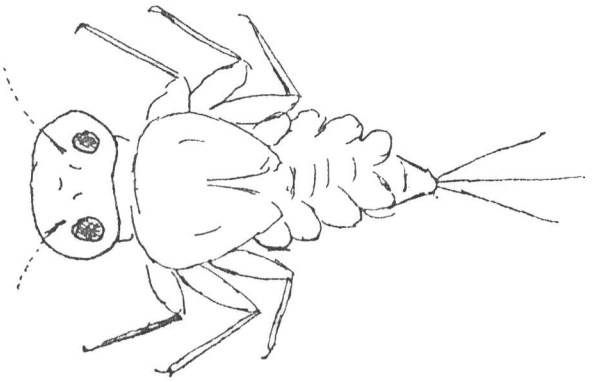


11. Gill absent on segment 2, small or absent on segment 1; gills on 3-7 or 4-7 consist of two parts - a front leathery flap and a membranous back flap with lobes; paired sharp bumps often occur on top of the abdominal segments. Ephemerellidae ➤

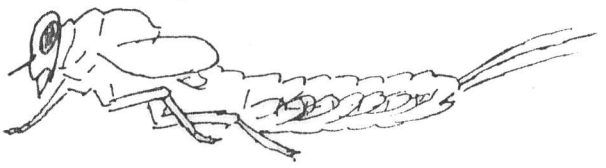


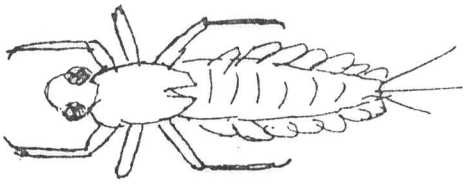
↓ Gills absent on abdominal segments 1-5, 1-7 or 2-7; paired sharp bumps not found on abdominal segments 12.

12. Nymph distinctly flattened; eyes and antennae on top of flattened head 13. ➤

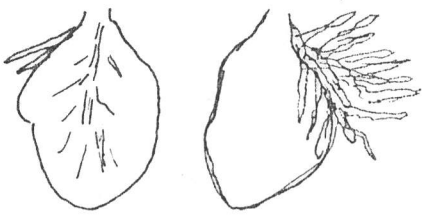


Nymph not flattened or only slightly so, more cylindrical; eyes and antennae on side or front of head, mouthparts at bottom of head 14. ➤

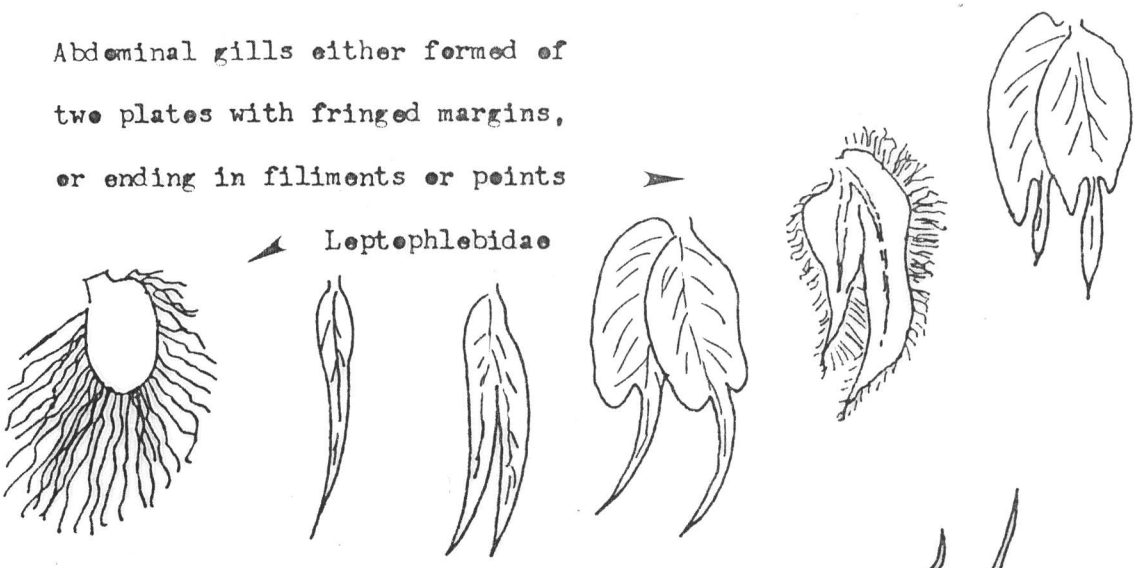




↓ 13. Abdominal gills with single oval plate with tuft at base; rarely the gill may be pointed or have a narrow appendage at the bottom ➤ Heptageniidae

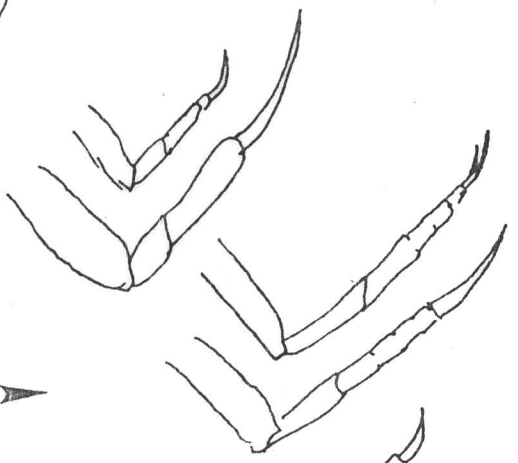


Abdominal gills either formed of two plates with fringed margins, or ending in filiments or points ➤



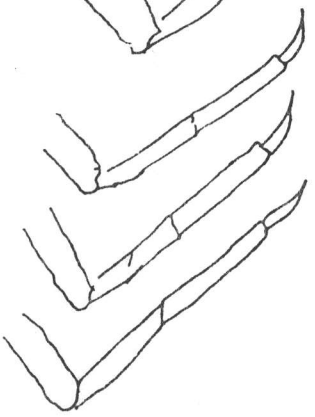
➤ Leptophlebidae

14. Claws of hind legs differ in structure from those of middle and hind legs; claws ofmiddle and hind legs very long and slender ➤

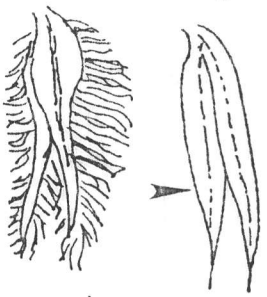


Ametropodidae
Metropodidae

Claws on all legs similar in structure, those on hind leg may be longer than those in front but not longer than tibia 15. ➤

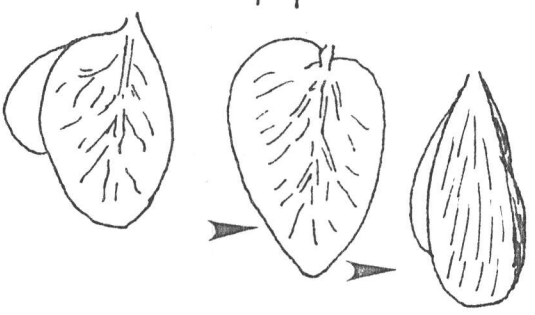


15. Abdominal gills on segments 2-7 either forked, intufts with all margins fringeder with double layers with all margins fringed. ➤



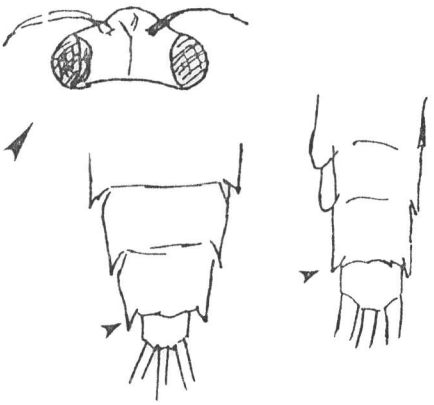
Leptophlebiidae ➤

Gills roughly oval in shape with single, double, or triple layers; not with long filaments, points or fringes 16. ➤



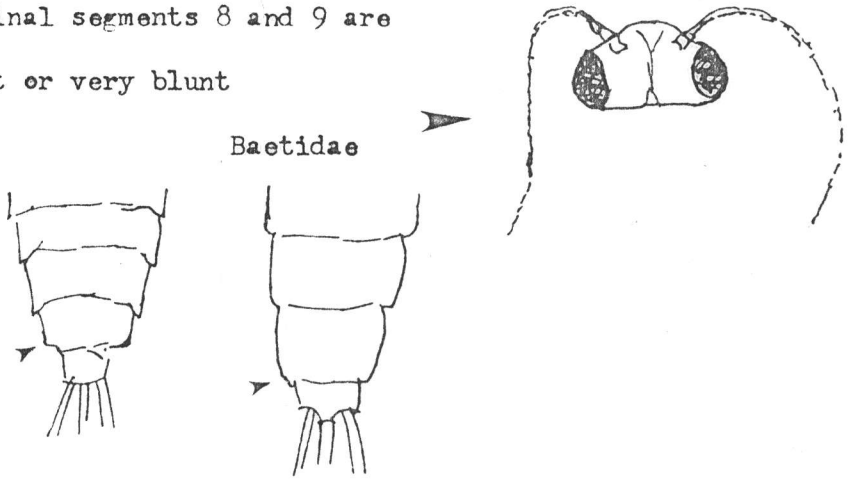
16. Antennae short, less than twice width of head; sharp backward - pointing spines formed by abdominal segments 8 and 9 (some exceptions)

Siphlonuridae



Antennae long, more than three times head width; projections on abdominal segments 8 and 9 are absent or very blunt

Baetidae



Diptera - True Flies

It is safe to say that there are more species of aquatic diptera than species of any other of the aquatic orders in Yellowstone National Park. We do not have a good understanding of the size and diversity in the park - partly because of the time involved and partly because it is a difficult group with which to work. Unlike mayflies, caddisflies and stoneflies, where all members of the order are aquatic, the diptera contain families which are wholly, partly or entirely non-aquatic.

Almost all types of aquatic habitats are inhabited by one or more species of diptera. Hot pools or frigid alpine streams; deep lakes or shallow ponds; alkali pools, saline seeps, tidal pools - you name it- even oil pools - you'll find some diptera at home there.

As with most of the aquatic orders, only the egg and larval stages are aquatic, the adults are terrestrial. There are usually three or four larval stages and pupation most often orrurs in the water. In a few species there may be several generations per year and in a few other species it may take two or more years to mature - most species, however, require only one year per generation.

Following is a summary of the families which have most of the aquatic forms.

Tipulidae - crane flies. The adults of this family might be mistaken for giant mosquitos. Unlike mosquitos they cannot bite and are harmless to humans. About 25% of the craneflies are non-aquatic and live in damp soil. If that soil happens to be in a farmer's field they can do extensive damage to the root system of the crops - farmers call these forms

'leather jackets'. Most species, however, are aquatic and provide important links in the balance of aquatic ecosystems. Most species consume large amounts of dead organic matter while a fairly large group are predators. There are about 70 genera of tipulids in North America which contain anout 1500 species. Thre has been little work done on northern Rocky Mountain craneflies. We have identified about 15 genera and twice as many species from Montana.

Ptychopteridae - phantom crane flies. We have encountered members of this family only rarely. There are reported to be about 20 species in the United States - we have found one. The larvae feed on decaying organic matter at the edges of ponds and bogs. The adults resemble crane flies.

Tanyderidae - primitive crane flies. Both the larvae and adults resemble true crane flies. Members of the family are very rare.

Blepharoceridae - net winged midges. Adults resemble mosquitos in size and appearance. The larvae are unique as our picture shows. The larvae inhabit riffle areas of clear cold mountain streams but are not common. Four genera occur in western United States and specimens have been taken in the park. Their identity is not known.

Deuterophlebiidae - mountain midges. This is another rare and unique group. Mountain midges are most often found in clear cold mountain streams - sometimes into the alpine zone. Deuterophlebia coloradensis and D. neilsoni have both been taken from park waters. There are five described species from the United States.

Psychodidae - moth flies. Adults are small hairy flies - the larvae are secondarily divided into many segments and feed on algae and organic matter in clear streams. We have no records of this group in the park.

Dixidae. This family contains over 40 species but is rare in our area. Most of our records are from spring seeps and we have no collections from the park.

Culicidae - mosquitos. Although we do not have a complete species list for the park we can aver that many species are found here. In neighboring Montana there are 46 species in six genera. Mosquitos are not only pesty from their biting but may also carry encephalitis and other diseases. In all aspects they are among the most unwanted of the aquatic insects. Larvae live in temporary to permenent pools, ponds, swamps and other water where they feed on live and dead organic matter. Adult females are the ones who suck blood.

Chaoboridae - phantom midges. The name phantom comes from the fact that the larvae are almost transparent and very difficult to see. We have collected these consistantly in the park ponds and lakes which occasionally dry up. The larvae are predacious and feed on other invertenrates which they can catch. Some authors consider this family a subgroup of the mosquitos.

Simulidae - black flies. Black flies, also called buffalo gnats, are common in the park and several species have been identified. We know of no effort however to systematically document their occurance. The larvae use fan-like mouth structures to strain diatoms and organic matter from the current for food. Adult females suck blood from man and other animals and are notorious pests in some areas at certain times of the year. There are 5 genera and 80 or more species found in the United

States. Simulium arcticum and S. tuberosum have been taken from the Madison River in the park.

Chironomidae - midges (Tendepedinidae) This family is the most abundant of the aquatic diptera both from the standpoint of total species and total numbers. There are an estimated 2500 species in United States and in Montana we have documented over 75 genera. Probably several hundred species will be found in Yellowstone's diverse habitats. Chironomidae are found under all conditions and represent all trophic levels. A dozen or more different species may inhabit a square meter of stream bottom and total numbers will often be in the thousands. Lake ooze supports enormous numbers of midge larvae to the greatest depths and many lakes would be barren of fish if it were not source were not available. Even though larvae and adults are both small, their great numbers collectively supple a huge volume of food.

Ceratopogonidae - biting midges, punkies. (Heleidae) About 6 genera and 100 species of these pests are to be found in the United States. The larvae inhabit vegetation mats and debris in springs, ponds and streams where they live on dead and living organic matter. The adults are known locally as 'punkies' and 'no-see-ums' and inflict severe bites on man and animals when they are abundant. We have found several species in the park but, fortunately, none in large numbers.

Athericidae - snipe flies. (Rhagionidae) Atherix variegata is a common dipteran larvae found in many of our mountain streams. This genus is the only one in the family but several species are known from other areas. Females attach their eggs to twigs which overhang the water and, after oviposition, the female dies attached to the eggs. As the eggs

hatch larvae drop into the water where they develop. The larvae are predators and there is a single generation per year.

Stratiomyiidae - soldier flies. The larvae of members of this family are unique in that they have such extensive deposits of calcium - carbonate in their skin that they appear hard, immobile and almost lifeless. They are general feeders on organic matter in spring creeks and in mildly influenced thermal waters. We have taken 2 genera in Montana.

Tabanidae - horse flies, deer flies, gad flies. There are three aquatic and several non-aquatic genera making up some 400 species in the United States. Those genera which are not truly aquatic require swampy wet ground in which to develop. Horseflies are severe pests of livestock and people when they are present in large numbers. Of the aquatic larvae, some are predators and some are general feeders. We have records of six genera and many species in Montana but know little about the park fauna.

Syrphidae - flower flies. The commonest member of this family is Eristalis tenax, the rat-tailed maggot. This larvae has a long respiratory tube which it extends to the water surface for air. This is necessary because it is usually found in water thich with decaying organic matter and therefore little oxygen. Members of this family are not often encountered.

Dolichopodidae. Only a few species of this family are truly aquatic but the adults congregrate near streams so they are very common in collections from stream vegetation. The aquatic larvae are rare - they are predators where found.

Empididae - dance flies. Only a few of the several hundred forms known are aquatic. They are rare in our area.

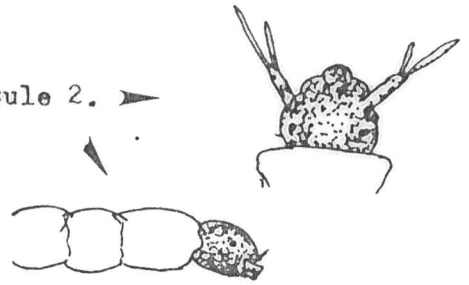
Sciomyizidae - marsh flies. We have few records of this family from our area. Some of the larvae are parasitic on snails.

Ephyridae - shore flies, brine flies. There are about 50 genera, a dozen of which are common, in United States. Ephydrids are found ina wide variety of habitats. Some are capable of living in highly saline waters (brine flies in Great Salt Lake) and some even in pools of petroleum. Brackish, warm, fresh and alkaline waters are all utilized by some species. Ephydrids are common in the park, especially in the thermal waters with their varying chemical composition.

Anthomyiidae and Muscidae. Only a few of the several thousand species in these families are aquatic. They are rare in our area.

Key to Aquatic Diptera Larvae

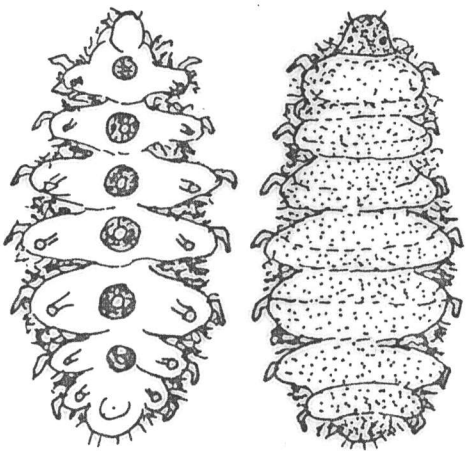
1. With a visible schlerotized head capsule 2. ➤



Head capsule not readily visible 12.

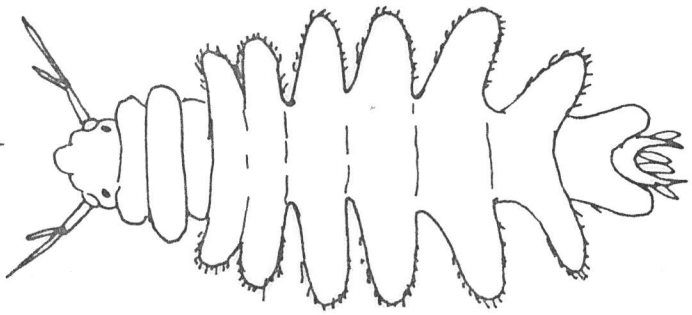


2. Dark colored larvae with six segments and a round sucker on the bottom of each segment Blepharoceridae ➤



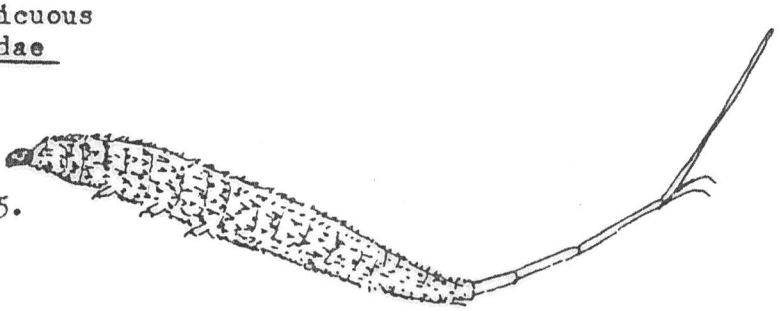
Body with more than six segments and no suckers on the bottom 3.

3. Abdomen with seven pairs of prolegs extending out from side, antannae with two branches Deuterophlebidae ➤



Not as above 4.

4. End of abdomen with a long conspicuous respiratory tube Ptychopterydae ➤

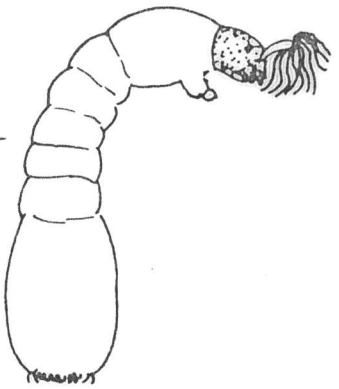


Without the long tube 5.

5. With legs 6.

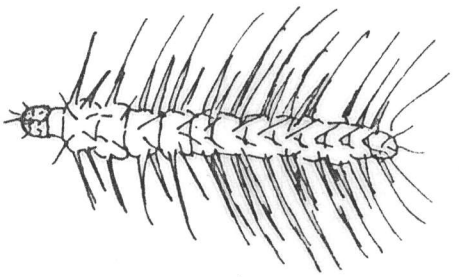
   Without legs 9.

6. With a single leg projecting forward from the thorax Simulidae ➤



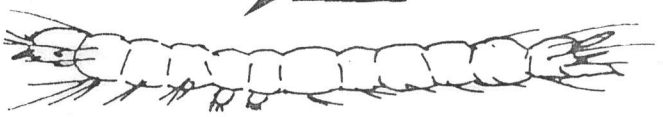
   Legs not as above 7.

7. Body depressed, most body segments with long lateral processes in some species Ceratopogonidae ➤



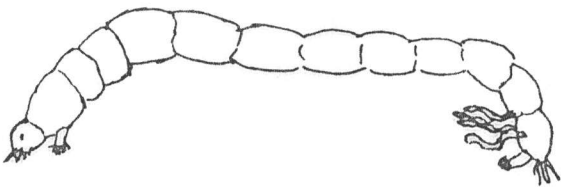
   Body not depressed:; long lateral processes not present 8.

8. Pair of pro-legs on each of first two abdominal segments: larva often assumes 'U' position ➤ Dixidae ➤

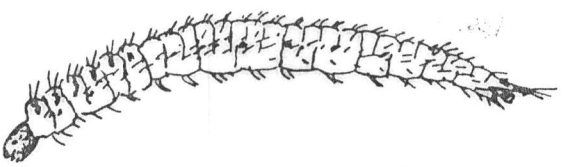




   Prolegs not as above, one pair on thorax, one pairat end of abdomen Chironomidae ➤



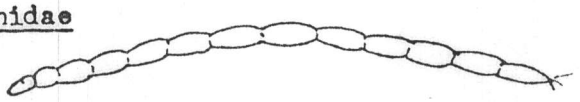
9. Body segments secondarily divided into subsegments Psychodidae ➤



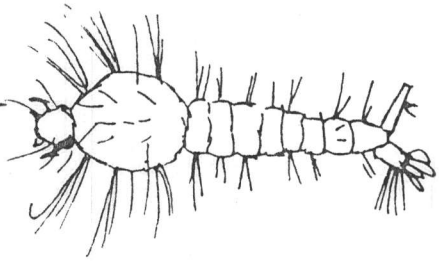
   Segments not secondarily divided 10.

10. Thoracic segments enlarged and fused 11.

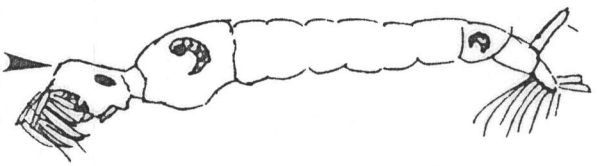
Thorax not enlarged. Ceratopogonidae



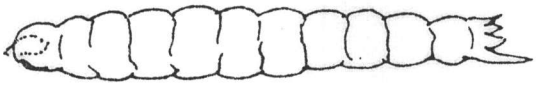
11. Thorax and body depressed (top to bottom) Culicidae

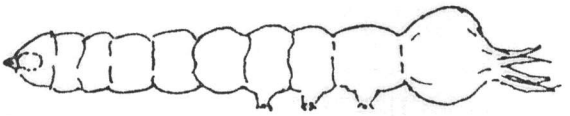


Body compressed (side to side) Chaoboridae



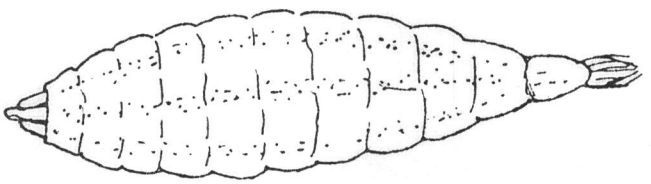
12. Head capsule developed but retracted into first segment; lobed respiratory disc at end of abdomen. Tipulidae





Not as above 13

13. Body spindle shaped and very hard due to calcium carbonate inthe integument Stratiomyiadae

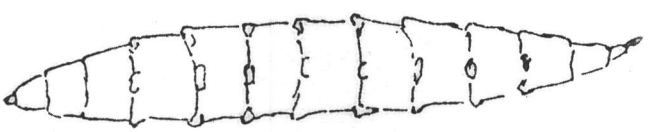


Body not hard with calcium carbonate 14.

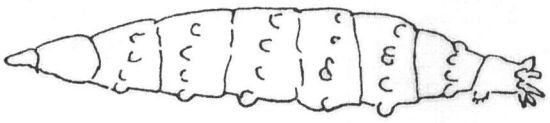
14. Without prolegs but may have creeping welts 15

With prolegs on one or more segments 16

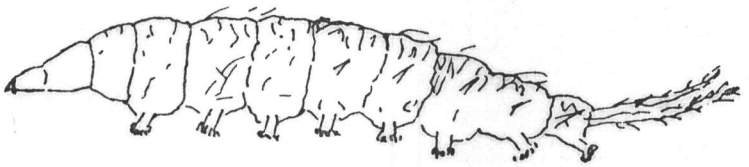
15. Posterior spiracle in a vertical slit or compressed spine: girdle of creeping welts on several segments Tabanidae



Spiracular disc at posterior end surrounded by lobes
Sciomyzidae ➤

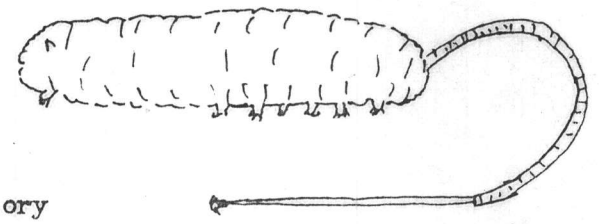


16. With eight pairs of prolegs and a pair of long fringed terminal projections
Rhagionidae ➤



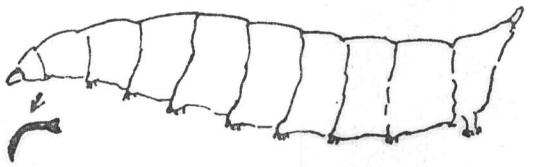
Not as above

17. With a posterior respiratory tube twice as long as body
Syrphidae ➤

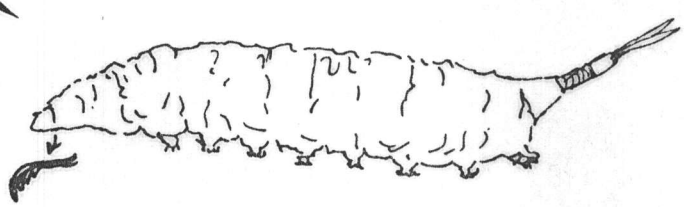


Without the very long respiratory tube 18.

18. Mouth hooks sharp and slender with no teeth Anthomyiidae ➤



Mouth hooks with teeth
Ephydridae ➤



Plecoptera - stone flies.

About 160 species of stoneflies are reported from the Rocky Mountains. About 120 species are known from Montana and we have found 61 species so far, in Yellowstone National Park.

There are two major groups of stoneflies - one predacious and the other herbivorous. Consequently stoneflies enter into the food web of streams at several different levels. Most stoneflies prefer cold clear running water but a few species have adapted to warmer siltier environments. Some have been able to colonize wave-swept shores of lakes.

Yellowstone Park has much habitat suited to stoneflies - hence the relatively large number of species found here. Certainly all the species which live here have not been found to date.

Stonefly life history is ; egg, nymph (12 to 24 moults which may take as long as three years but usually takes one year), and adult. The adults are terrestrial where they mate and females return to the water to lay their eggs and start the cycle anew.

The following families of stoneflies occur in the park:

Nemouridae. Five of the eight genera of Rocky Mountain nemourids are found in the park. They are: Amphinemoura with 1 species, Malenka with 3 species, Podmosta with 2 species, Prostoia with 1 species and Zapada with 4 species. Most nemourids prefer small cold streams and emerge from April to August depending on temperature and altitude. Members of this family are grazers.

Taenopterygidae. Four genera are known from western United States - we have found 2 in the park. Doddsia occidentalis emerges in April and

May and Taenionema nigripenne and T. pacificum emerge in June and July. Members of this family are herbivores.

Capniidae. The capnids are known as the 'winter stoneflies' because of their early emergence - they are often collected from snowbanks on warm late winter days. Capnids are usually small - some only 3 mm in length, and black, with long cerci. Some have normal wings, some have shortened wi wings (brachypterous), and some have practically no wings at all (micropterous). There are seven genera in the family - we have three in the park. Capnia has 4 species, Utacapnia has 2 species and the most common species is Eucapnosis brevicauda. Capnids are grazers.

Leuctridae. Of the 11 western species known, we have found 2 in the park. Paraleuctra vershina is a very common species found during June and July. P. occidentalis has been collected a few times in May from small cold streams.

Peltoperlidae. Only a single species of this family is known to occur in the northern Rockies. Yoraperla brevis is a rare species which is found in cold high torrential streams. It is found in those habitats in the park. It is herbivorous.

Pteronarcidae. Both Rocky Mountain genera are found in the park. Pteronarcys californica, the 'salmon fly', lives in most of the larger streams and rivers in the park (we have records of this species in the Firehole River previous to the 1959 earthquake but none since). This is our largest species of stonefly and fishermen eagarly await its emergence during June and into July when it is taken most voraciously by fish.

Pteronarcella badia occurs in large numbers in some of the smaller rivers and larger streams in the park. Members of this family are grazers.

Perlodidae. There are 11 genera and over 30 species of this family found in the Rocky Mountains. Six genera and 15 species are known from the park. Additions to this group will undoubtedly be made as more collecting is done. Members of this family are medium-sized and are predacious. Isoperla has the largest group of species with 9, Cultus has 3 species, and Arcynopteryx, Kogotus, Megarcys, and Skwala are each represented by a single species. Almost all flowing water habitats are colonized by one or more species of this family.

Perlidae. These are large stoneflies and are mimiced extensively by fly-tyers. Hesperoperla pacifica is found in all rivers and large streams in the park. Claassenia sabulosa and Doroneuria theodora are much scarcer.

Chloroperlidae. Eight genera and 25 species make up this family in the Rockies. Five genera and 15 species are known from the park. Alloperla has 2 species, Paraperla 1, Sweltsa 6, Suwallia 3, Triznaka 2, and Utaperla 1. These are very common stoneflies emerging from streams between June and August. They vary in color from light green to yellow to bronze and are small to medium in size.

Key to the Plecoptera Nymphs (Stoneflies)

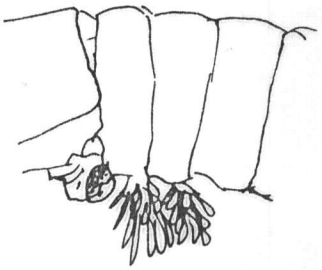
1. Glossa and paraglossa of equal length 2.



Paraglossa longer than glossa 7.

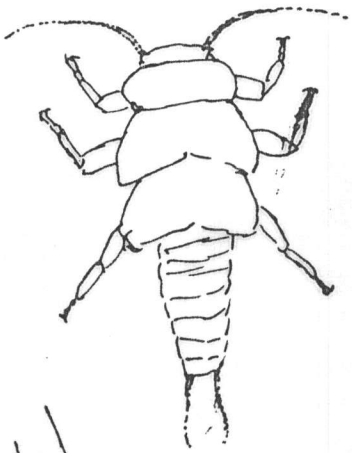


2. Front segments of abdomen with branched gills Pteronarcidae



Front abdominal segments without branched gills 3.

3. Ocelli two; form short and robust Peltoperlidae

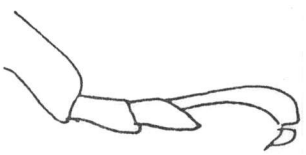


Ocelli three; form elongate 4.

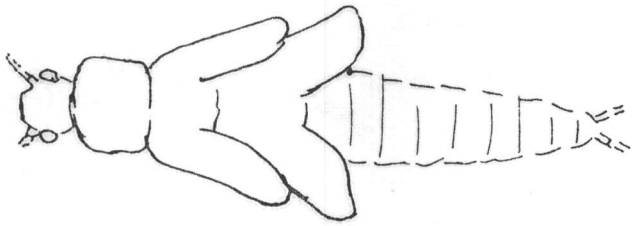
4. Second tarsal segment much shorter than the first 5.



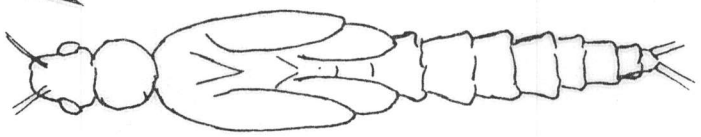
Second tarsal segment as long as the first Taeniopterygidae



5. Form stout with wing pads strongly divergent from body axis Nemouridae



Form elongate and cylindrical with wing pads nearly parallel 6.



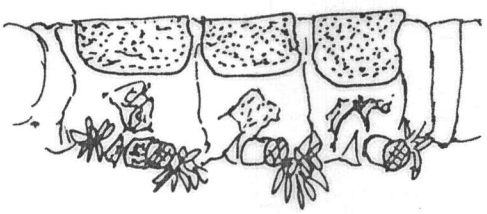
6. Notch on inner margins of hind wing pads located on anterior third; abdominal 1 - 9 segments divided on side by a membraneous fold Capniidae



Notch on inner margin of hind wing pads located on posterior third; no more than 7 abdominal segments divided on the side by a membraneous fold Leuctridae

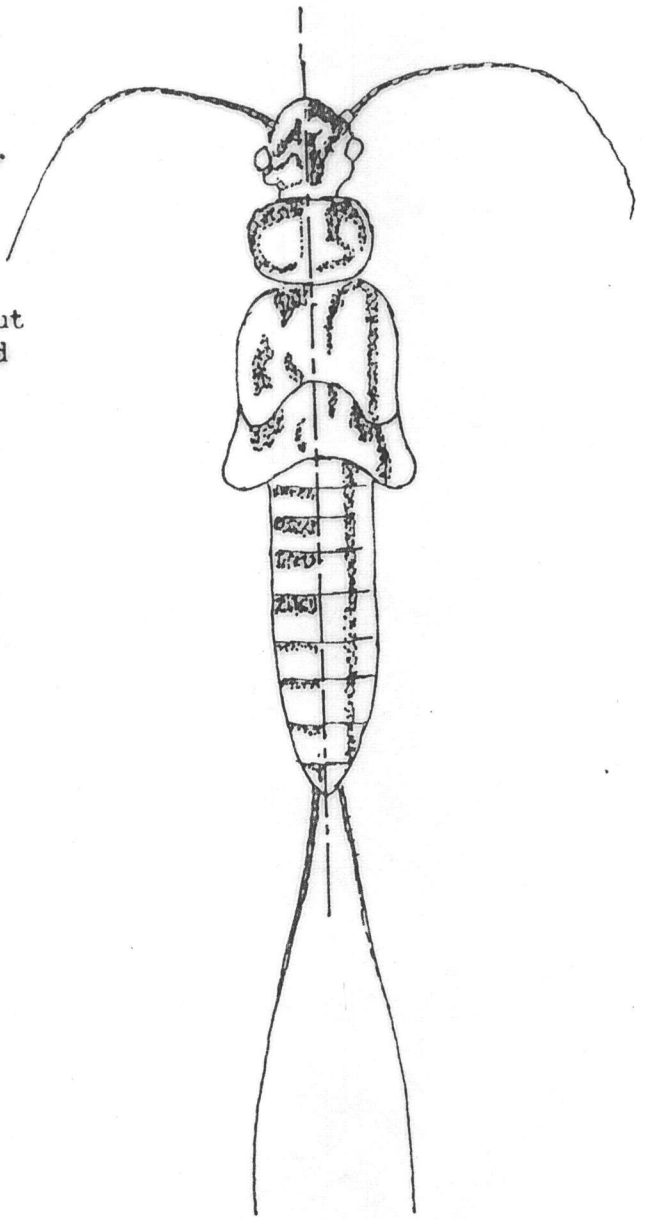


7. Gills present at bases of legs Perlidae

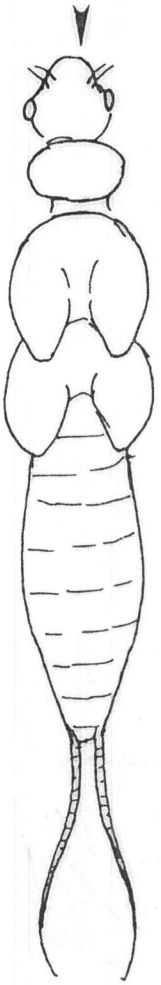


Branched gills absent from bases of legs 8.

8. Dorsal surface usually pigmented in a definite pattern; cerci as long as, or longer than abdomen; hind wingpads divergent from body axis Perlodidae



No pattern on dorsal surface: cerci about 3/4 as long as abdomen; wingpads rounded and not divergent from body axis
Chloroperlidae



Other insects:

Coleoptera - beetles. Many species of water beetles from many families have been identified from the park. We have not had time to construct a key to them.

Lepidoptera - butterflies and moths. Pyragaractis confusalis is a common aquatic moth of the family Pyralidae. It makes nets on top of rocks in riffle areas of rivers where it spends its larval life. It is found in the park in large numbers.

Megaloptera - alderflies, dobsonflies. Almost surely, several species of alderflies, genus Sialis, will be taken in the park. Dobsonflies do not occur here.

Neuroptera - spongilla flies. We have taken none of this group to date but have not been very thorough in our collecting for them. Certain areas of the park are rich in sponges, the host of these insects, so some may eventually be found.

Collembola - springtails. These very small insects are widespread and numerous in North America. We know of no identifications from the park but many species will eventually be found here.

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