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AN INTRODUCTORY GUIDE TO STREAM INSECTS
OF SOUTHERN VANCOUVER ISLAND

by

D. E. Mounce

FISHERIES RESEARCH BOARD OF CANADA
Pacific Biological Station, Nanaimo, B. C.

Circular No. 95

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INTRODUCTION

Streams harbour an abundant and varied insect life usually unnoticed by the casual visitor. Although a few winged forms (adults) may be seen flying above, or resting among, the streamside vegetation, or dipping to the water in seemingly senseless flutters, it is beneath the surface among the rocks and stones that myriads of immature insects occur. For the knowledgeable observer, turning a few stones into a small dish reveals a rich array of minute forms. Under a handlens, they are transformed into fascinating creatures. These are the young stages of aquatic insects with which this brief guide deals, and it is hoped that through its study, a better understanding of the wonderful and complex life that inhabits our local streams will result.

The guide was prepared in response to requests from teachers and students for pictures and brief descriptions of some of the common aquatic insects to be found in local streams.

The author wishes to thank J. H. Mundie for substantial assistance and criticism that has improved the guide and C. L. Mounce for reading the manuscript and making valuable suggestions.

INSECTS AND THEIR LIFE CYCLE

Insects are the commonest kinds of animals and are familiar to everyone, especially in the adult stage. Butterflies, moths, houseflies, mosquitoes and grasshoppers are common members of this group. All are characterized by having three body divisions: a head, thorax and abdomen (Fig. 1); the thorax bears three pairs of jointed legs and usually two pairs of wings in the adult. The head has one pair of antennae.

The insect life-cycle follows one of two general patterns. The adult female of aquatic insects lays her eggs in or on the water. In forms (i.e. species) with simple life-cycles these hatch into "nymphs"; in species with complex life-cycles they hatch into "larvae". The complex life-cycle involves a pupa and the cycle is referred to as "complete metamorphosis" (Fig. 2). Nymphs grow directly into the adult and the life-cycle is termed "incomplete metamorphosis" (Fig. 3). Larvae differ greatly in form from the adults and many appear grub-like, while nymphs are superficially like the adults they will turn into, but lack wings. Larvae and nymphs are voracious feeders; some clamber about the bottom of streams browsing on plant material, some prey on other animals, while still others remain fixed in one place and strain the water by intricate filtering mechanisms. Growth is by molting; i.e. a shedding of the body covering to allow for enlargement of the body. The full-grown larva develops into a pupa. This is a resting stage during which the adult structures, including the wings and compound eyes, are formed. In the nymph, however, the adult features, most noticeably the wing pads on the back of the thorax (Fig. 1) develop gradually. The pupa or mature nymph ascends to the water surface or walks ashore to allow the adult to emerge.

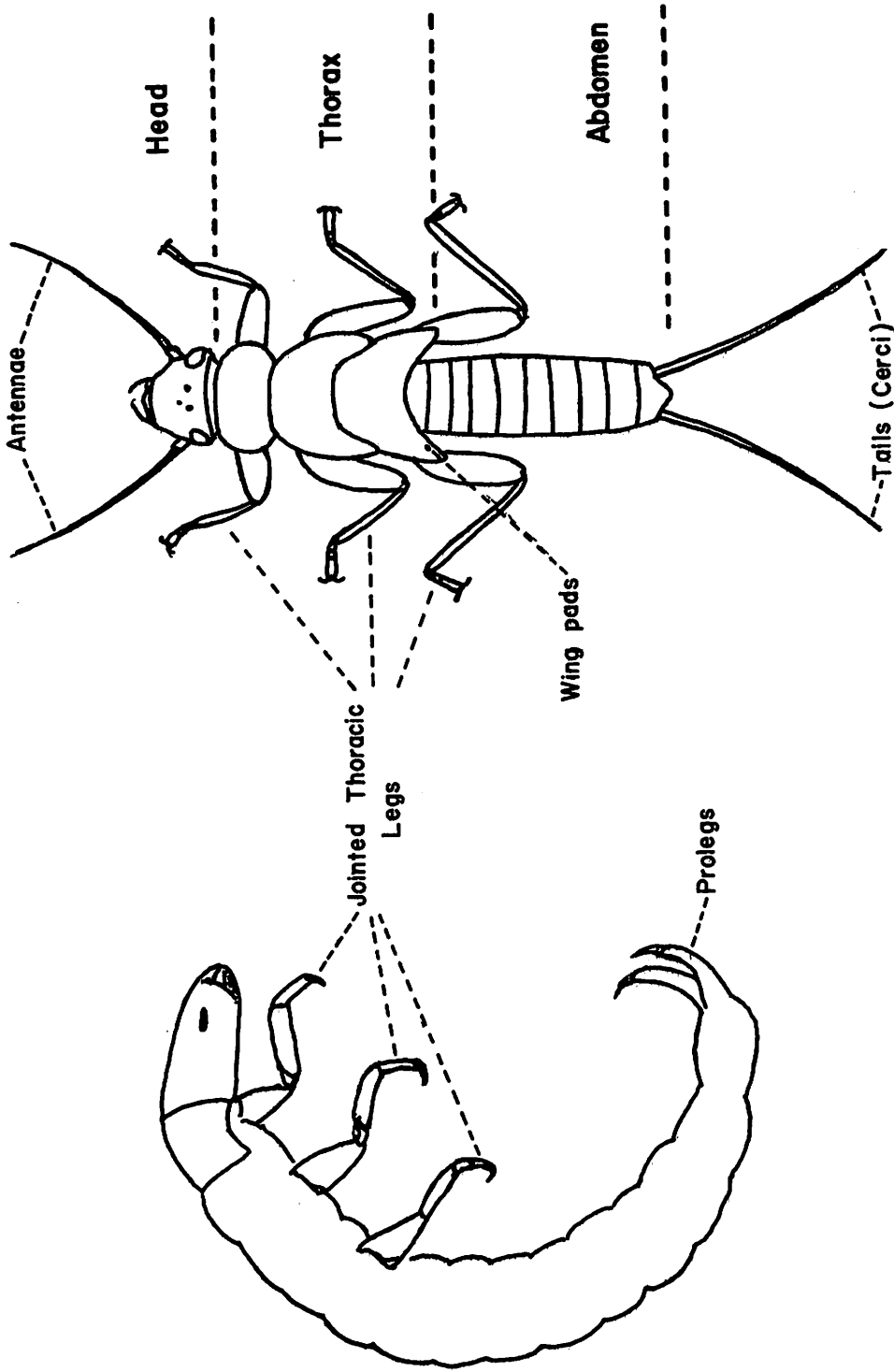


Fig. 1. Generalized insect larva and nymph showing structures mentioned in text.

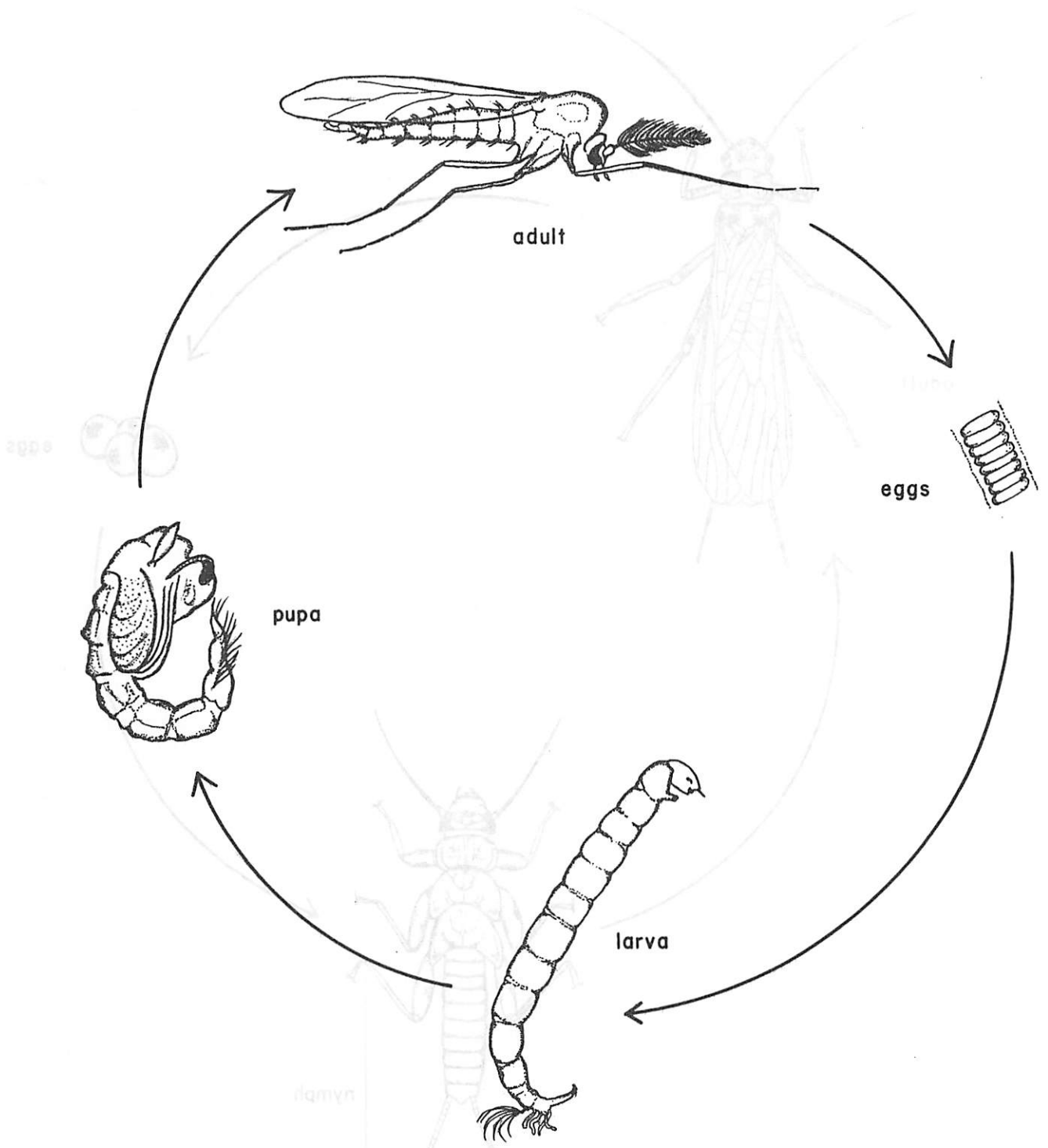


Fig. 2. Life cycle of an insect with complete metamorphosis.

Fig. 3. Life cycle of an insect with incomplete metamorphosis.

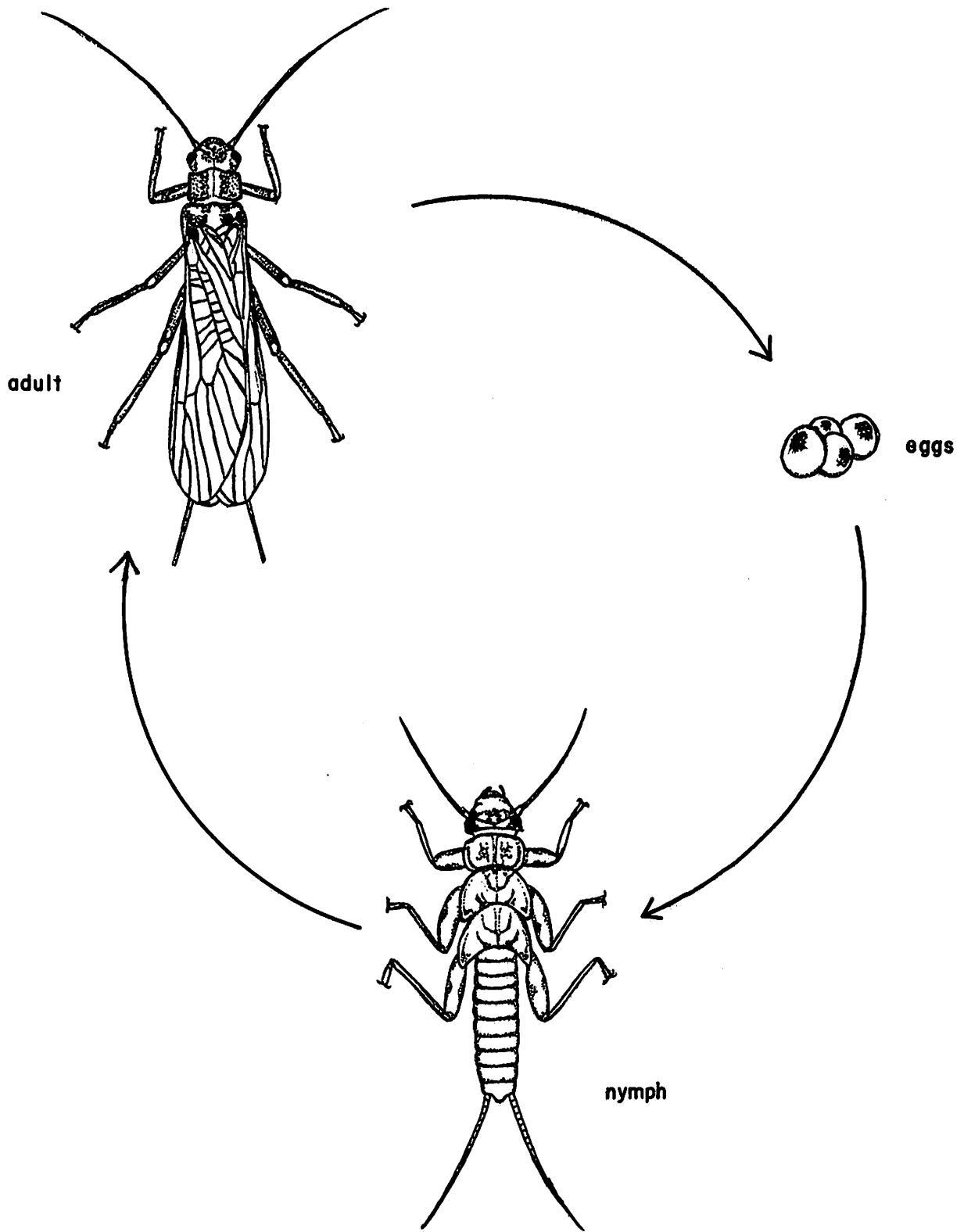


Fig. 3. Life cycle of an insect with incomplete metamorphosis.

After emergence the adult rests for a moment to allow its wings to harden and then flies off. Mating takes place in the adult phase and completes the life cycle.

All of the immature stages of aquatic insects occur on or under the water but only the true bugs (Hemiptera) and the beetles (Coleoptera) have aquatic adults. In the other major groups of aquatic insects, the adults live on land but usually remain close to the stream. They can often be seen in mating swarms or ovipositing (egg laying) on the water surface. The adult stage is mainly a reproductive phase; many adults are short-lived and do not feed, although there are several exceptions.

STREAMS

Aquatic insects occur in all bodies of fresh water, from stagnant pools to the largest lakes, from semi-permanent trickles to the fastest rivers. This guide deals only with those found in flowing water, i.e., streams and rivers. Streams are small versions of rivers and are ideal for study: they are shallow and wadable, the bottom is within reach, and no specialized equipment is needed for sampling. On Vancouver Island, streams are abundant and are delightful places to explore. Here one can see the importance of the total environment, for the stream cascading among the tall stands of alder and fir, is part of a complex ecosystem comprising many interrelated factors. For example, the type of soils, the slope of the land and the amount of rainfall all contribute to making a stream what it is, but perhaps the most important influence comes from the streamside vegetation. The marginal trees and shrubs provide shade in summer; their roots help to prevent erosion of the soils into the water; their leaves fall into the stream and decompose to provide much insect food; and the tree-dwelling insects alighting on the surface, serve as important fish foods especially during times of scarce aquatic foods. Thus the alteration of streamside vegetation, e.g., by logging or herbicide spraying, may substantially change the nature of the stream itself.

A typical Vancouver Island stream is roughly composed of two alternating and contrasting habitats - the riffle and the pool. Riffles are areas of swift flow, usually shallow, with rocky and gravelly bottoms. These highly oxygenated clean gravel stretches offer favourable niches for many animals, and it is here that most of the stream insects occur with as many as fifty thousand individuals per square metre. Diatoms (minute green plant cells), a principal food of herbivorous larvae and nymphs, grow on the tops of stones in these rapid sections. In addition the fast current carries minute particles of food to those animals such as blackfly larvae (Fig. 48) and the net spinning caddis (Fig. 26a) which feed by filtering mechanisms.

Although many immature insects occur among the gravel and feed on material deposited by the water, those forms that exist on the surfaces of stones are subject to the forces of the current and most have evolved streamlining or various anchoring devices to resist dislodgement.

Pools are areas of deep slow water, with a sandy or silty bottom. These are the settling basins of the streams. The soft substrate may be rich in organic material but less well oxygenated than riffles due to the decomposition of debris and slower flows. Pool insects are usually the burrowing forms, and those with ample gill surfaces for respiration. Pools are also the habitat of coho salmon fry which rest in the quiet water awaiting the arrival of drifting insects dislodged from the upstream riffles or of insects alighting from the surrounding vegetation.

The division of streams into alternating riffles and pools is a simplification, as many stretches fall between these extremes and have slower flows and less coarse bottoms than riffles, but not the slow silty extremes of pools. These transitional areas contain animals found in both riffles and pools. Slack areas and back eddies also occur in streams. Here leaves and debris accumulate and provide food and shelter for many organisms.

IMPORTANCE OF STREAM INSECTS

The importance of aquatic insects can hardly be overstated, for it is on them that our stream fishes depend. Coho salmon fry, for example, spend from 1 to 2 years in the stream before migrating to sea, and during this time their food is primarily aquatic insects. Although trout may crop larvae or nymphs from the bottom, coho fry feed mainly on those animals dislodged by the swift current. These insects carried downstream are part of the "organic drift" of streams. During darkness larvae or nymphs may lose visual contact with their surroundings and are swept from the surface of the rocks and gravel and may be eaten by fry. This is especially common at dusk and dawn.

Another activity of importance to the fish is the emergence of adult insects. Although the pupa or mature nymph making its way to the water surface may be very vulnerable, it is the adult, freeing itself from the pupal or nymphal skin, or resting on the surface to harden its wings which triggers the frantic feeding sessions of trout with which sports fishermen are familiar. This 'emergence' or "hatch" as it is termed by the fisherman, is brought about by a change in light intensity, and usually occurs at dusk and dawn. During egg laying adults may also fall prey to fish.

SEASONAL ACTIVITY

Winter, for the majority of insects, is spent as small larvae and nymphs. Spring brings increasing daylight and rising temperatures. Diatoms flourish and these are eaten by herbivores. Growth of larvae and nymphs is rapid and may be followed by emergence of adults in late spring. They mate, and the offspring mature to emerge as adults in the fall. Other species grow less rapidly and may have one period of emergence per annum, e.g., midsummer; some stoneflies, however, have adults emerging in midwinter. An emergence once every 2 years or longer occurs in some dragonflies and stoneflies and in insects of very cold streams. The abundance of maturing insects in the spring

coincides with the emergence¹ of salmon and trout fry thus assuring them of their food. The larvae and nymphs of those insects that will emerge in midsummer or fall provide fish with food through to the autumn. Thus these scarcely visible, almost unknown, aquatic insects are essential to coho, chinook and trout and therefore play an important role in the economy of British Columbia.

COLLECTING AQUATIC INSECTS

The best times of year to look for aquatic insects are late spring and fall when many are full grown prior to emergence. During these periods mature larvae and nymphs, pupae and adults will be available. A few simple pieces of equipment will aid their study. Although some of the larger forms can be recognized with the naked eye, most are minute so a hand lens is a necessity. Many of the characteristics which distinguish the organisms to order and family are only visible under 10 \times - 25 \times magnification. A small white pan into which rocks, leaves or mud from the stream can be placed, enables the observer to see the animals easily. A simple method of collecting riffle animals consists of holding a fine-meshed net upright on the stream bottom while the rocks and gravel upstream are disturbed by one's foot. The dislodged insects are carried by the current into the net and then the material from the net is washed into the pan. A suitable net (Fig. 4) is constructed of a strong wire frame (approx. 1 foot wide) attached to a pole. A nylon netting of about 0.3 mm mesh opening is fastened to the wire frame.² Tweezers or forceps will enable the collector to pick up the animals. For the capture of the small agile ones, a small suction pipette (a 6-inch length of plastic tube with a rubber bulb on one end) is invaluable. The rubber bulb is squeezed to expel air. When the open end of the tube is placed near the insect and the bulb is released, the animal is drawn up the tube. The specimen may then be transferred to other containers by squeezing the bulb to eject it. Vials with caps and a preservative (2% formalin is adequate) will be needed if the animals are to be kept for later study. Only plastic containers and equipment should be used. Glass containers should not be taken into the field as they are easily broken, for example by being knelt or fallen on, and can inflict serious cuts.

¹The student of insects uses the term "emergence" to describe the coming out of the adult from its pupal or nymphal skin. To fish biologists, an "emergence" is the exodus of fish fry from out of gravel where they have been living as alevins since hatching from the eggs.

²If only a few animals are wanted a small aquarium dipnet or a nylon stocking attached to the frame will suffice.

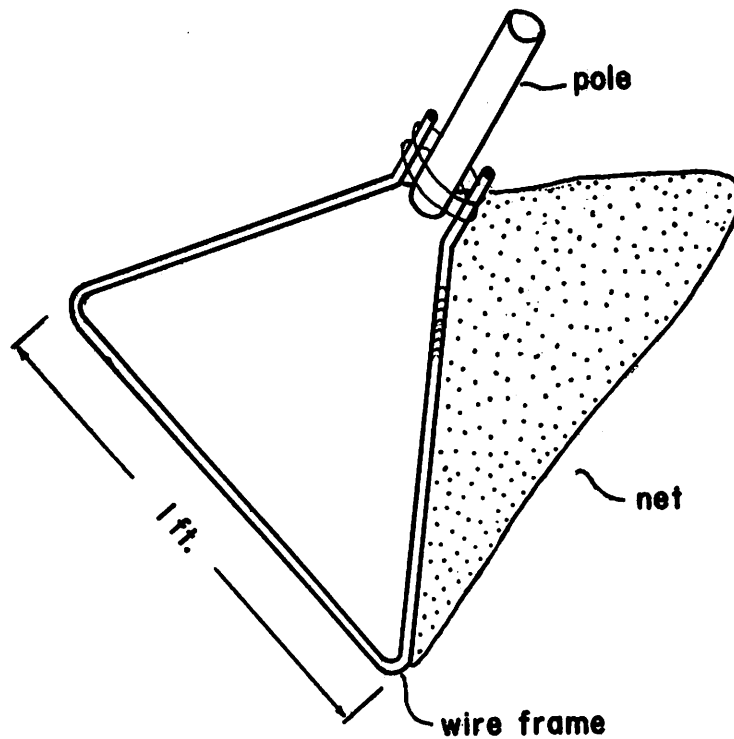


Fig. 4. Simple net for collecting riffle insects.

USING THE GUIDE

This guide is intended as merely an introduction to the aquatic insects of Vancouver Island streams, and the taxonomy of the animals is therefore not taken very far. To further the identification would require the use of dissecting and compound microscopes which are beyond the resources of most amateur naturalists. For those with access to such equipment, the texts listed will enable the collector to classify the larvae or nymphs further. Even with sophisticated instruments the identification to the species level is usually not possible without rearing the species so that immature and adult stages can be associated.

There are 12 major groups (orders) of insects which have aquatic stages but only those likely to be encountered commonly in local streams are dealt with here. An order may contain numerous families, subfamilies, genera and species. Where possible the commonest families are noted along with a brief description of their distinguishing features, life cycles, habitat preferences, adaptations and common names. In some of the rare orders the description applies only to the larva or nymph likely to be found in local streams. The section "similar insects" outlines possible sources of confusion to the collector, between apparently similar animals of different orders. It should be remembered that this guide deals only briefly with each order and the student wishing to delve further into the world of aquatic insects should consult the works listed below. These will lead to many specialized papers on the subject.

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Figure 5 is a pictorial key to the common orders of stream insects. To use, the description fitting the specimen is chosen from the alternatives at the beginning. The solid lines are followed and the inapplicable descriptions successively eliminated, until the order under which the specimen occurs is found. The animal may then be compared with the appropriate figure and description. The solid line with each figure represents one millimeter (mm)³ and gives an indication of the actual size of the animal.

³1 mm = 1/25th inch or 1/10 of cm.

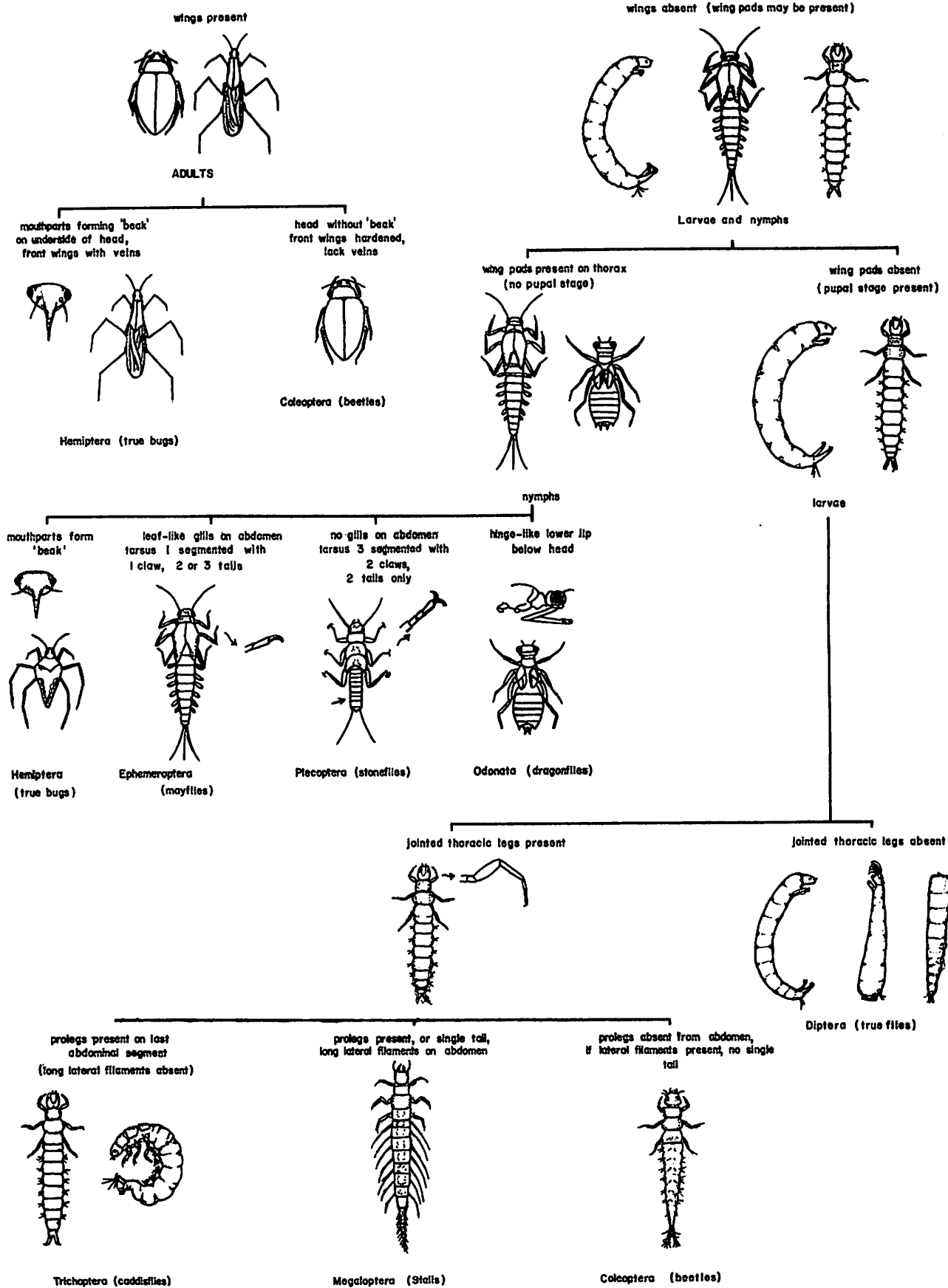


Fig. 5. Pictorial key to common aquatic insects of local streams.

COMMON ORDERS OF STREAM INSECTS

EPHEMEROPTERA (Mayflies)

These common algal and detritus feeders frequently make up the largest part of the food of stream fishes. If a stone is lifted several of these active nymphs are usually seen scuttling away. They are found in all parts of the stream. Some nymphs are adapted for swimming actively in the pools or among water plants, others to living on the bottom, burrowing in the mud or clinging to the rocks in rapidly flowing water.

Mayflies are unique among insects in that the nymph develops into an intermediate winged stage termed the "subimago" before transforming into the adult or "imago". The subimago or "dun" as it is known to the fisherman, is dull in appearance while the imago or "spinner" is shiny with longer legs and tails (cerci). Mayfly adults are short-lived, do not feed, and occur commonly in large mating swarms where they dip and dive above the water on sail-like wings. Adults may be observed, usually at dusk, on local streams from April to October but are most numerous in the spring as the name "mayfly" indicates. Many of the fisherman's "flies" are tied in imitation of the adults.

Distinguishing features

Nymphs (Fig. 7-11)

Mayfly nymphs have two or three tails and plate or leaf-like gills on the abdomen. The tarsus, or foot, is one-segmented and bears only one claw. The antennae are short.

Adults (Fig. 6)

The delicate-bodied adult has two or three long tails, and two pairs of wings held upright at rest. The fore wings are much larger than the hind, which are absent in a few small species. The antennae are short and the legs are very weak and seldom used for locomotion.

Similar insects

The nymphs may be confused with plecoptera (stonefly) nymphs. A common misconception is that mayfly nymphs always have three tails, stonefly nymphs two. However, some families of mayflies have members with only two tails and in some other cases the young nymph may not develop the middle tail until nearing maturity. Stonefly nymphs have only two tails and plate or leaf-like gills are absent from the abdomen; the tarsus is three-segmented and bears two claws (Fig. 14b) and the antennae are long.

Five families of mayflies are found commonly in local streams:

Heptageniidae (Fig. 7)

These are large (up to 2 cm) flattened forms, commonly found on the underside of stones in fast riffle areas. The flattened form allows the nymph to stay below the main force of the current. A suction disc, formed

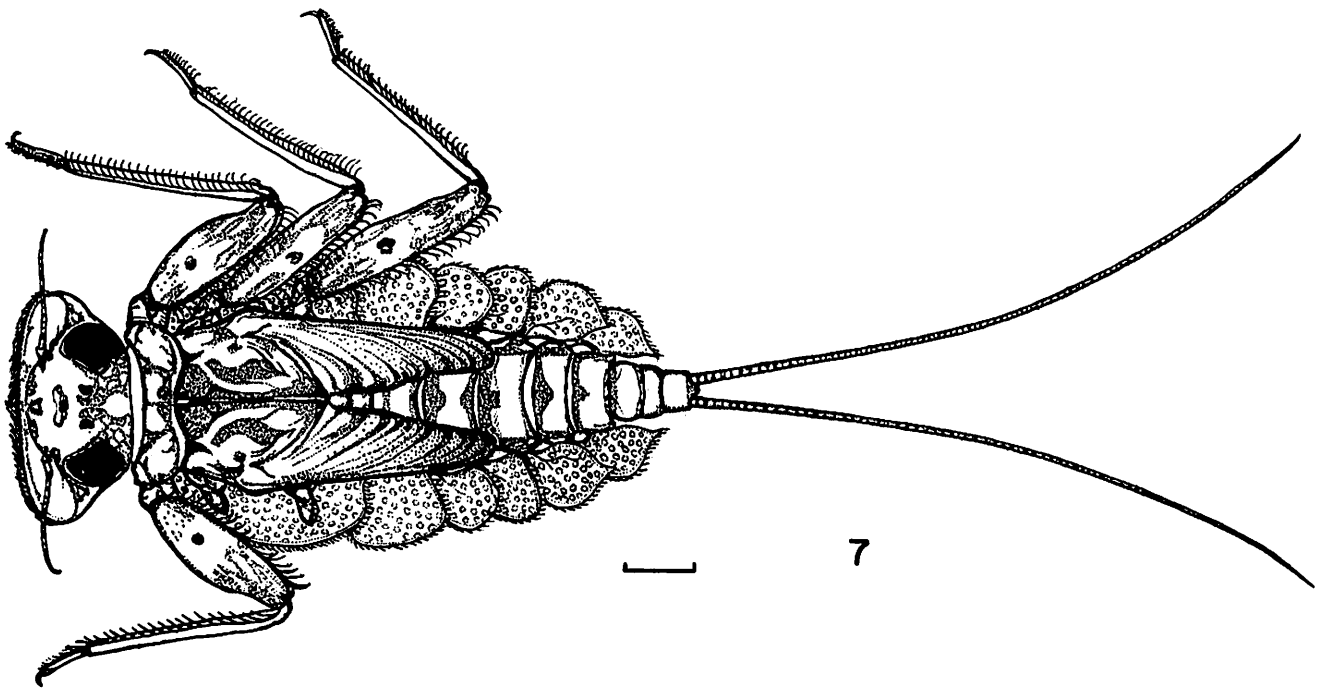
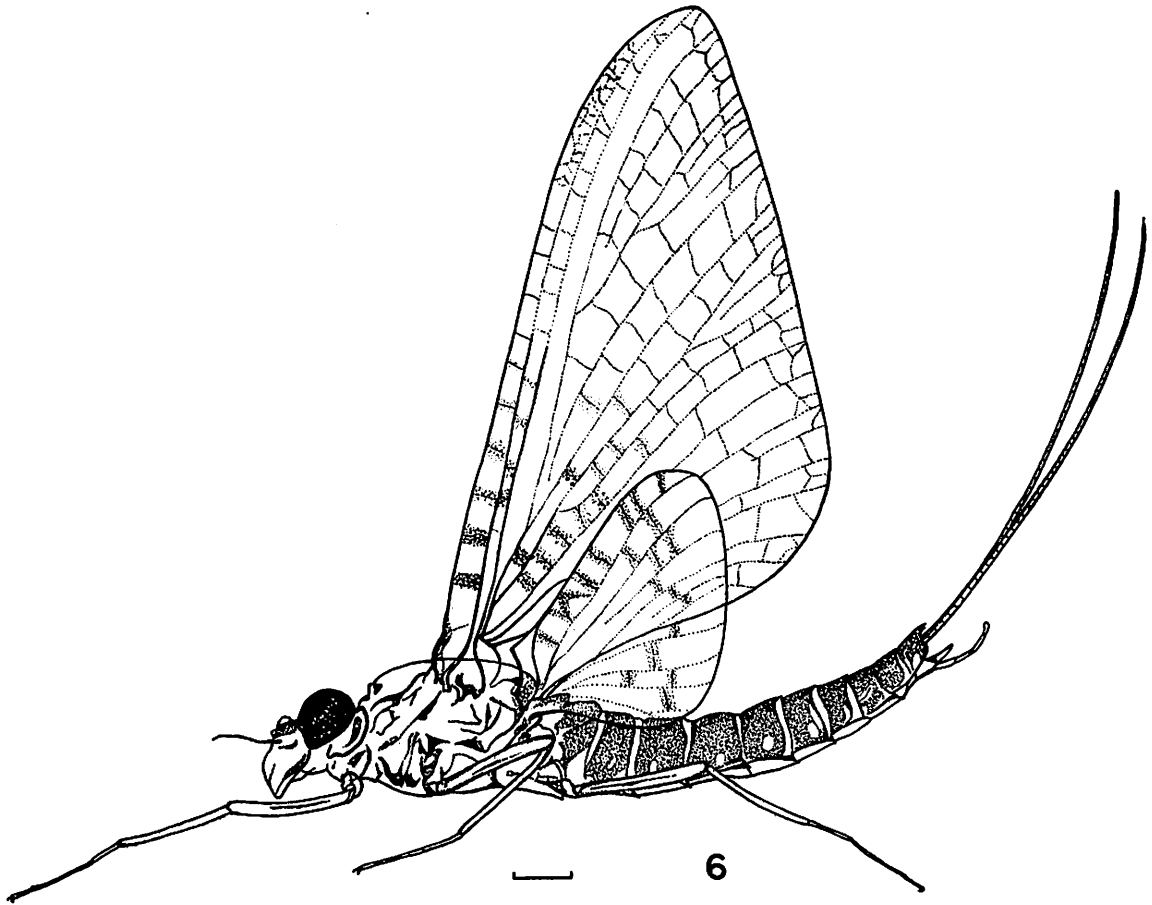


Fig. 6. Ephemeroptera (Mayfly) adult.

Fig. 7. Heptageniidae mayfly nymph. Two legs removed to show overlapping of ventral gills to form "suction disc".

by the overlapping of the large gills on the underside of the abdomen, prevents dislodgement in some species. The heptageniidae are distinguished from other mayfly nymphs by the eyes and antennae which, owing to the flattened body, are on the dorsal surface of the head. Other mayflies have the eyes on the lateral margins of the head. Several species have only two tails. The nymphs are algal feeders and scrape the surface of the rocks with complex brush-like mouth parts.

Baetidae (Fig. 8)

The baetids are small, streamlined, agile swimmers of both pools and riffles. The nymphs have seven pairs of small rounded gills; the outer tails have a "hair"⁴ fringe only on the inner side and the terminal abdominal segments lack any spine-like prolongations of the lateral margins. These algae and detritus feeders are among the commonest local mayflies.

Ephemerellidae (Fig. 9)

These nymphs clamber among debris in riffles and pools. Some of our largest mayflies belong to this family and can be recognized by the 4 or 5 pairs of plate-like gills, the tails with hairs on both sides and the backward extensions of the lateral margins of the abdominal segments. Several species have large spines on the dorsal surface of the head, thorax and abdomen.

Leptophlebiidae (Fig. 10)

These detritus feeders are found in the slower portions of streams. The common genus (Paraleptophlebia) has seven pairs of "tuning fork" gills and the outer tails have hair on both sides. The gills are moveable and are beaten in unison to aid in respiration. Some species have large tusks for burrowing into soft substrate.

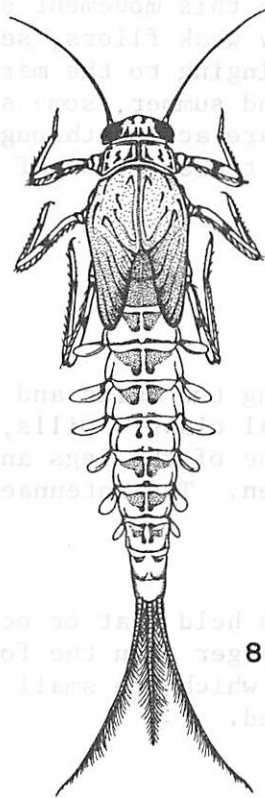
Siphoneuridae (Fig. 11)

The nymphs are pool dwellers, with seven pairs of large gills. They are commonly seen scuttling over the bottom, but blend invisibly with the sand when still. The outer tails are fringed on the inner side only and the last abdominal segments have prolonged lateral spines.

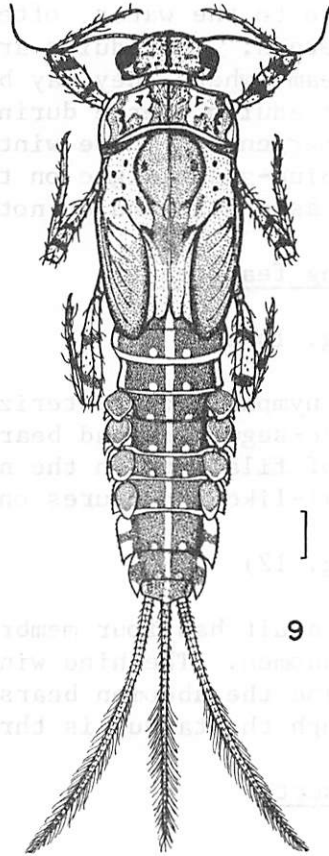
PLECOPTERA (Stoneflies)

Stonefly nymphs are common inhabitants of the fast-flowing rocky stretches and are usually restricted to well oxygenated, unpolluted waters. Ranging up to 1 1/2 inches in size, the nymphs frequent the underside of stones during the day, and come to the tops to feed at night. The smaller species generally feed on algae, while the larger are carnivores, pursuing mayfly nymphs and chironomid larvae. The nymphs in turn may serve as an important food of fish. Nymphal development takes a year in most species and up to 2 years or more in some. When mature the nymph crawls from the stream

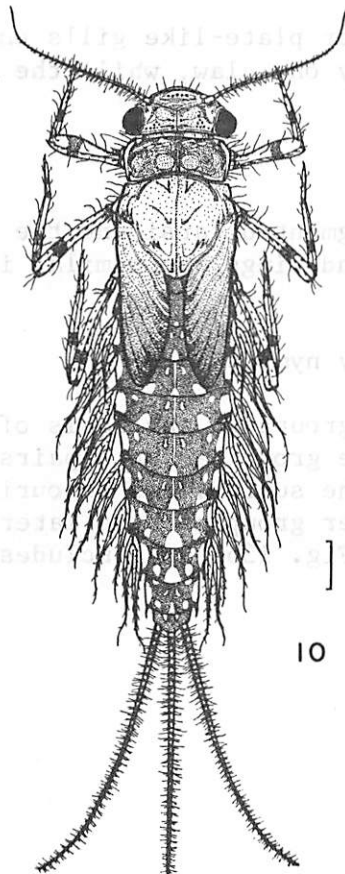
⁴The term "hair" is used to describe hair-like structures or setae, not to be confused with mammalian hair.



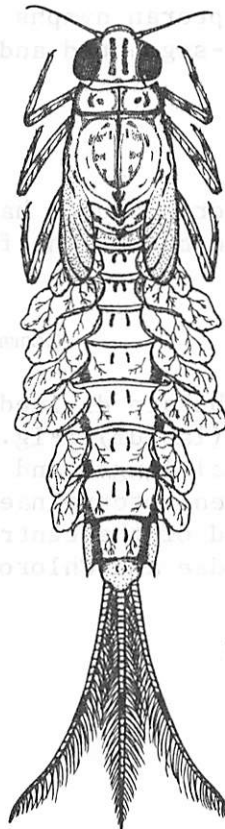
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Fig. 8. Baetidae nymph.
Fig. 9. Ephemerellidae nymph

Fig. 10. Leptophlebiidae (Paraleptophlebia) nymph.
Fig. 11. Siphonuridae nymph.

but may return to the water, often repeating this movement several times before the adult emerges. The adults are generally weak fliers, seldom venturing far from the stream, where they may be found clinging to the marginal vegetation. Although most adults emerge during spring and summer, some species have a fall and winter emergence. These winter adults are active throughout the day, and may feed on blue-green algae on the bark of trees. Some of the summer forms are noturnal as adults and do not feed.

Distinguishing features

Nymphs (Fig. 14-20)

The nymph is characterized by having two tails and a tarsus (foot) which is three-segmented and bears two tarsal claws. Gills, if present, are small tufts of filaments on the neck, or base of the legs and do not occur as plates or leaf-like structures on the abdomen. The antennae are long.

Adults (Fig. 12)

The adult has four membranous wings held flat or occasionally rolled around the abdomen. The hind wing may be larger than the fore. Long antennae are present and the abdomen bears two tails which are small in some species. As in the nymph the tarsus is three-segmented.

Similar insects

Nymphs

Ephemeropteran nymphs have leaf or plate-like gills on the abdomen. The tarsus is one-segmented and bears only one claw, while the antennae are short.

Adults

Megalopteran adults have five-segmented tarsi and the wings are held roof-like over the back. The fore and hind wings are similar in shape and size.

Common stonefly nymphs

The nymphs are divided into two groups on the basis of the structure of the lower lip (labium) (Fig. 13a): One group has both pairs of lobes of the labium of equal length and contains the subfamilies Nemourinae, Capniinae, Leuctrinae and Taeniopteryginae. The other group has the lateral lobes produced far ahead of the central lobes (Fig. 13b) and includes the families Perlidae, Perlodidae and Chloroperlidae.

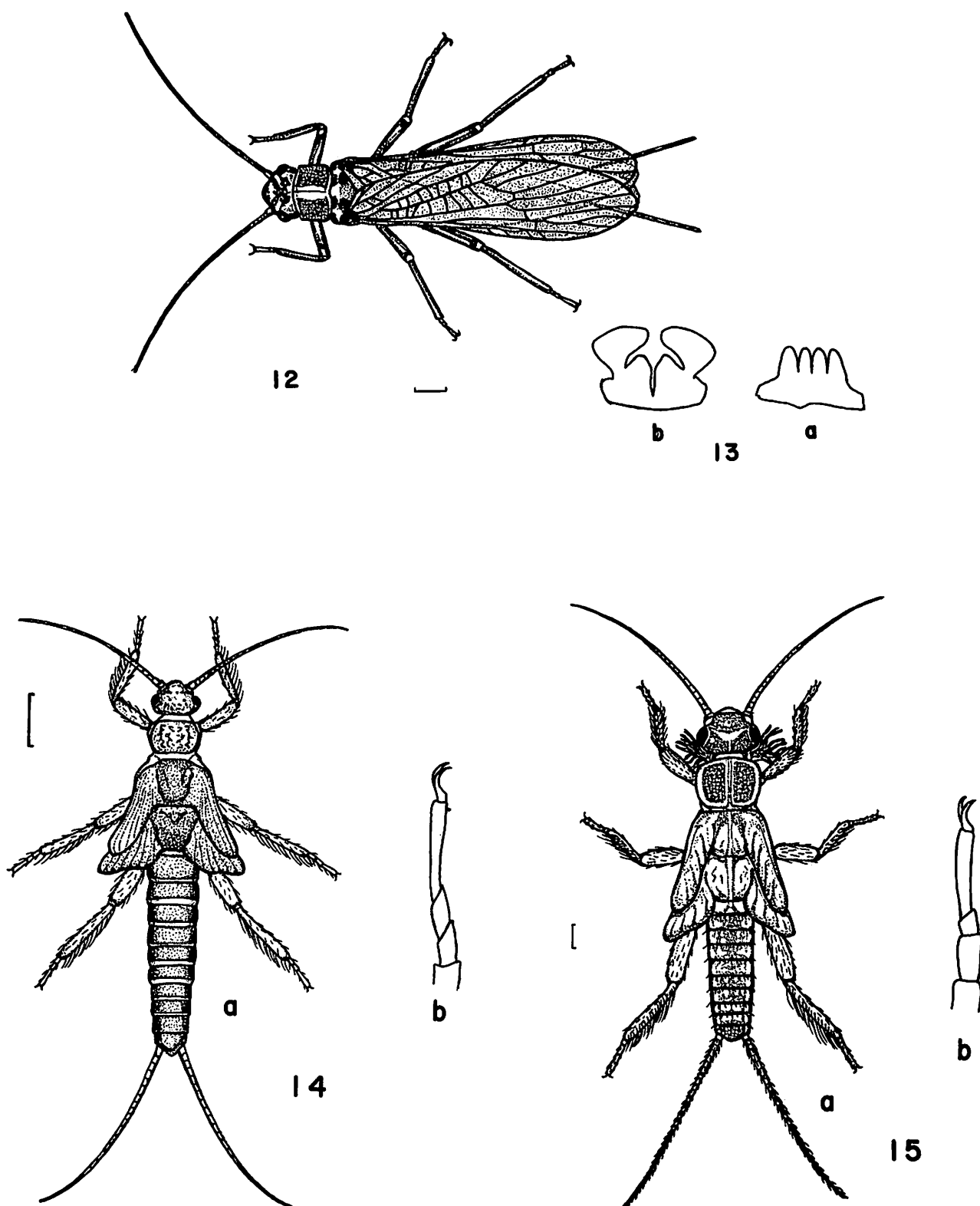


Fig. 12. Plecoptera (Stonefly) adult.

Fig. 13. Labia (lower lips) of stonefly nymphs a. pairs of lobes equal in length. b. outer lobes produced beyond central pair.

Fig. 14. a. Taeniopteryginae (Brachyptera) nymph (after Frison). b. Tarsus of fore leg.

Fig. 15. a. Nemourinae (Nemoura) nymph (after Frison). b. Tarsus of fore leg.

Group I - Both pairs of lobes of labium of equal length

Taeniopteryginae (Fig. 14)

The nymphs of this subfamily are generally small (less than 10 mm), dark insects, characterized by the tarsus which has the first and second segments about equal in length. The common genus Brachyptera has the ventral portion of the ninth segment of the abdomen produced. Adults emerge from late winter to spring.

Nemourinae (Fig. 15)

This is a common subfamily on local streams and contains only the single genus Nemoura. The mature nymph is distinguished by the wing-pads, set at an angle to the body, the tarsus which has the second segment much shorter than the first and the hind legs which, when outstretched, reach past the tip of the abdomen. Colouration is usually brown to black and the nymph seldom reaches 15 mm (5/8 inch) in length. The adults occur mainly in spring and summer.

Capniinae (Fig. 16)

These small, cylindrical nymphs, generally dark in colour, have the second segment of the tarsus shorter than the first, and the dorsal and ventral surfaces of abdominal segments 1 to 9 separated by a membranous fold. The nymphs are algal feeders. The adults emerge from November to April and feed on blue-green algae.

Leuctrinae (Fig. 17)

Very similar to the Capniidae, these small nymphs have the dorsal and ventral surfaces of the first seven or fewer abdominal segments separated by a fold. The nymphs are algal feeders. The adults appear from December to June and have the wings rolled around the body at rest.

Group II - Outer lobes of labium produced ahead of inner

Perlidae (Fig. 18)

These nymphs are among the largest species found locally and are mainly predators. Reaching a length of nearly 5 cm (2 inches) they have profusely branched filamentous gills at the base of the legs.

The adults emerge in spring and summer.

Perlodidae (Fig. 19)

These nymphs are medium-sized (2 cm) and are relatively uncommon locally. The hind wing-pads of the mature nymph are set at an angle to the body and the tails are usually at least as long as the abdomen, which is almost always pigmented in a distinct pattern. The adults are spring and summer forms.

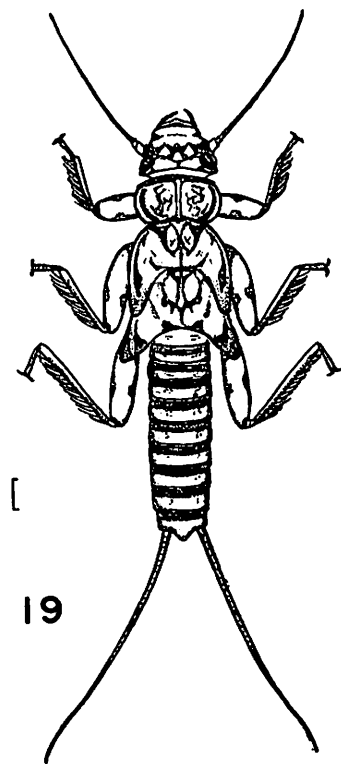
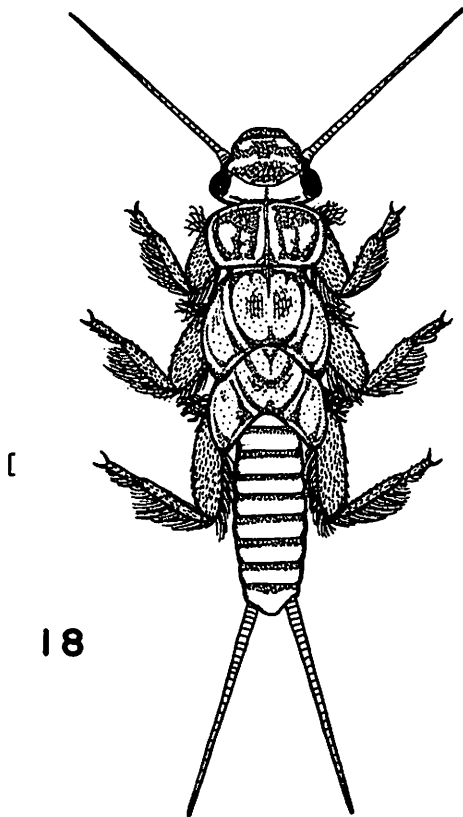
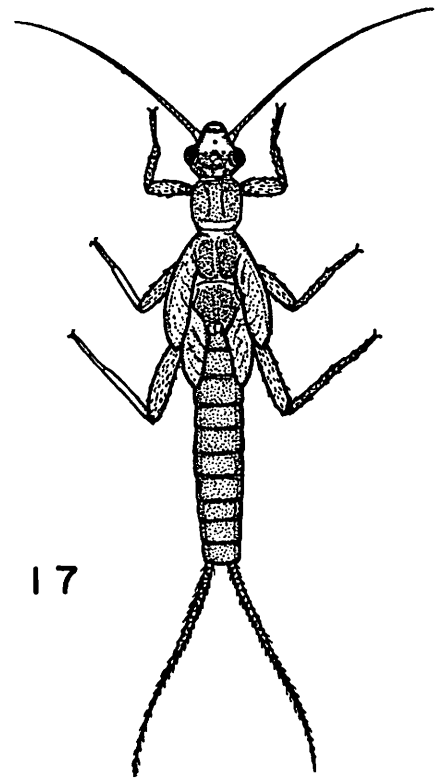
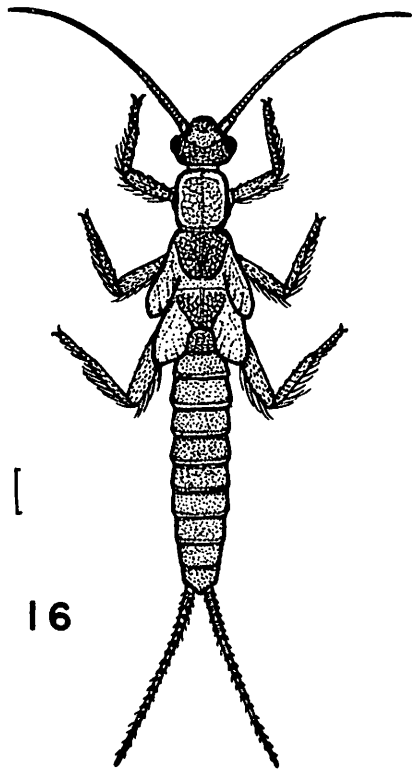


Fig. 16. Capniidae nymph (after Frison).
Fig. 17. Leuctriidae nymph (after Frison).

Fig. 18. Perlidae nymph (after Frison).
Fig. 19. Perlodidae nymph (after Frison).

Chloroperlidae (Fig. 20)

This family is common. The nymphs, which reach 15 mm in length, are usually slim yellow or greenish animals which have the wing-pads parallel to the body and the tails less than the length of the abdomen. The body is generally not patterned. The adults occur in spring and summer.

TRICHOPTERA (Caddisflies)

Caddisfly larvae occur commonly in our local streams. The case-bearing forms are conspicuous, and usually first noticed as moving sticks or bundles of leaf fragments on the stream bottom. The moth-like adults, termed "sedges" by the fisherman, are clumsy fliers, usually secretive but may be seen scampering over the water surface at dusk as the females deposit their eggs.

The larvae are separated into two groups: the case builders and the free-living forms which lack cases. The case builders feed mainly on algae and leaf detritus; they construct cases of selected materials from the stream. These are bound by silk into a case around the animal. Modified salivary glands located near the mouth produce the silk. Larvae found in pools generally build cases of leaves or twigs; those in riffles utilize heavier objects, e.g. sand grains and small stones which help to prevent their dislodgement by the current.

Free-living larvae are predacious and usually inhabit riffles. Several of them build intricate webs which filter food from the water (Fig. 26a).

Pupation of the caddis takes place in cocoons or hideaways. The case-bearing forms cement their case to the bottom, seal the ends and pupate within. The free-living types construct special silken cases among the stones for pupation. The pupa (Fig. 21) has large jaws (mandibles) for cutting itself out of the cocoon and long feathery legs for swimming to the water surface to emerge. Larvae, pupae and adults are readily devoured by fish.

Distinguishing features

Larvae (Fig. 23-26)

The larvae have three pairs of jointed thoracic legs and a pair of hook-like anal prolegs on the end of the abdomen for attachment. The head, and thorax to various degrees, are hardened (sclerotinized); the abdomen is soft. Filamentous gills may be present on the abdomen.

Adults (Fig. 22)

The adults are moth-like with two pairs of hairy wings held roof-like over the back when at rest. Long sensory antennae are present.

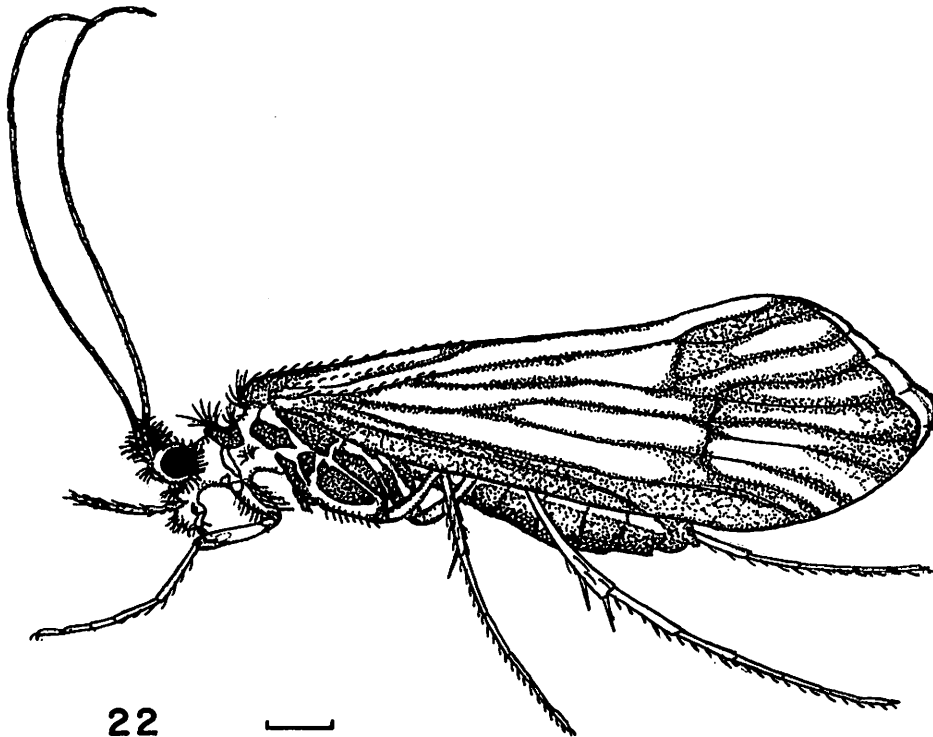
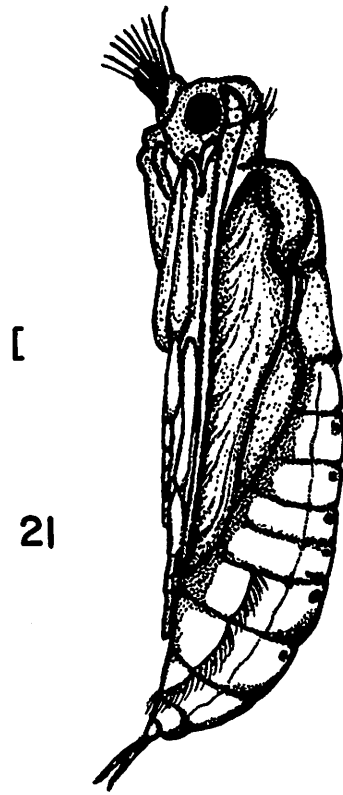
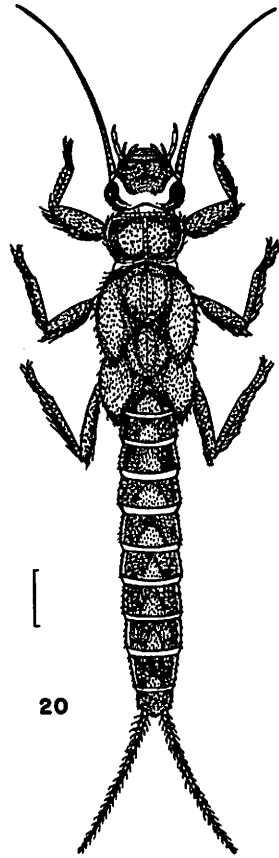


Fig. 20. Chloroperlidae nymph.
Fig. 21. Pupa of Trichoptera (Caddisfly).
Fig. 22. Adult of Trichoptera.

Similar insects

Larvae

Coleopteran (beetle) larvae differ in having no anal prolegs.

Megalopteran larvae have two long lateral processes on each abdominal segment.

Adult moths (Lepidoptera) differ from caddis in having a long coiled tube (proboscis) below the head. The wings of moths are covered entirely with minute scales, those of caddis mainly with fine hair (very rarely small numbers of scales may be present).

Common caddis larvae

Limnephilidae (Fig. 23)

The limnephilids are the commonest of the "tube" case makers likely to be encountered locally. These large larvae (up to 2 inches) are found in the pools and slower areas of riffles. They have only the first two thoracic segments hardened. The family is recognized by a "hump" on the dorsal surface of the first abdominal segment, and the minute antennae, which are located midway between the eye and the margin of the head, or closer to the margin of the head.

Glossosomatidae (Fig. 24)

The saddle-case builders have a stone case like a turtle shell. This case has a stone bridge across the ventral opening, holding it on the larva much as a saddle is held on a horse. It, the small anal claw (Fig. 24b), and the sclerotized first segment of the thorax are characteristic. The cases of the larvae and pupae are very common on stones in riffles.

Rhyacophilidae (Fig. 25)

Rhyacophilids are free-living predacious forms found in riffles. The larvae are fairly common and may reach 1 inch in length. This family is closely related to the Glossosomatidae, but may be distinguished by a large anal claw (Fig. 25b) and the absence of a larval case.

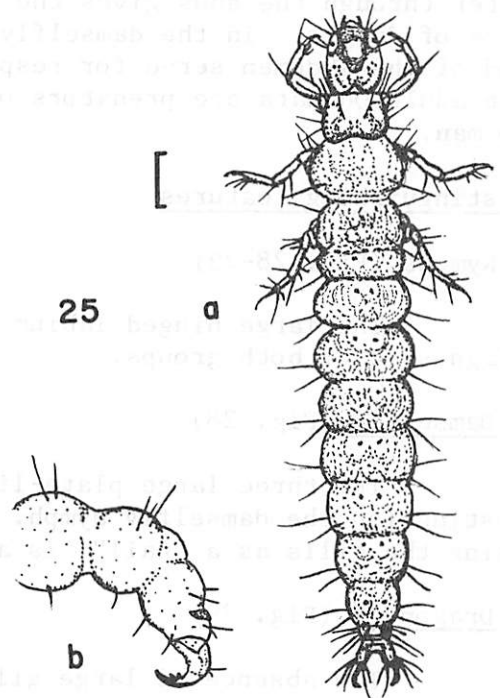
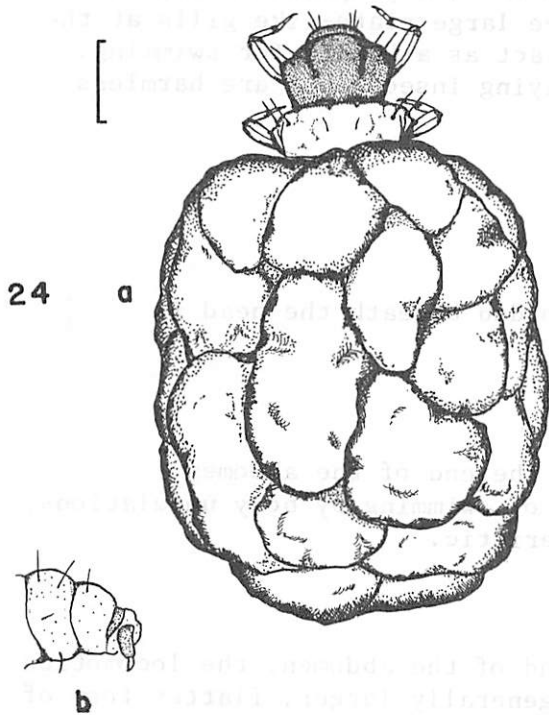
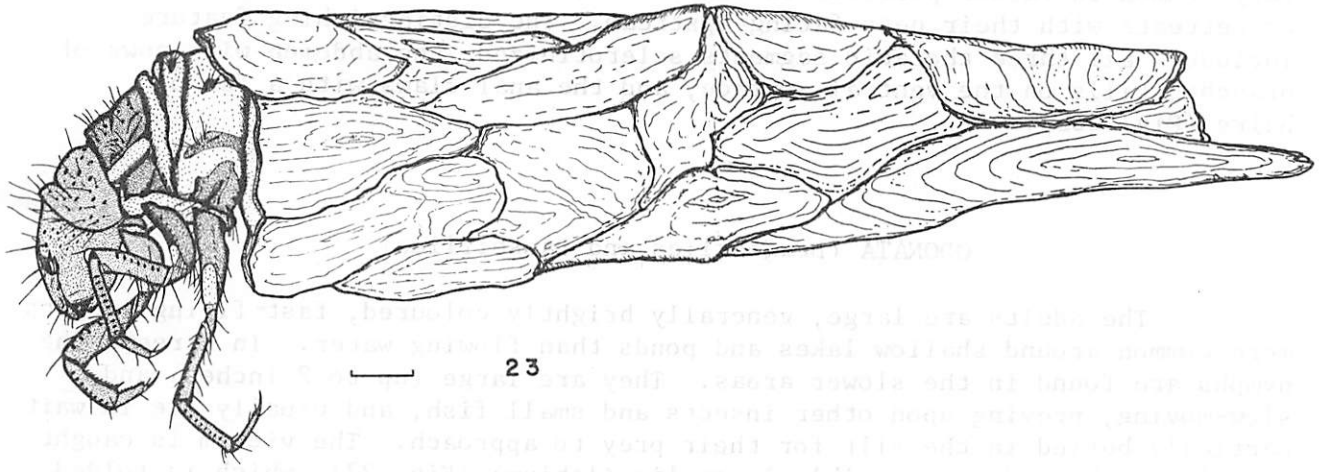


Fig. 23. Limnephilidae larvae in case.

Fig. 24. a. Glossosomatidae larva in case. b. Terminal segments of abdomen showing small anal claw.

Fig. 25. a. Larva of Rhyacophilidae. b. Terminal segments of abdomen showing large anal claw.

Hydropsychidae (Fig. 26)

Members of this family spin a silken net to capture food and may be very common in faster portions of riffles. The larvae are usually in crevices or retreats with their nets facing upstream. The distinguishing features include: all three thoracic segments sclerotized, the abdomen with rows of branched gills on the ventral surface, and the anal claws with a fan of hairs (Fig. 26b).

ODONATA (Dragonflies and Damselflies)

The adults are large, generally brightly coloured, fast-flying insects more common around shallow lakes and ponds than flowing water. In streams the nymphs are found in the slower areas. They are large (up to 2 inches) and slow-moving, preying upon other insects and small fish, and usually lie in wait partially buried in the silt for their prey to approach. The victim is caught by a large, hinged, protrusible lower lip (labium) (Fig. 27), which is folded beneath the head when not in use. There are two main groups of Odonata: dragonflies and damselflies. Both are found infrequently in local streams.

Respiration occurs in the rectum of dragonfly nymphs, when water is drawn in through the anus by muscular action. The rapid expulsion of this water through the anus gives the nymph a form of "jet propulsion" used in time of danger. In the damselfly nymphs three large plate-like gills at the end of the abdomen serve for respiration and act as a "tail" for swimming. The adult Odonata are predators on smaller flying insects but are harmless to man.

Distinguishing features

Nymphs (Fig. 28-29)

The large hinged labium (Fig. 27) folded beneath the head is diagnostic of both groups.

Damselfly (Fig. 28)

The three large plate-like gills at the end of the abdomen distinguish the damselfly nymph. The method of swimming by body undulations, using the gills as a "tail", is also characteristic.

Dragonfly (Fig. 29)

The absence of large gills on the end of the abdomen, the locomotion by "jet propulsion" when disturbed, and the generally larger, flatter form of the dragonfly separates it from the slimmer damselfly.

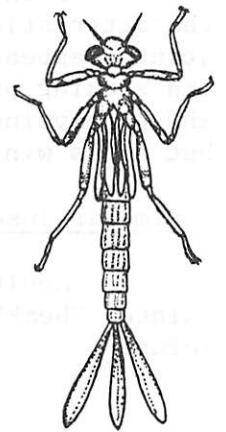
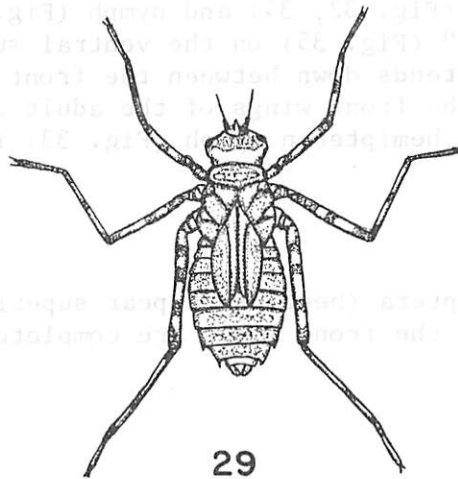
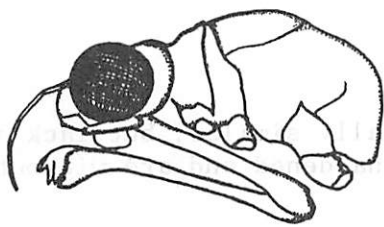
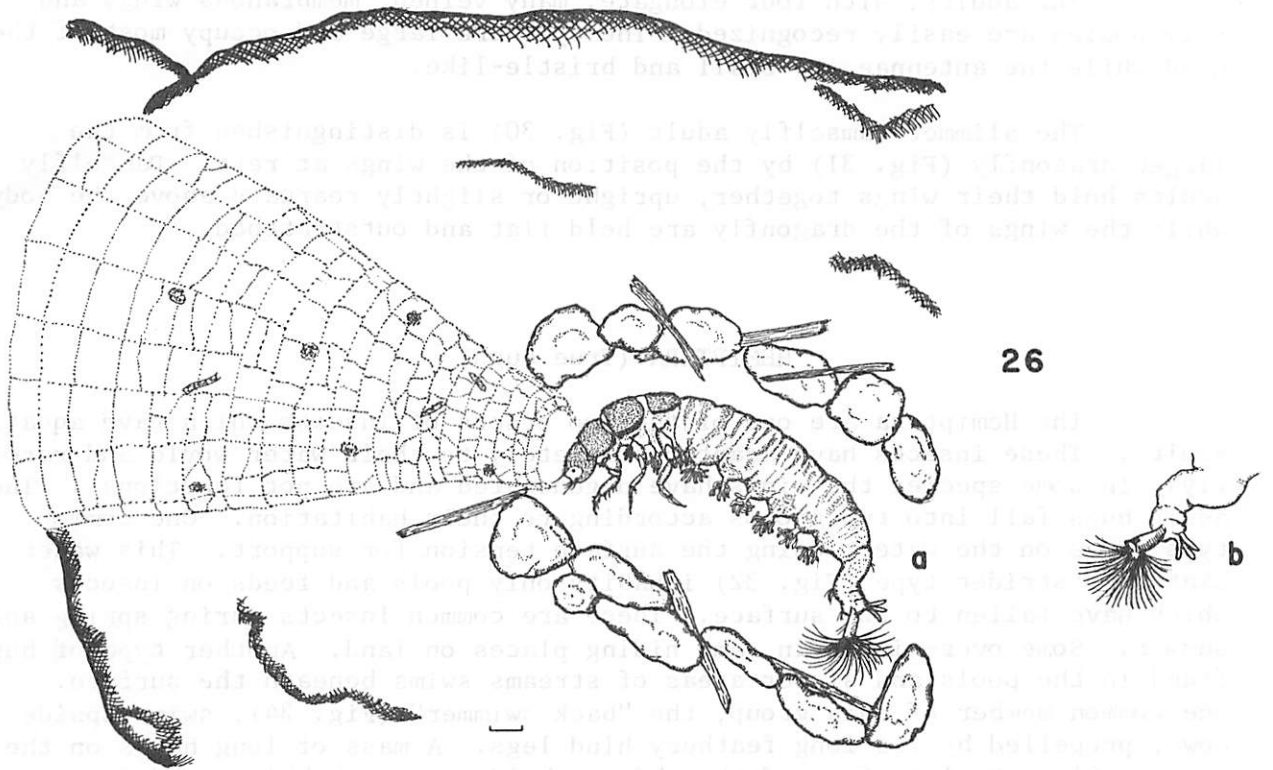


Fig. 26. a. Larva of Hydropsychidae with net. b. anal claw with hair fan.
Fig. 27. Lateral view of anterior of Odonata nymph showing labium (lower lip) folded beneath head.
Fig. 28. Damselfly nymph.
Fig. 29. Nymph of Dragonfly.

Adults (Fig. 30-31)

The adults, with four elongate, many veined, membranous wings and slim bodies are easily recognized. The eyes are large and occupy most of the head while the antennae are small and bristle-like.

The slimmer damselfly adult (Fig. 30) is distinguished from the larger dragonfly (Fig. 31) by the position of the wings at rest. Damselfly adults hold their wings together, upright or slightly rearward above the body, while the wings of the dragonfly are held flat and outstretched.

HEMIPTERA (True bugs)

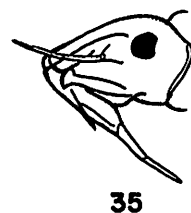
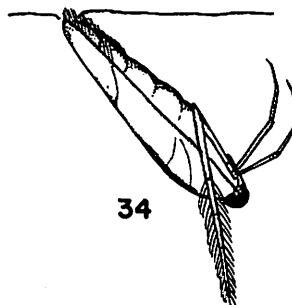
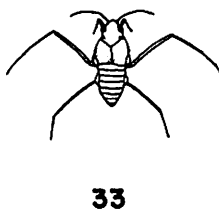
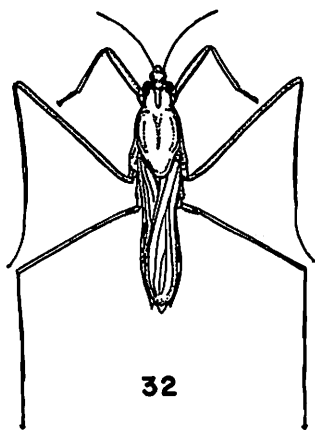
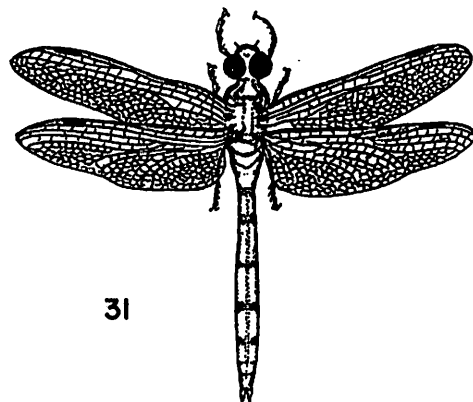
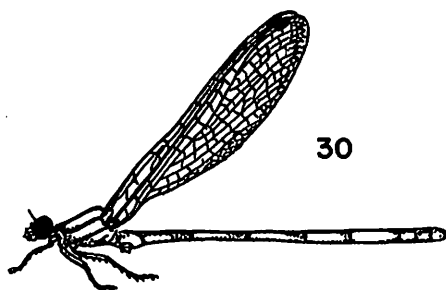
The Hemiptera are one of the two orders of insects which have aquatic adults. These insects have adapted completely to their water world and rarely fly. In some species the wings have degenerated and are not functional. The adult bugs fall into two groups according to their habitation. One common type lives on the water, using the surface tension for support. This water skater or strider type (Fig. 32) inhabits only pools and feeds on insects which have fallen to the surface. These are common insects during spring and summer. Some over-winter in damp hiding places on land. Another type of bug found in the pools and slower areas of streams swims beneath the surface. One common member of this group, the "back swimmer" (Fig. 34), swims upside down, propelled by its long feathery hind legs. A mass of long hairs on the anatomical ventral surface of the abdomen holds an air bubble, used for respiration, while the insect is below the surface. This predator feeds on other insects and fish eggs.

Distinguishing features

Both adult (Fig. 32, 34) and nymph (Fig. 33) can be recognized by the characteristic "beak" (Fig. 35) on the ventral surface of the head. This jointed appendage extends down between the front legs and is used for piercing and sucking prey. The front wings of the adult are hardened only at the base and have veins. The hemipteran nymph (Fig. 33) is very similar to the adult but lacks wings.

Similar insects

Adult Coleoptera (beetles) appear superficially similar, but lack a jointed "beak" while the front wings are completely hardened and are without veins.



- Fig. 30. Adult of Damselfly.
Fig. 31. Adult of Dragonfly.
Fig. 32. Hemiptera adult "water strider" type.
Fig. 33. Hemiptera nymph "water strider" type.
Fig. 34. Hemiptera adult "backswimmer" type.
Fig. 35. Lateral view of anterior of Hemiptera, showing jointed "beak" below head.

COLEOPTERA (Beetles)

The beetles include forms with aquatic adults which have developed various modifications for life underwater. Most are found in the slower stretches of the stream, although several families do have members which inhabit riffles. Many of the adult beetles must come to the water surface to replenish their air supply and have evolved structures for carrying an air bubble below the water. Modifications to the legs, including flattening and long hair fringes to aid in swimming, are fairly common. The adults and larvae of most forms are predacious. One common species, the whirlygig beetle, lives on the water surface and has divided eyes (Fig. 38) enabling it to see both in the air and water simultaneously. This animal feeds on surface insects and gets its name from the habit of swimming quickly in circles.

Distinguishing features

Larvae (Fig. 36)

The larvae have three pairs of jointed thoracic legs but lack prolegs on the abdomen. The head and thorax are hardened, the abdomen variable, usually sclerotized but occasionally soft.

Adult (Fig. 37)

The adult is distinguished by the fore wings which are completely hardened and lack veins. The fore wings at rest meet in a straight line down the back and cover the membranous hind wings.

Similar insects

Larvae

Trichopteran larvae have a pair of anal prolegs present on the abdomen. The common Megaloptera found locally has no prolegs but has long lateral processes on the abdominal segments, and a single median tail-like structure.

Some beetle larvae have lateral abdominal processes but they lack both prolegs and the single median tail.

Adults

Hemipteran adults have a jointed beak; the front wings are hardened only at base and are veined.

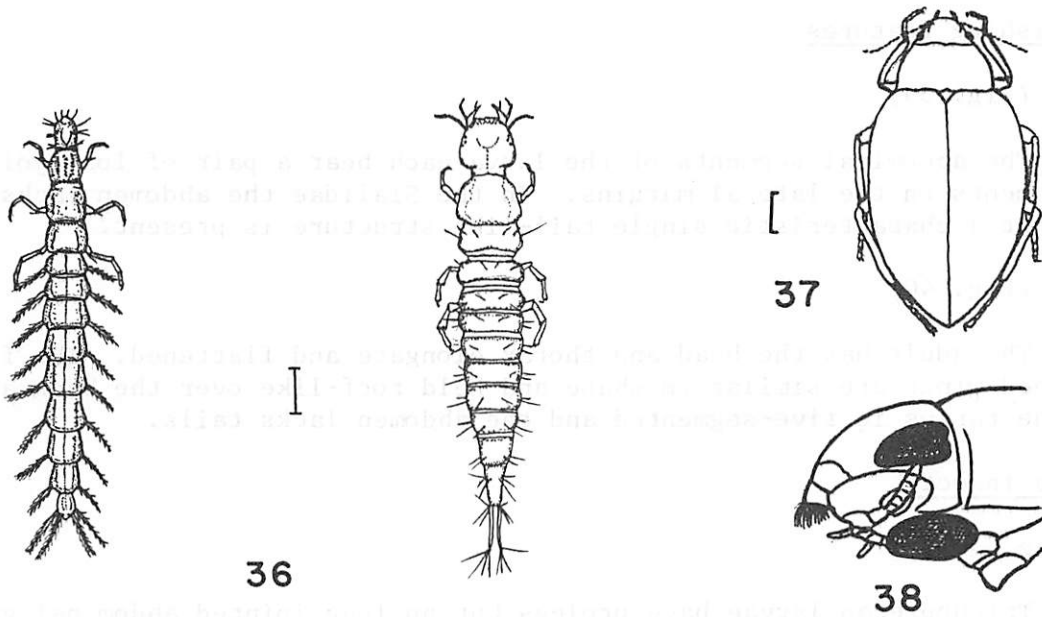


Fig. 36. Larvae of Coleoptera.

Fig. 37. Adult Coleoptera.

Fig. 38. Lateral view of anterior of adult "whirlygig" beetle - showing divided eyes.

MEGALOPTERA (Alderflies, Helgramites)

Members of the Megaloptera are rare in local streams. The larva most likely to be encountered belongs to the family Sialidae of which there is only a single genus - Sialis (Fig. 39). This occurs under stones in riffles and well-aerated portions of pools. In other parts of the world fishermen refer to the predacious larvae as "helgramites" and the larger forms are prized as bait. The dark, clumsy flying, adults may be found on vegetation close to the stream and usually scamper away if threatened, flying only as a last resort. Eggs are laid on vegetation overhanging the stream, and the larvae on hatching drop into the water.

Distinguishing features

Larvae (Fig. 39)

The abdominal segments of the larva each bear a pair of long jointed gill filaments on the lateral margins. In the Sialidae the abdomen lacks prolegs but a characteristic single tail-like structure is present.

Adults (Fig. 40)

The adult has the head and thorax elongate and flattened. The four many-veined wings are similar in shape and held roof-like over the back at rest. The tarsus is five-segmented and the abdomen lacks tails.

Similar insects

Larvae

Trichopteran larvae have prolegs but no long jointed abdominal gill processes. Coleopteran larvae lack prolegs and although long lateral processes may be present there is no single median tail.

Adults

Plecopteran adults are somewhat similar but the tarsus is three-segmented and usually two tails are present on the abdomen. Also the fore and hind wings of Plecoptera usually differ in shape, the hind being larger.

DIPTERA (True flies or two-winged flies)

The Diptera or true flies comprise a vast group of families many of which have aquatic stages. The larvae have a very wide range of habitations, from the most polluted puddle to the cleanest river. This wide tolerance to extremes makes the Diptera the most numerous of the aquatic insects, and very important both as a food for other organisms and as pests. The blood-sucking habits of the adults of many aquatic Diptera, i.e. mosquitoes, blackflies and some no-see-ums are well known. The larvae, which may form an important food of stream fishes, feed on a variety of materials including algae, other animals and dead vegetable and animal matter. Both adults and larvae show a wide size range, e.g. biting midge of less than 2 mm to a crane fly of almost 5 cm (2 inches). Many adults feed on nectar; some supplement this with a blood meal, others do not feed.

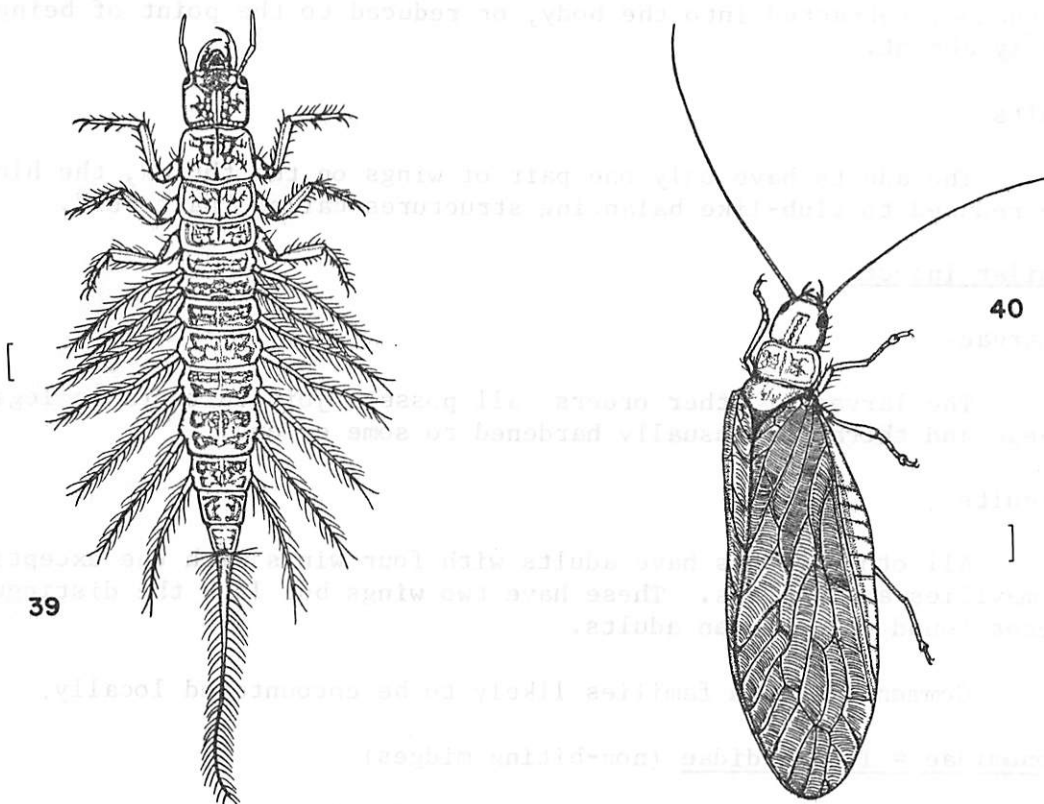


Fig. 39. Larva of Sialis (Megaloptera).

Fig. 40. Adult of Sialis (Megaloptera).

Distinguishing features

Larvae

Dipterous larvae lack jointed thoracic legs, but several pairs of fleshy prolegs may be present. The body is usually soft while the head may be hardened, retracted into the body, or reduced to the point of being almost entirely absent.

Adults

The adults have only one pair of wings on the thorax, the hind pair being reduced to club-like balancing structures called "halteres".

Similar insects

Larvae

The larvae of other orders all possess jointed thoracic legs, and the head and thorax are usually hardened to some extent.

Adults

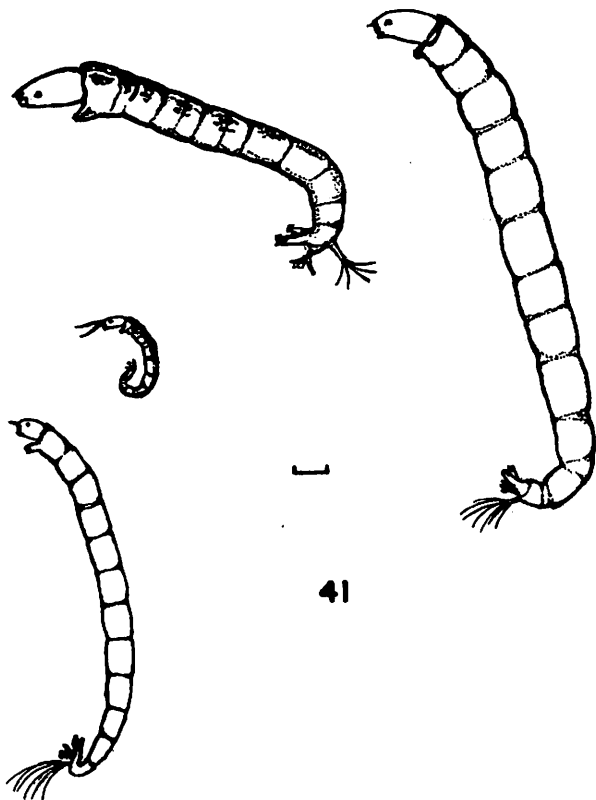
All other orders have adults with four wings with the exception of some mayflies and beetles. These have two wings but lack the distinguishing halteres found on dipteran adults.

Common dipteran families likely to be encountered locally:

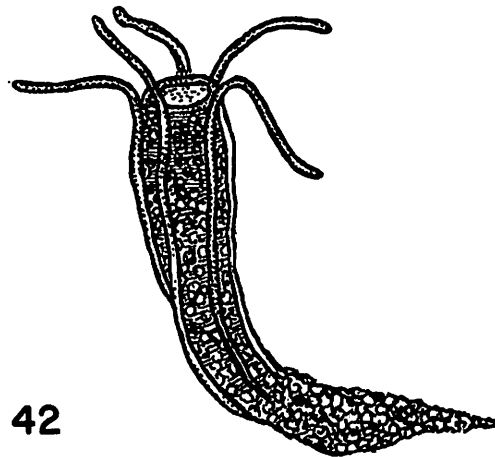
Chironomidae = Tendipedidae (non-biting midges)

The chironomids are the commonest of all aquatic insects, with the larvae occurring everywhere in our local streams. Although usually minute (newly hatched, they are less than 1/2 mm and rarely attain 2 cm in size), the larvae (Fig. 41) may comprise 80% of the total stream insects and therefore form an important food of fish. A pair of prolegs (occasionally fused to form a single structure) on the first thoracic and last abdominal segments of the soft body, and the sclerotinized head, distinguish these larvae. The larvae use the prolegs for creeping movements and they may thrash about wildly by body undulations if disturbed. Many feed on algae and detritus but some use animal foods, especially small worms and other chironomid larvae. Pool-dwelling forms may be burrowers or builders of fragile silt cases which may often be seen as small tubes on the bottom. Sand cases (Fig. 42) are constructed by some riffle species and may have a net spun across the entrance to entrap food carried by the current. Those larvae with blood rich in haemoglobin, so giving the animal a red colouration, are commonly called "blood worms".

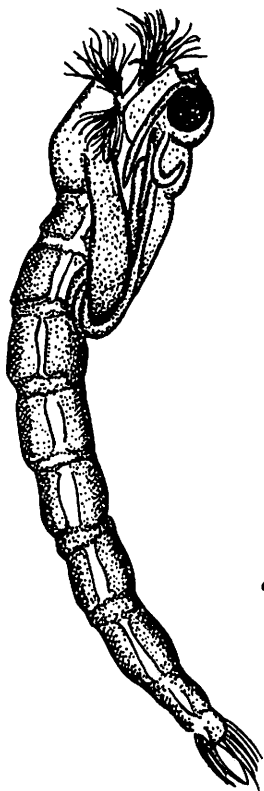
Pupation occurs in the water. The wing-pads and legs are held close to the body giving the pupa (Fig. 43) a mummy-like appearance. The thorax is relatively large and usually bears a tube or tuft of filaments for respiration. A flattened swimming paddle, sometimes fringed with long hairs, is present at the end of the abdomen. The adults (Fig. 44) are small, soft-bodied and delicate, characterized by long front legs which may be held off the surface when at rest. The males usually have large feathery antennae.



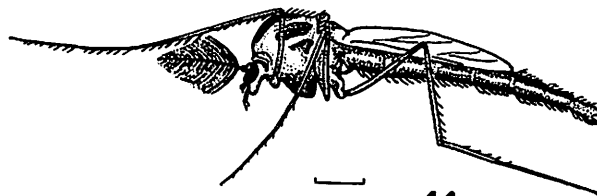
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Fig. 41. Various Chironomidae (Midge) larvae.
Fig. 42. Sand case of riffle dwelling chironomid.
Fig. 43. Chironomidae pupa (after Mundie).
Fig. 44. Chironomidae adult (after Mundie).

Although superficially mosquito-like in appearance, the adults do not feed, and represent the reproductive phase. Adults are common from April to October and the large mating swarms create an audible hum as they hover above the streamside vegetation.

Ceratopogonidae = Heleidae (biting midges, no-see-ums, punkies)

Although many biting midge larvae occur in streams, their usual habitats are swamps and damp soils. These predators superficially resemble chironomids but lack prolegs.

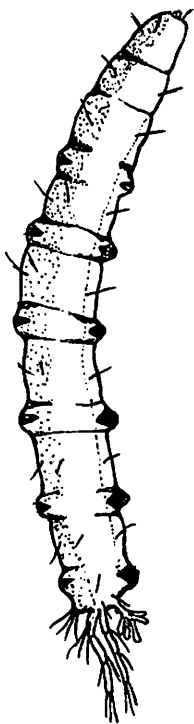
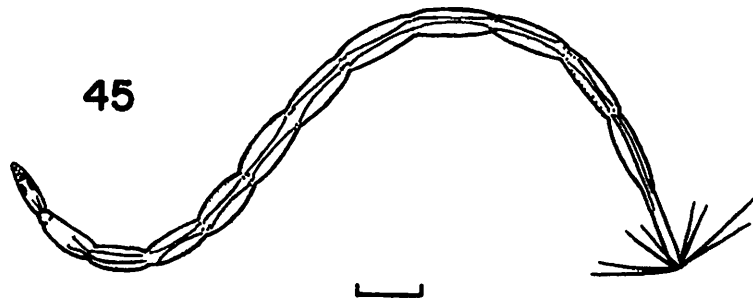
A common form has a slim snake-like body (Fig. 45) and swims with a distinctive figure 8 motion. Several species of the small (1 mm) adults are well known for their obnoxious biting. Although most species do not prey on man, those that do have a bite out of all proportion to their size. The adults are generally grey or dark coloured. They differ from small chironomids by folding the wings one above the other at rest.

Tipulidae (leather-jackets, crane flies, daddy-long-legs)

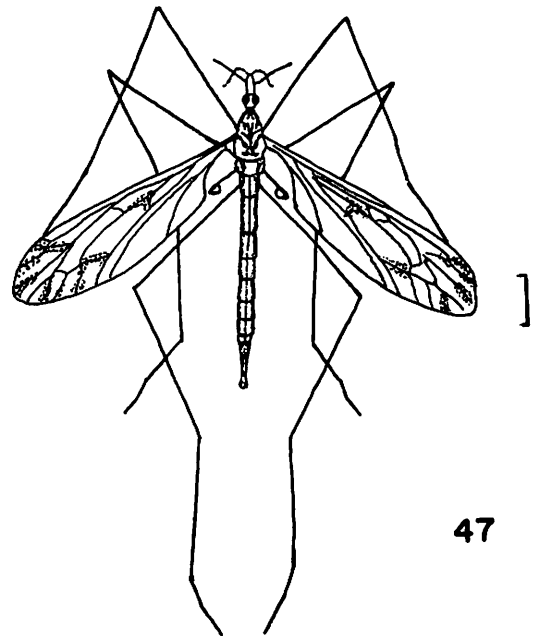
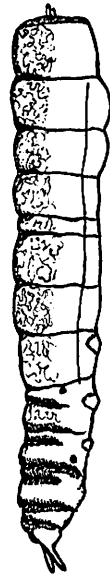
The tipulids contain some of the largest dipterous larvae and dwell in mud and sand in all portions of the stream. These large (up to 2 inches), soft-bodied organisms are distinguished by the apparent lack of a head which is retracted into the body (Fig. 46). Prolegs are lacking, but creeping welts used for movement may occur. Several lobes, which surround the breathing pores (spiracles) may be present on the tip of the abdomen. Although most larvae in streams are detritus feeders, some are predators.

Many tipulids live in moist soils; one such larva, which damages cultivated lawns, is commonly referred to as a "leather-jacket".

The adults (Fig. 47) (some may reach 5 cm in size) have long fragile legs which are easily broken if handled. Adults feed on nectar and do not bite man.



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Fig. 45. Larva of a common stream Ceratopogonid.
Fig. 46. Tipulidae (Cranefly) larvae.
Fig. 47. Tipulidae adult.

Simuliidae (blackflies, buffalo gnats)

The larvae of blackflies are found most abundantly in riffles and may be so numerous as to appear as a mat of brown moss on the surface of the stone. This small creature (seldom longer than 1 cm) is one of the best adapted to the precarious life of fast water. A modified proleg, forming a pad composed of rows of small hooks, at the end of the abdomen attaches the larva to the rock surfaces. If the larva is dislodged, the salivary glands produce a sticky strand of silk, which adheres to any object on contact. This allows the larva to pull itself back for re-attachment. The normal movement of the larva consists of the anterior portion of the body being stretched forward; a drop of silk is deposited on the rocks and grasped by the single thoracic proleg; the posterior hooks are released and the abdomen drawn in and re-attached; the head end is then released. The larva feeds by spreading its fan-like mouth parts into the current to capture small fragments of algae and detritus. These structures on the head, the attachment organ on the tip of the soft body, and the single thoracic proleg below the sclerotized head distinguish the larvae (Fig. 48). The pupae (Fig. 49) are usually found in clusters of open-ended silk cases on the surface of stones. The thorax usually bears a large bundle of respiratory filaments. On the tip of the abdomen a set of small hooks for attachment to the case is present. The adults (Fig. 50) are dark flies with a large thorax (hence the common name buffalo gnat) and broad wings. Many of the females need a blood meal to produce eggs. Some species prey on man and are a serious pest. Adults are fairly common from April to October; larvae are very abundant in spring and early fall.

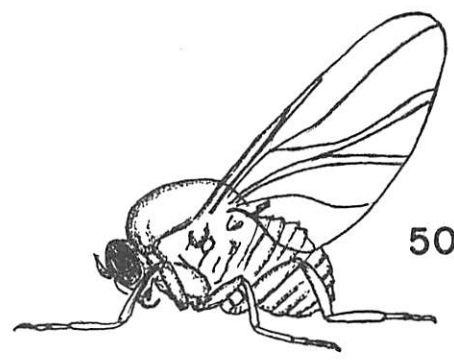
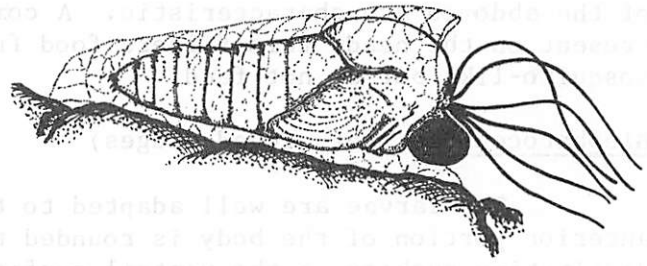
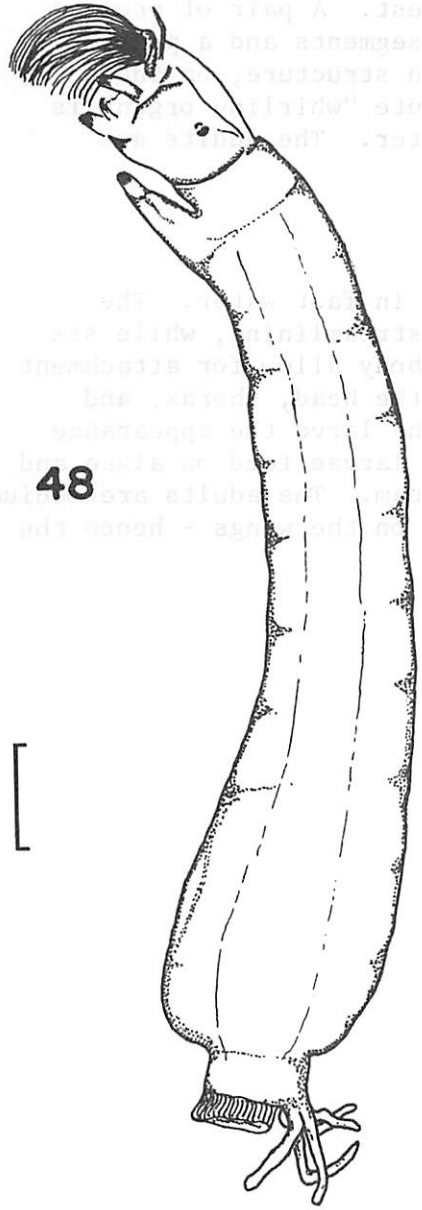


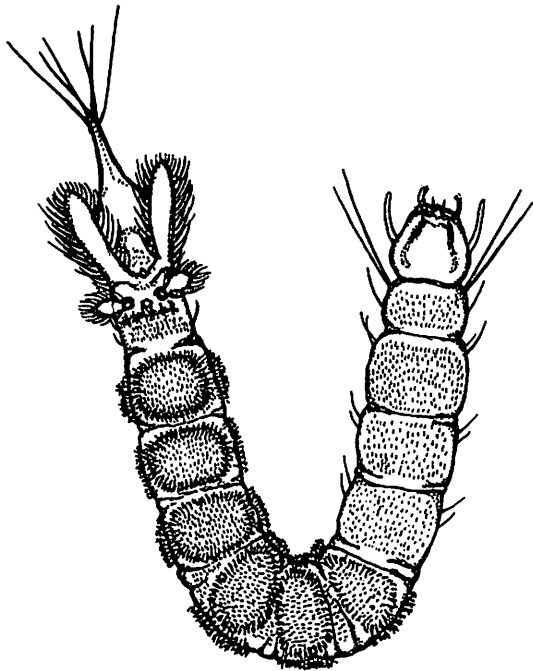
Fig. 48. Larva of Blackfly (Simulidae).
Fig. 49. Blackfly pupa in case on rock surface.
Fig. 50. Adult Blackfly.

Dixidae

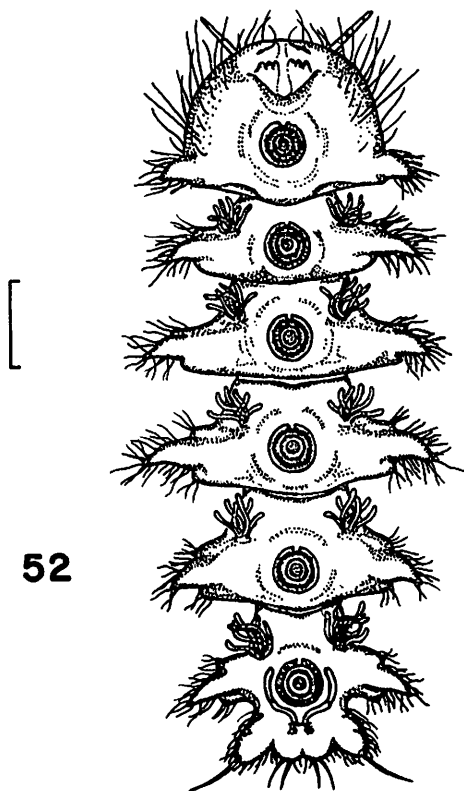
The larvae (Fig. 51) of dixids are also fast-water dwellers, but are relatively scarce on local streams. Found on rocks in shallow water, the larva assumes a distinctive U-shaped position at rest. A pair of prolegs on the ventral surface of the first two abdominal segments and a pair of fringed paddle-like processes, with a single median structure, on the end of the abdomen are characteristic. A complex, minute "whirling organ" is present on the head; this filters food from the water. The adults are mosquito-like but do not feed.

Blepharoceridae (net-winged midges)

The larvae are well adapted to their life in fast water. The anterior portion of the body is rounded to aid in streamlining, while six distinctive suckers on the ventral surface of the body allow for attachment and locomotion. The rounded anterior consists of the head, thorax, and first abdominal segment which are fused and give the larva the appearance of having only seven body segments (Fig. 52). The larvae feed on algae and are fairly common in the swiftest parts of the stream. The adults are medium sized (4 mm) and fragile with a network of creases on the wings - hence the common name.



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Fig. 51. Larva of Dixidae (dorsal view).
Fig. 52. Larva of Blepharoceridae (ventral view).

