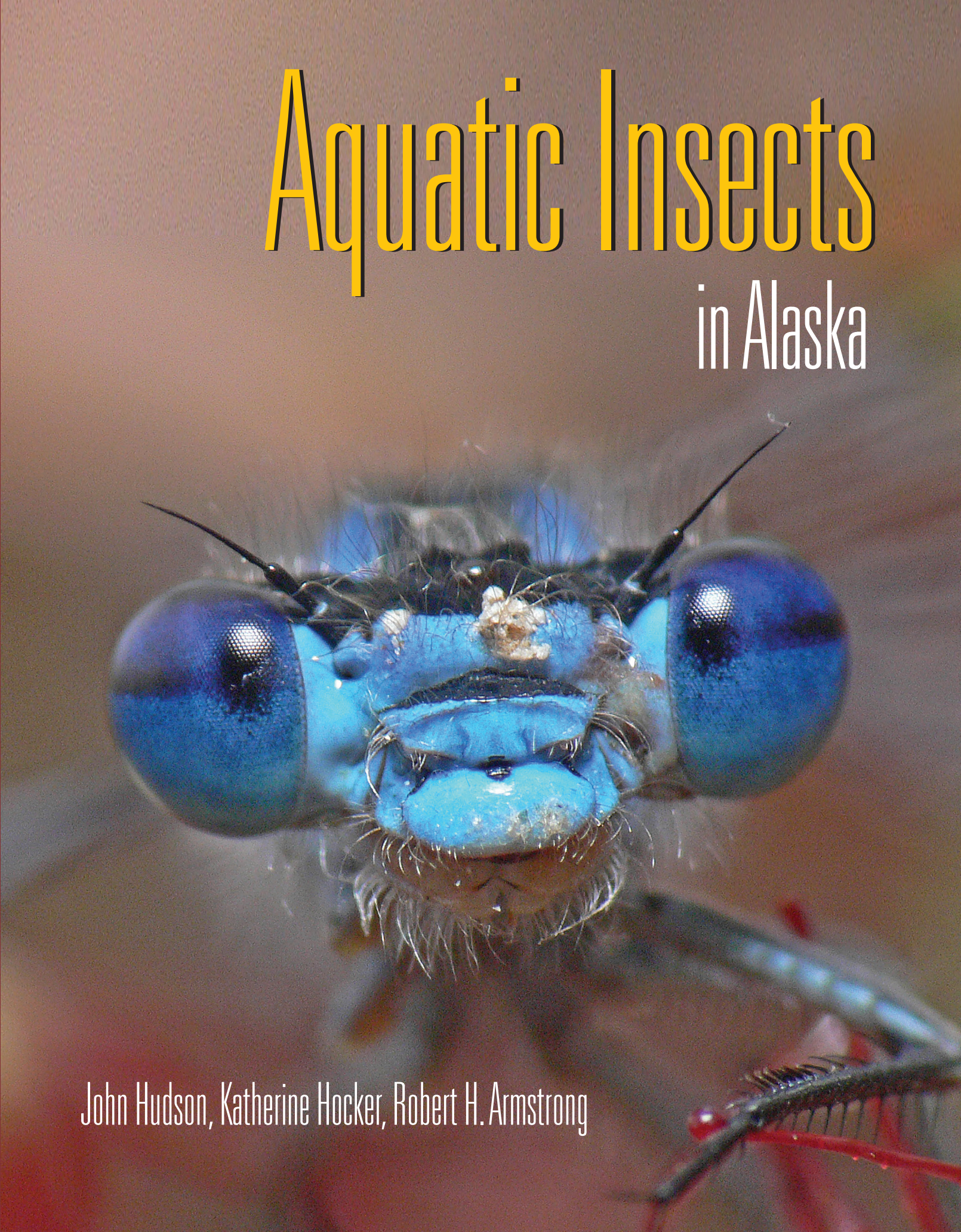
Aquatic Insects in Alaska



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Introduction

The schoolchildren are unusually quiet and focused, watching their teacher sweep the long-handled net along the edge of the pond. The net swishes through sedges, stirs up plumes of mud from the bottom, sends ripples across the still surface.

At last, the teacher lifts the dripping net from the pond and carries it to a large tray of water set on the bank. The children cluster around it. The teacher gently turns the net inside out into the water, carefully rinsing the mesh. There are a few scattered "yuks" from the onlookers, as the debris swirls. Someone says, "There's nothing there!"

"Wait, and watch," the teacher says, smiling.

There are a few moments of silence, as the water settles, then one girl gasps, "WOW!" The sample in the collecting tray is coming alive. Dark brown beetles swoop. Tiny light-colored specks dart to and fro. Clumps of bark wander under their own power across the bottom. And in one corner, a huge bug—as long as the teacher's thumb—stalks across the pan on six long legs. Completely mesmerized, the students gaze into a world of animals they never imagined.

All Alaskans know that our waters are alive. We see, catch, and eat the fish that swim in the rivers and lakes. We watch birds, otters, beavers, and bears splash in streams and ponds, and see moose wade through wetlands.

But there's a whole category of Alaskan aquatic wildlife that many people aren't aware of: aquatic insects. Aquatic insects are everywhere—from the Arctic tundra to the Southeastern rainforest. Just about every Alaskan stream, river, pond, or lake contains aquatic insects at some time of year.

Aquatic insects influence our lives. We admire dragonflies and swat Mosquitoes, both of which live underwater for much of their lives. We eat fish and birds that feed on aquatic insects. We munch on berries and enjoy flowers that are pollinated by the winged adults of aquatic insects.

Mosquito, adult female

The world of these important little animals is, in a way, a lot like the intertidal zone of our ocean shores: an underwater landscape where countless strange and fascinating grazers, predators, and living traps go about their small business, hidden from our eyes by their liquid atmosphere. But rivers, lakes, ponds, and streams don't have tides, so the aquatic insects' world remains covered and mysterious.

Dragonfly Day at Creamers Field in Fairbanks attracts bug enthusiasts of all ages.

Still, it isn't too difficult to get a glimpse. Turn over a rock in a stream, sit quietly by a pond in summer, or get a net and do some sampling, and you'll be surprised at how much you'll find.

About this book

Consider this book your introduction to the aquatic insects of Alaska. It was created to showcase the diversity of aquatic insects in the state, and to help people familiarize themselves with the major groups. We hope that it inspires you to learn more about Alaska's aquatic insects, and helps you to better understand how they're connected to Alaskans of all species—human and non-human.

The book is organized in four major sections:

- In the first section, you'll find an overview of aquatic insect natural history—how these creatures feed, grow, and survive the elements; and how they fit into the ecosystem.
- In the second section, you'll find descriptions of the various groups of aquatic insects in Alaska. Although this book is not intended to be a complete field guide, this section should help familiarize you with some of the important characteristics, behaviors, and habitats of these groups.
- The third section shows some examples of "other aquatics"—organisms that are not insects, but that you might encounter while looking for aquatic insects.

Collecting and looking at bugs often requires protection from the ones trying to collect you!

- The fourth section gives suggestions on how to find, catch, observe, and photograph aquatic insects.

What's an insect?

Look up the definition for the word insect (or ask any fifth-grader, for that matter) and you'll learn that insects are small animals that have six jointed legs, a body divided into three sections (head, thorax and abdomen), a hard exoskeleton protecting a boneless interior, compound eyes, and two antennae. Insects all belong in the phylum Arthropoda (the same group that includes crabs, spiders, centipedes, and more).

That's all true, but when you start looking more closely at aquatic insects (or insects of any kind, really) it gets a little more complicated. Chironomid larvae have soft, exposed bodies and no jointed legs. Some beetle larvae have appendages that look like legs—but they are without joints and number far more than six. So be aware that at some stages of its life, an insect may not fit all of the parts of the official definition.

Who would have thought that an insect as attractive as this (and that was helping to pollinate this beautiful flower) could be called a "Rattailed Maggot" in its aquatic stage as a larva?

What's an aquatic insect?

Like all animals, insects need water to survive. But some insects need water in a much more fundamental way than just having to ingest it. Some hatch underwater and spend the rest of their lives below the surface. Some start out underwater, then emerge to spend part of their lives on land. Still others never actually go below the water surface, but they do rely on that water surface to get their food.

These insects, whose lives are closely tied to streams, ponds, lakes, rivers, or even puddles for at least part of their life cycles—and whose bodies have adaptations to a water-related life—are known as aquatic insects.

A note: A few aquatic insects, such as ocean-going Water Striders and some Rove Beetles, live on ocean waters and along marine shorelines. In this book, however, we'll focus on aquatic insects of Alaska's fresh waters.

Aquatic insects are apt to show up anywhere there is fresh water. We have even found caddisfly larvae living on the rock face of Nugget Falls in front of Mendenhall Glacier in Juneau (see the story about them on page 32). Photo by John Hudson

Aquatic insect habitats of Alaska

Alaska is a huge state, spanning over 660,000 square miles of mountain ranges, river floodplains, glacial valleys, tundra, forest, wetlands, and rocky shores. It's also a water-rich land; even the areas that receive relatively little rain or snow can have extensive wetlands, due to permafrost and snow and glacial melt. Millions of lakes, ponds, and streams embroider the landscape, and each one offers habitat for aquatic insects.

Stream habitats

From tiny, tumbling mountain creeks to large rivers such as the Yukon, the Susitna, and the Stikine, ribbons of moving water tie Alaska's landscape together. The constantly-moving water of these streams creates particular parameters for life, shaping the community of aquatic insects that live there.

To thrive in the current of a river or stream, an insect must be able to cling tightly or otherwise anchor itself to rocks, logs, or other structures in the stream. Alternatively, it can tuck itself into the lee of a rock or another obstacle, or bury itself in sediment.

For aquatic insects that can keep their positions or avoid the current, moving water offers some advantages. Moving waters tend to be colder and to have smaller temperature fluctuations than still waters do. Stream environments also tend to have more oxygen, because colder water can hold more dissolved oxygen and because the motion of the water "stirs" oxygen into the stream.

Currents provide opportunities, too. For filter feeders the constant flow of water is like a conveyor belt of food. The current is also a free ride. If an insect decides to move downstream, it needs only to crawl to a place where the current is strong enough and let go. The stream then carries it to a new environment, perhaps with more food available, or fewer predators. This type of budget travel, known as drifting, is widely used among stream-dwelling insects. You'll find more about it later in this book.

Smaller streams may dry up during summer droughts. Glacial streams usually diminish greatly in winter, when the glaciers are not melting as quickly. In either case, aquatic insects must rely on physical or behavioral adaptations to see them through.

This portion of a Southeast Alaskan stream shows a sequence of pool, riffle, pool habitats. Each type of habitat may harbor different types of aquatic insects.

In the stream

Within a stream are many different types of habitats for aquatic insects. Depending on the channel steepness, the water may glide smoothly or roar down a waterfall. In pools, it moves very slowly. Because most natural streams have complex channels, there may be pockets of still water right next to swift and turbulent flow. In fact, due to friction, water velocity within a few millimeters of a hard surface such as a stone or log is much slower than the nearby flow. Many aquatic insects have flattened bodies that help them take advantage of this "boundary layer."

Where the water is swiftest, the rocks that line the bottom are the largest. In waterfalls and cascades, water drops suddenly over bedrock and boulders. Aquatic insects that live in these turbulent areas must be able to cling tightly to stay put—but these areas can also provide good food resources and plenty of oxygen.

In pools, the stream slows down, dropping fine sediments such as sand and silt. These areas provide habitat for burrowing aquatic insects, as well as those that can't hang on as effectively in strong current.

In riffles, water speeds up again and the bottom is usually covered with cobbles and gravels. The spaces between the rocks provide important habitat for aquatic insects to take refuge from strong currents and predators such as trout and young salmon.

Lake and pond habitats

Alaska has millions of lakes and ponds, ranging from thousand-square-mile Lake Iliamna, to the tiny pools that dot the Arctic tundra and rainforest muskegs. As with streams, still water habitats are varied. They include silty glacial lakes, beaver-dammed pond systems, forest lakes and bog ponds black with tannins, and glass-clear alpine tarns.

For insects of lake environments, the challenge isn't the current, but the lack of it. Lake and pond water can warm to very high temperatures fairly quickly, especially if there are no currents to circulate cooler, deeper water to the surface. Warmth is helpful for some aspects of life—it can speed development and food production. But warm, still water can become very oxygen-poor. Thus, to thrive in shallow lakes and ponds, aquatic insects must be able to get oxygen in other ways than by extracting it from the water around them.

Still waters can also experience large temperature swings and water level changes. A shallow bog pond near Fairbanks might reach 90° F in summer, then freeze nearly solid in the winter. In a drought, it might dry up completely. Insects of these environments must be able to deal with these fluctuations—either by completing the aquatic stage of their life cycles within the short periods when conditions are right, or by banking on adaptations that help them withstand freezing or drought.

Lake and pond habitat zones

Depending on its size, depth, and the type of water (glacial or non-glacial, tannin-stained or clear) a lake or pond offers a variety of habitats for aquatic insects.

The water surface is a distinct still-water habitat. To us, the water surface is soft and easily broken. But if we were the size of an insect, we'd experience the surface more as a thick, resilient skin. It's this property (called surface tension) that allows some insects,

The tundra of Kanuti National Wildlife Refuge is dotted with myriad pools and ponds.

notably water striders, to live their lives skating about on the pond, always in contact with the aquatic world but rarely going below the surface.

As you descend below the surface, light gradually fades. Below a certain point, little light makes it through. The amount of light influences the type of food available for aquatic insects. In well-lit upper waters, microscopic plants such as diatoms can grow. These feed microscopic animals, creating a sort of living soup for insects and other, larger creatures. In the dark and cool depths, no plants can grow, but food does sink down from above.

Most lakes and ponds contain aquatic vegetation such as sedges, rushes, pond lilies, and pondweeds. Many of these plants take root in the lake bottom, so they can grow only where the water is shallow enough for their stems to reach the light. Shallow ponds may be filled with plants. Larger, deeper ones may be ringed with plants in their shallow margins. In any case, tangles of aquatic vegetation can be rich jungles of aquatic insect life—great places to wet a bug net and see what's lurking below.

The deepest parts of a lake or pond tend to have the fewest aquatic insect types, but this dark zone is livelier than you might think. In the cool depths, dead organic matter is constantly drifting down like snow from the brighter world above. Waiting to receive this manna is a community of invertebrates, often including aquatic insects.

At this lake on the Kenai Peninsula there are many types of aquatic insect habitats including open water, bottom sediments, and vegetated margins.

Adaptations to aquatic life

For Alaska's aquatic insects, underwater is home; they are as comfortable in their liquid world as we are in the world of dust and sky. Like us, they breathe, move, feed, and endure by virtue of adaptations that suit them to their own particular niches in the aquatic landscape.

If you sneak up slowly on a Mosquito-filled pond, you may see the little snorkeling larvae resting just under the surface, and the surface film dimpled where their breathing tubes emerge.

Breathing

As mammals, we get the oxygen we need by pulling air into our lungs. There, the oxygen diffuses through delicate membranes and into our blood. Our hearts pump the blood throughout our bodies, delivering oxygen to nerves, muscles, glands, and other tissues. Waste gases such as carbon dioxide are removed from the body by the same process in reverse.

Insects need oxygen, too, and they also must get rid of carbon dioxide. But their capture-and-transfer system is quite different from ours. Instead of arteries and veins, insects' bodies have air-filled tubes. Roughly similar in pattern to our blood vessels, the tubes divide into fine branches to reach individual cells. Thus, an insect's entire body is, in a sense, filled with air. Oxygen diffuses almost directly from the air into the tissues.

How does the air get inside the insect? In many insects (particularly terrestrial ones), the air tubes originate at small openings called spiracles in the exoskeleton. This lets the air around the bug exchange with air inside the bug. Although insects don't have lungs, some do assist air circulation with movements of their bodies.

This Whirligig Beetle has trapped a bubble of air at the end of its abdomen so it can obtain oxygen while underwater.

Taking this system underwater means modifying it a little. That can be done by keeping at least some spiracles in touch with the air, or by developing ways to extract oxygen from the water.

Snorkelers

The aquatic larvae of some Mosquitoes and flower flies (the latter known rather unpoetically but descriptively as "Rattailed Maggots") keep spiracles in contact with the air through tubes. The tips of these tubes often have hairs that repel water, helping to keep them on the surface.

SCUBA divers

Other aquatic insects take the atmosphere with them when they dive, carrying along air bubbles next to their spiracles. For example, most adult water beetles trap bubbles of air under their wing covers or on the ends of their abdomens. The bellies of Water Boatmen and adult Riffle Beetles are covered with a dense growth of unwettable hairs, which trap a thin, silvery sheath of air called a plastron against spiracles on their abdomens.

Bubbles like this act a little bit like SCUBA tanks, but they're even better: as the insect uses oxygen from the bubble, more oxygen can

diffuse in from the surrounding water. Only after the bubble collapses due to nitrogen diffusing out into the water does the insect have to return to the surface for more air. Watch the adult diving beetles in a pond as they pop to the surface to replenish their bubbles, or try to get a glimpse of a boatman's silvery, air-covered abdomen as the boatman darts below.

Gills and other adaptations

To eliminate the need to go to the surface, some aquatic insects have evolved the ability to get their oxygen from the water through special membranes. For example, dragonfly larvae gently inflate and deflate their abdomens to circulate water through internal gills. Many underwater breathers even have appendages (sometimes also called "gills") that can provide more surface area for oxygen to pass through. These appendages may look like paddles or leaves (as in damselflies and some mayflies), like tufts (some mayflies and stoneflies), or like tiny strands (in Black Fly pupae).

Underwater breathing specialists are more vulnerable to low oxygen levels in the water than "snorkelers" or "scuba divers." But most have strategies to help them breathe in lower oxygen environments such as warm, still water. Some of them make interesting motions to enhance their respiration: mayflies flap the gills along their abdomens, damselflies wave their tail-like gills, and stoneflies do "push-ups" to increase water flow and oxygen uptake in less-than-ideal conditions. A few types of beetles, flies, and Mosquitoes extract oxygen from aquatic plants, which produce oxygen as a byproduct of photosynthesis.

Locomotion

Alaska's aquatic insects have many different ways of exploring their world. Some drift with the whims of the current. Some scuttle, some squirm, some paddle. Some use jet-propulsion. And some pretty much just stay put until it's time to emerge as adults.

Scuttlers and squirmers

Six strong legs (or an assortment of leg-like appendages) can get you quite a ways underwater, and many aquatic insects rely on their appendages to crawl from food source to food source, or to scamper away from predators. Some use claws to cling to surfaces. Others burrow into sand or mud.

Swimmers

The ability to swim—even just a little—is very helpful to aquatic insects. If a bug can move about efficiently in the water by itself, it has access to more foods and other resources. It also has a means of escape from trouble.

The most rudimentary swimmers are those that wriggle vigorously to swim but don't really possess any specialized swimming structures. These include some Mosquitoes, and many mayflies and stoneflies. Some Mosquitoes and mayflies are actually quite good at this. They're able to dart quickly away from a curious finger probing in a collection pan.

Some aquatic insects are far more accomplished swimmers. The masters are Water Boatmen, Whirligig Beetles, and adult Predaceous Diving Beetles. They cruise through still waters with ease, propelling themselves with powerful beats of their long legs. The "rowing" legs of many of these master swimmers are lined with stout hairs that form paddle-like structures.

The overlapping gills surrounding the abdomen of this Flat-headed Mayfly work like a suction cup.

Damselfly larvae have three leaf-shaped gills at the tips of their abdomens. These gills also function as swim fins.

Dragonfly larvae do a lot of crawling. If they want to get somewhere in a hurry, they can inflate their abdomens with water, then squirt the water quickly out their rear ends, shooting forward as they fold their legs back to make themselves more streamlined.

Mosquito larvae are nicknamed "wrigglers" because of the motion they use to dart about. Water Boatmen (far right) use their long legs like oars to swim about.

Staying put

For insects that live in areas of strong current, one of the biggest challenges isn't moving around, but staying in place. Without adaptations to avoid being swept away, these bugs would be at the mercy of the stream. Many have flattened bodies, which makes them more streamlined as they cling to surfaces. Some cling tightly with stout claws and powerful legs. Others have strong hooks on the ends of their abdomens to anchor them in place. Still others have specialized suction structures that help them attach.

The larvae of Net-winged Midges live in very fast-flowing streams, and use suction cups (a) to hold themselves in place. A larva can create a vacuum in each cup as it is pressed down, forming a tight and stable seal.

Common Net-spinner Caddisflies use hooks (b) at the tip of their abdomen to cling to rocks in swift-flowing streams.

Drifters

Stream-dwelling mayflies, stoneflies, caddisflies, and other insects sometimes hitchhike in the stream itself to move away from an area they find unsuitable—where food is scarce, for example. They do this by crawling to a place where the current is flowing, then letting go and allowing the current to carry them downstream to a new home. Of course, when a stream goes on a tear with heavy rain or snowmelt, bugs may have no choice but to set sail—a phenomenon known as "catastrophic drift."

Depending on currents and obstacles, a drifter can be carried a few feet or several yards. Once it settles, it may choose to drift again. To avoid predation by drift-feeding fishes, most drifters set out at dawn and dusk.

Feeding

Like Alaska's ocean waters, our freshwater world is filled with potential foods. Most aquatic insects have fairly specific diets and use specialized feeding structures and behaviors to find, capture, and consume foodstuffs that suit their particular skills and preferences.

Dead stuff and scummy stuff

Ask any eight-year-old naturalist and she'll confirm that Alaskan streams and ponds are filled with dead stuff: wads of leaves and twigs, broken grass stems, fallen trees, spawned salmon. She might also point out that the dead stuff—along with live plants, and rocks and other non-organic items—is often covered with scummy stuff: a slimy, usually dark brown or greenish film that can be quite thick. Called biofilm, this slime is a living layer of bacteria,

algae, and fungi. Rock slime is generally made up of algae—mostly diatoms—while bacteria and fungi colonize and help decompose dead leaves and other organic material. Biofilm that grows on live plants is an important primary step in the food chain, especially in standing water.

Both the dead stuff and the scummy stuff are important foods for aquatic insects. Some insects, known technically as *collectors-gatherers*, collect small particles of organic matter from the stream bottom. Others, known as *scrapers or grazers*, carefully scrape the biofilm away from the detritus or stones like cows grazing on grass. Members of a third group, called *shredders*, munch the whole package: detritus, biofilm, and all. Like someone snacking on a peanut butter-covered cracker, they may be getting richer nutrition from the topping, but they eat the whole thing. As they eat large pieces of detritus, such as dead leaves, shredders produce fine particles of fecal matter that provide food for filter feeders.

Many stoneflies and caddisflies are shredders. They are responsible for the skeletonized leaves found at the bottoms of streams and ponds.

Tiny stuff

Pond and stream water is a soup of microscopic organisms and miniscule bits of organic debris. In streams, certain aquatic insects specialize in capturing these tiny drifting pieces of food. Black Fly larvae have comb-like appendages that filter food from the water as it flows by. Some Mosquito larvae use vibrating brushes to filter tiny food particles. Some caddisflies and Chironomids create and deploy nets to trap food particles; they tend their nets carefully, gleaning the particles and making repairs as necessary. Whether they use body parts or nets, these insects are known as *collectors-filterers*.

This Predaceous Diving Beetle larva has captured and is eating a smaller diving beetle larva.

Green stuff

Live plants provide a good source of food for aquatic insects. Some insects eat leaves, others suck the juices from stems. Others, such as some aquatic caterpillars, burrow into stems for food and shelter until they emerge as adults.

Moving stuff

Finally, many aquatic insects are *predators* chasing down and eating other aquatic invertebrates, or even fish. Some are ambush hunters, staying still and camouflaged until the prey is close enough, then reaching or darting out to grab. Others chase their prey down like wolves (or perhaps like swallows

This dragonfly larva is trying to capture a threespine stickleback using its specialized extendable and grasping lower lip.

The ultimate predators

Dragonflies and damselflies may be the ultimate aquatic predators. The larvae of all dragonfly and damselfly species are carnivorous. Whether they ambush their prey or actively hunt it down, all possess a bizarre secret weapon: a lower "lip" (called the labium) that is held, folded, under the jaw. When prey gets close enough, the labium propels forward, unfolding, and grabs or impales the prey. The labium then drags the prey to the mouth where sharp mandibles reduce it to bite-size bits.

Captive dragonfly or damselfly larvae, supplied with a few live Chironomid larvae, mayfly larvae, or worms, will often demonstrate how the labium works, which is well worth watching. Larger dragonfly larvae can capture and eat small fish, too.

capturing flying insects on the wing). To kill and consume their prey, these predatory insects may have piercing-sucking mouthparts (such as those of Giant Water Bugs) or powerful sharp jaws armed with sharp teeth (such as those of Predaceous Diving Beetles).

Avoiding being eaten

It's important to be able to get food, but it's equally important to avoid becoming food—especially for aquatic insects, which are favorite food items for many animals (see pages 18-24). Most aquatic insects have one or more forms of physical or behavioral defense.

Most aquatic insects are camouflaged—they have dull colors, stripes, or speckles—and some, including very hairy species of Forestflies (stoneflies) and dragonflies, even develop coverings of fine particles and/or biofilms that help them blend into their surroundings. Some deter smaller predators with hard exoskeletons and spines or stiff hair. The elaborate cases built by some caddisflies can be a form of camouflage as well as a protective retreat.

Forestfly larvae (stoneflies) are well camouflaged when sand grains and other small particles become trapped in their dense covering of fine hairs.

One of the best camouflages that we've seen is created by these Northern Case Maker caddisflies. They are almost impossible to see amongst the debris in the ponds where they live.

Larger predators such as big insects, birds, rodents, and toads may be fended off with nasty-tasting chemicals—a defense that's shared with many terrestrial insects.

Aquatic insects can also defend themselves through the way they behave. Many are most active after dark, when fish, birds, and other predators can't see them. Some have swift escape responses—think of Mosquitoes wriggling quickly away from the surface when a shadow passes over. Some, such as Giant Water Bugs, will defend themselves when attacked by biting back—a habit that has earned them the nickname "toe biters."

Whirligig Beetles secrete a distasteful chemical when captured. In trying to flush their mouths of the bad taste, fish often spit the beetles back out to freedom.

Freezing and drying

Two of the biggest challenges faced by Alaska's aquatic insects are cold and drought. Cold winter weather freezes streams and ponds—often stopping the water altogether. Combined with shorter daylight this reduces the food resources many aquatic insects need to grow. Summer and winter droughts can dry up streams, leaving only disconnected pools on the surface. They can also shrink ponds, sometimes to nothing but patches of cracked mud. To thrive in this dramatic environment,

aquatic insects have to deal with both challenges.

Avoiding the freeze

One method to avoid freezing is to simply stay in liquid water, which is the warmest environment when all else is frozen. Here insect larvae can even feed and grow in the world below the ice.

Some insects avoid freezing by supercooling—manufacturing cryoprotectants and antifreezes so their body fluids are maintained at temperatures considerably lower than the freezing point of water.

Surviving the freeze

One of the biggest dangers to living tissue is ice. Freezing binds up water that is essential to life, and sharp ice crystals pierce cell walls, damaging or destroying them. But many aquatic insect larvae in Alaska can survive being frozen into ice. When the ice melts, the insect comes "back to life."

How do they do it? They build up high concentrations of sugars or sugar alcohols that serve as antifreeze within their cells. Ice may form in the fluid outside the cells, where there is no antifreeze, but there it can't bulge the cells out or puncture their critical membranes.

Photo by Todd Sformo

Larvae living in Arctic streams and ponds that freeze solid in winter can survive temperatures as low as -20° to - 30° C. This photo shows several Nemoura arctica *stoneflies (Forestflies) frozen in ice. When the ice melts they will "come back to life."*

Another method for avoiding freezing is to form winter cocoons such as those made by larvae of Chironomids living in the Arctic. These cocoons apparently prevent the formation of ice crystals within larval tissues.

"Sleeping" through it

To withstand tough conditions such as temperatures too cold for feeding or growth, or ponds or streams that dry out, some aquatic insects effectively sleep through the problem. Their movements slow or stop, they stop eating, and they stop growing and metamorphosing. Eggs, larvae, pupae, or adult insects may go dormant, depending on the species and the season. In a drought, larvae may burrow into mud, hide in the crevices of logs or stones, or work their way down into the still-wet gravel of the stream bed. When the water returns after a drought, or warms after a cold spell, the insects can return to their active lives.

Avoiding the issues

One way to escape freezing or drought is to avoid being in the water when challenging weather arrives. Many aquatic insects' growth and development are timed to the seasons, with the aquatic phase in the water at the optimum time. In northern streams that run reliably year-round, some stream insects spend months or years in the water as larvae, and the cold-susceptible adults emerge to take advantage of brief summer warmth.

Some aquatic insects have extremely short generation times, so that the aquatic larval phase is very brief. This reduces the chance that the larvae will be left high and dry by drought, so these insects can be successful in using even

the smallest, shortest-lived pools (think of the Mosquito wrigglers you may find in an old tire). Many of these short-timers spend winters in the egg stage, which can endure cold and drought.

Life cycles

Imagine if we humans were born in one form, then transformed into a completely different form right before kindergarten, and then changed again, into something else, sometime around middle school. That's the life of an insect. Insects—including aquatic insects—go through several transformations, often quite dramatic, during their lives. This process is called *metamorphosis*.

All insects begin as *eggs*, where the insect embryo grows and develops, fueled by nutrients in the yolk. Eventually, the embryo is ready to emerge, and works its way out of the egg. At this stage it's known as a *larva* or *nymph*. Insect larvae often look very little like their *adult* parents, and often (as in the case of insects with aquatic larvae) they have very different lifestyles.

Most insect eggs are extremely tiny, so a larva has a long way to grow before it reaches adult size. But insects don't grow as we do. Their bodies are encased in outer layers called *exoskeletons*, which are often quite hard, and have a relatively fixed size. To get bigger, the bug must *molt*: it must break through its exoskeleton and form a new, larger exoskeleton over its new form. The exoskeleton is made up of various sizes and shapes of interconnected rigid plates, or *sclerites*, which are made of a type of protein called *chitin*.

Insect larvae may go through dozens of these molts as they grow, and their shapes may change during the process. For example, older dragonfly larvae (ones that have gone through several molts) have large wing pads that the younger larvae lack.

An insect's adult form is the form in which it reproduces. In the case of most aquatic insects, the adult form is winged. Wings help the insects range more broadly: to find mates and food, and to find suitable places to lay eggs. For those stream insects that drift downstream as larvae, it is the winged adults that carry the next generation (as eggs) back upstream.

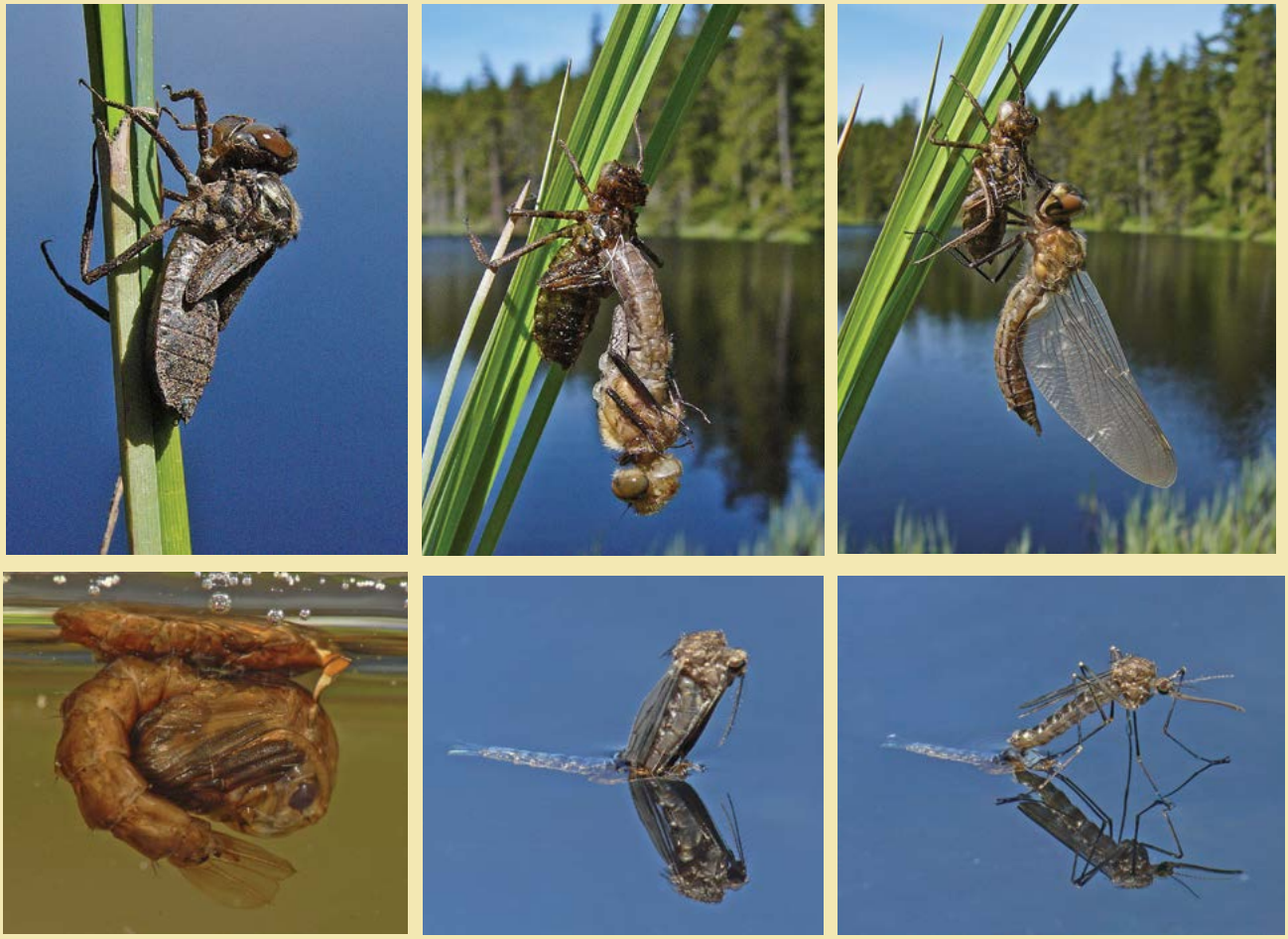
Complete or incomplete

Many insect types go straight from their last larval stage to their adult stage. A stonefly larva, for example, will—when it is ready for its last molt—crawl from the water onto streamside rocks or vegetation, where it emerges from its last larval exoskeleton as a winged adult.

This adult caddisfly (top photo) is laying eggs in the thin film of water flowing down a rock face. The eggs she has been laying (middle photo) probably number into the thousands.

Even some of Alaska's largest insects, the dragonflies, lay very tiny eggs (lower photo). They are smaller than the head of a pin. One female dragonfly may lay thousands of eggs during the few weeks she is alive.

Emergence



Whether metamorphosis is complete or incomplete, eventually a developing larva or pupa contains a fully formed adult insect ready to enter the terrestrial world. For dragonfly larvae the process of emergence (upper photos) involves leaving the water, grasping vegetation tightly, and wriggling out of the exoskeleton. Next, fluid is pumped into the wings and abdomen to expand them. Within an hour the dragonfly is ready for its maiden flight. In contrast, adult Mosquitoes leave their pupal skins by emerging at the water's surface, a process that takes less than five minutes (lower photo series).

Some insects have an extra stage between the larva and the adult. This stage is called the *pupa*, and it usually looks quite different from either the larva or the adult (although if you look closely, you can often see a bit of both in it). While it's a pupa, the insect is fairly quiet. It doesn't eat or swim much; some pupae don't move at all. But under its exoskeleton, big things are happening: the insect larva is being reconstructed into an adult.

This process of metamorphosis with a pupal stage is called *complete metamorphosis*. For insects that skip the pupal stage and instead transform into the adult within the larval exoskeleton, the process is called *incomplete metamorphosis*. Aquatic insect groups that go through complete metamorphosis are considered more evolutionarily advanced and include Mosquitoes and Chironomids, diving beetles, and caddisflies. In the incomplete metamorphosis group, considered more primitive, are mayflies, dragonflies and damselflies, and stoneflies, among others. The water bugs, such as Water Striders, undergo gradual metamorphosis in which the larva resembles a small adult without fully developed wings.

Recently molted mayfly larvae have lightly colored soft exoskeletons, making them vulnerable to predation and injury before the exoskeleton hardens.

Ecology

When we think of Alaskan wildlife, our minds usually leap to the big and the fuzzy: brown bears and caribou, otters and eagles, king salmon and killer whales. We don't often contemplate the tiny and wriggly. But without aquatic insects, Alaska would be a poorer place by far. Aquatic insects help form the foundation for countless food chains. They help create soil and enrich estuaries and the ocean. As pollinators they enable many plants to produce seeds. Alaska's ecology as we know it would collapse if all our aquatic insects were to vanish.

Emergence

If you spend time near an Alaskan stream or pond in the right season, and if you pay close attention, you'll get to witness aquatic insects leaving the water behind and taking to the air. This process is called emergence. It happens in different ways for different insects.

Some insects, including many mayflies, stoneflies, dragonflies and damselflies, crawl from the water onto rocks, logs, branches, or stems. There they may pause for some time while their bodies make final adjustments. Finally, under pressure from within, the exoskeleton splits—usually along the back. The soft insect slowly pushes out, eventually pulling its abdomen free. Then it rests for some time while its wings lengthen and become firm, and its new exoskeleton hardens.

Other aquatic insects emerge directly from the water surface. Good examples of these are Mosquitoes, mayflies, and Chironomids. Their pupae rise to the surface, where unwettable hairs help keep them buoyant. The back of the exoskeleton splits and the bug oozes up and out, pausing for a moment before flying free. Some aquatic insects emerge while underwater.

Don't be discouraged if you miss the main event. Even if you don't see the bugs emerging, you may notice their abandoned exoskeletons on rocks and vegetation near the water.

Life spans

We're most familiar with the winged adult stages of aquatic insects such as dragonflies, Mosquitoes, and mayflies. Many of these exist for only a brief time (weeks or days) before dying. In fact, mayflies, which may live only a few hours as adults, are often used as metaphors for things that are fleeting. Their scientific name, Ephemeroptera, even means "short-lived-wings."

But adulthood in insects is not really proportional to adulthood in humans. Especially among the aquatic insects, which can survive as larvae underwater through the winter, most of an insect's life is spent in the larval stage, which may last for months or years. Some dragonflies, in fact, can live several years as larvae before they ever emerge as adults—but adults live only for one season.

Aquatic insects as food

Hundreds of Alaskan animals—from fish to birds to amphibians to mammals—feed on aquatic insects. There are even some plants that feed on them.

Fish food

Aquatic insects are important food for Alaska's freshwater fish. In fact, all Alaskan freshwater fish, including all six species of salmon, feed on aquatic insects at some point during their lives. Some fish such as grayling, are bug specialists. During Arctic summer days, when the sun rarely sets and insects are active, grayling can feed on adults and larvae round the clock. King salmon born in the Yukon's headwaters rely on aquatic insects to sustain their 2,000 mile long journey to the ocean. Chum and pink salmon fry feed on aquatic insects in their estuarine nurseries. Landlocked sockeye (red) salmon, called kokanee, eat aquatic insects as adults. Throughout their lives, trout, char, and many whitefishes feed on aquatic insects. Even fiercely piscivorous (fish-eating) northern pike start their lives as small, insect-eating fry.

Coho salmon juvenile with mayfly

A juvenile coho salmon searches for aquatic insects

Arctic grayling one year old

Young northern pike

Bird food

Over half of Alaska's common bird species probably include aquatic insects in their regular diet. They take the larvae from the water, pluck emerging adults near streams and ponds, or glean adults at rest or nab them on the wing. Some of these birds are particularly dependent on aquatic insects.

Caddisflies don't always find secure retreats inside their cases! This solitary sandpiper has captured a caddisfly larva by the head and is shaking the case off.

During the short but intense summers of northern Alaska, when long daylight hours keep the tundra warm, insects can grow, develop, and reproduce rapidly. This provides a burst of food at just the right time for many Arctic-nesting shorebirds, such as phalaropes and sandpipers. Adults and juveniles feast on aquatic Chironomid larvae, Crane Fly larvae, and other fly larvae, along with other aquatic and terrestrial insects.

A female harlequin duck and her chick cruise along the edge of a stream looking for an aquatic insect meal.

Because harlequin ducks are usually seen on salt water, they seem like unlikely birds to rely on aquatic insects. In fact, these tough little ducks nest along fast-moving freshwater streams and forage much of the summer on mayflies, stoneflies, caddisflies, Chironomids, and others. Once hatched, the fuzzy ducklings plunge into the rapids with their mothers, catching the same prey.

American dippers seem to especially like caddisflies. They will "shuck" caddisflies from their cases by shaking or pounding them against rocks or ice.

American dippers probably know aquatic insects better than any other Alaskan birds. These compact little gray songbirds live their whole lives in and near fast-moving mountain streams throughout Alaska, and they catch almost all their food—including aquatic insects, worms, fish, and fish eggs—

underwater. Dippers catch aquatic insects by ducking their heads underwater and searching the stream bottom with their keen eyes, then pouncing on or chasing down their prey. Sometimes they dive and "fly" underwater, holding their own against strong currents, or turn over stones to catch insects hiding below.

This American dipper is preparing to feed a stonefly larva to its chicks in a nearby nest.

Birds that nest near water often rely on aquatic insects to feed their growing chicks. Bohemian waxwings are known to capture emerging adult aquatic insects such as mayflies, stoneflies, and even adult dragonflies. Rusty blackbirds feed on the ground along the edge of the water, where emerging insects are easy pickings. Bank swallows also capture many adult aquatic insects. Northern waterthrushes are closely tied to moving water, finding and catching aquatic insects. Some birds of prey

Dragonflies are especially important food for some birds, such as this rusty blackbird, that nest near lakes and ponds

Once its aquatic stage is complete, a mayfly larva may crawl ashore to emerge. The emerged insect is called a subimago, a stage that looks much like the adult but with cloudy, slightly-fringed wings. For the next day or two, the subimago will stay close to the stream, until it molts its exoskeleton for the last time, becoming a reproductive adult. During this time it may be vulnerable to predation by birds such as this hermit thrush.

Swallows, such as this violet-green swallow, are often seen hawking recently emerged aquatic insects over streams and ponds.

savor aquatic insects. American kestrels are very small falcons that specialize in "hawking" or snatching insects from the air. Dragonflies are favorite prey of recently fledged young and migrating kestrels.

Among the most productive bird habitats in Alaska are the thickets of alder, willow, and cottonwood lining the shores of lakes and streams and covering gravel bars in large braided rivers. Countless warblers, such as this yellow-rumped warbler, and other songbirds glean adult aquatic insects from the foliage of these riparian thickets.

Amphibian food

All eight of Alaska's amphibian species feed on insects at some point in their lives. Northwestern salamanders, long-toed salamanders, and rough-skinned newts all feed on aquatic insects when they themselves are aquatic larvae. After they metamorphose to adults, they continue the insect feast. Wood frogs, Columbia spotted frogs, and western toads, plus non-native Pacific chorus frogs and red-legged frogs, feed heavily on insects as adults.

Most of Alaska's frogs and toads, such as this wood frog, feed on adult aquatic insects when they return to lay their eggs in ponds.

Mammal food

Amazingly, there is an Alaskan mammal that subsists largely on aquatic insects. The water shrew is a tiny mammal that frequents ponds and streams. Although it looks mouselike, it's not a rodent. Water shrews are outstanding swimmers and divers. They can use their sense of smell underwater, by blowing bubbles from their noses, then pulling the air back in to detect the scent of prey.

Photo © B. 'Moose' Peterson/ardea.com

The water shrew frequents ponds and streams and feeds mostly on aquatic insects.

Bats aren't usually associated with Alaska, but there are five species of these flying mammals in the state, and all five feed on insects. Little brown bats and silver-haired bats, in particular, are known to forage over water, and to feed on adult aquatic insects such as Mosquitoes and caddisflies.

Plant food

Aquatic insects also feed some of Alaska's carnivorous plants. Sundews are common plants of bog habitats throughout the state. They capture insects with sticky hairs, then exude digestive liquids and absorb nutrients from the dissolving bug. Bladderworts have an even more clever style of hunting. Urn-shaped growths on the bladderwort stem are vacuum-powered traps. When an insect brushes against sensitive hairs near the trap entrance, it is sucked into the interior of the bladder where it is slowly digested.

Sundew plants often line the edges of bog and tundra ponds throughout Alaska. Adult aquatic insects, such as this Hudsonian Whiteface dragonfly, often fall prey to these carnivorous plants.

Orchids attract many insects, such as this Dance Fly, to drink nectar. When an insect reaches in to sip the sweet substance, packets of orchid pollen called pollinia stick to it, and are carried to the next orchid the insect visits. You can see the pollinia attached to this Dance Fly's head and proboscis.

Pollinators

When we think about what insects contribute to our lives, we often overlook a very critical service: pollination. Pollination is the process of fertilizing female flower parts with pollen from male flower parts, allowing the female flower parts to develop seeds and fruits. Many plants have evolved to rely on insects as pollinators, and many aquatic insects are important to pollinating some of our most important and beloved plants. Adult Flower Flies, Mosquitoes, Chironomids, and some moths that have aquatic or semi-aquatic stages, are important pollinators.

Aquatic insects as decomposers

As munchers of dead salmon, fallen leaves, and other debris, aquatic insects break things down. This helps release into a stream nutrients that would otherwise be tied up in debris. Thus, aquatic insects are important in the nutrient and carbon cycles, contributing to the richness of streamside soils, as well as nutrient flow from streams into lakes, estuaries, and the ocean.

Aquatic insects and us

Have you ever eaten Alaskan salmon? Have you enjoyed watching swallows swoop or ducks dabble? If so, you've benefited from aquatic insects, which are important food for young salmon and birds alike. But aquatic insects affect human life in more direct ways than founding food chains. They bite us, bug us, teach us, entertain us, and even help us catch fish.

Aquatic insects as parasites

It's a rare Alaskan—or visitor to Alaska—who has not donated blood to an aquatic insect. Almost all of Alaska's notorious biting insects are aquatic or semiaquatic during their larval stages. Mosquito and Black Fly larvae live under water: Mosquitoes usually in still water and Black Flies in running water. Horse Flies and Deer Flies, and the tiny Biting Midges known as "no-see-ums" lay their eggs in or near water, and the larvae mature in the water or in very moist environments such as mud or silt.

One of Alaska's most annoying bugs is the adult Biting Midge. These tiny "no-see-ums" are not easily repelled by "Mosquito" repellent and can get through most window screens and bug nets. Despite their meager size (as small as this letter "o"), they have well-developed cutting teeth and mandibles that inflict painful bites as the bugs search for capillaries.

Across much of the world, the bites of blood-sucking insects such as Mosquitoes can transmit diseases that cause serious harm to human and animal health. Fortunately, at least for now, Alaska's climate keeps us relatively free of such diseases. For example, our chilly weather and short seasons prevent the malaria-causing organism *Plasmodium falciparum* from completing its growth cycle within its Mosquito host, and the particular Mosquito species that carries the malaria organism does not quite reach Alaska. Unfortunately, one of the consequences of climate change is a warmer Alaska, which could, in time, lead to more insect-borne diseases invading the state.

Indicators of water quality

Streams, ponds, and other surface waters are the lifeblood of Alaska's environment, and the health of our waters directly affects the health of our communities. Keeping track of water quality is an important part of monitoring the state of our environment. To do this, we can enlist the aid of aquatic insects as tiny water quality technicians.

Aquatic insects make great monitors. They are abundant and easily sampled. Because sensitivity to pollution varies among species—some are extremely susceptible, others more hardy or pollution-tolerant—they can indicate water health issues. Insects' short life cycles also allow their populations to respond fairly quickly to environmental change.

Simply collecting and analyzing a water sample doesn't give the best picture of the health of a stream or pond. Pollutants may enter the water occasionally (such as after a spill or a storm) and be there for only a short time, so they can be missed by "snapshot" water samples. As full-time residents of their home waters, aquatic insects form a community that reflects what has happened to the stream over time.

To "listen to the insects" in a stream or pond, scientists collect samples from different habitats. They then count and identify the different types of bugs. The resulting data

"The big three"

Changes in water quality can be the first sign of deteriorating stream health. Three groups of aquatic insects are considered especially important in monitoring water quality of streams. Most caddisflies, mayflies, and stoneflies are sensitive to pollution, low oxygen levels, and other problems. Changes in the populations and species diversities of these groups can indicate deteriorating stream health—or improving conditions. Their populations and diversities can also be used to help get a rough idea of the quality of a newly-monitored stream: when caddisflies, stoneflies, and mayflies are collectively the dominant insect groups in a sample, the stream is considered relatively healthy.

Caddisfly

Mayfly

Stonefly

represent that water body's invertebrate demographics. Future samples can then be compared to standards for healthy waters, or with that water body's baseline data, to see if there are trends. Is the abundance of pollution-tolerant species on the rise? Have sensitive species all but vanished within the last three years? The answers to such questions help us find out if the health of a given stream is stable, or if it is threatened by pollution, climate change, or other factors.

Education

Aquatic insects are also great teachers. Every year, throughout Alaska, students of all ages take field trips to local streams and ponds, where they swoop nets through the water, then empty the contents into pans on the shore. After the initial squeals of surprise and squeamishness at the myriad little crawlies they've captured, the students sort the critters into ice-cube trays. They gaze through magnifying glasses, taking notes and making sketches, marveling at mayfly nymphs' waving gills and the cleverly constructed cases of caddisfly larvae.

In the field and in the classroom, the tiny invertebrates teach endless lessons: about insect anatomy, about classification, about adaptations to aquatic life. Through studying aquatic insects, students become aware of stream food chains and food webs, and nutrient cycles. Perhaps most importantly, they learn how water connects our human world to the lives of insects.

Capturing, holding and releasing an adult dragonfly can be a life-changing experience.

Alaska "flies"

Alaska's major game fish include salmon, trout, char, grayling, whitefish, and pike. Most such large fish are predatory, so flyfishers trying to catch them will usually fish with "streamers" (fishing flies that imitate small fish) or other large patterns.

But flyfishers seeking aquatic insect "specialists" such as grayling will often use flies that imitate aquatic insect larvae or adults, such as this Black Fly pattern.

Major groups of Alaskan aquatic insects

There are many hundreds of species of aquatic insects in Alaska, but many are so similar to each other that they can be distinguished only under a microscope. Since this book is designed as an introduction to aquatic insects of Alaska, we won't catalog every species here. We'll describe the seven major orders of Alaskan aquatic insects, and within each order we'll profile the major families (a division that's two steps above the species level).

After looking through this section, you should be able to examine an aquatic insect and figure out what order it belongs in. With more careful examination, you may also be able to identify which family it is part of. If you decide to dive further into identification (for example, if you want to try to identify your aquatic insect's species), look at the end of this book for suggested references that provide more detail.

Classifying insects

An insect is a type of animal that lacks a backbone and has jointed legs. Taxonomists (scientists who study and determine the classification of living things) have placed insects in a special category of animals known as arthropods, a word of Greek origin meaning "jointed foot or leg."

Among the many groups of arthropods found on Earth, insects are literally in a class of their own. Unlike other arthropods such as crabs, centipedes, and spiders, insects have six legs, three body parts (head, thorax, and abdomen), and wings. These traits have earned insects a place in their own class, the class Insecta. The class Insecta is divided into orders. Orders are divided into families, families into genera, and genera into species. All the species within the class Insecta are, by definition, insects.

The Four-spotted Skimmer dragonfly – genus Libellula and species quadrimaculata – is one of many species in the Skimmer family (Libellulidae), which is one of many families in the order Odonata (dragonflies and damselflies). The Black Meadowhawk dragonfly (Sympetrum danae) shares enough characteristics with the Four-spotted Skimmer to be in the Skimmer family, too. The American Emerald dragonfly (Cordulia shurtleffii), however, is different enough from the Four-spotted Skimmer and the Black Meadowhawk that taxonomists have placed it in a different family of dragonflies (the Emeralds, or Corduliidae).

Think all this Greek and Latin is confusing? In fact, scientific names often hold interesting information and clues. For example, the family name for Emerald dragonflies, Corduliidae, comes from the Greek kordyla, *which means "club." This gives you a heads-up that some adult dragonflies in the Emerald family have bulbous abdomens.*

Four-spotted Skimmer

Black Meadowhawk

American Emerald

The Major Orders of Aquatic Insects

Caddisflies
Order Trichoptera (page 29)

Dragonflies and Damselflies
Order Odonata (page 47)

Flies
Order Diptera (page 55)

Mayflies
Order Ephemeroptera (page 75)

Stoneflies
Order Plecoptera (page 87)

Water Beetles
Order Coleoptera (page 98)

Water Bugs
Order Hemiptera (page 110)

Caddisflies—Order Trichoptera

Architects, net-spinners, and others

If you've ever stared at the bottom of a pond and suddenly realized that something you thought was a tiny clump of bark bits or spruce needles was actually crawling, you've probably seen a caddisfly. This order of insects is best known for constructing elaborate cases, using materials ranging from twigs to sand grains to carefully-cut pieces of leaves. But caddisflies of some families don't build cases at all. Some caddisflies build fixed shelters, from which they deploy silken nets to capture food. Most caddisflies feed on dead or living plant materials; some are predators.

Adult caddisflies have a fluttering, moth-like flight; in fact, some types are easily mistaken for moths because they tend to fly at night. Caddisfly larvae have six prominent legs and long, soft abdomens that end with two fleshy legs, called *prolegs*, that each bear a claw.

In case-maker caddisflies the vulnerable abdomen is safely concealed inside a rigid case. These cases are constructed piece by piece using silk that the caddisfly larva exudes from its mouth. Different types of case-building caddisflies specialize in different case materials and case shapes, and cases can be cleverly adapted for a variety of habitats. Characteristics of the larvae that are important for distinguishing families include the presence of gills and their shape, the presence of rigid plates (called *sclerites*) on the thorax, and the case shape and materials.

Caddisflies undergo complete metamorphosis, so they have a pupal stage before they become adults. In case-building species, the pupae usually remain inside the case. In free-living species, the larva may construct a cocoon, attached to a rock or other underwater anchor, in which to transform into an adult. Once the transformation is complete, the adult wriggles to the surface, sheds its pupal skin, and flies away.

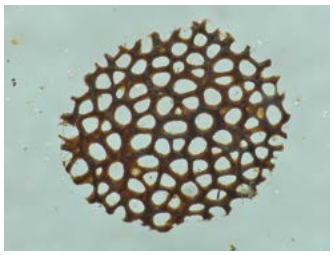
Caddisfly larvae can be found in still waters and fast-moving streams alike. Many types are sensitive to water pollution, so they can be good indicators of stream health. Alaska is home to at least 134 species of caddisflies.

Because they have a fluttering, moth-like flight, and because some types tend to fly at night, caddisflies can sometimes be mistaken for moths at first glance. But unlike moths, which have feather-like branched antennae, caddisflies have filament-like, unbranched antennae.

Caddisflies' family name, Trichoptera, means "hairy-winged," referring to the adults' fuzzy wings.

Caddisfly larvae have six prominent legs and long, soft abdomens. The abdomen is usually concealed in those species that construct portable cases or fixed retreats.

Just before pupating, a free-living caddisfly larva (such as this Green Rock Worm) spins a silken cocoon in which to transform into an adult.



Some case-building caddisflies construct silken nets at each end of the case just before transforming into the pupa. These sieve-like structures allow water to flow into the case while keeping would-be predators out.

Caddisflies in the Green Rock Worm family do not build cases. This free-living lifestyle is well suited to their predatory ways, which require quick mobility and maneuverability.

Case-building caddisflies pupate within their cases, which may be firmly attached to the undersides of submerged rocks or to branches.

Caddisfly case materials

Sand and Stones

Vegetation

Silk

Apataniid Case Makers

Apataniidae

Apataniid Case Makers are very similar to Northern Case Maker Caddisflies (see page 42), a family they once belonged to. Larvae live in cool streams and cold lakes. In streams, they can be found at high elevations and living on rocks in turbulent flows or in a thin film of water on rock faces near waterfalls. The larvae feed on algae that is scraped from the surface of rocks.

Larval identification notes

- Heads of some larvae flat, or even slightly concave, and surrounded on three sides by a semicircular ridge
- Cases made of small rock fragments or sand; most are cylindrical, tapered and curved
- Some larvae add moss, algae, and leaf and twig fragments to the cases as camouflage

Apataniid Case Maker larva

Apataniid Case Maker larva and case (photo by California Dept. of Fish & Game, Aquatic Bioassessment Laboratory)

Interesting facts

- One species from Alaska is reportedly parthenogenic, meaning females can produce offspring without the help of males.
- The prefix "mano" in *Manophylax* (see story below) is Greek for "rare," indicating that members of this genus are exceedingly localized or infrequently encountered.
- Functional Feeding Group: scrapers

Nugget Falls with Juneau's Mendenhall Glacier in the background (photo by John Hudson)

Stories from the field

In 2002 a new species of Apataniid Case Maker Caddisfly was discovered at Nugget Falls near Mendenhall Glacier in Juneau. Despite searches in similar habitats all over Juneau, that species, Manophylax alascensis, *has been found only at this single location. These grazers of microscopic algae live in a rather unique habitat—a thin film of flowing water on vertical bedrock faces along the margins of this powerful waterfall. During rainy periods, some larvae venture outside the areas kept wet by the falling water and spray. When the sun returns, the water dries out from under them forcing the larvae to make a slow and steady retreat back to moist habitat. We have visited this site to watch the tiny larvae climb the rock faces as they feed.*

Comb-lipped Case Makers

Calamoceratidae

Most species in this family occur in the tropics or subtropics. The five species found in North America live in cool streams where plant detritus and dead wood, their primary foods, accumulate in pools and other slow-flowing areas. The larvae are often covered in silt and can be found attached to roots or twigs at the stream edge, just below the water surface. As larvae grow, they change the materials they use to build their cases, from sand and small pieces of detritus to sand and wood fragments and eventually to hollowed twigs and plant stems. A single species, *Heteroplectron californicum*, is known from Alaska.

Larval identification notes

- Head and top of first segment of thorax dark brown and shiny
- Row of 16 stout hairs across upper lip

Comb-lipped Case Maker larva (photo by California Dept. of Fish & Game, Aquatic Bioassessment Laboratory)

Interesting facts

- Mature larvae frequently live inside a single hollowed-out twig or plant stem that is lined with silk and open at both ends to allow water to flow over the gills.
- Some larvae use empty cases of stone made by other caddisflies, adding small pieces of wood to the front ends (photo below).
- Mature larvae often tunnel into large pieces of bark, branches, and submerged logs, eventually pupating inside their burrows.
- Functional Feeding Group: shredders

Comb-lipped Case Maker larva (photo by California Dept. of Fish & Game, Aquatic Bioassessment Laboratory)

Common Net-spinners

Hydropsychidae

Common Net-spinner Caddisflies spin intricate, rectangular mesh nets that strain their food—algae, fine organic particles, and small aquatic invertebrates—from the current. A typical net is attached to a rock or log and forms a pouch against the surface. The open end faces upstream and the net is bowed by the current so that its shape resembles a bowl cut in half and glued to a wall. Often it is coated with algae, strands of which may wave in the current. The larvae periodically emerge from their retreat to feed on whatever the net has caught. They can be found living in a variety of flowing waters, from intermittent streams to large, fast-flowing rivers.

Common Net-spinner larva

Interesting facts

- Larvae do not build portable cases but may construct camouflaged retreats of gravel, sand, or plant debris at the base of the net.
- In a sample tray the larvae can rapidly move backwards with great agility using their abdomens, which are tipped with two claws (a).
- Young larvae do not construct nets at all, and some species do not construct nets during the winter.
- When larvae become dislodged from their retreats, they may attempt to enter the retreats of other net-spinning caddisflies. This usually causes a fight, which the owner of the net usually wins.
- The larvae are often found in streams flowing out of lakes.
- Functional Feeding Group: collector-filterers, predators

Larval identification notes

- Rigid plates on top of all three thoracic segments
- Conspicuous branched gills next to the middle and hind legs and along the underside of the abdomen
- Often a tuft of long hairs near the tip of each proleg (a)

Fingernet Caddisflies

Philopotamidae

Fingernet Caddisflies do not build portable cases but rather live and feed inside elongate, fingerlike silk nets. The nets are up to 60 mm long by 5 mm wide, and have the finest mesh among all the netspinning caddisfly families. Large numbers of these nets are often found together. The nets, which are usually attached to the underside of rocks in streams, are anchored at the opening, leaving the rest to flap about in the water current. The larvae feed on fine small particles of organic matter and diatoms caught in the net.

Interesting facts

- The nets of mature larvae may have tens of millions of openings and be made from more than 1 km of silk.
- A hole at the end of the net bag provides an escape exit, helps to maintain flow through the net as it becomes clogged, and allows feces to pass out.
- The specialized lip is used to gently scrape food particles from the inside of the net.
- Functional Feeding Group: collector-filterers

Larval identification notes

- Unique to this family: a broad (nearly as wide as the head) T-shaped and membranous upper lip (labrum); in other families the upper lip is narrower than the head, dark colored, and rigid
- Only first thoracic segment has rigid plate on top; abdomen conspicuously white

Fingernet Caddisfly larva

Giant Case Makers

Phryganeidae

Giant Case Maker larvae construct large cylindrical cases from pieces of leaves and bark they cut to size and sew together, either into stacked rings or as a continuous spiral. The cases are often much longer than the larvae themselves. Compared to other case-maker caddisflies, they are more slender and agile, characteristics considered primitive among caddisflies.

Giant Case Maker larva (photo by Tom Murray)

Giant Case Maker larva (photo by Tom Murray)

Larval identification notes

- Mature larvae conspicuously larger than those of other families
- Top of the head and first segment of the thorax usually marked with dark bands or patches on a yellow background
- Top of the second and third thoracic segments mostly soft tissue (they lack large hard plates)

Interesting facts

- Adults of *Phryganea cinerea* have been found living at great depths (100 m) in large lakes.
- The omnivorous larvae feed on dead and living plant matter as well as a variety of aquatic invertebrates.
- A larva removed from its case will quickly set to work constructing a new case with any suitable material available.
- Functional Feeding Groups: shredders, predators

Green Rock Worms

Rhyacophilidae

The name Green Rock Worms describes these stream-dwelling caddisfly larvae quite well. Many are green—some brilliant green—and while they are certainly not worms, these free-living predatory caddisflies might be mistaken for worms as they crawl among rocks in search of prey. As free-living larvae, they do not live in cases or fixed retreats, but they do build loose assemblages of small stones (often between two rocks) held together with silk. Within these protective structures, the larvae spin cocoons where they transform into adults. Openings in the structure allow water to bring oxygen in and carry wastes out.

Interesting facts

- One study noted that larvae left behind threads of silk wherever they went.
- The larvae use an ambush strategy when hunting mobile prey like mayflies, and a searching strategy when hunting sedentary prey like Black Flies.
- The free-living habits of Green Rock Worms make them more vulnerable to fish predation than other caddisflies. Not surprisingly, fly fishers have designed flies to mimic these caddisflies.
- Functional Feeding Group: predators

Green Rock Worm larva

Larval identification notes

- First segment of thorax and last segment of abdomen topped with a single rigid plate
- Well-developed anal prolegs each end in a sharp claw
- Most lack gills on the abdomen
- When present, abdominal gills are branched
- Deep constrictions between thoracic and abdominal segments give larvae a muscular appearance

Green Rock Worm larva

Hoodcase Makers

Molannidae

Hoodcase Makers are distinguished by their flattened and tapered cases, which extend out on either side and above the head, forming a "hood" that obscures the larva from above. Larvae live on sand and mud substrates in lakes, cold springs, and slow-flowing parts of streams and rivers. The case is often built of sand and small rock fragments, making the larvae difficult to see unless they are moving. They may also incorporate detritus and wood fragments into their cases though some cases are made entirely of detritus. The omnivorous larvae feed on small invertebrates as well as diatoms, algae, and the tissues of larger plants.

Interesting facts

- Larvae bury themselves into the substrate before pupation.
- One species, *Molannodes tinctus*, is found only in Alaska and the Yukon Territory.
- Functional Feeding Group: collectors-gatherers, predators

Larval identification notes

- Case shape is distinctive of this family

Hoodcase Maker larva (top view)

Hoodcase Maker larva (side view)

Humpless Case Makers

Brachycentridae

Humpless Case Makers lack the humps that case maker caddisflies normally possess on the top and/or sides of the first segment of the abdomen. But it's their small size and interesting cases that help set them apart from other caddisfly families. Some build four-sided tapering cases from thin pieces of plant material arranged like the logs of a cabin. Other species build cases that are round in cross-section, either entirely from silk or from the circular windings of ribbon-shaped plant materials (see photo below). They inhabit running waters, from small streams to rivers; some species are commonly found on moss-covered rocks. Their diet consists of diatoms, algae, fine organic matter, and insects.

Interesting facts

- Using silk, larvae in the genus *Brachycentrus* anchor their cases—facing upstream—to rocks or plants. They use hairs on their exceptionally long middle and hind legs to snare food particles that drift by on the current.
- Certain Chironomid larvae enter Brachycentrid pupal cases to pupate. This will result in the death of their "host."
- Functional Feeding Groups: collectors-filterers, collectors-gatherers, shredders

Larval identification notes

- No humps on the top or sides of the first abdominal segment

Humpless Case Maker larva

Humpless Case Maker larva (photo by Tom Murray)

Lepidostomatid Case Makers

Lepidostomatidae

Lepidostomatid Case Maker larvae typically live in cool springs and streams, but they can also be found in lakes and even temporary streams. They are usually found in the slow moving parts of streams where dead plant matter, their main food source, accumulates. Most species construct a four-sided case from rectangular pieces of bark and leaves; some build spiral-shaped cases of plant material or tubes made of sand grains.

The larvae of Lepidostomatid Case Makers look similar to Northern Case Maker larvae, but they lack a hump on top of the first abdominal segment. With the help of magnification, one can also distinguish the two families by the location of the antennae. In Lepidostomatids the antenna is right next to the eye, while in Northern Case Makers it is halfway between the eye and the front of the head.

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Lepidostomatid Case Maker larva (photo by California Dept. of Fish & Game, Aquatic Bioassessment Laboratory)

Larval identification notes

- Similar to Northern Case Maker larvae, but lack hump on first abdominal segment, and antenna is right next to eye

Interesting facts

- Some larvae are scavengers on salmon carcasses.
- Functional Feeding Group: shredders

Lepidostomatid Case Maker larva (photo by Tom Murray)

Longhorned Case Makers

Leptoceridae

Longhorned Case Makers are inhabitants of lakes, ponds, and the slow parts of streams. Most live on the bottom, and some species prefer the shallows. Their cases can be quite variable. Some are made of sand, with wide openings tapering sharply and surrounded by wide flanges. Others are straight tubes of rock fragments, mollusk shells, or plant material with twigs or conifer needles attached to the sides. Some are entirely of silk. Some, made entirely of plant materials, are spiral-shaped. Other plant-material cases consist of stacked twigs and stems, resembling tiny, hastily-constructed log cabins. Depending on the species, the diet may include detritus, living plant tissue, and/or invertebrates.

Interesting facts

- Some species in the genus *Ceraclea* burrow into freshwater sponges and eat them.
- Some lake-dwelling members of the family get around using their long hind legs to swim.
- Functional Feeding Group: shredders, collectors-gatherers, predators

Larval identification notes

- Antennae at least six times as long as wide
- Hind legs are much longer than the middle and front legs

Longhorned Case Maker larva

Longhorned Case Maker larva

Northern Case Makers

Limnephilidae

The Northern Case Maker family contains the greatest number of species (over 70) of any caddisfly family in Alaska. These caddisflies occur throughout the state in nearly every kind of freshwater habitat. Some may even venture out of the water and into adjacent moist habitats. Most consume plant materials by shredding leaves and other debris or by scraping diatoms and fine pieces of detritus from the surface of rocks and wood. Some feed upon salmon carcasses.

The larval cases are diverse in form and materials. They can be round, three-sided, or flat. Some are made of leaves carefully cut and "sewn" together into purse-like retreats (see photo below left). Some are made with pieces of twigs, bark, and leaves arranged lengthwise or stacked transversely. Cases of sand or small rock fragments can be thick or slender, curved or straight, and may have conifer needles attached to the outside. *Dicosmoecus* larvae build their cases so stout and strong that hungry dippers must thrash them against rocks to force the larvae out.

Northern Case Maker larva

Larval identification notes

- Although many genera in this family have distinct cases, the characteristics used to distinguish Northern Case Makers from other families are too numerous to mention here and difficult to see without a microscope.

Interesting facts

- Functional Feeding Groups: shredders, collectors-gatherers

Northern Case Maker larva

Purse-case Makers

Hydroptilidae

Commonly called micro-caddisflies, the Purse-case Makers are small indeed. The largest species known from Alaska can reach 6 mm in length (smaller than a hemlock needle), but most others are only 2 to 3 mm long. Many have laterally-compressed abdomens that fit nicely inside two-piece, purse-shaped cases. These cases are often covered with concentric rings of filamentous algae or coated with a layer of sand. Other members of this family construct a silk case shaped like a bottle with the base cut off; the larva's head and legs protrude from the "bottleneck."

The herbivorous larvae feed on the liquid contents of filamentous algal cells, or graze on diatoms. They live in lakes, ponds and cold springs, fast-flowing streams, and the calm sections of large rivers.

Interesting facts

- Fragments of rockweed *(Fucus)*, an intertidal seaweed found throughout North Pacific waters, were found in the guts of larvae from Finland.
- Functional Feeding Groups: piercers-herbivores, collectors-gatherers, scrapers, shredders

Larval identification notes

- Smaller than larvae of most other families
- Rigid plates on top of all thoracic segments
- Abdomen rather wide relative to head and thorax; without gills
- Most have conspicuous constrictions between the abdominal segments

Purse-case Maker larva

Purse-case Maker case

Stone-cased Caddisflies

Uenoidae

Stone-cased Caddisflies live in running waters. Some can be found on rock faces covered with a thin film of water; others prefer turbulent streams. These caddisflies construct cases of small rock fragments. There are two types: straight tubes with larger stones attached to the sides (photo below) or sharply curved and tapered cases. Larvae graze on diatoms and fine organic matter on the surfaces of rocks and pupate on the underside of rocks, often in dense aggregations.

Interesting facts

- Some species feed on the tops of rocks during the day and retreat to the underside during the night.
- Species within the genus *Neophylax* reduce competition with one another by living in different sections of the stream between the headwaters and the mouth.
- Functional Feeding Groups: scrapers

Larval identification notes

- Front edge of plate on top of middle thoracic segment is notched (a)

Stone-cased Caddisfly case (photo by California Dept. of Fish & Game, Aquatic Bioassessment Laboratory)

Stone-cased Caddisfly larva (photo by California Dept. of Fish & Game, Aquatic Bioassessment Laboratory)

Tortoise-case Makers

Glossosomatidae

In Tortoise-case Makers the case, an oblong dome of rock fragments, completely covers the larva, like a tortoise shell. Under the dome, a band of rocks separates two equal-sized holes, one at each end. The larva can spin around to poke its head from either its front or back "door" when feeding. Gaps between the rocks allow water to pass through. While many caddisflies are able to "add on" to their cases to accommodate their growth, Tortoise-case larvae are forced to upgrade as they outgrow their homes. After moving into a new case, built off the end of the old one, the larva casts away the old case.

Tortoise-case Maker caddisflies can be very abundant. They live in cool, fast-flowing streams where they scrape algae and detritus from rocks for food. High densities of small larvae can give the surface of rocks a gritty texture.

Interesting facts

- Most caddisflies that build portable cases use their anal claws to hold on to the case; Tortoise-case Makers extend their claws out of the case as an extra set of "legs" for holding on to surfaces.
- Prior to pupation, the larva removes the rock band under the case and then firmly anchors the rim to a rock with silk (lower photo).
- At one time in their evolutionary history, Tortoise-case Makers probably lived case-free and constructed their rock domes just to protect themselves as pupae. Over time, larval behavior evolved to build the pupal retreat earlier.
- Functional Feeding Groups: scrapers

Tortoise-case Maker cases

Larval identification notes

- The design of the case is unique among caddisfly families
- No gills on the abdomen
- Only first thoracic segment is covered by rigid plates
- All three sets of legs are the same length

Tortoise-case Maker larva

Tube-making Caddisflies

Polycentropodidae

Tube-making Caddisflies live in fixed retreats made of silk. They use their larval retreats to filter zooplankton and insects from slow currents or to conceal themselves from potential prey. Filter-net retreats are shaped like trumpets that end in long tapering tubes, or like bags held open in the current.

Tube-making larvae that ambush prey from their retreats hide within cylindrical or depressed open-ended tubes equipped with silken trip-wires. Like web-weaving spiders, these ambush predators detect their prey by feeling vibrations along the silk strands.

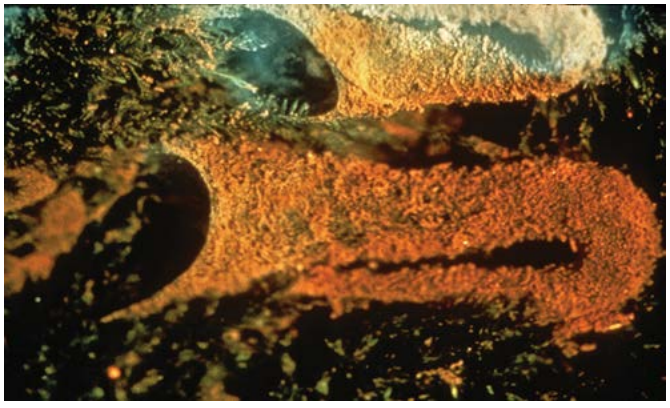
Tube-making Caddisfly larva

Interesting facts

- Tube-making Caddisflies can be very abundant on submerged plants and branches, especially at lake outlets where countless zooplankton are helplessly swept into their waiting nets.
- With undulations of the body, a dense row of hairs along each side of the abdomen helps keep oxygen-rich water moving through the retreat.
- Functional Feeding Groups: collectors-filterers, shredders, predators

Larval identification notes

- Pointed projection at the base of each front leg
- Only the first thoracic segment covered with sclerites
- Abdomen without gills
- Prolegs are long and each bears a large, strongly bent claw



Tube-making Caddisfly filter-net retreats (photo by Rich Merritt)

Dragonflies and Damselflies—Order Odonata

Master hunters

In the air or underwater, dragonflies and damselflies are master predators. The adults are agile and swift fliers. They chase down other insects on the wing, scooping them up in baskets formed by their own spine-covered legs. The aquatic larvae are most often found in still water, where they hunt down other aquatic invertebrates and even fish and amphibians. With its millions of lakes and ponds, Alaska is great Odonata country. At least 33 species are full-time residents of Alaska; a few other species have visited the state, but do not breed here.

Odonata means "tooth" and refers to the insects' jagged mandibles—another reminder of their predatory nature. Adult dragonflies and damselflies, with their long, slender abdomens, huge eyes, and shining, veined wings, are pretty much unmistakable. Once you have observed the aquatic larvae for a while, you'll soon find them easily recognizable too. In general, they're long-bodied, with six long legs, mobile heads, and large eyes.

Adult dragonflies and damselflies are easy and fun to observe—just hang out by a pond during the summer. You might see them fighting, hunting, feeding, mating (on the wing!) or laying eggs. The aquatic larvae are a little harder to spot (they're well camouflaged), but they're easy to capture in a net, and if you put them in a pan with some smaller aquatic insects, you can watch them hunt and capture prey.

Dragonflies and damselflies lay their eggs on the water surface, or insert them into moss, debris, or aquatic vegetation. After hatching, the larvae hunt and grow in their watery kingdoms until it is time for them to emerge as adults. Although adult dragonflies and damselflies rarely live more than a few weeks, the larvae of some dragonflies can live years underwater.

Some adult dragonflies can cruise at 35 miles per hour.

This dragonfly larva is preparing to extend its lower "lip" to capture prey. Notice the sharp, hooked lower lip spread wide and ready to grab.

Dragonflies and damselflies will mate on the wing and at rest. The process begins when the male clasps the female behind the head with special appendages on the tip of his abdomen. The female then bends her abdomen forward and connects to the base of the male's abdomen. Dragonflies joined in this way are said to be "in tandem" or in the "wheel position." The eggs are fertilized just before the female lays them.

A female dragonfly may lay her eggs while still connected to the male, or while alone. The male may hover nearby to guard her from other males. This female is laying her eggs inside plants just below the water surface.

Some adult dragonflies, particularly damselflies and skimmers, are parasitized by aquatic mites. How do underwater mites board these sleek jetliners of the insect world? Upon hatching from the egg, the six-legged larval mite seeks out a damselfly or dragonfly that is nearly ready to emerge from its larval skin. During emergence, the tiny mite crawls onto the adult odonate for a free flight, including complimentary juice service (that is, all the body juices it can suck from its host). These ectoparasitic mites are visible as numerous bloated spheres usually "seated" in the luggage compartment (underside of the abdomen). Once sexually mature and ready for mating and egg-laying, the adult dragonfly or damselfly returns to a watery habitat. The engorged mites then exit the aircraft during a water landing, transform into 8-legged adults, and lay eggs to complete the round trip (life cycle).

Mites parasitizing an adult dragonfly

How to tell a dragonfly from a damselfly

Both adult and larval dragonflies tend to be larger and burlier than their delicate damselfly cousins. Adult dragonflies rest with their wings held apart and flat, while adult damselflies hold their wings upright over their backs. Dragonflies and damselflies both have huge eyes, but adult dragonflies found in Alaska have eyes touching each other, while adult damselflies' eyes are widely spaced. If you're looking at larvae, the two are even easier to tell apart: larval dragonflies' abdomens end in sharp spines, larval damselflies have large, leaf-shaped gills on the ends of their abdomens.

Dragonfly adult

Dragonfly larva

Damselfly adult

Damselfly larva

Emerald Dragonflies

Corduliidae

Emerald Dragonflies are a northern group named for the strikingly green eyes of mature adults. The larvae occur in a wide variety of still- and slow-water habitats. Larvae crawl about on vegetation and the bottom sediments, or sit flat against the bottom with legs outstretched, waiting for prey to come their way. They eat a variety of aquatic invertebrates including fly larvae and small crustaceans, mites, and other larval odonates.

Adult Emeralds are rather secretive, rare, and localized. They are fast fliers and spend most of their time on the wing. Males are often seen patrolling low over water and along shorelines, stopping frequently to hover while searching for mates. Eggs are laid in flight: the female taps or drags her abdomen in the water, drops eggs down into the water, or taps her abdomen in mud or wet moss.

Identification notes

- **Larvae:** body relatively flat and short compared to that of Darners; difficult to distinguish from Skimmer Dragonfly larvae
- Usually uniformly brown and conspicuously hairy
- Serrations on the end of the lower lip larger than those of Skimmers (¼ to ½ as long as wide)
- Lower lip spoon-shaped and obscures lower half of face
- **Adults:** medium-sized (43-55 mm long), dark, with brilliant green eyes (red-brown in juveniles) and metallic green and bronzy bodies
- Some have pale yellow spots on thorax and brown spot at base of hind wings
- All have at least one narrow white ring at base of abdomen
- Hold bodies vertically or at angle when perched

Interesting facts

- In habitats that dry up, the larvae of some Emerald Dragonflies can survive up to 9 months.
- The southern range of the Treeline Emerald Dragonfly is farther north than that of any other odonate species, making it the most northerly distributed dragonfly on the planet. It prefers to lay eggs in deep, cold pools underlain by permafrost.
- Functional Feeding Group: predators

Stories from the field

While studying dragonflies in Alaska's interior, we frequently contend with biting insects, including swarms of bloodsucking deer flies. Emerald Dragonflies frequently come to our rescue, grabbing the pests in mid-air with audible thuds, then loudly tearing their prey to bits while perched on our clothing.

Emerald Dragonfly adult

Emerald Dragonfly larva

Emerald Dragonfly larva

Skimmer Dragonflies

Libellulidae

Three groups of Skimmer Dragonflies occur in Alaska: whitefaces, meadowhawks, and one species of king skimmer, the Four-spotted Skimmer. The larvae feed on mollusks, Chironomids, crustaceans, Biting Midges and other invertebrates—even other dragonflies. To catch their prey, some crawl about on vegetation actively searching; others lie motionless on the bottom sediments, in ambush.

Like some of the larvae, adult Skimmers are ambush predators. They catch flying insects during short flights from favorite perches. Mating takes place on the ground, on vegetation, or in the air. Females lay eggs alone, in tandem with the male, or with the male hovering nearby to guard them from would-be suitors. In flight, they flick the eggs onto moist surfaces, splash them onto the shoreline, or dip their abdomens into the water to release them.

Skimmer Dragonfly larva (photo by Christophe Brochard)

Four-spotted Skimmer adult

Whiteface adult (left) and Meadowhawk adult (right)

Interesting facts

- The adult male of one of our Skimmers will attack and hold other males that get too close to his egg-laying mate.
- The Four-spotted Skimmer Dragonfly occurs in boreal regions around the globe. In 1995 it was designated the official state insect of Alaska.
- The family name Libellulidae comes from Libellula ("little book"), a Latin name first given to dragonflies by Linnaeus in 1758.
- Functional Feeding Group: predators

Identification notes

- **Larvae:** body relatively flat and short compared to that of Darners
- Lower lip spoon-shaped and obscures lower half of face
- Distinguished from Emeralds by relative size of serrations at end of lower lip: in Skimmer larvae, serrations are 1/10 to 1/6 as long as they are wide
- **Adults**: perch in horizontal position
- Whitefaces < 40 mm long, black, with red and yellow markings and white face
- Mature adult Meadowhawks mostly red or all black
- Four-Spotted Skimmers have broad black and yellow abdomen and spotted wings

Mosaic Darner Dragonflies

Aeshnidae

As both adults and larvae, Mosaic Darner Dragonflies are some of the largest aquatic insects found in Alaska. The larvae are formidable aquatic predators. They stalk their prey—which include many types of invertebrates and even small fish— with cat-like stealth until they are within striking distance. Cannibalism is common.

Adult Mosaic Darners are the largest dragonflies in Alaska. To some people, the exceptionally long, spear-like abdomen resembles a darning needle (thus the name for this group). Before reaching sexual maturity, Mosaic Darner adults can be seen miles from water, even in cities, and will sometimes find their way into houses. Around water, males often fly a regular beat, stopping frequently to hover while searching intently for the cryptic females.

Mating can take up to 75 minutes. The female uses her ovipositor to lay eggs in water-soaked wood, mud, and live or dead plants, either above, on, or just below the water surface. Just about every type of permanent standing-water habitat in Alaska harbors at least one Mosaic Darner species.

Interesting facts

- The Common Green Darner dragonfly, a species known to migrate hundreds of miles, has been found twice in Alaska. This species is likely only an occasional visitor, not a full-time resident.
- In the far north, Mosaic Darner Dragonflies may take six years to complete their life cycle.
- The first Zig-zag Darner described for science was collected near Sitka, Alaska by a Russian in 1861. Its scientific name, *Aeshna sitchensis*, honors the city.
- Functional Feeding Group: predators

Stories from the field

During the short Alaskan summer, many birds and other animals work around the clock to capture prey for their hungry offspring. Bohemian Waxwings—strikingly colored songbirds found in Alaska—commonly gorge on berries in fall and winter. In summer, their attention shifts to flying insects which they feed to their chicks. In Tetlin National Wildlife Refuge we've watched waxwings fly 100 yards from their nest to grab Darner Dragonflies in mid-air, usually without a chase. The Darners were apparently so focused on catching their next meal that they were completely oblivious to the avian insectivores.

Identification notes

- **Larvae:** elongate and slender (compared to other true dragonflies), with spindle-shaped and tapered abdomens that are somewhat cylindrical
- Body and legs may be patterned and lower lip is flat
- **Adults:** brown with blue, green, and sometimes yellow spots and stripes
- Most perch in vertical position

Mosaic Darner Dragonfly larva

Mosaic Darner Dragonfly adult

Pond Damsel Damselflies

Coenagrionidae

Pond Damsels are northerners: this damselfly family includes the greatest percentage of species that live in the far north. In Alaska, they are usually the most abundant odonates at a given site. The larvae can be found in many types of still water habitats—including bogs, fens, ponds, lakes, marshes, sloughs, and even brackish and alkaline waters and thermal springs—as long as vegetation is plentiful. There, they feed on Chironomids, small crustaceans, mites, beetles, mayflies, and caddisflies. In certain species cannibalism is common.

After mating, the male and female usually remain in tandem while the female uses her ovipositor to insert eggs into holes cut into vegetation. Males identify potential mates by color, though some females may avoid harassment by sporting a "male" color pattern.

Identification notes

- **Larvae:** relatively short and thick-bodied compared to Spreadwing Damselflies
- Gills have light and dark bands; lower lip broad and does not extend beyond second pair of legs when folded under the head (a)
- **Adults:** hold wings together over abdomen; usually held horizontal when at rest.
- With the exception of Sedge Sprites, adult males (and some females) blue and black; females may be black with lighter areas of grey, green, or tan
- Sedge Sprite, Alaska's smallest damselfly (< 30 mm long), has metallic green body and abdomen tipped with light blue

Pond Damsel Damselfly larva (photo by Christophe Brochard)

Interesting facts

- A female Northern Bluet (a species in this family) may dive a meter deep to lay her eggs in submerged vegetation. A bubble of air held between her wings provides up to 90 minutes of oxygen. Upon returning to the surface, she must be pulled free of the surface tension by the mate or another male.
- Some larvae spend up to 5 months embedded within ice—a habitat that certainly eliminates exposure to predators during the winter.
- Some female Pond Damsels test water temperature by touch before laying eggs.
- Functional Feeding Group: predators

Pond Damsel Damselfly adult

Spreadwing Damselflies

Lestidae

Spreadwings are damselflies that hold their wings partly open when at rest. Of the two species that occur in Alaska, the Northern Spreadwing is widely distributed throughout most of the state, while the Emerald Spreadwing has been found only in the central portion of the state. Both species usually have some metallic green color on their abdomens.

Unlike other odonates, Spreadwing Damselflies commonly lay eggs in temporary water bodies and overwinter in the egg stage. Larvae hatch in late winter and early spring. After a few weeks of rapid growth, adults emerge before the water dries up.

Though excellent swimmers, Spreadwing Damselfly larvae usually hunt by crawling through dense vegetation. Their preferred prey are Chironomids, but they will also capture fly and mayfly larvae, Water Boatmen, and ostracods.

Interesting facts

- While attached to the male, the female usually deposits her eggs in vegetation above or below water by making a small incision in the plant and releasing up to 6 eggs. Some mated pairs dive below the surface to lay eggs.
- At high dissolved oxygen levels in the water the larvae can obtain sufficient oxygen through the surfaces of their abdomens. At low oxygen levels, they must use their external gills.
- The eyes of adults change color from light to dark blue as temperature decreases.
- Overwintering eggs can survive temperatures as low as -22° C and the larvae can spend several months embedded in ice.
- Functional Feeding Group: predators

Identification notes

- **Larvae:** lower lip elongate and stalked (spoon-shaped), extends beyond second pair of legs (a)
- **Adults:** ≥35 mm long with front of thorax and top of abdomen blackish to metallic green
- Usually perch with wings spread open at a 45 degree angle and abdomen pointed downward

Spreadwing Damselfly adult

Spreadwing Damselfly larva (photo by Christophe Brochard)

Flies—Order Diptera

Pests and pollinators

Each summer, in Alaska's northern and western tundra, the air and the water alike swarm with insects. Swirl a net in either medium and the vast majority of what you'll catch are members of the order Diptera—the true flies. Mosquitoes, Chironomids, Biting Midges…they're a summer pestilence for bears, humans, and caribou, but they're also a summer feast that provisions fish, dragonflies, and migratory birds.

While many types of insects are referred to as "flies," only the members of the order Diptera (meaning "two wings" because these insects have only one pair of wings) are considered the true flies. The Diptera are among the most diverse and evolutionarily advanced insect orders on Earth. Alaska's true flies range in size from near-microscopic Chironomids to burly Horse Flies. Many of them have aquatic or semi-aquatic larvae.

Because the Dipteran order is so diverse, the larvae vary quite a bit in shape, size, and color. But in general, aquatic fly larvae are worm-like or maggot-like. Unlike many other aquatic insect larvae, fly larvae do not have long, jointed legs. Instead, they often have fleshy stubs (prolegs), fleshy knobs called creeping welts, and/or fans of stout hairs that help them squirm, burrow, and swim.

True flies go through complete metamorphosis—they pass through a pupal stage before they become adults. In this stage, they encase themselves in a hard capsule of exoskeleton-like material or in a softer cocoon. Some types go through their pupal stage in the water, while others crawl out of the water to pupate in waterside vegetation or detritus. Some pupae, such as those of Mosquitoes and many Chironomids, are very active, able to swim away from predators. Others are mostly immobile.

At times adult flies can be very abundant near water. These Chironomids are in a mating swarm over a small stream.

Many flies are important in the pollination of flowers. These flies (above) are feeding on pollen from a pond lily. The Flower Fly below mimics a bee (though it can't sting). Notice that unlike a bee, which has four wings, the Flower Fly has only two wings

The order Diptera contains the most notorious Alaskan insects, such as this female Mosquito. Mosquitoes, as well as Black Flies, Biting Midges, Horse Flies, and Deer Flies, can make life miserable for Alaska's humans and wildlife.

Fly larvae—such as this Crane Fly larva—often look like worms. Notice the mayfly larva to the left.

As adults, many dipterans (such as this Chironomid) don't feed at all, and may live only a few days.

Fly larval and pupal stages can look quite different from each other. Above is the larval stage of a Phantom Midge. To the right is the same insect's pupal stage just before the insect emerges as an adult.

Aquatic Dance Flies

Empididae

Aquatic Dance Flies are predators as both larvae and adults. The larvae crawl among rocks and moss in swift-flowing stream reaches. Many consume helpless Black Fly pupae, and some will even use the empty pupal cases as their own pupation chambers. Semi-aquatic species may be found along the wet margins of streams and ponds.

Adults subdue their prey, which may be larger than themselves, with a long dagger-like proboscis. Some have front legs adapted for grasping prey. A few species will also feed on nectar. Mating swarms are often seen over streams, where they fly in dance-like twisting and turning patterns.

Interesting facts

- Functional Feeding Group: predators

Identification notes

- **Larvae**: tan to white in color, with 7 or 8 pairs of fleshy prolegs under abdomen
- Abdomen may be tipped with up to 4 fleshy lobes and/or tufts of hair
- Small head usually tucked into thorax and visible through the skin as a pair of dark-colored rods
- **Adults**: dark, with rounded head, distinct "neck," humped thorax, and tapered abdomen

Stories from the field

"Most dance flies eat other small flies, such as mosquitoes and midges. In some species, the male dance fly offers the female a nuptial gift of an insect he has caught. He can then mate safely while the female is distracted by eating. In other species, the male is more imaginative and artistic. He wraps his gift in silk before offering it to the female, gaining precious time as she unwraps the insect before consuming it. We've all known stingy people. But dance flies? One species captures an insect, sucks out the juices for his own meal, and then wraps it in silk. He offers a female the parcel and begins to copulate. By the time she has unwrapped the empty insect shell, he has completed mating and even gotten a meal to boot." From Crump, Marty (2005). Headless Males make Great Lovers and other Unusual Natural Histories. *The University of Chicago Press. p. 24.*

Aquatic Dance Fly adult

Aquatic Dance Fly larva

Biting Midges

Ceratopogonidae

Very few people will ever encounter the larval form of this tiny fly, which is known as a no-see-um or moose fly. Unfortunately, most Alaskans—of many species—are all too familiar with the adult females. To get the energy-rich blood they need to produce eggs, female Biting Midges slice into capillaries with their cutting mouthparts, and drink deep. Although several species are disease vectors, the bites leave only short-lived welts and mild burning sensations. Adult males feed on pollen or nectar.

Larval Biting Midges are able to absorb dissolved oxygen from the water directly through their body wall. They live in streams and ponds; many are adapted to tolerate brackish water and can be quite abundant in estuaries and salt marshes. Some burrow into mud and sand while others wriggle about on the surface of sediments and submerged vegetation. Their diet varies by species and may include invertebrates, algae, or detritus or all of the above.

Biting Midge adult (no-see-um)

Interesting facts

- Some adult females will prey on other insects—including their mates.
- Some larvae can swim in the water column by rapidly flexing (up to 9 times per second) their long, stiff bodies in a serpentine fashion.
- To keep themselves from sinking to the bottom, the air-breathing pupae hold pockets of air under their wing pads, keeping their breathing tubes at the surface.
- Functional Feeding Groups: predators, collectors-gatherers

Larval identification notes

- Burrowing larvae needle-shaped
- Larvae that crawl on the surface shorter, somewhat flattened, with prominent fleshy tubercles or hairs on top of abdomen

Biting Midge larva (burrowing type)

Black Flies

Simuliidae

Black Flies hold the record for the highest population density of any aquatic insect. Their densities are sustained by a constant food supply flowing past in the current of the streams and rivers where they live. Using a pair of fans that surround the mouth, the sedentary larvae of filter-feeding species strain particles such as algae, diatoms, bits of plant matter, bacteria, protozoans, and small invertebrates from the current. Such resources are abundant at lake outlets, where a single square meter may hold tens of thousands of Black Fly larvae. The larvae convert these tiny particles of food into much larger fecal pellets, making the residual nutrients and energy available to other invertebrates.

All Black Fly larvae possess a ring of tiny hooks on the base of the abdomen. To avoid being swept away by the current, they use the hooks to anchor themselves on a pad of silk glued to rocks, wood, or live vegetation. Short distance movements are made using an "inchworm" technique. Dissolved oxygen is absorbed through the body wall. Mature larvae pupate within a cocoon spun from silk.

Adult female Black Flies, with their sharp, serrated mouthparts, are notorious for their bloodsucking ways. Bites usually continue to bleed after the fly has departed, a lingering effect of the anticoagulant used to expedite blood flow. Both sexes feed on nectar, pollen, and a sugary fluid (honeydew) excreted by aphids and other insects. Feeding adults may venture many miles away from their larval habitats. Females lay hundreds of eggs and many species go through several generations in a single year.

Identification notes

- **Larvae**: Lower one-third of body swollen, so larvae resemble bowling pins
- **Adults:** Compact, black or brown, and humpbacked
- Legs short and stout, wings broad
- Most males have reddish eyes

Interesting facts

- Conspicuous white bands on the legs of adults of certain species give those Black Flies the common name "white socks."
- Larvae of species without filter fans must move about to feed.
- To escape predators or to move to new locations, larvae travel downstream on the ends of anchored silken threads.
- In females the shape of the claw varies among species depending on whether they feed primarily on birds or on mammals.
- Functional Feeding Group: collectors-filterers or collectors-gatherers

Black Fly larva

Black Fly adult (photo by John Hudson)

Chironomids

Chironomidae

Chironomids are rather plain insects. To the naked eye, the larvae lack any obvious characteristics of an insect—most people dismiss them as worms. The pupae are seldom seen and the adults are easily confused with many other flies, including Mosquitoes. While charismatic critters such as Predaceous Diving Beetles and dragonfly nymphs draw lots of attention, few kids race home from streams to show off jars of larval Chironomids.

Yet, Chironomids may be the most evolutionarily successful and ecologically important aquatic insects on the planet. They hold records for most number of species found at a site, most insect biomass at a site, most numerous insect at a given site, and most widely distributed aquatic insect family. They're consumed by more different species than any other aquatic insect, and they're tolerant of more variation in pH, temperature (-15° to 39° C), and dissolved oxygen. They live in a vast variety of aquatic habitats, from the highest elevation streams to the bottoms of Earth's deepest lakes. Any place in Alaska with a little water—even salty estuaries and silty glacial streams—is likely to be home to at least one species of Chironomid. We've even seen Chironomid larvae living in urinals on supplied stream water.

Chironomid larvae feed on live plants, dead plants, fungi, and other invertebrates, using a wide variety of techniques. Dissolved oxygen is absorbed through the body wall. Most larvae live inside silk-lined tubes or elaborate cases, some are swimmers, and the predators crawl around in search of prey. Some case-builders attach their homes to snails, or to other insects such as mayflies and stoneflies.

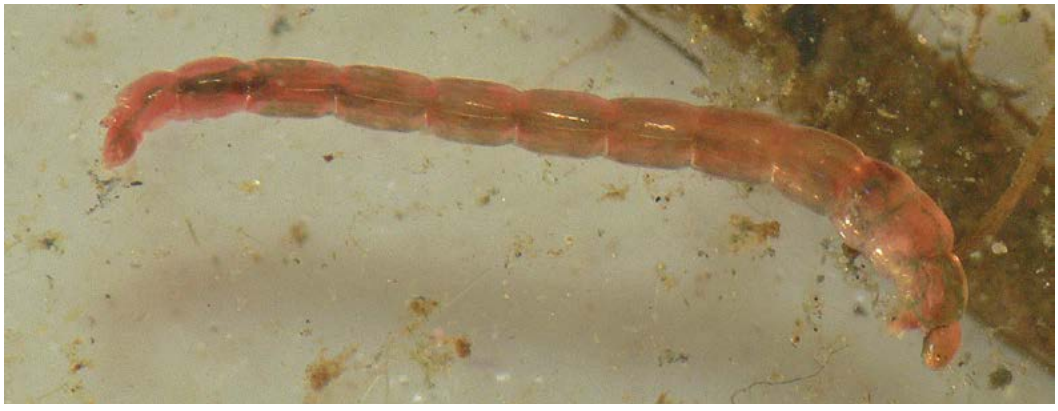
Larval identification notes

- Elongate, slightly curved, and usually cylindrical, with head capsules
- Paired prolegs near head and at the end of abdomen

Interesting facts

- Some Chironomid larvae are bright red. Hemoglobin allows these larvae to live in low-oxygen environments such as lake bottoms.
- Adult Chironomids generally don't feed, but some may drink honeydew or nectar. They live only a few days.
- The larvae of several Chironomid species pass the winter in a dormant state under the ice inside special cocoons.
- Chironomid adults and larvae are critical food resources for many invertebrates, fish, and birds.
- Functional Feeding Groups: predators, collector-gatherers, collectors-filterers, scrapers-grazers, shredders

Chironomid adult



Chironomid larva

Crane Flies

Tipulidae

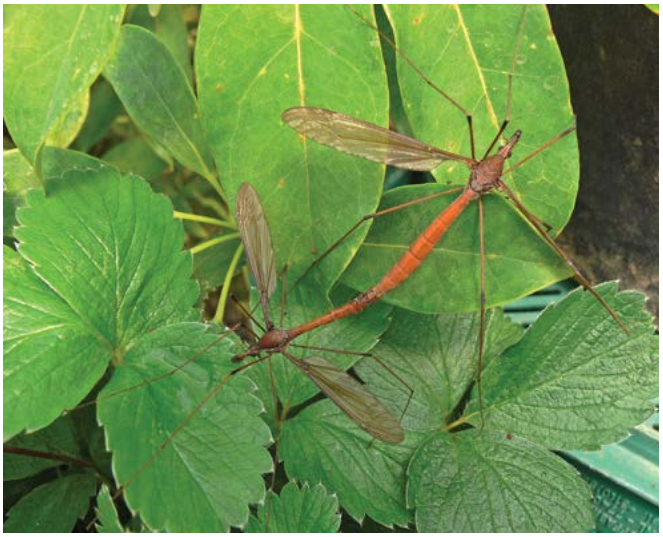
Crane Flies are the largest family of flies, with more than 15,000 aquatic and terrestrial species worldwide. Like the Chironomids, they can be found in just about any aquatic or semi-aquatic habitats and a few are adapted for life in brackish water. Larvae of most aquatic species live on the bottom where they feed on fine organic matter or shed leaves, especially alder leaves. Some species are predatory. Larvae often have swollen abdominal segments covered with spines or stout hairs. These provide the legless larvae with some traction for moving about on or within bottom substrates. While a few species can absorb oxygen from the water, most take in air at the surface through two large spiracles at the end of the abdomen. Fleshy lobes, sometimes covered with non-wettable hairs, surround the spiracles, allowing the larvae to hang from the surface film while replenishing their air supply.

Identification notes

- **Larvae**: elongate, cylindrical to slightly flattened, and soft-bodied
- Head usually withdrawn into thorax
- Head consists mainly of soft tissues except for mouthparts and a few rod-shaped sclerites
- **Adults**: Look like large Mosquitoes with extremely long legs

Interesting facts

- Two species found in the state are named after Alaska.
- Adults are sometimes known as "mosquito hawks" and folk belief says they eat Mosquitoes. They don't. Because they only live a few days (just long enough to mate and lay eggs), adult Crane Flies don't feed at all.
- The thick and tough skin of some larvae has earned larval crane flies the name "leather jackets."
- The rather large soft-bodied larvae provide juicy morsels for stream-dwelling fish such as Dolly Varden char and Arctic grayling
- Functional Feeding Groups: predators, collectors-gatherers, shredders



Crane Fly adults mating

Crane Fly larva

Dixid Midges

Dixidae

Dixid Midge larvae may be found in lakes, ponds, marshes and the slow-moving reaches of small streams. As air breathers they spend most of their time near the surface. Their diet of microscopic algae and animals is filtered from a current of water created by the movements of special brush-shaped mouthparts. By rapidly bending and straightening their bodies, the larvae propel themselves through the water or across the bottom. Mature larvae glue themselves to a fixed substrate just above the water where they pupate. The mosquito-like adults live less than a week, and males swarm at dusk near the edge of water bodies.

Larval identification notes

- Elongate body usually held in the shape of a "U"
- Thorax barely enlarged; first and (usually) second abdominal segments have paired short prolegs
- End of abdomen has breathing tube and pair of paddle-like structures

Interesting facts

- Because the body of resting larvae will push the water surface slightly upwards, creating a surface bulge called a *meniscus*, they have also been called "meniscus midges."
- Functional Feeding Group: collectors-filterers

Dixid Midge larvae

Horse and Deer Flies

Tabanidae

The larvae of Horse Flies (the larger ones) and Deer Flies (the smaller ones) are seldom seen. They burrow through mud and decaying organic matter along the edges of streams and ponds and in the shallows of marshes and swamps. A few species live in estuaries and salt marshes. As air breathers, they're never far from the surface, where they take in oxygen through spiracles at the end of their abdomens. Most Horse and Deer Fly larvae are predators of snails, worms, and other insects. Mature larvae crawl onto land to pupate in moist soil.

Adults are large, and they're strong fliers and will venture miles from water. The females are infamous for their persistent attempts to get a blood meal from mammals, including humans. They inflict a painful bite with mouthparts designed to cut through skin and suck blood. Females also feed on pollen and nectar, as do the males.

Horse Fly adult

Identification notes

- **Larvae**: cylindrical and tapered at both ends
- Most abdominal segments encircled with "creeping welts"
- Head is well developed, but usually withdrawn into the thorax
- **Adults:** stout-bodied with patterned wings and colorful eyes

Interesting facts

- Adult Horse and Deer Flies are fond of sunny, warm weather; cool, cloudy weather keeps them grounded. Females, always on the lookout for blood, are attracted to large moving objects.
- American Emerald and Four-spotted Skimmer Dragonflies will readily grab and consume Deer Flies as they swarm about one's head.
- To avoid trips to the surface for air, a few species have breathing structures modified for tapping into plant roots to "steal" oxygen.
- Functional Feeding Group: collectors-gatherers

Horse or Deer Fly larva

Longlegged Flies

Dolichopodidae

Longlegged Flies are a diverse group of mostly terrestrial flies with nearly 7,000 species known worldwide. Aquatic and semi-aquatic larvae live in a variety of habitats: mud and sand along the edges of streams and lakes, algal mats, decaying seaweed, and damp soil and leaf litter. Some have been found in the hollow stems of sedges. Aquatic larvae stay close to the surface where they take in air through spiracles at the tip of their abdomens. Both the adults and larvae are predators. The maggot-like larvae use creeping welts to provide traction while in pursuit of their favorite prey: Chironomids and Mosquito larvae. Most adult Longlegged Flies have conspicuously long legs and metallic greenish-blue to greenish-bronze coloration. Like adult Dance Flies, they engage in dance-like mating swarms over water and some adults spend much of their time skimming over the water surface.

Longlegged Fly larva (photo by California Dept. of Fish & Game, Aquatic Bioassessment Laboratory)

Longlegged Fly larva showing the end of the abdomen (photo by California Dept. of Fish & Game, Aquatic Bioassessment Laboratory)

Larval identification notes

- Body white, cylindrical, and elongate with fleshy ridges encircling each abdominal segment
- Head is usually retracted into thorax and is mostly comprised of soft tissue containing 4 dark rod-shaped sclerites
- End of abdomen concave (enclosing the spiracles) and surrounded by rearward projecting lobes

Interesting facts

- Adult males engage in elaborate courtship displays that involve waving their boldly colored legs in the "face" of a potential mate.
- Functional Feeding Group: predators

Longlegged Fly adult (photo by Tom Murray)

Mosquitoes

Culicidae

Mosquito larvae, often called "wrigglers," move about by rapidly flexing their legless bodies. They are air breathers, spending much of their time at the surface where most replenish oxygen supplies through a snorkel-like tube at the tip of the abdomen. Nearby movements or looming shadows send these wrigglers downward to the safety of the depths. Larvae inhabit ponds, ephemeral pools and puddles, and slow-moving waters.

Most Mosquito larvae are suspension feeders. Mouth brushes create a current of water past the head from which they filter microorganisms, zooplankton, and detritus. Some scrape food off surfaces; others will actually drink water to extract the smallest of suspended particles. The pupae, sometimes called "tumblers," can be quite mobile, but they spend most of their time hanging just below the surface until emerging as adults a few days later.

As with other blood-sucking flies, it's the female that does the biting (actually piercing) to get the protein she needs for her developing eggs. Victims include birds, mammals, and even amphibians.

Identification notes

- **Larvae:** lack prolegs, and thorax is much larger than rest of body
- Most possess a respiratory siphon that projects at an angle from the tip of the abdomen
- **Adults**: long proboscis
- Wings scaly and held flat over body

Interesting facts

- In Alaska's Interior, an 8-inch by 7-inch patch of the human forearm can receive an estimated 280 Mosquito bites per hour.
- Mosquitoes can beat their wings as fast as 600 times per second! Small species beat their wings faster than larger species, and wingbeat frequency increases with increasing air temperature. In mating swarms, males find females by the pitch of their wing vibrations.
- Functional Feeding Groups: collectors-filterers

Male Mosquito—note the feathery proboscis (a)

Mosquito larva

Mosquito pupa

Female Mosquito—note the piercing proboscis (b)

Moth Flies

Psychodidae

Moth Flies get their common name from the adult's resemblance to a tiny moth. The larvae, however, have been provided with their own special common names—filth flies, drain flies, or sewage flies. These names identify them with their habits and habitats, not their appearance. While some species live in clear, fast flowing streams, other species can be found living in moist to semi-liquid decomposing organic matter, the type of foul-smelling scum and sludge common in wastewater treatment plants, sink and shower drains, and sewage lagoons. Out in nature, floating mats of moss and algae and the margins of ponds make a nice home.

Not surprisingly, the larval diet consists of detritus, wastes, and the associated rich growths of algae, fungi, and bacteria. A short breathing tube on the end of the abdomen protrudes above the anoxic ooze to provide the larva access to fresh air. Larvae also have a pair of lateral spiracles on the thorax.

Identification notes

- **Larvae**: body segments (a) divided two or three times into secondary segments—many topped with a sclerotized plate
- Thorax similar in width to the rest of the body
- Abdomen ends in a short breathing tube
- **Adults:** body hairy; wings covered with hairs or scales
- Wings often broadly rounded ending in a slight point and held over body roof-like or flat and to the sides
- Color varies from yellow to black

Interesting facts

- Drain-dwelling Moth Fly larvae successfully contend with hot water, soaps, and cleaners and other chemicals
- The nocturnal adults are weak fliers usually found in damp habitats; they feed on polluted water and flower nectar.
- Functional Feeding Groups: collectors-gatherers

Moth Fly adult (photo by Tom Murray)

Moth Fly larva (photo by California Dept. of Fish & Game, Aquatic Bioassessment Laboratory)

Mountain Midges

Deuterophlebiidae

Mountain Midges live in extreme habitats. The larvae of most species are found in very steep, cold, and swift-flowing mountain streams. These lives in the "fast lane" require a highly specialized body form to endure the pounding of falling water. Flattened bodies, and clusters of tiny curved hooks on their abdominal prolegs, help the larvae hold their own and even crawl about over slick algae-covered rocks. High levels of dissolved oxygen in these cold and turbulent streams allow the larvae to literally breathe through their skin. They graze on the thin layer of biofilm growing on the bedrock and boulder surfaces.

Adult Mountain Midges are delicate and extremely short-lived flies. The time from emergence through mating and egg-laying to death is less than two hours. Males emerge first—early in the morning—and swarm over the water awaiting the emergence of females. After mating, the female lays her eggs underwater, losing her wings as she crawls below the surface. Eggs hatch in spring. The oval-shaped pupae affix themselves to the surface of rocks. Most species complete one generation per year.

Identification notes

- **Larvae:** Forked antennae
- Head and thorax distinct from abdomen
- Seven pairs of long lateral prolegs
- **Adults:** Silvery blue fan-shaped wings widest at the base
- Male antennae can be nearly four times as long as the body

Mountain Midge larva

Interesting facts

- Adults lack functional mouthparts.
- Evolutionarily, Mountain Midges are one of the most primitive families of flies.
- Only six species have been found in North America.
- Functional Feeding Group: scrapers

Stories from the field

Researchers from Michigan State University were the first to discover Mountain Midges in Alaska, in Fish Creek near Juneau. Intent on photographing the larvae, we visited the stream in early winter while it was ice-free and still flowing well. We had high hopes of collecting them, as most aquatic insect larvae can be found during any time of the year. Armed with a stiff brush, waders, and winter clothes we searched the areas of the stream where they had been found before. After a few hours we got lots of aquatic insects, especially stoneflies and mayflies, but no Mountain Midges. After returning home we discovered that Mountain Midges overwinter as eggs, rather than as larvae or pupae. Most species have a single generation per year.

Net-winged Midges

Blephariceridae

Net-winged Midge larvae are uniquely equipped to live in current that would sweep most other insects downstream. On the undersides of their abdomens are six attachment discs. Pressure applied to the disc creates suction by forcing water out through a v-shaped notch. To move around, the larvae alternately release, move, and attach the three front and three rear sets of discs, their route thus tracing a zig-zag pattern. The larvae scrape biofilm from rock surfaces. Dissolved oxygen is absorbed through the body wall and through paired tufts of gills on the undersides of the abdominal segments.

Adult Net-winged Midges look like delicate versions of Crane Flies. Females are predators of other insects; males feed on nectar or not at all. Females crawl under water to cement their eggs to substrates, or lay them on the wet surfaces of rocks near the stream. Net-winged Midges have a single generation each year and overwinter as larvae.

Interesting facts

- Upon emergence, adults' wings are quickly unfolded and immediately functional, allowing them to depart the water surface before drowning in the swift current. Creases in the wing give it a netlike appearance.
- Larvae are restricted to smooth-surfaced rocks because their attachment discs cannot generate suction pressure on moss-covered or rough-textured rocks.
- Functional Feeding Group: scrapers

Larval identification notes

- Flattened, with seven apparent segments; first through sixth segments each bear a single attachment disc on the underside and a pair of short lateral leglike structures called pseudopods

Net-winged Midge larva showing the attachment discs (a)

Net-winged Midge larva top view

Net-winged Midge larva side view

Phantom Crane Flies

Ptychopteridae

Larval Phantom Crane Flies are quite at home in a habitat that few aquatic insects would tolerate. They prefer the stagnant shallow (3 cm deep) margins of swamps and ponds, where they live in and on water-saturated decaying organic matter – otherwise known as muck. While the front end is occupied with the consumption of fine decaying organic matter and associated microorganisms, a long narrow extendable breathing tube at the back end pokes up like a snorkel through the muck and water surface to obtain air.

Ice formation in the fall sends the larvae deep into the sediment, where they remain dormant while absorbing oxygen through their cuticles. Like the larvae, pupae obtain air through a long breathing tube. Adults emerge in May and June to mate.

Identification notes

- **Larvae**: body extendable
- Pairs of prolegs (b) on each of first 3 abdominal segments
- Long breathing tube (a) on tip of abdomen
- **Adults:** resemble adult Crane Flies

Phantom Crane Fly larva

Interesting facts

- Some adults have very long, swollen legs with conspicuous bands of white and black. These species extend their legs outward to "sail" through the air on a breeze. When flying through partial shade the black parts on the adult appear and reappear, phantom-like.
- Functional Feeding Group: collectors-gatherers, shredders

Stories from the field

Seeing an adult for the first time was an exciting experience. While looking for insects at night with a head lamp, we came across something white that was rapidly revolving in a circle. Only after taking its photo with a high speed flash did we realize it was a Phantom Crane Fly adult. It had black and white markings on each leg and was rapidly moving up and down, which presented a very confusing circle of white.

Phantom Crane Fly adult (photo by Tom Murray)

Phantom Midges

Chaoboridae

Phantom Midges are named for the transparent larvae of some species. These long, narrow larvae float horizontally in the water column, with the assistance of air bladders. They absorb oxygen through their body walls directly from the water. Other Phantom Midge larvae resemble Mosquito wrigglers, and like wrigglers they breathe air and spend most of their time at the surface.

All Phantom Midges are predators. They use a sit-and-wait strategy to get their food, capturing, impaling, or crushing any prey that wander within reach of their grasping antennae. Prey include Mosquitoes and other small invertebrates, including those that fall into the water.

Like Mosquito larvae, Phantom Midge larvae propel themselves through the water by rapidly flexing and jerking their bodies. Adults live for less than a week. They feed on nectar, pollen, and insect secretions or not at all.

Interesting facts

- Phantom Midges are among the most common fossil insects found in lake sediments.
- Many lake-dwelling species make daily vertical migrations. Daytime is spent hidden within bottom sediments; at night the larvae ascend into the upper waters to feed. This behavior reduces the risk of being eaten by fishes that feed by sight.
- Phantom Midges were once classified as belonging to the Mosquito family (Culicidae).
- Functional Feeding Group: predators

Phantom Midge pupa

Phantom Midge adult (photo by Tom Murray)

Larval identification notes

- Some almost transparent, with a single jointed grasping antenna above the mouth (a)
- Mosquito-like species lack the mouth brushes of Mosquitoes and have grasping antennae and large mandibles

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Two types of Phantom Midge larva (above and below)

Rattailed Maggots/Flower Flies

Syrphidae

The larvae of these flies are aptly named for their maggot-like body form and long, tail-like, retractable breathing tubes. In some species the tube can be several times longer than the body. The larvae of aquatic and semi-aquatic species live in tree holes and the shallow margins of marshes and ponds. In these habitats they burrow within sediments so highly enriched with organic matter that oxygen is often lacking. By extending their breathing tubes to the water surface, the larvae are able to remain buried while feeding on decaying organic matter and associated microorganisms.

The adults, commonly called "flower" or "hover" flies, feed on nectar and frequently hover during flight. Although harmless, the adults mimic bees and wasps. Their yellow and black stripes suggest to would-be predators that they can sting.

Stories from the field

Seeking to get a photo of a Rattailed Maggot, we searched several marshy areas that appeared to be oxygen deficient, but to no avail. Would they be at our local sewage treatment plant? We requested and received a personal tour and permission to look for the "maggots." When we found a perfect lagoon—the foulest spot in the facility—we said, "We'll think about it." In the meantime, someone suggested trying our local horse stables. Much to our relief we found Rattailed Maggots living in the pond where horse manure was disposed of.

Larval identification notes

- Semitransparent with blunt front end and long breathing tube at back end
- Some species have prolegs

Rattailed Maggot adult known as a Flower Fly

Interesting facts

- Some species are common in the organic sludge found in sewage-treatment lagoons.
- Breathing tube lengths vary with the depth of each species' preferred habitat.
- In Juneau we've seen Rattailed Maggot larvae living in small bedrock pools covered by the Mendenhall Glacier several decades ago.
- Functional Feeding Groups: collectors-gatherers, predators

Rattailed Maggot larva

Shore Flies

Ephydridae

Shore Fly larvae are air breathers. Most species get their oxygen at the water surface through a short breathing tube. For this reason they are restricted to the shallows, fine organic matter saturated with water, and floating mats of algae. Although confined to living near the air-water interface, Shore Flies have colonized an impressive variety of habitats: streams, lakes, ponds, bog pools, and thermal springs as well as alkaline lakes, salt marshes, estuaries, and tide pools.

Larval diets are equally varied. Depending on the species, larvae prey on live invertebrates or scavenge dead ones, shred or scrape algae, and engulf dead organic matter and the microorganisms contained therein.

The adults, often called Brine Flies, are small flies commonly seen swarming in the air, skating on the water surface, or running about on algal mats. They feed on algae and dead insects; some even prey on springtails.

Interesting facts

- Outside of Alaska, Shore Flies have been found living in natural pools of crude oil and in hot springs where water temperatures exceed 45°C (133°F).
- Some larvae have breathing tubes designed to pierce and obtain oxygen from plant roots. This behavior reduces the risk of being eaten by sight-feeding fishes while breathing at the surface.
- Many of the pupae are quite distinctive: they have a pair of hooks or a hook-like structure for gripping vegetation (a).
- Functional Feeding Groups: predators, collectors-gatherers, shredders, scrapers

Larval identification notes

- Body cylindrical and tapering towards the head
- Head inconspicuous
- Abdomen ending in a pair of small spines or a breathing tube, which may be forked

Shore Fly pupa

Shore Fly larva (photo by Rich Merritt)

Shore Fly adult (just emerged)

Snail-killing Flies

Sciomyzidae

Most Snail-killing Flies, true to their name, kill snails during the larval stage—but different species kill in different ways.

Predatory larvae burrow into snail egg masses to engulf and consume eggs, or they attack snails by biting the foot. In the latter case when the snail responds by withdrawing its foot, it pulls the larva into the shell, where the larva quickly consumes its victim. Each larva may kill and consume several snails.

In contrast, "parasitoid" Snail-killing Fly larvae invade and consume a single "host." Death is prolonged for the victim of a parasitoid; these larvae take their time consuming the snail—while it's still alive—over a period of several days.

As air-breathers, Snail-killing Fly larvae are usually found close to the water surface, where they take in air through abdominal spiracles. Pupation may occur inside snail shells and in moist detritus. Some pupae are free-floating.

Interesting facts

- The larvae can gulp air to maintain buoyancy.
- Some parasitoid species feed on Fingernail Clams as well as snails.
- Adults are commonly called Marsh Flies.
- Functional Feeding Group: predators, parasitoids

Identification notes

- **Larvae:** yellow to dark brown, cylindrical, tapered at both ends
- Body segments of many species encircled with rounded tubercles
- Spiracles surrounded by fleshy lobes or located on a short, broad breathing tube
- Some larvae covered in a thick layer of short, fine hairs
- **Adults:** house-fly size, yellowish to brownish in color
- Conspicuous forward-pointing antennae
- Many have brown markings on wings

Snail-killing Fly larva (photo by California Dept. of Fish & Game, Aquatic Bioassessment Laboratory)

Adult Snail-killing Flies mating (photo © Bruce Marlin)

Mayflies—Order Ephemeroptera

Delicate and strong

Mayflies have caught the fancy of humans for many reasons. The winged adults are graceful aerialists with famously short lifespans (they rarely survive more than a week or so). Adults and larvae are important food for fish, so in some parts of the world they're popular models for artificial flies: the many permutations of "drakes," "duns," and "spinners" in a flyfisher's box are patterned after mayfly larvae and adults. Mayflies live in a variety of aquatic habitats and, like caddisflies, encompass many species that are sensitive to pollution, so they're helpful for monitoring water quality.

Adult mayflies are handsome, delicate-looking insects with two or four triangular wings held vertically when they are at rest. They sometimes rest with their abdomens curled upward, displaying slender, fragile tails that may be longer than their bodies. They range in color from drab brown or reddish, to rich green to bright yellow.

Mayfly larvae vary quite a bit in shape, but they always have six legs. Their abdomens are tapered, and they have two or three long tails. Some mayfly larvae have more rounded bodies, while others are dramatically flattened. Many types have prominent leaf-like gills down the sides of their abdomens. When they swim, mayflies flip their abdomens up and down like a dolphin.

Mayflies don't undergo complete metamorphosis, so they don't go through a pupal stage. But they do have an unusual extra life stage. Once its aquatic stage is complete, a mayfly emerges from its larval skin underwater or at the water surface, or it crawls ashore to emerge. The emerged insect is called a subimago, a stage that looks much like the adult but with cloudy, slightly-fringed wings. For the next day or two, the subimago will stay close to the stream, until it molts its exoskeleton for the last time, becoming a reproductive adult. At least 50 species of mayflies have been documented in Alaska.

Subimago (above) and adult mayflies are easily identified by their long tails and large triangular wings.

This is the exoskeleton of a mayfly larva that has crawled out of the water and emerged as the subimago below.

The above photo shows a recently emerged mayfly subimago. At right is an adult mayfly emerging from the subimago stage.

Most mayfly larvae eat algae and detritus or biofilm. Many types have elaborate color patterns that help camouflage them as they feed among the stones and detritus.

Cleftfooted Minnow Mayflies

Metretopodidae

The Cleftfooted Minnow Mayflies are primarily a northern family of mayflies. The larvae are fast and vigorous swimmers. Their long legs have a wide range of motion, like the oars of a rowing skiff. Short, stiff tails densely covered with swimming hairs provide additional propulsion with each undulation of the wide abdomen. They prefer to live in slow areas of streams and the margins of lakes.

Larval identification notes

- Only mayfly family with forked claws (a) on front pair of legs
- Most abdominal segments with plate-like gills
- 3 tails

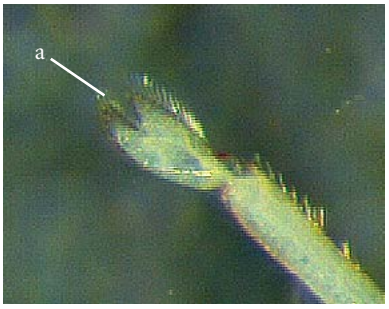


Photo by Dan Bogan

Interesting facts

- Functional Feeding Groups: predators, collectors-gatherers

Cleftfooted Minnow Mayfly larva (photo by Dan Bogan)

Combmouthed Minnow Mayflies

Ameletidae

Combmouthed Minnow Mayflies are elongate and streamlined mayflies that were once placed in the Primitive Minnow Mayfly family. The larvae live in streams and are typically found in pools and in the shallow slack-water margins of riffles and glides. These fast-swimming mayflies propel themselves through the water using their three short, stout tails—which are densely fringed with stiff hairs—like fins. Combmouthed Minnow Mayflies get their food by scraping diatoms from hard surfaces or collecting fine particles of detritus. The mouth combs are rows of stiff spines on the tip of their scraping mouthparts.

Larval identification notes

- Mature larvae have conspicuous pigmentation pattern
- Mouthparts with a pair of conspicuous comb-like structures
- Tails (3) short, stout, and densely fringed with long hairs and usually with a dark band
- Plate-like, oval gills have a dark-colored hardened edge on the outside margin

Interesting facts

- Larvae crawl out of the water before emerging.
- Functional Feeding Groups: collectors-gatherers, scrapers

Combmouthed Minnow Mayfly larva

Combmouthed Minnow Mayfly larva

Flatheaded Mayflies

Heptageniidae

Members of this family have flattened heads and bodies—an adaptation to life in flowing water. Those species occurring in the fastest-flowing habitats are especially flat and possess long legs and long curved claws, both of which help the larvae cling to algae-slick rocks as water rushes over them. Several species have overlapping gills that form a virtual suction cup that provides a firm grip on smooth rocks. In streams these ubiquitous larvae can be found in pools, riffles, glides, and rapids grazing upon diatoms and other biofilms. It's difficult to pick up a plate-sized stone and not find several of these mayflies scurrying around the underside.

Larval identification notes

- 2 or 3 tails
- Broad and flat heads
- Plate-like gills on abdominal segments 1-7
- In most species, body is compressed and legs extend outward from the body like crab legs

Flatheaded Mayfly larva

Interesting facts

- In 2005, R. P. Randolf and Patrick McCafferty described a new species of Flatheaded Mayfly collected near Circle, Alaska. They named it *Rhithrogena ingalik* in honor of the Ingalik people who once inhabited the interior of Alaska.
- Functional Feeding Groups: scrapers, collector-gatherers

Flatheaded Mayfly larva

Primitive Minnow Mayflies

Siphlonuridae

Like the other minnow mayflies, Primitive Minnow Mayfly larvae are excellent swimmers and may be mistaken for small fish. Unlike larvae of most other mayfly families, the larvae of this family can be quite common in standing waters. In ponds and lakes they cling to aquatic vegetation or rest on the bottom between short bursts of swimming. Some may be found in slow-flowing, sand-bottomed rivers.

Interesting facts

- Some species do not appear to produce males.
- Functional Feeding Groups: collectors-gatherers, predators, scrapers

Larval identification notes

- Similar to Small Minnow Mayflies
- 3 tails
- Short antennae, less than twice width of head
- Platelike gills on abdominal segments 1-7 that cover sharp spines on the sides of each segment

Primitive Minnow Mayfly larva

Pronggill Mayflies

Leptophlebiidae

Most Pronggill Mayfly larvae inhabit shallow, slow-flowing or standing water at the margins of streams, rivers, marshes, and ponds, including temporary bodies of standing water. In Southeast Alaska we have found them in steep streams fed by snowmelt. They are generally poor swimmers, and those that venture into flowing water tend to seek refuge from the current under rocks, in moss, and on logs and other debris. Their diet consists of detritus and algae, although they will sometimes shred leaves.

Larval identification notes

- Gills long, narrow, and deeply forked (prong-like) and present on most abdominal segments

Interesting facts

- The larvae of some species make spring migrations—sometimes by crawling along the shoreline—from large rivers to small tributaries, and eventually into seasonally isolated ponds and marshes. After emerging from their new home they return to the main river to breed and lay eggs.
- Functional Feeding Groups: collectors-gatherers, sometimes scrapers

Pronggill Mayfly larva

Sand Minnow Mayflies

Ametropodidae

Sand Minnow Mayfly larvae are fast swimmers with special adaptations for living on the shifting sands of large swift-flowing rivers. Their streamlined bodies and short, stiff, hair-covered tails help them propel themselves against strong currents. Long, pointed claws on the middle and hind legs anchor their position in the unstable sediments, and pads of short, stiff spines at the base of each front leg provide friction to hold them in place.

Their cleverest adaptation, however, is behavioral. A larva uses its front legs to excavate a shallow pit in front of its head. Then it waves its legs to initiate and maintain a vortex (i.e. spiraling water) within the pit. Diatoms and other small food particles suspended in the water are swept into, and concentrated by, the vortex. The larva then collects the food with its spiny front legs and other filtering devices.

Interesting facts

- When at rest the larvae burrow into the sediment with only their eyes and gills exposed.
- Sand Minnow Mayflies were first discovered in Alaska in the Yukon River.
- Functional Feeding Groups: collectors-filterers, collectors-gatherers

Larval identification notes

- Claws on middle and hind legs long and slender; claws on front legs short and stout with 4 or 5 long spines
- 3 tails
- Plate-like gills on most abdominal segments

Sand Minnow Mayfly larva (photo by California Dept. Fish & Game, Aquatic Bioassessment Laboratory)

Small Minnow Mayflies

Baetidae

Small Minnow Mayflies are probably the most widely distributed and abundant mayfly family in Alaska. The small, fish-like larvae are excellent swimmers. Many have a streamlined body form that helps them move about and maintain their position in torrents of water. They can be found living in a wide variety of habitats: lakes and ponds, steep mountain streams, and even the cold, muddy rivers flowing out of glaciers. Their diet consists of diatoms and detritus.

Interesting facts

- Small Minnow Mayflies can represent a large fraction of the invertebrate drift in a stream. In streams with drift-feeding fish, most larvae drift between dusk and dawn to avoid detection.
- Adults wag their abdomen when at rest.
- Small Minnow Mayflies are often the first mayflies to colonize new streams exposed by retreating glaciers.
- Functional Feeding Groups: collectors-gatherers, scrapers

Larval identification notes

- Similar to Primitive Minnow Mayflies
- Antennae long, usually longer than twice the width of the head
- Upper lip notched
- All claws similar in size and shape
- Gills plate-like
- 2 or 3 tails

Small Minnow Mayfly larva

Small Minnow Mayfly larva

Small Square-gill Mayflies

Caenidae

At less than 8 mm in length (excluding the tails), Small Square-gill Mayflies are among the smallest of mayflies. The larvae are fond of places where sand and silt tend to accumulate, such as calm waters along the edges of streams, ponds, and small lakes. They can also be found crawling about on dense vegetation. Tiny and slow-moving, Small Square-gill Mayfly larvae are often coated with fine particles of silt and detritus, making them difficult to observe. They are unique among mayfly larvae in possessing a pair of large 4-sided gills on the second abdominal segment. As they crawl over and through fine sediments, these special gills act as protective covers to prevent abrasion and clogging of the delicate breathing gills underneath. Their diet consists of fine particles of organic matter and diatoms.

Larval identification notes

- A pair of large 4-sided gills on abdominal segment 2 that cover smaller plate-like fringed gills on segments 3-6
- 3 tails
- Hind wing pads absent

Interesting facts

- Larvae raise their abdomen upward when they walk.
- The adult phase lasts fewer than four hours.
- Functional Feeding Groups: collectors-gatherers, scrapers

Small Square-gill Mayfly larva (photo by Dan Bogan)

Spiny Crawler Mayflies

Ephemerellidae

Most Spiny Crawler Mayflies live in streams and rivers, yet most are poor swimmers. Those that live in fast-flowing water have flattened bodies, short and stout legs, and a friction pad of dense hairs under the abdomen, all adaptations that prevent them from being swept away by swift currents. On slippery, algae-covered rocks the friction pad provides enhanced traction, much like the felt soles found on some wading boots. Larvae adapted for slow-water habitats are cylindrical in cross section and have long spindly legs for crawling around and clinging to root tangles and moss mats.

Interesting facts

- Spiny Crawler Mayflies in the genus *Drunella* are omnivores. While their primary foods are algae and detritus, they will occasionally prey on other insects.
- When taken from the water or disturbed, the larvae will often raise their tails upward like scorpions poised to strike.
- Functional Feeding Groups: predators, collectors-gatherers, scrapers

Larval identification notes

- The only family of mayflies that lack gills on abdominal segment 2
- In some species, top of head, thorax, and abdomen have rounded or sharp spines
- Abdominal segments usually have lateral spines
- 3 tails

Spiny Crawler Mayfly larva

Spiny Crawler Mayfly larva

Spiny Crawler Mayfly larva

Stoneflies—Order Plecoptera

"True Alaskans?"

Perhaps, while snowshoeing early in the spring in Alaska, you've noticed an insect on the surface of the snow. On closer examination, you realize that the bug is alive: it's perched on the frozen surface as if it never got the memo about how insects are supposed to behave in winter. It's an interesting-looking insect, too—it looks a bit like a cross between a housefly and a cockroach. It has intricately-veined wings folded neatly across its back, and on the end of its abdomen are two stiff, pointed tails. You've just encountered an adult stonefly.

You could describe Alaska's stoneflies as "true Alaskans." They're quite tolerant of cold: you can find active stonefly larvae under the ice of midwinter streams, and the larvae of at least one species are able to survive being frozen and go on feeding and growing, none the worse, when they thaw out. Many types of Alaskan stoneflies are adapted to emerge well before the snow has melted, making the most of Alaska's chilly springs.

Some stonefly larvae are carnivores, while others feed on plant matter and detritus. Among the latter are several types that are shredders: they munch their way through vast amounts of dead leaves and plant matter. In doing this, they're serving a very important purpose in the ecology of the stream—breaking down dead things to help release their nutrients and energy for use by the living.

To identify stonefly larvae in your stream sample, look for insects with long antennae, two tails, and no plate-like or forked gills on the abdomen, and two claws on each foot. Although they are not strong swimmers, stonefly larvae propel themselves through water using a side-to-side motion. Stonefly larvae come in a variety of colors; many are yellowish or brownish. Many Alaskan stonefly larvae remain very tiny their whole lives, but some types grow big enough to set off the heebie-jeebies. Don't worry, though—stoneflies don't bite.

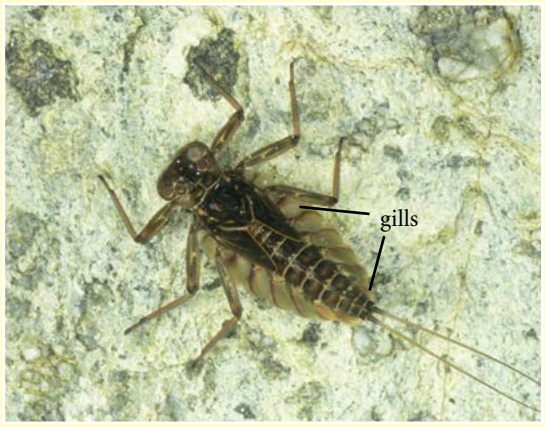
Several species in the Snowfly (Capniidae) and Forestfly (Nemouridae) families are often found on the snow, especially on sunny days. Do they go out on the snow to absorb warmth from the sun?

This nemourid stonefly larva is "shredding" a fallen leaf. Although shredders ingest leaf material, the bacteria and fungi feeding on the leaf are what these consumers relish. The skeletonized leaves left behind by shredders suggest leaf veins may provide more structural support than nutritional value, or may just be too tough to eat.

How to tell a stonefly from a mayfly

Stonefly and mayfly larvae can look very similar: both are elongate with six legs and long abdomens and tails. They often inhabit the same waters, and may be about the same size. There are a several ways to distinguish them, although you might need a magnifying lens to look for the finer details. Stoneflies always have two tails, while mayflies may have either two or three. Most stoneflies have no abdominal gills, while most mayflies have prominent plate-like or forked abdominal gills. When swimming, mayflies move their bodies up and down, whereas stoneflies move side-to-side.

Stonefly



Mayfly

Forestflies/Little Brown Stoneflies

Nemouridae

Forestfly larvae are small, stout, and hairy stoneflies that live in small rivers, streams, and springs. They cling to rocks or wood, or tuck themselves among accumulations of dead leaves. The nutritious microbes living on autumn-shed leaves are a favorite seasonal food for many species. In fact, some species have life histories timed to take advantage of this highly nutritional food resource. Other foods include fine organic matter, algae, and aquatic mosses.

Adults emerge from late winter to early summer and are often seen crawling about on snow. Some feed on young leaves and buds of streamside vegetation or on pollen.

Forestfly larva

Larval identification notes

- Small (usually less than 12 mm long), stout, and hairy
- Abdomen quite short, giving them a cricket-like appearance
- Hind leg usually extends beyond tip of abdomen
- Some species have tube-shaped gills, sometimes branched, under mouth or neck

Forestfly larva

Interesting facts

- The female extrudes a mass of eggs that cling to her abdomen until she dips it into the water. Upon contact with the water, the egg masses of some species "explode," allowing individual eggs to settle to the bottom, where they are less likely to be seen and eaten.
- Eggs laid in spring may hatch soon after being deposited, or they may "rest" for several weeks before hatching in late summer.
- Some larvae are able to survive being frozen in ice.
- Functional Feeding Group: shredders

Stories from the field

One of our favorite stonefly species is the Cataract Forestfly (Visoka cataractae). *The larvae of these nifty little Nemourids show up often in Juneau stream samples, but if we hadn't been patient, we'd never have noticed them. Their bodies are covered with long hairs that trap little pieces of debris, creating magnificent camouflage jackets. We've found that only after the water in the sample pan has stopped swirling, and the debris has settled, can we spot the tiny bits of crawling "debris" that are actually stoneflies.*

Golden Stoneflies

Perlidae

Golden Stoneflies are named for their yellowish bodies which are usually boldly marked with black. The active and powerful-looking larvae prefer riffle habitats in a variety of waters, from small streams to large rivers. Young larvae typically feed on plant material, but as they get older they become voracious predators, consuming mayflies, caddisflies, Chironomids, Black Flies, and other stoneflies. Adults emerge in late spring and summer after spending up to three years in the larval stage.

Interesting facts

- Adult males have a fleshy hammer-like structure at the tip of the abdomen, which they drum on various objects to attract the attention of females.
- One species is known to feed on salmon eggs and newly hatched salmon alevins.
- Functional Feeding Group: predators

Golden Stonefly larva (photo by California Dept. of Fish & Game, Aquatic Bioassessment Laboratory)

Golden Stonefly larva (photo by Don Chandler)

Larval identification notes

- Conspicuous, highly branched gills at the base of each leg
- No gills on abdomen
- Many are yellow with bold black markings

Needleflies/Rolledwinged Stoneflies

Leuctridae

Like Snowflies, Needleflies are small stoneflies with long, skinny bodies. Little is known about the larvae. They are most common in small, spring-fed streams, where they shred leaves and other organic matter deep within the streambed. With wings that are held close to the body and slightly curved around the abdomen, the adults resemble conifer needles and are sometimes called Rolledwinged Stoneflies. The adults emerge from spring through summer and can be found in dry leaves or on streamside vegetation.

Larval identification notes

- Body long and slender; no gills; wing pads parallel
- Similar to Snowflies, but in Needlefly, abdomen is about the same width along entire length while Snowflies have bulbous abdomens that are widest near the end

Interesting facts

- Some can survive and live in streams that freeze completely during winter.
- Some species are able to complete their life cycle in streams so small that little or no surface water may be visible.
- Functional Feeding Group: shredders

Needlefly adult (photo by Tom Murray)

Needlefly larva (photo by Tom Murray)

Sallflies

Chloroperlidae

Sallflies are one of the most species-rich stonefly families in Alaska (23 species are known from the state). They are also the most widely distributed group, occurring from the Arctic tundra to the coastal rainforest. The larvae of several species have special adaptations to survive extreme cold.

In the gravel substrate of swift-flowing streams, Sallflies are often the most abundant insects: in the top 10 cm of a streambed, there can be more than a thousand larvae in just one square meter. Mature larvae are predators, although the younger larvae of many species are scrapers and collectors-gatherers.

Adult Sallflies are often refreshingly easy to identify: most are some shade of yellow or green. Some are especially bright, seeming almost to glow. They emerge throughout the summer and are commonly found crawling on streamside vegetation or flying near streams.

Sallfly adult

Sallfly larva

Sallfly larva

Interesting facts

- Sallflies typically live deep in the streambed. In Montana, the genus *Kathroperla* has been found living in groundwater 4 m below farm fields. Amazingly, these fields were over 1 km from the channel of a large river—a long crawl when it's time to emerge!
- In salmon streams, the abundance of Sallfly larvae near the streambed surface increases dramatically during the spawning run as the stoneflies scavenge dead eggs and alevins as well as the flesh of spawned-out adult salmon.
- Functional Feeding Groups: predators, collectors-gatherers

Identification notes

- **Larvae:** yellowish to light brown with no gills and short tails (¾ the length of the abdomen or shorter)
- In mature larvae, outer edges of wing pads parallel or slightly divergent
- **Adults:** often yellow or light green

Salmonflies/Giant Stoneflies

Pteronarcyidae

This family contains North America's largest stoneflies. Some mature larvae rival those of the Mosaic Darner Dragonflies in size. Unlike the predatory darners, however, the Giant Stoneflies achieve their great proportions primarily from a diet of leaves and other detritus. Occasionally they scrape diatoms for food or capture small insects when the opportunity presents itself.

Larvae can be found in accumulations of leaves and other detritus or on logs in the slow currents of streams and rivers. The early-summer emerging adults are an important seasonal food resource for fish and thus are often emulated by flyfishers. Some adults are active nocturnally.

Salmonfly larva showing the branched gills (photo by Tom Murray)

Salmonfly larva (photo by Tom Murray)

Interesting facts

- Eggs may "rest" for more than a year before larvae hatch, and the life cycle can take as long as 4 years to complete.
- The first thoracic segment of the Giant Stonefly (*Pteronarcys californica*) has sharply pointed corners that may represent a painful reason for hungry fish to spit out an otherwise substantial meal.
- Functional Feeding Group: shredders

Larval identification notes

- Tufts of gills on underside of thorax and first 2 or 3 abdominal segments

Snowflies/Slender Winter Stoneflies

Capniidae

Snowflies, or Slender Winter Snowflies, are insects of winter. After hatching in the spring, larvae delay their development until fall and winter, when most of their growth occurs. They usually live deep within streambed gravels or accumulations of detritus in springs and small streams. Their diet consists of decaying leaves and the microbes within them. By converting a large leaf into tiny fecal pellets, these little shredders help to feed other aquatic invertebrates that filter small particles from the current for food. Snowflies are highly sensitive to changes in habitat and water quality, so their presence is a good indicator of a healthy stream.

Adults emerge early in the year and can be seen crawling around on snow and ice. Some adults are flightless, having wings that are very short or so small they appear to be missing.

Interesting facts

- In glacial rivers, the larvae can be found in groundwater many meters from the edge of the channel.
- Early-emerging adults will take refuge from the cold by entering small crevices in the snow.
- Functional Feeding Group: shredders

Larval identification notes

- Long and slender; lack gills on mature larvae, outer edges of wing pads nearly parallel
- Very similar to Needleflies; the bulbous abdomen of some Snowflies helps to distinguish them from Needleflies, which usually have straight-sided abdomens

Snowfly larva

Stripetail and Springfly Stoneflies

Perlodidae

This stonefly family contains two distinct species groups: a group with gills (Springflies) and another without gills (Stripetails). Both the larvae and adults are similar in form, habits, and habitat use to Golden Stoneflies. Many species are common in the drift. The insectivorous larvae feed on Chironomids, Black Flies, mayflies, and caddisflies. The adults are active fliers and can be found from spring to fall. Some adults crawl around on streamside vegetation during warm weather, others hide among debris on the ground or in the crevices of downed wood.

Interesting facts

- In many species the young larvae feed on algae and detritus before gradually adding more insects to their diet until they become completely carnivorous.
- The eggs may "rest" for nine months or longer before the larvae begin to develop.
- Functional Feeding Group: predators

Larval identification notes

- Similar to Golden Stoneflies but lack branched gills on thorax
- Many have fingerlike gills near base of each leg and/or on underside of head and neck
- Head and thorax usually distinctly marked
- Some species have dark stripes down length of abdomen
- Tails as long as, or longer than, abdomen
- Hind wing pads divergent

Perlodid adult with egg mass on the end of abdomen.

Perlodid larva

Willowflies

Taeniopterygidae

Willowfly larvae are sluggish stoneflies found in cold rivers and streams of all sizes, from the coastal rainforest to the Arctic tundra. They can be found among gravels and cobbles in fast-flowing water or on dead leaves and other accumulated organic debris in the calm parts of streams.

Most growth occurs in fall and winter when the larvae grow fast on a diet of both living and dead plant material. Due to their small size (especially in summer), slow-moving nature, and tendency to become coated with fine particles of sediment, Willowfly larvae can be difficult to find in a sample pan. The adults emerge from late winter to early summer; some crawl about on the snow.

Larval identification notes

- Single segmented gill at base of each leg, or plate on underside of abdomen that covers last two segments
- In mature larvae, outer edges of wing pads strongly divergent

Interesting facts

- The males of some species are flightless.
- Preserved larvae tend to curl from head to tail into the shape of a C.
- Functional Feeding Groups: shredders, scrapers

Willowfly larva

Water Beetles—Order Coleoptera

Distinctive and diverse

Insects are by far the most diverse group of animals on Earth, and beetles are the most diverse group of insects. Among Alaska's aquatic members of the order Coleoptera are beetles that spend their lives underwater, beetles that spend only part of their lives underwater; beetles that crawl and beetles that row, beetles that hunt like wolves and beetles that suck the juices of aquatic plants like Mosquitoes sucking our blood.

As diverse as they are, all adult beetles are distinguished by their similar flight apparatuses: their forewings are modified into hard covers called *elytra* that protect their hind (flight) wings. While at rest, a beetle folds its wings across its back, enclosed in the hard shell formed by its elytra. This distinctive body design helps make adult water beetles among the most easily recognized aquatic insects. No matter what family they belong to, adults look "beetle-like": oval, with two elytra, six legs, and fairly short antennae.

When you watch a Predaceous Diving Beetle darting and looping around its home pond as gracefully as a swallow, it can be easy to forget that the beetle has alternative transportation, too. If food runs out or the pond becomes too warm, too crowded, too cold, too lonely, or too polluted, the beetle can take wing and find a new aquatic home.

Aquatic beetle larvae can be a little harder to identify. While all have six legs and long, multi-segmented bodies, some have bizarre spike- or whip-like appendages along their abdomens. Some have vicious-looking hooked jaws, and others have armor-like plates along their bodies. The aquatic larvae of many types must surface periodically to breathe, but some are capable of absorbing oxygen directly from the water or from aquatic plants.

Although adults of some families, such as Whirligig Beetles (left) and Predaceous Diving Beetles (lower left) are powerful swimmers, others, such as Crawling Water Beetles (below) are rather poor swimmers.

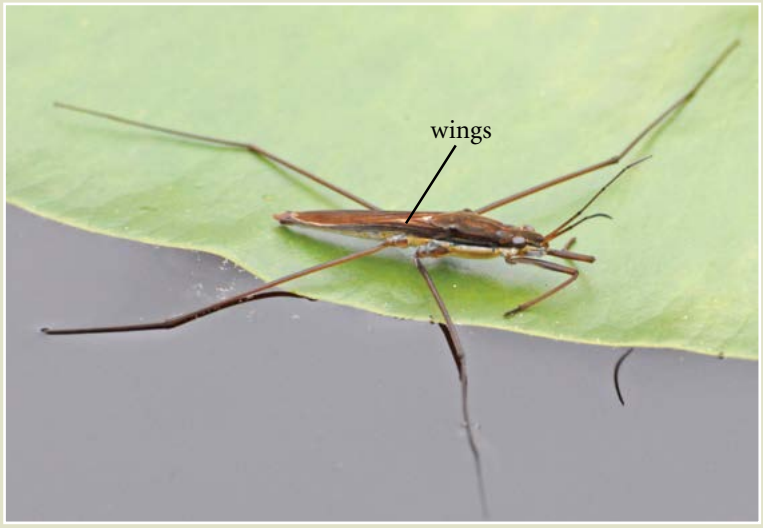
Sometimes called "water tigers," the larvae of Predaceous Diving Beetles are skilled hunters. This one is eating its own kind.

This Crawling Water Beetle adult is eating a caddisfly larva.

Predaceous Diving Beetle larvae often hunt and obtain air near the water surface, where they are vulnerable to predation by belted kingfishers.

Beetle or bug?

The water beetles (Coleoptera) and the water bugs (Hemiptera) can look similar. But study them closely and you'll see differences. Water beetles have elytra (wing covers) but bugs don't; you can see bugs' wings folded over their backs. Water beetles have chewing mouthparts, while water bugs' mouths are modified into piercing/sucking beaks.



Aquatic Leaf Beetles

Chrysomelidae

Aquatic Leaf Beetles can be found in lakes, ponds, and slow-moving streams. For these herbivores, all plant parts—leaves, stems, and roots; above and below the water—are fair game. The grub-like larvae can be found feeding on the upper surfaces of floating leaves, such as pond lily leaves, or on the roots, stems, and leaves of submerged plants. Semi-aquatic larvae chew their way across the tops of floating leaves, leaving meandering ruts filled with their droppings.

Depending on the species, Aquatic Leaf Beetles prefer to eat a particular type of plant or several species of plants occupying the same type of habitat. Adults spend most of their time above the water, occasionally venturing below the surface. They lay eggs on the undersides of floating leaves and the tops of submerged stems.

Larval identification notes

- Thick and grublike
- Head and legs small (a)
- Mouthparts directed downward

Interesting facts

- Most Aquatic Leaf Beetles pupate on land, but one genus (*Donacia*) pupates in water, in silk cocoons that enclose bubbles of air.
- Aquatic Leaf Beetles are used as biological control agents in the fight to eradicate purple loosestrife, an invasive plant that has damaged wetland ecosystems throughout the Lower 48 states and Canada.
- Larvae in the genus *Donacia* puncture and take oxygen from plants using sharp spurs on the tips of their abdomens.
- Functional Feeding Group: herbivores

Aquatic Leaf Beetle larva

Crawling Water Beetles

Haliplidae

Although once thought to be carnivores, Crawling Water Beetles are in fact plant eaters. Both the adults and larvae feed on algae and can be found living among aquatic vegetation in ponds, slow streams, and the margins of lakes. Mature larvae construct pupal chambers in moist mud and transform to adults within 2 weeks.

Adult Crawling Water Beetles are small and oval-shaped, with long swimming hairs on their legs. They get around by crawling on vegetation or slowly swimming through the water. The wing covers are yellow or light brown, densely pitted, and with dark spots or interconnected stripes or blotches. Trapped air bubbles under abdominal plates help to regulate buoyancy and supplement the main air supply stored under the wing covers. Larvae obtain oxygen by absorption through their body walls.

Crawling Water Beetle adult

Interesting facts

- Females use their mandibles to cut holes in plants, through which they deposit eggs.
- Adults use large plates under the abdomen to transfer air bubbles from the tip of the abdomen to the underside of the wing covers.
- They can survive for up to 6 weeks without food.
- Functional Feeding Group: shredders

Crawling Water Beetle larva

Identification notes

- **Larvae:** distinguished from other beetles by legs with five segments and a single claw on each leg
- The bodies of some larvae are covered with long filaments or spines
- **Adults:** distinguished from other beetles by large plates at the base of hind legs that cover most of abdomen

Marsh Beetles

Scirtidae

Compared to other beetle families, not much is known about the Marsh Beetles. The aquatic larvae eat fungi, diatoms, and algae growing on decaying organic matter, in shallow lake and pond waters. The mouthparts are highly modified into a complex filtering apparatus used to sort food particles. Larvae breathe air, which they obtain through openings on the tips of their abdomens. Mature larvae construct pupal chambers on land.

The terrestrial adults are oval in shape, golden-brown in color and can be found on live vegetation or decaying organic matter near water bodies. They reportedly feed on pollen. One species, *Cyphon variabilis*, occurs in Alaska.

Larval identification notes

- Larvae unique in having many-segmented antennae that are longer than head

Marsh Beetle larva (photo by California Dept. of Fish & Game, Aquatic Bioassessment Laboratory)

Interesting facts

- Functional Feeding Groups: scrapers, collector-gatherers, shredders

Marsh Beetle adult (photo by Tom Murray)

Predaceous Diving Beetles

Dytiscidae

These predatory beetles live in lakes and ponds, where they feed on just about anything they can catch and subdue: insects, worms, leeches, crustaceans, snails, frogs, salamanders, fish, and even carrion. In fishless Arctic lakes they are often the top predators. Adults and larvae are air breathers. Both must surface regularly to recharge internal air chambers through spiracles on the tip of the abdomen.

The sleek, oval adults glide through the water powered by legs that are densely covered with stiff swimming hairs. Adults have such poor vision that they must first seize and taste their prey before deciding to eat it. Suitable prey are then torn and cut into bite-sized pieces using mandibles hidden away under the head. Females use ovipositors to lay eggs on land, inside aquatic plants, or on plants.

Compared to the adult, the larval Predaceous Diving Beetle is a rather odd-looking and sluggish creature. Some species have oversized heads, undersized legs, and narrow necks; they seemingly struggle to move through the water. Appearances are deceiving, however. They approach their prey with such stealth that their oversized mandibles surround the oblivious target while special mouth parts sense edibility. Then the mandibles seize the prey. A toxic digestive fluid kills the victim and liquefies the insides.

Predaceous Diving Beetle adults

Identification notes

- **Larvae** (below): large hooked piercing mandibles
- **Adults** (above)**:** males have smooth wing covers (right); wing covers of females are grooved (left)
- Distinguished from other water beetles by thread-like antennae (a)

Interesting facts

- Suction cups on some males' forelegs are used to grip females while mating.
- Adults are competent fliers and will fly in search of better habitat.
- Females use ovipositors to lay eggs on land, inside aquatic plants, or on land plants.
- When mature, the larvae leave the water to pupate on land.
- Functional Feeding Group: predators

Predaceous Diving Beetle larva

Riffle Beetles

Elmidae

Riffle Beetles live in well-oxygenated, fast-flowing streams. The larvae and adults are often found together, clinging to rocks and decaying wood, where they feed on algae and detritus. Once mature, the larvae leave the water to pupate on shore. Upon emergence, adults disperse on the wing—the only flight of their lives—to new habitats where they take up a fully aquatic lifestyle. The long-legged, black adult beetles are apparently distasteful to fish and other predators.

Larval identification notes

- Elongate, hard-bodied, somewhat circular in cross-section and yellow to golden in color
- The tip of the larva's abdomen has a ventral plate underneath that houses clinging hooks and retractable gills

Interesting facts

- In Alaska, Riffle Beetles are only known from the southeastern part of the state.
- Adult Riffle Beetles use a plastron (physical gill) to absorb oxygen from the water. The plastron is composed of a pad of non-wettable hair-like setae (numbering more than a million per square millimeter) that traps a layer of air.
- Functional Feeding Group: collectors-gatherers

Riffle Beetle adult (photo by California Dept. of Fish & Game, Aquatic Bioassessment Laboratory)

Riffle Beetle larva (photo by California Dept. of Fish & Game, Aquatic Bioassessment Laboratory)

Rove/Shoreline Beetles

Staphylinidae

Few Rove Beetles are truly aquatic and most semiaquatic species live in the intertidal zone and nearby sandy beaches and rocky shorelines. No larvae have yet been found living in fresh water, but the mostly predatory adults are common in wet areas next to streams, ponds, and lakes. Sometimes they can be seen slowly walking on the water, held up by surface tension.

Adult Rove Beetles in the genus *Stenus* are able to skim across the water surface without moving a muscle. This amazing feat is accomplished by the release of a surfactant, called *stenusin*, from their hind ends. Stenusin breaks the surface tension, forcing water molecules suddenly apart. This pushes the lazy beetle along at speeds reaching 70 cm per second—a free ride thanks to chemistry and physics.

Interesting facts

- Rove Beetles feed on small crustaceans and insects or decaying organic matter.
- None live beneath the water surface.
- Rove Beetles are the most common beetles found in Alaska's intertidal areas.
- Functional Feeding Groups: predators, collectors-gatherers

Adult identification notes

- Elongate; most have short wing covers leaving much of the abdomen exposed

Rove Beetle adult

Trout-Stream Beetles

Amphizoidae

Trout-Stream Beetles are rare inhabitants of cold mountain streams and rivers. Both the adults and larvae can be found under the water or along stream banks. In the water, the beetles crawl on rocks and logs and within accumulations of debris, searching for their favorite prey: stoneflies. Larvae take in air through two spiracles at the tip of the abdomen; the adults carry an air bubble with them during underwater excursions. They pupate in streamside soils.

Interesting facts

- To ward off predators, adult Trout-Stream Beetles secrete a noxious liquid from their scent glands.
- Mature larvae spend most of their time out of the water, entering it only to seize prey.
- Functional Feeding Group: predators

Larval identification notes

- Elongate and strongly flattened
- Thorax and abdomen covered with rigid plates that project laterally into thin, flat projections
- Mandibles prominent
- Abdomen ends in two short tails

Trout-Stream Beetle larva (photo by John Hudson)

Water Scavenger Beetles

Hydrophilidae

The common name for this family (whose scientific name means "waterlovers") isn't necessarily a good description, because not all members are aquatic. Among aquatic species, the omnivorous adults consume live plants, especially algae, and are known to scavenge decaying plants and carrion. They are good fliers and will take to the air to colonize new habitats when water levels drop too low or food becomes scarce. Eggs, numbering 100 or more, are placed inside silk cases attached to vegetation at the surface or under the water.

Most larvae are fully aquatic and predatory, but are rather slow swimmers. They take a "sit and wait" approach to feeding. Anything that wanders too close is grabbed and—if the larvae can hold on—torn to bits with large mandibles. Larvae of most species must go to the surface to replenish their internal air supply through openings in the tip of the abdomen. Mature larvae leave the water to pupate under rocks and logs or in organic debris or moist soil.

Identification notes

- Both larvae and adults superficially similar to Predaceous Diving Beetles
- **Larvae:** 8 abdominal segments, are sometimes wrinkled, and have large toothed mandibles
- **Adults:** strongly convex with short, club-shaped antennae
- Move legs alternately when swimming and breach heads when surfacing for air

Water Scavenger Beetle adult

Interesting facts

- As larvae, many species leave the water to eat their catch, which they liquefy using digestive juices before consuming.
- Adults carry a silvery film of air, under the thorax. Its main function is to transfer air from the surface to an air bubble stored under the wing covers.
- Larvae in the genus *Berosus* can absorb all the oxygen they need with long, paired gills on each abdominal segment.
- Functional Feeding Groups: predators, scavengers

Water Scavenger Beetle larva (photo by California Dept. of Fish & Game, Aquatic Bioassessment Laboratory)

Whirligig Beetles

Gyrinidae

While both the larvae and adults of Whirligig Beetles are aquatic, it's the surface-dwelling adults—with their constant and quick whirling motions—that are most often seen. A Whirligig adult's top half repels water and the bottom half is wettable so that the insect floats at the midline. Front legs are long and slender for grabbing prey; middle and hind legs are short and flat, and move quickly for rapid propulsion. Two sets of eyes, one above and another below the water surface, give them a view of both the aquatic and terrestrial worlds. When venturing below the surface the beetles carry a bubble of air along as an oxygen supply.

Adult Whirligigs catch small aquatic invertebrates or scavenge terrestrial invertebrates that fall into the water. Their short antennae detect and locate trapped prey by sensing the surface vibrations created by their struggles. To avoid predation, adult beetles often form dense aggregations that may contain hundreds of whirling individuals of several species. When attacked they secrete a distasteful fluid that usually ensures their release unharmed. If current living conditions become poor, they can take to the air in search of more suitable habitat, usually in a lake, pond, or very slow-moving stream.

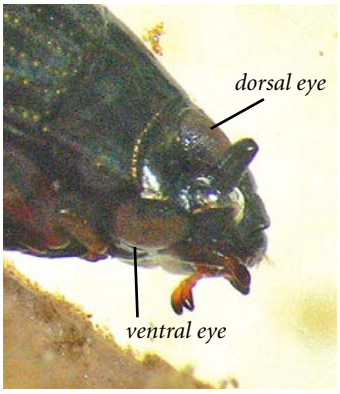
Females lay eggs on leaves and stems of submerged vegetation. The larvae hang out on the bottom, where they prey on small invertebrates. They get around by crawling on vegetation with the help of small hooks on the tips of their abdomens, and they can swim by undulating their bodies. Larvae pupate in cocoons constructed on emergent vegetation or under rocks, logs, and other objects on the shoreline.

Identification notes

- **Larvae:** elongate, cream to white in color, with brown markings on the the head and thorax
- Abdomen with 10 pairs of long slender gills and tip of abdomen with a pair of curved hooks
- **Adults**: eyes separated for viewing above and below the water simultaneously

Interesting facts

- Adults can "kick" their swimming legs up to 60 times per second
- Adults use a form of "sonar" for nighttime navigation. Bow waves produced by their forward motion reflect off objects and are detected by the antennae.
- Adults overwinter buried in the bottom sediments of large streams and lakes.
- Functional Feeding Groups: predators, scavengers



Whirligig Beetle adults

Water Bugs—Order Hemiptera

Skaters, rowers, and monsters

Like water beetles, water bugs are among the most entertaining pond insects to observe. Whether they're skating across the surface (Water Striders) or rowing their way below (Water Boatmen and Giant Water Bugs), they are easy to spot and recognize. Once you spot them, you can watch them go about their lives: hunting, feeding, resting, fleeing.

Unlike water beetles, water bugs don't go through complete metamorphosis. They don't even go through a big change in appearance as they mature—unlike beetles, dragonflies, mayflies, and other aquatic insects in this book, water bugs look basically the same from hatching to adults.

One family of Alaskan water bugs, the Water Boatmen, feed on a variety of foods, including detritus, plants, and other invertebrates. Most Water Boatman use their piercing/sucking mouthparts to feed on plant juices and their prey's body fluids. The other two families—Water Striders and Giant Water Bugs—are predators. They grasp their prey, pierce it with their beaks, and suck out the juices.

Giant Water Bugs, though widely distributed in most of North America, are known in Alaska only from the southeastern part of the state. These big, scary-looking monsters of the aquatic world are (if provoked) more than willing to bite!

Water bugs don't change to different forms as they grow and mature. However, their appearance does change. The youngest nymphs (such as the Water Strider young at left) have very short abdomens and no wings. As they grow to adulthood, their abdomens lengthen and their wings develop (such as the Water Strider adult below).

Predatory water bugs suck the juices out of their prey. Above: Water Striders feeding on a moth that has fallen onto the surface of a pond.

Below: Having captured and pierced a Mosquito pupa, a Water Boatman sucks its body fluids.

Photo by John Davis

Most Alaskan water bugs are smaller than a thumbnail. But Alaska's Giant Water Bugs can grow to 2.5 inches in length. That's about as long as an average-size adult thumb!

Giant Water Bugs

Belostomatidae

Reaching 2.5 inches (65 mm) in length, *Lethocerus americanus*, the only species of Giant Water Bug known from Alaska, may well be the state's largest aquatic insect. These hunting insects seize prey with "raptorial" hook-tipped front legs. Using a sharp beak under its head, the bug secretes digestive juices into the victim and then sucks out the liquefied remains. In the ponds and lakes where they live, these big predators hang upside down among plants with their seizing legs ready to grab any small creature that swims by, including small fish.

Interesting facts

- In Alaska Giant Water Bugs have been found only in the extreme southern portion of the state on Revillagigedo and Wrangell Islands.
- On Wrangell Island, parts of Giant Water Bugs have been found in regurgitated pellets from Western Screech Owls.
- Adult males carry the eggs on their backs.
- Functional Feeding Group: predator

Identification notes

- Body flattened and shaped like an elongated oval when viewed from above
- Large size and strong looking front legs

Adult Giant Water Bug (photo by Tom Murray)

Shortlegged Striders

Veliidae

Shortlegged Striders are active predators that skate about on the surface of ponds, fens, marshes, bogs, and slow-moving streams. For quicker movements, and to avoid producing ripples that might alert potential prey, they release a fluid that suddenly reduces the surface tension of the water behind them. The rapidly expanding water surface pushes these little bugs across the water seemingly without effort (In reality, the fluid requires a lot of energy to produce). These striders sense movements and location of potential prey through wave vibrations on the water surface. Captured prey are stabbed with piercing mouth parts. Their common name comes from the fact that they have shorter legs than the Water Striders (Gerridae) do.

Interesting facts

- Shortlegged Striders are usually wingless; those with wings use them to fly in search of new habitats.
- Dense water-resistant hairs can give the body a silvery appearance.
- Functional Feeding Group: predators

Identification notes

- When extended rearward, hind leg's first segment (a) may extend just barely beyond the end of the abdomen; in Water Striders this segment extends well beyond the tip of the abdomen
- Segment behind the head is wider than the abdomen

Shortlegged Strider adult (photo by Tom Murray)

Water Boatmen

Corixidae

Water Boatmen live along the edges of rivers, lakes, and ponds and in slow-moving streams. They are often the most common aquatic insects seen by the casual observer. With powerful strokes of their long hair-covered legs they dart through the water in search of prey. Air for breathing is stored on the undersides of their bodies, primarily as a *plastron* (flattened air chamber). The rowing motion of the hind legs increases the plastron's efficiency in obtaining oxygen. Water Boatmen are less dependent on atmospheric oxygen than are other water bugs, although in oxygen-poor habitats they must come to the surface more frequently to replenish their air supplies.

Interesting facts

- In water bodies that do not freeze to the bottom, adults overwinter underwater.
- The tiny eggs (about 0.5 mm) appear as a dense crust on submerged rocks, sticks, or plants.
- Water Boatmen, especially the males, can produce sound by rubbing the bases of their front legs against the sides of their heads. The clicking sound is used to attract mates, form aggregations, or establish territories.
- Water Boatmen are the largest group of water bugs in Alaska.
- Functional Feeding Groups: piercers-herbivores, collectors-gatherers, predators (piercers)

Identification notes

- Triangular beak (a) and short forelegs (b) are unique among water bugs in Alaska

Water Boatman

Water Boatman

Water Striders

Gerridae

Water Striders can literally walk on water. They accomplish this feat using legs that are covered with thick layers of microscopic hairs. Tiny air bubbles trapped in these hairs provide buoyancy, while a pair of claws on each leg function as tiny oars. With a stroke of the middle legs, the strider glides across the water surface, steering with the middle and hind legs. Front legs are used for grasping their prey, which they first pierce, then suck body fluids from, using their beak-like mouths. Their primary foods are insects that fall onto or become trapped on the water surface. They detect surface waves to find and home in on struggling prey. Striders also produce waves to communicate with potential mates. Their habitats include lakes, ponds, slow-moving streams, and estuaries.

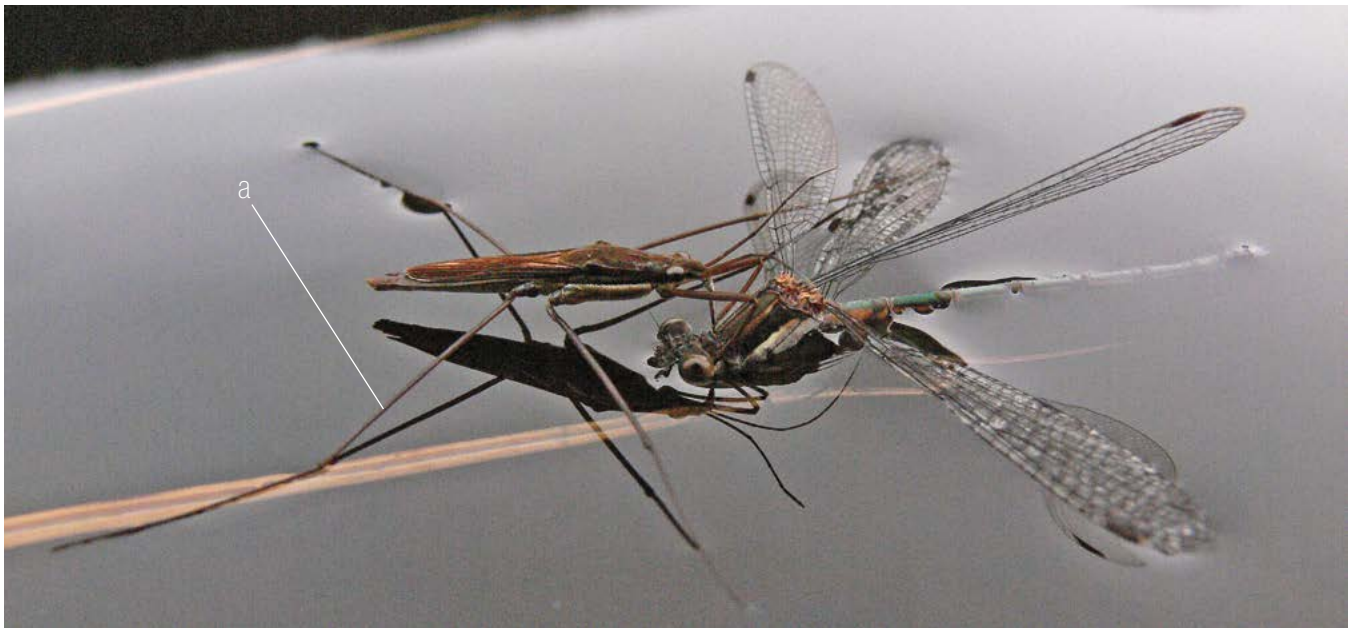
Interesting facts

- When their habitat dries up, adults can fly in search of a wetter place to live.
- Adults overwinter away from water.
- They will cannibalize each other under crowded conditions.
- Functional Feeding Group: predators (piercers, scavengers)

Identification notes

- Juveniles can be confused with Shortlegged Water Striders but first segment of hind leg (a) extends beyond tip of abdomen

Water Striders mating



Water Strider feeding on a damselfly

Other aquatic organisms

Of course, insects aren't the only inhabitants of Alaska's streams, lakes, and ponds. If you observe closely, or if you take samples, you'll come across a number of other animals. Some, such as arachnids (mites and spiders) and crustaceans (amphipods, copepods, and others) can be mistaken for insects. Others, such as amphibians and mollusks (clams, mussels, and snails), clearly aren't. In this chapter, you'll find photos and notes describing some of the many fascinating "other critters" that you might encounter while observing aquatic insects in Alaskan waters.

Worms

Aquatic oligochaetes

Aquatic oligochaetes are closely related to familiar earthworms. Like earthworms, they have a distinctive ringed appearance. They avoid sunlight by living on the bottom of deep lakes or burrowing into sediments. Many types can swim, but they more commonly move by alternately contracting and expanding sections of their bodies. They're important decomposers, endlessly processing matter through their bodies to extract algae, bacteria, and nutrients.

Oligochaete

Some aquatic oligochaetes are bright pink or red, indicating that their blood contains hemoglobin to help bind oxygen and keep them breathing in low-oxygen conditions. Invertebrate communities dominated by oligochaetes usually indicate poor water quality conditions.

Leeches

Leeches are also related to earthworms, though a little more distantly. Alaska's leeches tend to live in warm, still waters. They move by looping along like inchworms, but they can also swim by undulating their bodies. They have suction organs on their heads and tails—easy to observe when they attach themselves to a collection pan, or to your leg.

Leech

While most leeches prey on Chironomids, worms, amphipods, and mollusks, others are famous for sucking blood. Firmly attached to skin with their head suction organ, they "saw" their way through with sharp teeth. Then, after injecting an anticoagulant to prevent blood clotting, they balloon with fresh blood.

Although it's creepy to find a leech sipping from your skin, it's not usually painful. In fact, leeches are used in modern medicine, including surgery and pain management. In Ketchikan, Alaska, leeches placed on a man's severed ear helped to restore blood flow after the ear was reattached.

Planarians

Planarians are flatworms, found in water and moist soil from the alpine to sea level. They're somewhat slug-like in shape and movement. They have an interesting digestive arrangement. Unlike most animals (including us)—where food enters through one opening, travels through a specialized tube for digestion, then continues as waste material through another opening—planarians have just a single opening that serves for eating and excretion alike and, in the strange-but-true category, planarians can learn to navigate their way through a maze…and if sliced lengthwise they will regenerate into two individuals.

Planarian

The planarian in the photo was found in an alpine stream near Juneau—where the undersides of the rocks were covered with them.

Horsehair worms – Nematomorpha

Like their namesake, these parasitic worms are long, slender, and somewhat stiff. In Southeastern Alaska, the adults have been found in small mountainside streams. The eggs and larvae are consumed by aquatic insects, fish, and tadpoles. Once inside a host, nematomorph larvae burrow into tissues and absorb nutrients that will sustain their development into adult.

The cycle is complete when the adult worm grotesquely writhes its way out of the host's body. If that host happens to live on land, it will, for unknown reasons, seek water allowing the worm a convenient return to the watery world where its life began. Remarkably, some larvae do not develop further until the first host is consumed by a predator, such as a dragonfly larva or beetle.

Cnidarians

Hydras

Hydras are tiny, handsome animals usually found in lakes and ponds. They don't swim, but attach themselves to vegetation or debris. When they need to move, they creep along very slowly on their bases like a Space Shuttle moving to the launch pad. If they need a little more speed, they "somersault" end over end to a new location—or they release their bases and drift.

Spotting a hydra can be challenging—not only are they tiny, but when disturbed they contract into tiny lumps. Only when everything is calm will they expand again and unfurl their tentacles. Like their cousins, sea anemones, hydras are predators that kill and capture prey such as cladocerans and copepods using stinging and sticky cells on their tentacles. Hydras reproduce by budding – growing a new individual off another.

Hydra (photo ©Stephen P. L. Luk)

Sponges

Like their marine relatives, freshwater sponges are soft, formless, colonial animals that grow on plants, rocks, and debris. Look for tiny spikes, called spicules, on their surfaces, and both small and large openings that allow water to circulate through their bodies. Sponges eat tiny bits of food carried in the currents of circulating water.

Freshwater Sponge

Several types of aquatic insects, including some caddisflies and Chironomids, are known to eat sponges. Sponges are the particular hosts for the aquatic larvae of Spongillaflies, tiny insects that pierce the sponges with sharp mouthparts and suck the contents out.

Mollusks

Snails

Snails are often found in Alaska's ponds, lakes, and slow-moving streams. They have a single shell, usually cone shaped (as in limpets) or spiraling. They are often well camouflaged. The thickness of freshwater snail shells is related to the amount of calcium available in the water.

Limpet

These important aquatic herbivores graze using ribbons of sharp teeth arranged together in rows within their mouths. The snail roughly "licks" particles of food from a surface such as a diatom-covered rock. You can sometimes see the radula at work if you put a snail in a clear plastic bag of water; after it emerges from its shell and begins to crawl, it may begin to rasp the inner surface of the bag with its radula.

Snails are important food for many aquatic organisms. Humpback and broad whitefish in Alaska feed heavily on valve snails and pea clams, many of which pass through the fish's gut completely unharmed. Biologists believe whitefish unwittingly play an important role in transporting these snail-paced critters throughout Alaska's freshwater systems.

Snail

Freshwater clams and mussels

Freshwater clams and mussels, like their marine cousins, are bivalves, meaning that they

Clam

are mollusks with two shells. Both clams and mussels move using a single muscular foot that helps them burrow or flip along the bottom. In general, freshwater mussels tend to prefer stable sand or gravel habitats over mud. Clams

Mussel

and mussels are filter feeders. They draw water in and expel water out through paired siphons that usually protrude from the shells when the animals are relaxed.

The larvae of most Alaskan freshwater mussels are parasites on fish. As soon as the microscopic larva hatches, it swims through the water by clapping its shells together. If it finds a fish of its host species, it grabs hold.

The fish eventually forms a cyst around the tiny mussel, which feeds on the fish's body fluids until it is ready to drop off and become an adult.

Crustaceans

Fairy shrimp

Although they are not true shrimp (not even very closely related), fairy shrimp do look a bit like shrimp: they are somewhat flattened side-to-side, with many swimming legs and a bit of a curve to their backs. They're great swimmers—and they almost always swim on their backs as they filter algae from the water with specialized legs. Some feed on bacteria, small invertebrates, and crustacean eggs.

Fairy shrimp are adapted to live in ponds

Fairy Shrimp (Photo by Tom Murray)

and wetlands that dry up during certain weather conditions or at certain times of year. Their eggs can survive long periods of drought, then hatch out when their pond is full of water again.

Tadpole Shrimp

These little crustaceans, with their broad, rounded protective "shields," look a bit like miniature horseshoe crabs or trilobite fossils. They have large compound eyes—sometimes three of them. Tadpole shrimp are related to fairy shrimp, and like fairy shrimp they are adapted to temporary ponds, and their eggs can survive freezing and long droughts.

Tadpole shrimp cruise along by beating their dozens of legs. Some eat detritus and algae; others bulldoze their way through sediments in search of aquatic insects, eggs, fairy shrimp, and other prey.

Amphipods

Amphipods look a bit like fairy shrimp, but they are in a completely different order of crustaceans. They do not have distinct heads as fairy shrimp do, they're much more flattened,

Amphipod

and they swim on their sides or right side up, rather than upside down. At rest or when threatened, they head for cover and curl tightly.

Amphipods are abundant in many Alaskan water bodies: lakes, streams and ponds. Some types are very tolerant of going from salt to fresh water, so they can be found by the hundreds in the intertidal areas of streams.

Both amphipods and fairy shrimp are important food for fish, birds, and predatory aquatic insects.

Isopods

Aquatic isopods are closely related to terrestrial "pillbugs." Like pillbugs, they are somewhat flattened top to bottom, and have hard shells made up of a number of plate-like segments. Unlike amphipods and fairy shrimp, which they resemble, aquatic isopods do not swim—rather, they crawl around using their many-clawed legs.

Isopod

Cladocerans

Sometimes called "water fleas," cladocerans are common in the open waters of ponds and lakes. They're oval or bean-shaped, almost transparent, and enclosed in a tough outer carapace. Their nickname comes not from their shape but from their swimming style: they stroke the water with their long antennae,

Water Flea with eggs

causing them to jerk upward, then drift down, then jerk up again—making it look as if they are hopping through the water.

Cladocerans eat microscopic algae and bits of detritus, which they filter from the water with their legs. Like other tiny freshwater crustaceans, they are very important food for many other aquatic organisms, including tiny fish, insects, and even carnivorous plants such as bladderwort. Survival of young sockeye salmon in their nursery lakes is closely linked to the abundance of water fleas and other zooplankton. Like copepods, cladocerans are sometimes so abundant that a few liters of water can contain thousands of them.

Ostracods

Encased in paired shells, ostracods or "seed shrimp" look a bit like tiny clams, but they are crustaceans, not mollusks. Although they are not particularly strong or fast swimmers,

they're much more mobile than clams: they swim using their long antennae and swimming appendages, which can be pulled back into the shells when danger threatens. They can't crawl or grip hard, so they're mostly restricted to the still waters of ponds and lakes, and the spaces between stream sediments.

Ostracod (photo by Tom Murray)

Copepods

With their sideways-pointing antennae that look like the horns on a long-horned steer, a single eye, and a short, stiff tail, copepods are fairly easy to recognize. The females of many types common in Alaska carry their eggs in two large pouches, one on each side of the abdomen, making them even more unmistakable. Although hard to find with the naked eye, the tiny objects racing at lightning speed across a sample pan are likely to be copepods.

Copepod

Copepods live in a variety of aquatic habitats, from the still, open waters of lakes and ponds to the sediments of fast-flowing streams to temporary pools and wetlands.

Some even live in wet soils and on the gills of fishes as parasites. Their diets are equally diverse and include algae, detritus, bacteria, protozoans, other crustaceans, and various fly larvae. During a copepod "bloom" there can be thousands of them darting around in a pond—a feast for dragonfly larvae, predaceous beetles, and fish.

Arachnids

Aquatic mites

Closely related to spiders, aquatic mites are commonly captured in stream, pond, and lake samples. Their heads, thoraces, and abdomens are fused together into rounded bodies. Many water mites are so small that you can't see their eight busily-paddling legs, so they seem to glide through the water with no visible means of propulsion. Others dwell on the surface supported by water tension and transported around by breezes.

Mite

Like their spider kin, aquatic mites are carnivorous. They attack and kill tiny organisms, or suck the blood or body fluids of

insects or fish. Larval mites parasitize dragonfly and damselfly larvae. Not wanting to be left behind during emergence, the mites crawl from the abandoned larval skin onto the adult dragonfly, where they take up residence under the abdomen and continue their parasitic ways.

Aquatic and semi-aquatic spiders

Although most familiar spiders are land dwellers, some do make their way into the water, either temporarily or as a way of life. Fishing spiders feel for ripples in the water surface, a signal to pounce, and sometimes dive underwater to catch invertebrates or tiny fish.

Long-jawed Orb-weavers weave horizontal webs just over the water surface, capturing aquatic insects

Fishing Spider

Long-jawed Orb-weaver

Hexapods (non-insect)

Springtails

Springtails are tiny, insect-like invertebrates—but despite the fact that they have six legs, they are not considered insects. They're often found around the edges of ponds, slow-moving streams, and in wetlands. They are soft-bodied, sometimes hairy, and range in color from dark gray to yellow to bright red. They eat detritus and tiny organisms.

Springtails

Springtails are rarely seen underwater—but like water striders, they often make use of the water surface. If you see one in your sample pan, look quickly, because it could leap away and vanish at any moment! A springtail has a tail-like appendage called a *furcula*, held under

Springtail

tension below its abdomen. When released, the furcula snaps outward, propelling the tiny animal into the air. The remarkable power of surface tension allows the bug to make this seemingly impossible leap.

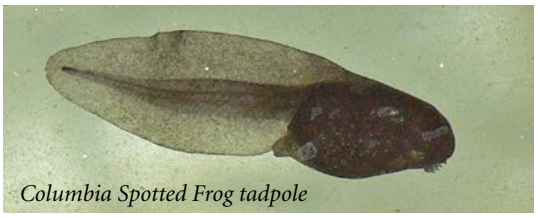
Amphibians

Frogs and toads

Frogs, toads, salamanders, and newts are only locally common in Alaska—there are large parts of the state that don't have them. Where they do occur, they need very still water to breed, so you'll find them only in ponds, lakes, and very slow moving streams. But if you are in the vicinity of a breeding pond, you might see hundreds of amphibians.

Wood Frog tadpole

When you're studying aquatic insects, the amphibians you're most likely to encounter are the newly hatched young, called tadpoles or larvae. These tiny amphibians are completely aquatic: they swim well with strong tails, and have gills. Gradually, their bodies change to be more suited to moving about on land, and eventually they come ashore.



Columbia Spotted Frog tadpole

Frog and toad tadpoles are mostly herbivores, nibbling on algae and detritus. Newt and salamander larvae are predators: they'll eat aquatic insects and other invertebrates, tiny fish, fish eggs, and even each other.

Alaska has six species of native amphibians: wood frogs, Columbia spotted frogs, western toads, long-toed salamanders, northwestern salamanders, and rough-skinned newts. Pacific tree frogs and red-legged frogs have been introduced to a couple of sites in Southeast Alaska.

Fish

Salmonids

Salmon, trout, grayling, whitefish and char are *salmonids,* or members of the family Salmonidae. These handsome, hardy fish are abundant throughout Alaska, anywhere there is cold, well- oxygenated water. Juvenile salmonids (and many adults) depend heavily on aquatic insects for food.

If you capture free-swimming juvenile salmonids (called *fry*) in your collecting pan, you can recognize them by the distinctive rounded adipose fins just in front of their tailfin. Many species have stripes or spots on their sides.

When they're very young, salmon can be harder to identify. Shortly after they hatch,

Coho Salmon fry

they hunker down in the stream gravels for several weeks, each fish with a bulging yolk sac attached to its belly. The yolk sacs nourish them until they have grown enough to swim on their own.

Sticklebacks

Sticklebacks are small fish of ponds, ditches, creeks, and lakes. They have a distinctive dragonish look, with armor plating, angular heads, and sharp spines on their backs. Alaska's

freshwater sticklebacks are usually dull greenish-brown in color, but when breeding, males develop bright red bellies and green or blue eyes.

Male sticklebacks are conscientious parents: they build nests, attract females, then carefully tend the eggs by guarding them and fanning water across them to keep them oxygenated. After the eggs hatch, the male continues to guard his offspring until they are big enough to fend for themselves.

Threespine Stickleback, just hatched

Sculpins

Sculpins of many different sizes are abundant throughout Alaska's waters. They're often found among the gravels of fast-moving streams. Some move between fresh water and salt water.

Sculpins have distinctive large heads, large, rounded pectoral fins (side fins), and slightly flattened bellies. They're usually very well camouflaged. In a collecting pan, the tadpole-shaped fish that hang out on the bottom and scuttle under cover when it's available are likely to be sculpins.

Sculpins are voracious predators of aquatic invertebrates and other prey, and many types feed primarily at night.

"Microscopics"

If you happen to have a microscope to study your stream or pond sample, you'll probably find many other fascinating aquatic organisms. Some possibilities are amoebas, paramecia, and rotifers. Wet, mossy areas might yield tardigrades—strange, microscopic beasties known as "water bears."

Coastrange Sculpin

Bob's favorite photographs

Taking photographs of aquatic insects has been one of my most challenging endeavors in 50-plus years of photographing nature in Alaska. Many of these insects are quite tiny, and they spend most of their time in an aquarium attempting to hide. If they are out and about and see you approaching they usually run or dart to a corner of the tank where photography is impossible.

Probably the two most important aspects of getting a good aquatic insect photograph are patience and luck. Here are three of my favorite photographs and the stories behind them.

Male Mosquito from page 66

Trying to get a photograph of a recently emerged adult Mosquito was a real challenge. One autumn I captured several Mosquito larvae from a water-filled old tire in the back yard and raised them in a small aquarium in the house. I filled the aquarium with water to the top so I would not have to photograph through glass.

The Mosquitoes emerged from their pupal skins in about five minutes and flew away. In addition, they emerged at night, often quite late. For three nights I would periodically examine the aquarium to see if any were emerging. Usually I would see only empty pupal skins and no adults. Finally on the third night around midnight I saw one Mosquito starting to emerge. I had the photo gear in place and was able to get this photo of a male Mosquito just before it flew off.

Fortunately, the Mosquitoes I was raising were a species nicknamed "snow mosquitoes." The females overwinter as adults and do not seek a blood meal until the spring. I have not seen them in the house, but come spring…

Phantom Midge photo from page 57, top photo

I spent close to three hours attempting to get a photograph of this Phantom Midge larva. Whenever I would make the slightest movement the insect would dart into a corner of the aquarium and hide. I almost felt as if I was bonding with it and that it had a real personality as it would always stare at me. Finally it seemed to accept my presence and posed perfectly. As you can see, however, it still kept an eye on me.

Water Boatman photo from page 111, bottom photo

When you put different types of aquatic insects in an aquarium they often go about their normal predator/prey behavior. In this case a Water Boatman attacked and started to suck the juices from a Mosquito larva. This is an example of just plain luck. I happened to be sitting next to the aquarium when that event occurred.

Finding, collecting and photographing aquatic insects

Where to look

Aquatic insects can be found almost anywhere there is water—in rivers, streams, lakes, ponds, and even drainage ditches and mud puddles. Even seemingly inhospitable places such as crashing waterfalls and murky glacial rivers harbor aquatic insects. Since most fish love to eat them, the greatest number of insects may be in fishless streams and ponds. However, anywhere there is water should be considered fair game.

In any given type of water body the greatest diversity of insects will be found by searching a variety of habitats. Some insects like to live within the spaces among gravels, while others may prefer the surface of large rocks. Some live in mud and other fine sediment. Others live in decaying leaves or on live vegetation. Fast-flowing rivers and streams are preferred by some while others like slower moving streams and still water.

Ethics

When collecting aquatic insects to look at, bring home, or photograph, there are certain ethical and legal considerations. First you need a Fish Resource Permit for Scientific/ Educational Purposes from the Alaska Department of Fish and Game. This free permit can be obtained from their website. It stipulates that any invertebrate organism, except freshwater mollusks, with one or more life stages living in fresh water may be captured, collected, and possessed. It further stipulates that all freshwater invertebrates collected must be either released unharmed at the site of capture, or killed and retained for voucher collections, or retained live in permitted aquaria.

One ethical and perhaps legal consideration would be to not disturb areas where fish have spawned. Digging in the gravel may kill incubating fish eggs or young. Also, you should avoid disturbing large areas of any individual stream or pond. You should sample only a small portion of habitat and then move on to another area or water body.

In general, most insects found in streams and rivers require well-oxygenated cool water. These insects will usually not survive in warm, poorly-oxygenated water. Unless you can transport them in portable coolers and can cool and recirculate water in an aquarium, it's best to just look at them at or near the collecting site and release them as soon as possible.

On the other hand, many pond-dwelling insects will survive in an aquarium and can be a delight to watch and rear. Some, such as water beetles and Mosquitoes, obtain their oxygen from above the water surface and do not need special aeration or cooling to keep them alive.

Equipment

Nets and other gear for capturing, examining and sorting aquatic insects can be purchased from scientific supply houses (see page 135). Try to keep equipment simple, packable and light. We like to use sturdy D-shaped nets for capturing insects in streams and ponds. For examining insects, shallow white plastic pans work best. Many naturalists

In streams a good way to capture aquatic insects is to place a net firmly against the stream substrate and then disturb the area upstream from the net with your feet or hands. The dislodged insects are then swept into the net by the water current.

Once the insects are collected in the net they can be transferred to a white plastic pan for sorting and identification.

also bring ice cube trays for sorting their catch. Other useful items include fine-pointed tweezers, eye droppers, and a 10-20x hand lens.

For capturing adult insects, we like nets with about an 18-inch diameter opening and a six-foot-long handle. The collapsible nets and handles sold by various scientific supply houses are easy to pack around and use.

Some adult insects, especially dragonflies, can be put into plastic bags and inserted into a portable cooler with an ice pack. Once cooled down the insects can be "posed" for photography and examination. After a fairly short time they will warm up and fly away.

A low-tech method of capturing aquatic insects is to look on the undersides of stones, on the surface of wood debris, and in packs of dead leaves. Although usually well camouflaged, the insects can be spotted when they move about. Use tweezers or an eyedropper to gently pick them up and place them in a small container of water for examination.

Collecting techniques

In streams, a good way to capture aquatic insects is to place the D-net firmly against the stream substrate and then disturb the area upstream from the net with your feet or hands. The dislodged insects are then swept into the net by the water current. Since some stream insects can cling very tightly, you may want to spend some time "petting the cobbles" (rubbing the rocks thoroughly with your hands) as well as shuffling through the sediments. We've even used a stiff-bristle brush to dislodge super-clingers such as Net-winged Midges.

Stream insects that avoid fast-moving water can be captured with a net, too. Plunge the net underneath an overhanging bank, or sweep it over a pile of debris in a pool, using a brief back-and-forth motion to stir up the sediments, then sweep the net through.

Capturing adult insects can be challenging and fun. This group of youngsters and adults were capturing and identifying dragonflies at the 2010 Dragonfly Day at Nikiski in Southcentral Alaska.

Would you believe there are several aquatic insects on the under side of this rock?

In ponds you can bring insects into the net by plunging it towards the bottom and raising it quickly to create an upwelling. Pulling the net through aquatic vegetation at the pond edges will capture insects lurking among the stems and leaves.

Photography equipment

Photographing tiny aquatic insects can be very challenging. The equipment used for the photos in this book is fairly inexpensive and easy to use. We recommend the "prosumer" type cameras without interchangeable lenses. These cameras have a much greater depth-of-field than Digital Single Lens Reflex (DSLR) cameras. At high magnification a lot of depth is needed to bring the entire insect into focus. We have successfully used the Panasonic DMC-FZ30, FZ50 and FZ100 models. These cameras accept a special lens, and have a hot shoe to accept an external electronic flash. All focusing, and f-stop/shutter speed selections, are done in the manual mode.

The special lens is called a Raynox DCR achromatic close-up lens. It attaches to the end of the camera lens. Both the DCR-250 and the DCR-150 are useful for small-insect photography, and they are relatively inexpensive. With these lenses you can use the zoom on your camera and at full extension can usually full-frame a Mosquito from about 4 inches away.

For illumination we use an electronic flash attached to the hot shoe of the camera and bounce the light off white cardboard or plastic attached to the flash. We like the LumiQuest Pocket Bouncer for its durability and packability.

For best results choose an electronic flash that has a power ratio-control. Most "prosumer" type cameras can flashsync at any shutter speed and f-stop. We usually use the highest f-stop the camera offers (usually f-8 or f-11) and adjust the power ratio-control on the flash until the insect is well illuminated.

For precise focusing, especially needed on very tiny subjects, we recommend using a Velbon Super Mag Slider. This allows you to make fine adjustments forward, backward, and sideways as your subject moves about.

Using a small portable table makes it easier to look at and sort aquatic insects in the field.

However, with practice you can make fine adjustments by resting the camera on a table and slowly moving it about.

Field photography

You can bring a small aquarium into the field and photograph insects on the spot though this can be somewhat difficult as the glass may fog over and bubbles may form in the water. Having a small table to set everything on makes it easier.

Photographing insects that are inside an aquarium can be difficult as they like to hide in the corners. A simple technique for photographing insects from above is to use a plastic plate with gradually sloping sides, in which the insects are always out in the open. You can paint the plate to simulate natural background colors. Mounting your camera on a tripod directly over the insect works the best. Avoid photographing insects in water from an angle, because refraction often distorts the subject.

Photographing adult insects without capturing them is fairly easy with many of the current models of digital cameras and lenses. Telephoto lenses that will focus fairly close are best for not disturbing the insect. For example, the Nikon AF-S Nikkor 28-300mm lens will focus about 18 inches away from the subject. The Panasonic DMC-FZ100 will focus at around three feet at the full lens extension of 600mm (35mm equivalent).

One trick for finding and photographing some adult aquatic insects is to visit bridges over streams. After emerging from the stream the adults often rest on the bridge railings, abutments, and underside of the decking before flying off. If you move slowly and do not allow your shadow to fall across them, the insects may be easy to approach and photograph. Also, in late winter and early spring, you can usually find adult stoneflies crawling over the snow near streams. In

The basic equipment used to photograph the larval stages of aquatic insects consisted of (left to right): Raynox DCR-250 close-up lens, Velbon Super Mag Slider, Sunpak 333 electronic flash, LumiQuest Pocket Bouncer.

This shows a basic setup that we used for photographing insects under water.

Southeast Alaska we've seen adult Crane Flies all winter long.

Home photography

Setting up your equipment under somewhat controlled conditions at home can provide the most natural-looking scenes. Some insects like to crawl on vegetation or sit on top of rocks, so placing these in the aquarium can provide natural settings to your photos. Placing a natural object or objects (such as rocks or vegetation) behind the aquarium helps provide a more natural looking background.

Air bubbles suspended in the water result in poor quality photographs. One trick to remove bubbles is to submerge a small submersible pump such as the Mini-Jet 404 in a five gallon bucket, pump the water up through a plastic tube, and let it fall back into the bucket. For some reason, water that has been recirculated in a bucket for a while contains no air bubbles. Do not use any water that has been chlorinated. If you can't use natural stream or pond water, make sure to plan ahead and remove the chlorine from your tap water by leaving it out for at least 24 hours, or by using a dechlorination solution (available from pet supply stores).

For the best results when taking photographs through glass and water, try to keep the camera lens at the same level and perpendicular to the insect. If you try to photograph the insects at an angle, the results are usually distorted because of refraction. We used the smallest and cheapest glass aquariums we could find.

One technique that works well for photographing emerging insects is to fill the aquarium with water right to the top. Then as the insect emerges from the water you can position the camera so that you are not shooting through glass or water. By hanging or draping a colored shirt about a foot back from the aquarium you can add color to the water surface. The electronic flash bouncing off the shirt adds the color. A blue sweater was used to create this effect for the photos of an emerging Mosquito on page 17.

The techniques we described above were the ones we found the most efficient and easiest to use. It can be fun and rewarding to set up special habitat aquaria for photographing aquatic insects. Try one with a cooling system and flowing water for stream insects, and another with still water and natural vegetation for pond insects.

Glossary

Abdomen – the third main body part of an insect; connected to the thorax

Adult – the breeding stage of an insect's metamorphosis; adults usually have wings and six legs

Arthropod – an invertebrate with an exoskeleton, segmented body, and jointed appendages

Biofilm – a community of microscopic organisms (e.g. fungi, bacteria, algae) living on the surface of rocks, wood, or plants

Boundary layer – a zone of reduced water velocity near the surface of rocks and other fixed objects in streams

Collectors-filterers – insects that collect small particles or organic matter suspended in the water for food using silk nets or specialized body parts

Collectors-gatherers – insects that feed on fine particles of organic matter that accumulate on the bottom of lakes and streams

Compound eye – an eye comprised of many (often thousands) of light-sensitive lenses

Detritus – dead organic matter

Diatom – a type of algae encased in a cell wall made of silica (silicon dioxide)

Drift – insects and other invertebrates that temporarily enter the water column to be transported downstream in the current

Emergence – the shedding of the larval or pupal skin to reveal the adult or (in the case of mayflies) the subimago

Exoskeleton – the rigid external skeleton that protects insects and certain other invertebrates

Insect – a class of animals in the phylum Arthropoda possessing three body parts (head, thorax, abdomen), compound eyes, two antennae, and three pairs of jointed legs

Larva—the immature form of an insect that hatches from an egg

Labium – the lower "lip" of an insect

Metamorphosis – the transformation of an insect from larva into adult

Molting – the process of shedding the exoskeleton to replace it with a new one

Omnivore – an animal that eats both plants and animals

Ovipositor – an organ used to lay eggs

Parasitoid – an organism that lives inside or on another organism (the host) and that eventually kills the host, sometimes by consuming it

Piercer-herbivores – insects that use piercing mouthparts to feed on the fluids inside plant cells

Piercer-predators – predators that use piercing mouthparts to feed on the body fluids of their prey

Plastron – a thin bubble of air (physical gill) trapped against the body by a dense pad of stiff hydrophobic (water repellent) hairs; dissolved oxygen in the surrounding water diffuses into the bubble and then passes into the insect body through spiracles, allowing air-breathing insects to breathe underwater

Proboscis – a tube-shaped mouthpart used for piercing and/or sucking

Proleg – a small fleshy leg, lacking joints, found on some larval insects

Pupa – in complete metamorphosis, the life stage of an insect between larva and adult; in most insects, the pupa is not active

Scrapers – insects that graze on a thin layer of biofilm growing on the surface of rocks, plants, or wood

Sclerites – the rigid, plate-like parts of an insect exoskeleton

Shredders –insects that chew live plant tissue or decaying fragments of dead leaves and twigs; shredders that consume decaying organic matter gain nourishment from microbial decomposers (e.g. fungi and bacteria)

Spiracles – openings in the exoskeleton of insects that permit air exchange with internal tissues

Tannins – dissolved organic matter that can turn some water bodies the color of tea

Thorax – the middle body part of an insect, located between the head and abdomen, and usually having legs and/or wings attached

Zooplankton – tiny invertebrates that live in the open water of lakes, ponds, and large rivers

Further sources of information and supplies

Adams, Jeff; Mace Vaughan; Scott Hoffman Black. 2004. *Stream Bugs as Biomonitors: A Guide to Pacific Northwest Macroinvertebrate Monitoring and Identification* (compact disc). The Xerces Society.

This CD-ROM includes detailed identification guides and descriptions of nearly 500 Pacific Northwest macroinvertebrates. Also available is a companion field guide with images and brief discussions of the 56 groups (mostly families) of macroinvertebrates that are likely to be encountered in the riffles of wadeable Northwest streams.

Armstrong, R.H.; J. Hudson; M. Hermans. 2007. *Dragons in the Ponds.* Published by Nature Alaska Images. 32 p.

This would be an excellent book to help children learn about dragonflies. It covers all of the families that occur in North America and their biology and identification. The anatomy and life history of dragonflies is shown in easy to understand photographs as well as narrative.

Collet, Dominique M. 2008. *Insects of South-central Alaska.* Kenai Watershed Forum. 192 p.

Although this book covers the common insects of South-central Alaska it includes good information on many aquatics. It covers collecting and preserving insects, general insect biology and classification and identification. Much of the information presented would apply throughout Alaska.

Eiseman, C. and N. Charney. 2010. *Tracks & Sign of Insects and Other Invertebrates, A Guide to North American Species.* Stackpole Books. 582 p.

This book is a great source for information not available in other books. For several aquatic insects it covers their eggs, webs, shelters, burrows, tracks and predators.

Hocker, Katherine and Richard Carstensen. *Discovery Guide to Streamwalking—common plants and animals of Southeast Alaskan streams and ponds.* Discovery Southeast.

This laminated "pocket guide" includes illustrations of common stream invertebrates, small fish, and amphibians, as well as a big-picture view of stream habitats.

Hudson, J. and R.H. Armstrong. 2010. *Dragonflies of Alaska* (second edition). Published by Nature Alaska Images. 56 p.

This book covers the identification of all 35 species of dragonflies found in Alaska. It also discusses and shows photographs of most of the common aspects of dragonfly behavior that you can easily observe.

Jepsen, Sarina; Jeff Adams; Lisa Schonberg; Erika Arnold; Celeste Mazzacano; Scott Hoffman Black. *Aquatic Invertebrates in Pacific Northwest Freshwater Wetlands: An Identification Guide and Educational Resource.* The Xerces Society.

This CD-ROM includes a key to family for the aquatic invertebrates in Pacific Northwest freshwater wetlands. It also contains information on wetland bioassessment, collecting and preserving wetland invertebrates and wetland conservation.

Linsenmaier, W. 1972. *Insects of the World.* McGraw-Hill Book Company. 392 p.

This has been a good source of information on the many remarkable adaptations and behavior of insects. Excellent drawings help illustrate these adaptations and behavior. The book is probably out-of-print but should be available through the library system.

McCafferty, Patrick. 1998. *Aquatic Entomology.* Jones and Bartlett Publishers. 448 p.

Aquatic Entomology is a must-have for anyone interested in the subject. It presents life history and identification to families of aquatic insects in an easy to understand format.

Merritt, R.W.; K.W. Cummins; M.B. Berg. 2008. *An Introduction to the Aquatic Insects of North America.* Kendall Hunt publishing Company. 1158 p.

This is a must-have book for the more serious entomologist. It is very technical and covers identification to the genus level. Much of the life history information can be understood with the aid of a glossary of terms.

Thompson, Gerald; Jennifer Coldrey; George Bernard. 1984. *The Pond.* Oxford Scientific Films Ltd. Massachusetts Institute of Technology, Cambridge, Massachusetts. 256 p.

Although much of the information is from Britain this book covers the insects and other creatures that you are apt to run across in ponds. It is written in an easy to understand manner with excellent photographs and drawings. We have been able to obtain it through the library system.

Thorp, James; D. Christopher Rogers. 2011. *A Field Guide to Freshwater Invertebrates of North America.* Academic Press. 274 p.

In addition to providing taxonomic keys and color photographs of all major aquatic macroinvertebrate groups, this guide provides a wealth of basic information about aquatic habitats, macroinvertebrate ecology and physiology, and identification and collecting techniques.

Scientific supply houses.

BioQuip Products, 2321 Gladwick Street, Rancho Dominguez, CA 90220, USA; telephone: (310) 667-8800; Fax: (310) 667-8808; www.bioquip.com

Carolina Biological Supply Company, PO Box 6010, Burlington, NC 27216-6010; telephone: 800.334.5551; www.carolina.com

Fisher Scientific; www.fishersci.com

Sargent Welch, P.O. Box 4130, Buffalo, NY 14217; telephone: (800) 727-4368; www.sargentwelch.com

Index to aquatic insects orders and families

Discover

- **How aquatic insects feed, grow, and survive the elements; and how they fit into Alaska's ecosystem.**
- **The various orders, and families, of aquatic insects in Alaska.**
- **The "other aquatics"—organisms that are not insects, but that you might encounter while looking for aquatic insects.**
- **How to find, catch, observe, and photograph aquatic insects.**

John Hudson is a fish biologist, aquatic entomologist, and co-author of *Dragonflies of Alaska*. He has conducted research in freshwater ecology and has studied aquatic insects throughout Alaska since 1994.

Katherine Hocker is a naturalist, writer, illustrator, and educator. She has been fascinated by aquatic insects since she caught her first caddisflies as a child.

Robert Armstrong is a biologist, writer, and photographer. He has authored or coauthored several books on the natural history of Alaska.

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