

Dragonflies: Four Wings, Will Travel

An Introduction to the Natural History of North America's Migratory Dragonflies



Photo: © Dennis Paulson.

A tandem pair of Common Green Darners (*Anax junius*) laying eggs. The male (left) grasps the female (right) behind her eyes, guarding her as she oviposits.

Dragonflies are among the most easily recognized insects. Grouped in the order Odonata, a name that refers to their toothed jaws, they are dashing predators and aerial acrobats. Dragonflies are also strong fliers, and many species are known to migrate hundreds to thousands of miles, with some flying 90 miles in a day.

Although they are excellent fliers, dragonflies are truly aquatic insects, inhabiting wetlands, ponds, and streams as immatures. All but one North American species breed in fresh water. We mainly notice adults in flight, but their young live in freshwater wetlands.

Natural History

Development

To understand dragonflies, you must first know their larvae. Also called nymphs or naiads, these animals look nothing like the colorful aerial insects to which they give rise. Their bodies are sleek and streamlined to slide through vegetation, or flattened to allow them to lurk in mud. Their abdomen

is often tipped with three short stout spines, which surround a rectal gill chamber used to obtain oxygen from the water. They are voracious predators, with a remarkable hinged, toothed lower lip that shoots out at high speed to snatch prey, enabling them to feed on invertebrates, tadpoles and even small fish!



The Migratory Dragonfly Partnership uses research, citizen science, education, and outreach to understand North American dragonfly migration and promote conservation.

The Migratory Dragonfly Partnership steering committee members represent a range of organizations, including:

Conservation International
Ontario Ministry of Natural Resources
Peggy Notebaert Nature Museum
Pronatura Veracruz
Rutgers University
Slater Museum of Natural History,
University of Puget Sound
Smithsonian Conservation Biology
Institute
Texas Natural Science Center, University of Texas at Austin
U.S. Forest Service International Programs
U.S. Geological Survey
Vermont Center for Ecostudies
The Xerces Society for Invertebrate Conservation

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Depending on the species, dragonfly nymphs develop in the water for a month to several years, molting a dozen times as they grow. Dragonflies have simple metamorphosis, with



Photo: © John C. Abbott/Abbott Nature Photography.

Nymph of Black Saddlebags (*Tramea lacerata*). Adults of this species are highly migratory.

Behavior

Flight

Dragonflies are classified as perchers or fliers. Perchers, such as most skimmers and clubtails, hold their abdomen horizontally when at rest. They are alert, move their heads frequently to look around, and may fly up suddenly to capture prey or chase another dragonfly. Fliers, including darners, emeralds, and some skimmers, fly back and forth while feeding or searching for mates and hang under branches with the abdomen closer to vertical when resting. They do not watch for prey or mates when perched, but are alert enough to escape a stalking predator or photographer!



Photo: © John C. Abbott/Abbott Nature Photography.

Head of Common Green Darner (*Anax junius*).

the adult insect developing within the last larval stage. The nymph then stops feeding and comes to the surface to breathe air, signaling its readiness to leave the water and begin the next phase of its life.

The nymph crawls up on the shore or a convenient stem or leaf, splits its skin, and emerges as an adult within a few hours. The new adult looks quite ruffled until the wings expand and the body hardens. With many dragonflies, emergence occurs at night, but some of them emerge during daylight hours, when this amazing phenomenon can be easily seen.

The newly emerged adult, called a teneral, launches into its first flight and moves away from the water to finish maturing. The teneral has shiny wings, weak flight, and hardly any pigment. Its first flight may take it a long distance from the water, where it quickly develops a definitive color pattern (though still not its mature coloration). The insect may stay in a sexually immature stage for a few days to several months while away from the water. During the maturation period, adults concentrate on feeding.

Dragonflies are the most accomplished insect fliers. Their wings are surprisingly complex and perfectly structured for their complicated flight maneuvers. Not only does each pair of wings work independently of the others, but so does each wing. Dragonflies can fly swiftly at about the same speed as small songbirds (30 miles per hour), stop suddenly and hover, make instantaneous right-angle turns, shoot straight up in the air and even back up for a short distance.

Eyes

Dragonfly vision is the best in the insect world. The large eyes provide a wide visual field that allows the insect to see in all directions except directly behind the head. Each compound eye consists of up to 28,000 simple eyes (ommatidia) that give a mosaic view, which is especially good at detecting movement. Nerves from each simple eye are stimulated sequentially as an object moves across the visual field. The dragonfly's tiny brain calculates where a flying insect is headed and "leads" it to intercept at a predetermined point.

Temperature Regulation

Dragonflies lack internal temperature control; their body temperature is controlled by air temperature. On a cool morning, a dragonfly may rest perpendicular to the sun's rays to warm up, often perching on a pale surface that reflects sunlight onto its body. Fliers whirr their wings to warm up their thorax enough to help them lift into flight and warm themselves still more. To avoid overheating, fliers seek shade when their body temperature reaches a critical point. Perchers either point their

abdomen up at the sun (obelisking) at midday or hang it down below them to avoid overheating.

Eating and Being Eaten

Dragonflies capture their prey in the air. Some fly like a swallow and pick insects out of the air, while others watch from a perch like a flycatcher and take off after insects flying by. They hold their spiny legs out like basket to scoop up the insects they capture.

Despite being predators, dragonfly adults and nymphs can fall victim to a variety of animals. Birds eat dragonflies in great numbers, especially during breeding season when they can feed their young on tender teneral. Bats eat them at dusk, frogs and fish jump out of the water after adults, spiders catch them in webs or hunt them down, lizards and robber flies stalk them in the uplands, and dragonflies hunt and kill each other. Fish are such active predators on nymphs that some dragonfly species breed only in fishless ponds.

Reproduction

All dragonflies must return to the water to breed. Males spend long periods at the water searching for potential mates--females carrying mature eggs that need to be fertilized. Females of most species lay eggs immediately after mating, often accompanied or guarded by the male.

Males of many species defend a fixed territory against other males of the same species. This provides them access to any female entering their territory, without interference from other males. Males likely defend territories in what females deem appropriate habitat, and we can use that information to infer where nymphs are likely to be found. Males of non-



Photo: © John C. Abbott/Abbott Nature Photography.

Nymph of Common Green Darner (*Anax junius*) with fish prey.

territorial species cruise around lake shores or up and down rivers actively searching for females. When they encounter another male of their species, there is a chase, but neither remains at that spot.

Dragonfly mating is a complex dance, and most dragonflies mate only a few times in their life. Before encountering a female, the male does something that sets him apart from all other insects--he transfers sperm from a pore near the tip of his abdomen to an organ (seminal vesicle) near the abdominal base, where it is stored for immediate use. When a male encounters a female, he attempts to clasp her head with the three appendages on the end of his abdomen, which act like forceps to get a firm grip behind her eyes. If the female is ready to mate, she swings her abdomen up to the base of the male's, and structures there lock the tip of her abdomen in position for copulation. The two individuals now form a circle, often called the wheel position.

Copulation lasts from a few seconds in flight up to several hours at rest. In some dragonflies, the wheel position breaks but the male still grasps the female behind the eyes and they set off in tandem to lay eggs. In many species, the male releases the female but accompanies her to prevent others from mating with her. In other species, the female goes on her solitary way to lay eggs.

Dragonflies deposit their eggs using a variety of techniques. In some species, the female uses her well-developed ovipositor to inject eggs into plant tissue. Other females drop their eggs in or near water; females of some species tap their abdomens repeatedly on the water to lay eggs produced in a ball at the tip, while those of other species lay eggs on dry land in seasonal wetlands that flood later.

One female can lay thousands of eggs, scattering them over a wide area to increase the likelihood of survival of both eggs and young. The cycle begins again as the egg hatches into a nymph that must go through the aquatic part of its life cycle before we see the adult dragonfly.



Photo: © Dennis Paulson.

Spot-winged Glider (*Pantala hymenaea*) may be seen migrating in Texas from midsummer to fall.

Migration

Only about 17 of the 326 dragonfly species in North America are considered regular migrants, and their flights can create one of nature's most impressive spectacles. Tens to hundreds of thousands of individuals have been seen streaming southward along coasts, lake shores, and mountain ridges in fall, but their origins and destinations are still poorly known.

Many fall migration episodes have been documented, but movement back north is rarely seen, presumably because it occurs over a wider front and longer time period. We know it happens because dragonflies appear early in spring in places where nymphs have not yet emerged.

The best-known migrant in North America is the Common Green Darner. This species appears in early spring at northern latitudes, often seen flying before any local dragonflies have emerged. These are migrants from the south, perhaps from Florida, the Caribbean or Mexico. These individuals breed soon after they arrive in spring, and their nymphs develop quickly in wetlands warmed by the summer sun. Many adults emerge in August, and instead of maturing and breeding at the same site, they begin a southward movement that may take over a month. Their destination is at present unknown but presumably the same areas thought to produce spring migrants. Migrating individuals may breed along the way or at their final destination; their offspring migrate north in spring.

Other species with a similar seasonal pattern include some strong-flying skimmer species: Wandering Glider, Spot-winged Glider, and Black Saddlebags. These also appear suddenly at high latitudes in spring or summer and breed in warm shallow wetlands. Flights of what are presumably their offspring are seen moving south at the same time as the larger darners. Additional species are suspected migrants in eastern

North America, but information to confirm this is sketchy.

Common Green Darners migrate in the West as well, but not in the numbers seen in the East. Instead, the Variegated Meadowhawk is the predominant migrant. They appear in the Northwest in spring, and their nymphs develop rapidly and emerge in early fall. Tremendous numbers of these small reddish or brown dragonflies have been reported moving south along Pacific Northwest coasts and mountain ranges.

Dragonflies are a fairly well-known group of insects, but there is much yet to be learned about their ecology and behavior and especially one of the most amazing phenomena of nature--their spectacular annual migrations.



Photo: © Dennis Paulson.

Variegated Meadowhawk (*Sympetrum corruptum*).



Photo: © John C. Abbott/Abbott Nature Photography.

Black Saddlebags (*Tramea lacerata*).



Photo: © Dennis Paulson.

Wandering Glider (*Pantala flavescens*).