

TEXAS PARKS AND WILDLIFE

INTRODUCTION TO

Dragonfly and Damselfly Watching

BY MARK KLYM AND MIKE QUINN



Cover illustration by Rob Fleming.

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INTRODUCTION

Background

Dragonflies and Damselflies are members of the insect order Odonata, derived from the Greek word *odonto* meaning tooth. They are insects meaning that they have three body regions — a head, a thorax to which their four wings and six legs are attached and an abdomen. They are characterized by two pairs of net-veined wings and large compound eyes. Their wings are not linked together, allowing each wing to operate independently of the others. Damselflies have narrowly rectangular heads and eyes separated by more than their own width while dragonfly eyes are never separated by more than their own width. Both are predators throughout their lives and valuable in destroying mosquitoes, gnats and other insects though they can become pests near beehives and may take other beneficial insects like butterflies. Some of the larger naiads, the nymph stage of odonates, can take game fish fry, though they themselves can become food for larger game fish.

Odonates are usually the most conspicuous insect group near any body of water, although migrating or non-breeding adults often travel great distances from water. They are found near ponds, lakes, rivers, streams, bogs, swamps and marshes. Most species are dependant on permanent freshwater for their development although some fast developing species can use temporary or seasonal pools and some species have been found in brackish conditions.

Three suborders of Odonata can be found in the world today. One, the Anisozygoptera is known only from two “living fossils,” found only in Asia. The dragonflies, suborder Anisoptera, and the damselflies, suborder Zygoptera, are both world-wide in distribution, absent only from the polar regions.

It is estimated that there are more than 435 species of odonates in North America north of Mexico with more being recorded each year. Approximately 212 species of odonates have been taken in Texas. The color and behavior of these beautiful creatures excites many people, both amateur and professional, to study them more. Their gossamer jeweled wings, and spectacular aerial displays are entrancing. Unlike butterflies

or birds however, the color of odonates does not preserve well after death. The only reliable way to preserve color is with a photograph.

North American damselfly diversity has been estimated at 128 species of which 70 have been found in Texas. Their forewings and hindwings are similar in shape, and when perching are held close together over their backs, or only partially spread. They are smaller and more slender than dragonflies, with compound eyes that are separated. These weak fliers stay low to the ground or near the water surface in and around vegetation, but may roost high in the canopy.

The flight of the dragonfly is impressive. They are masters of the air, able to maneuver in ways equaled by few other animals. Some dragonflies are quite easily approached by humans, often hovering within arms reach. When at rest, dragonflies hold their wings at right angles to the body.

While fossil dragonflies with 28.5 inch wingspans have been found, the largest known today have about a six-inch wingspan.

Although odonates have been part of human culture through art and folklore since at least 300 B.C., they remain relatively unknown. This very diverse group of insects is enjoying a growing popularity among nature enthusiasts. Their large size and wide distribution make them easy to observe while their beautiful colors, intriguing body design and incredible speed hold your attention. Odonates have been observed flying at speeds in excess of 20 miles per hour.

Their sensitivity to environmental change makes dragonflies and damselflies some of the most visible indicators of wetland health and diversity. Observing population changes allows us to monitor environmental changes. Look for these species in large, long established parks, forested watersheds, and larger streams near the entry of unpolluted tributaries. Their sudden absence may be an indication of environmental health changes in the immediate area or upstream.

The enormous upswing in popularity for these insects promises a challenging and educational pursuit as the hobby grows. The authors hope you enjoy this introduction to the wonderful hobby of dragonfly and damselfly watching.

Life Cycle and Natural History

As insects, the Odonata go through an amazing morphological change during their life cycle. Witnessing this metamorphosis is to observe one of the true wonders of our natural world. For a considerable part of their lives these organisms are totally aquatic, dependant on water for their survival. The remainder of their life is spent fully airborne and dependent on flight for survival. The transition is very impressive. This section is a brief introduction to this fascinating phenomenon.

Mating

Male odonates may patrol a territory ranging from one square yard to more than 100 square yards or they may cover a two-yard to 50-yard stretch of riverfront. The size and shape of these areas may vary between and within species and may reflect the density of males in an area or the habitat quality. Males actively chase other males and females while defending a territory. Male odonates have the ability to remove a rival male's sperm from the female in order to ensure their own sperm is available to fertilize the eggs.

Male and female dragonflies tend to couple in the air, sometimes with an initial impact that can be heard easily. These tandem pairs of dragonflies can occasionally be seen flying about. The mating formation is called a wheel and occurs when the female curls her abdomen forward to pick up the sperm from the male's second abdominal segment, while attached to the male. The male may assist this process by curling or moving his abdomen to allow easier access. The female may hold the male with her legs to relieve strain. Some dragonflies mate in the air; others mate while perched. Some pairs may be seen flying in tandem after mating, but this is more common in damselflies than in dragonflies.

Damselflies become paired more quietly, often coming together on a piece of vegetation. The pair may fly off in tandem looking for a place to mate, but they usually land for the mating process. For some species, mating time is very short, in others it may continue for hours.

Female odonates have the ability to store sperm for long periods of time without fertilizing eggs. Eggs are fertilized immediately before oviposition.

Egg Laying

Oviposition varies according to species and/or circumstance.

Sometimes the male will guard the female to ensure the eggs he fertilized are deposited. This may even extend to remaining in tandem through the egg laying process.

Egg laying with the male in tandem may be above the waterline, at the waterline or even below the waterline — sometimes so deep the male and female both plunge below the surface breathing air that is trapped in the fine hairs on their bodies. The eggs are deposited individually on suitable vegetation — from wood to reeds. If the eggs are deposited above the waterline, the newly emerged larvae may fall into the water, or the vegetation may become inundated with water by flood or by dropping that part of the limb once dead. Eggs may be deposited in the stream sediment by some species.

In many cases when the insects are not paired during oviposition, the female hovers over a suitable location descending occasionally to dip her abdomen in the water and wash off an egg. Some species scatter their eggs over the water from the air.

There have been occasions when females selected unsuitable surfaces to lay their eggs, including oil slicks, vehicles, etc.

Odonate's eggs vary in size, shape and color. Size and shape of the eggs is directly related to whether the eggs are deposited in plant material or not. Most eggs are less than one mm (0.04 inches) across and spherical or cylindrical. They may be yellow, orange, brown or green.

The time spent in the ova is species and temperature dependant, generally ranging from one to eight weeks. Some species overwinter as eggs in which case the development is suspended temporarily, continuing in the spring.

Naiads

Odonate larvae are called naiads. These aquatic predators feed on numerous aquatic insects including both mosquito larvae and other naiads, and even fish fry. In turn, they are prey for a wide variety of fish

and frogs, even being used by trout fishermen as bait. Naiads may serve as host species for certain aquatic mites and avian parasites.

Large by insect standards naiads measure $\frac{1}{4}$ inch – two inches in length. Cryptically colored, they often sit and wait for their prey though some will stalk. They detect prey by sight touch or vibration and their unique extendable lower lip is equipped with hooks, facilitating the capture.

Immature damselflies have three fin-like appendages on the end of a long slender body. These appendages, called lamellae, are a part of their respiratory system. Generally broader and more robust looking, immature dragonflies lack the lamella and rely on foliations in their rectal area for respiration. Dragonfly naiads have the ability to expel water from their rectum, providing a form of jet propulsion.

Naiads undergo as many as 17 molts, during this stage of life. After the final molt, cast exoskeletons or exuviae may be found clinging to wet-land vegetation or rocks. Some emerge in one to two months. In the final stages of their immature form, developing wings can often be seen through the casing. As they approach the adult stage, their wings begin to swell and the lower lip retreats making it difficult for this animal to eat during the last few days before molting. Many species move to the surface during this period and begin to breathe air.

Most species spend at least one winter as a naiad.

Emergence

Unlike the more familiar butterflies or moths, Odonata do not go through a pupal stage in their development. Instead, when the naiad is mature, it climbs out of the water onto a stable surface such as a twig, plant stem or rock. There the immature skin splits along a fissure on the back of the thorax and the adult insect emerges. Once emerged, the Odonate requires time, usually a couple of hours, to inflate its wings and harden the body.

The very difficult process of emergence takes the insect through a particularly vulnerable period. Weather conditions, including both wind and rain, can introduce foreign materials or pathogens to the soft body of the newly



emergent or teneral adult. The emerging adults may be dislodged from the surface they are on, fall into the water and drown or be eaten. Other naiads may climb over the tenerals in areas where suitable surfaces are scarce, damaging the recently emerged insects. While inflating their wings and hardening their exoskeleton, these insects are easy prey for hungry predators such as birds and ants.

The date and time of emergence can be species specific. For example, damselflies in general tend to emerge in the morning and fly in early afternoon. This timing may also be influenced by weather and environmental factors.

The maiden flight of an Odonate, usually in a direction that will take it away from the water, is a short uncoordinated hop. Their flight muscles are weak and the thorax has yet to harden. As their muscles develop, their flights become more orderly.

Maturation

The maturing odonates now spend some time away from the water maturing sexually. This period may last from days to weeks, depending on the species and environment. Tenerals tend to be pale yellowish or green in color. This color brightens as the insect hardens, and often results in an insect that appears brighter than older specimens of the same species. During this time, the insects' wings harden and the colors intensify.

This is another period of high mortality for the odonate. Like many insects, their poikilothermic nature results in a tendency to move to warm surfaces, a characteristic which can result in untimely death of the specimen.

Once mature, these insects return to the water to mate.

Adult

The diets of Odonata are diverse, consisting mainly of other insects including gnats, mosquitoes, black flies, house flies, deer flies and even other odonates. This makes them quite popular with humans, especially hikers who welcome the presence of a dragonfly when swarmed by mosquitoes. Competition for prey in a given area is reduced by selection for

size among the species. Petaltails and clubtails often eat larger prey, darners and spiketails select medium-sized prey while cruisers, emeralds and skimmers prefer smaller prey. Odonates generally take only moving prey, but will chew or eat almost anything put in their mouths when in captivity.

While some species are crepuscular (active at dusk), most are active during the day (diurnal).

Perchers tend to fly out, capture their prey and often return to the same perch while flyers may circle in a limited area while food is available, or cruise while feeding along the way. Odonates can quickly gather in swarms where food is abundant. Swarms are male only groupings. Not all dragonflies congregate in the presence of food. For example, Clubtails are not known to feed in swarms.

Odonates often change their posture relative to the angle of the sun in order to regulate their body temperature. For example, when cool they may position themselves so that large surfaces face the sun. They may adopt a more obelisk (tip of their tail pointing into the sun) posture when it is warm.

The life span of adults vary in length from a few weeks to several months. In damselflies these average three to four weeks while in dragonflies they average six to eight weeks. Most species average one generation per year, overwintering as an egg or naiad and emerging in the spring.

Perching Behaviors

Many skimmers fold their forelegs behind their heads and do not use them to hold a perch except in very windy conditions. Other skimmers like to rest the sides of one or more legs against a perch and not use the claws to hang on. This allows an unimpeded take off if threatened.



Different species perch and fly at different heights resulting in a somewhat partitioned airspace. This reduces competition for limited resources.

Thermoregulation

These insects are most active when temperatures are above 65 degrees Fahrenheit. Being poikilothermic creatures, odonates are dependant on environmental factors to regulate their body temperature. Because of this, the same dragonfly may perch in the open on the river bank in the early morning, perch on sticks in partial shade during the late morning, and perch in the shade during the heat of the afternoon. This allows them to use energy from the sun or the shade of the plants as they need it. Basking and seeking shade are the two common methods of thermoregulation.

Varying color patterns can also aid in thermoregulation. In cool situations, darker colors move to the surface allowing more heat absorption from the sun. In warmer situations lighter color patterns help cool the insect. This transition is often the result of pigments migrating deeper into the exoskeleton. This is especially common in dragonflies with blue or red markings.

Some odonates have noticeably hairy thoracic segments creating an insulating effect.

Finding Odonates

When searching for dragonflies or damselflies, look for as many different aquatic habitats as possible. Check each available microhabitat. The downwind side of a pond may be particularly good on a windy day, especially for finding mating pairs!

Look for rarer stream species in large, long established parks, forested watersheds and larger streams near the entry of unpolluted waterways. These areas of limited disturbance provide optimum nurseries for stream species without impacts of siltation and runoff (see conservation section).

Slowly walking fields near suitable aquatic habitat can be particularly productive. If fence rows and forest edges, where habitat features show greater diversity can be found near water, they often provide artificial flyways where you have the opportunity to see different odonates.

Factors Influencing Odonata Diversity or Density

Flight Seasons

While some odonates emerge year-round as long as the weather is warm enough, other species, including the Common Baskettail, emerge only during a short period of a few weeks, generally in the spring. Species of a few groups of dragonflies including the Mosaic Darners, Hanging Clubtails, Striped Emeralds and Meadowhawks emerge late in the season. Knowing a species' emergence patterns help in finding some of the rarer species. Recording your experiences with emergent odonates and sharing it with other enthusiasts help to expand our knowledge about the species diversity in Texas.

The best time to look for an individual species is about $\frac{1}{3}$ through their flight season. Males generally begin emerging before females, and thus mature a little earlier. Females are generally the last survivors of a season.

Predators and Parasites

Odonates are prey for a wide variety of creatures including birds, frogs, fish, spiders and even carnivorous plants. Other odonates, flycatchers, falcons and Purple Martins have all been known to take dragonflies and damselflies.

Their eggs are often parasitized by tiny wasps of the Mymaridae family that are known to fly underwater to find eggs. In his book *Dragonflies through Binoculars*, Sidney Dunkle reports wasps of the genus *Thornella* have been observed riding female darners waiting for eggs to be deposited.

Red and green mites of the genus *Arrenurus*, often in very large numbers, can infest the adults of this order. Biting gnats *Forcipomyia fusicornis* may often suck blood from wing veins even when the insect is in flight.

Identification

Four elongate, many veined membranous wings, large multifaceted eyes that occupy most of the head, a small relatively complex thorax, small

bristle like antennae and a chewing mouth characterize odonates. The largest dragonfly known in the United States is $3 \frac{1}{4}$ inches long with all of them being more than $\frac{3}{4}$ inches long, making them large insects.

With the introduction of *Dragonflies Through Binoculars* insect enthusiasts across North America, both old and young now have a tool to assist in field identification of these beautiful creatures. While collection and careful examination may be necessary for identification of some species, this publication and others are making field identifications easier.



Since species within these families have many specific requirements, environmental conditions will dictate diversity. Some Odonata are attracted to the acidic conditions of the bogs of East Texas, while others may prefer running streams and still others make their homes in ponds or slow moving water. Knowing the “players” or what species or genera might be likely in a given area is the first step to successfully identifying dragonflies and damselflies in the wild. A good checklist for the region will help here.

While many odonates are identifiable at a distance, some may require further study, often away from the location of observation. Dragonflies can be quite tolerant of photography making photos of key areas for identification, like venation patterns on the wings, quite possible. Photography can also help preserve the color on a specimen, unlike collection of dead specimens in which case the color quickly fades. Key areas in making identification may include the venation patterns in the wings, colors on the head and eyes, size and color pattern of the insect, length of the abdomen to length of the wings and length of the back leg. Find photos of similar species and look at the species account, range maps, flying seasons and flight heights for comparisons.

Some species can be identified in the field only with great difficulty. In these cases environmental cues such as perch substrate, or behavior cues like percher or flier, and perch orientation may be significant. Many

of the smaller species of damselflies fly only inches above the surface of the water. Some species may in fact be identified reliably only after microscopic examination. Since some species can be gender dimorphic, the presence of an ovipositor can help in narrowing the specific options.

Odonates often have dramatic color dimorphism, although this is more common in some families than in others. No true albino dragonflies have been found to date.

Family Accounts

In describing the families of odonates, we give the number of species in each family recorded in North America (No. Am.), north of Mexico and in Texas (TX)

Kingdom: Animalia

Phylum: Arthropoda

Class - Hexapoda

Order - Odonata

Suborder Zygoptera – The Damselflies

Broad-winged Damsels – Family *Calopterygidae* (No. Am. 8, TX 5)

These are medium to large sized damselflies with broad, colored wings and often stunning, iridescent coloration on the thorax and abdomen, and long spindly legs. Dominant colors are red, blue and green with brown or black eyes.

Associated with streams or rivers, broadwings are characterized by low to medium flight often described as “butterfly like.” Their eggs are deposited in plants while the male guards nearby.

Spreadwings – Family *Lestidae* (No. Am. 18, TX 8)

These are medium-sized damselflies with mostly clear wings that may have an amber wash to the wings. They tend to hold their wings partially spread when perching. These often blue-faced damselflies with blue-eyed males and brown eyed females are generally metallic green in color with a wax like coating on the thorax or tip of the abdomen. They are noted for a long, slender abdomen.

Flying low from oblique perches, these insects are generally associated with dense emergent vegetation of ponds, marshes and temporary pools

or streams. Their eggs are laid in plants while in tandem or when the female is alone.

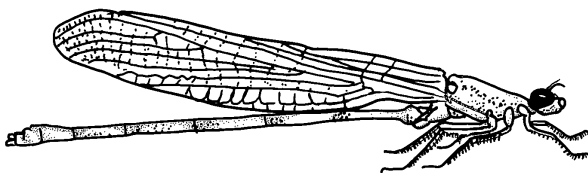
Threadtails – Family *Protoneuridae* (No. Am. 8, TX 3)

These small to midsized damselflies are represented by three reddish or brownish stream species found in central and south Texas. The balance of the family is a tropical group.

Pond Damsels – Family *Coenagrionidae* (No. Am. 98, TX 53)

These small to medium insects have mostly clear wings with short pterostigmas. Their brightly colored bodies may be blue, green, red, orange, yellow or purple and females of some species may have several color forms! The color of their eyes is often useful in identification. These are some of the most common, diverse and easily observed damselflies.

These low flyers may perch horizontally or obliquely on vegetation, rocks or the ground. They are common in bogs, lakes, ponds and streams. Most are rather feeble fliers.



Kingdom: Animalia

Phylum: Arthropoda

Class -Hexapoda

Order - Odonata

Suborder Anisoptera – The Dragonflies

Petaltails – Family *Petaluridae* (No. Am. 2, TX 1)

Our only representative of this family is the Gray Petaltail. It's found in East Texas and is our only large gray dragonfly. An unusual behavior is its tendency to perch vertically on tree trunks. The Gray Petaltail is generally associated with hillside springs in deciduous forests.

Darners – Family *Aeshnidae* (No. Am. 39, TX 16)

These medium to large dragonflies have clear wings with an occasional amber wash and sometimes a brown patch at the base of the hind wings. Their wings are noticeably long. The family has multicolored

bodies including browns, blues, greens, yellows and the occasional red or purple, and long abdomens. Their large, compound eyes meet broadly along a seam and are blue, green or brown.

Darners tend to hang vertically or obliquely from branches although they have been known to hang from tree trunks. Associated with ponds, lakes, marshes, bogs and sluggish streams, these dragonflies fly at a broad spectrum of heights and may feed in swarms over fields and clearings. Darners are swift flyers and some species are known to migrate.

The female lays her eggs in plants when alone. She has a blade-like ovipositor.

Clubtails – Family *Gomphidae* (No. Am. 98, TX 31)

These small to large dragonflies have clear wings with an amber wash or small brown spots at the base of their wings. They are usually well camouflaged with widely separated green or blue eyes. The club or flare on the end of their abdomens is most pronounced in the males.

Perching horizontally on the ground, rocks, logs or leaves (generally bare, flat surfaces), these dragonflies are perchers although some males may make long patrolling flights. These low to medium height flying insects are associated with rivers, streams, some lakes and ponds.

Some species of this family are rare and elusive while others may have very short flight seasons – often early in the season. Male abdominal appendages may be important for conclusive identifications.

Spiketails – Family *Cordulegastridae* (No. Am. 8, TX 2)

These large clear winged dragonflies have striking black or brown and yellow lateral thoracic striping with green or blue eyes that meet at one point. They have long slender abdomens.

Associated with small clear woodland streams, they can be found along small rivers, brooks and seepages. They fly at low to medium heights, generally one to two feet above the water, often in low densities. Males typically fly long patrols along streams while females are often noted laying their eggs in the bottom sediment while alone.

In North America, all eight species are in one genus.

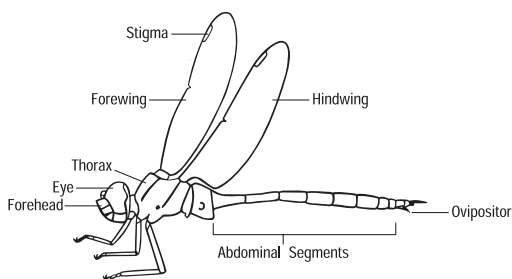
Cruisers – Family *Macromiidae* (No. Am. 9, TX 5)

While most of these medium to large dragonflies have clear wings, some have small brown patches at the base of their hind wings. They are generally brown or black with yellow spots on the abdomen and one lateral thoracic stripe. Their faces are also generally striped with yellow. Cruiser eyes meet broadly along a seam and most river cruisers have green eyes.

Found around rivers and lakes or along roadsides and clearings, they fly at low to high heights and are noted as swift flyers. They hang vertically or obliquely from branches when perched. The female lays eggs in the water unattended by the male.

Emeralds – Family *Corduliidae* (No. Am. 50, TX 14)

The Emerald family is characterized by medium to large dragonflies that are mostly clear winged, though some may have an amber wash or brown patches in the wings. Brown or black with yellow stripes or spots, these insects generally have a green or bronze iridescence. Their eyes meet broadly along a seam. Males often have a spindle shaped abdomen.



Associated with sphagnum bogs, streams or lakes, Emeralds are generally considered fliers, although one genus includes some perchers that fly at low to medium heights. Most Emeralds fly at medium to high heights. In many species the flight is direct but interrupted by periods of hovering. These insects feed in swarms over large fields or clearings. Many of these species have very northern distributions.

Noted for hanging vertically from twigs, or obliquely from tree trunks, some species perch horizontally on the ground or tree trunks.

Female emeralds generally lay eggs in water when they are alone.

Skimmers – Family *Libellulidae* (No. Am. 105, TX 73)

By far the most diverse, common and easily observed family of dragonflies in North America are the skimmers. These small to large insects with clear wings or wings with conspicuous wing patterns are colorful and often gender dimorphic. Their eyes meet broadly along a seam.

Noted perchers, these dragonflies sit horizontally, vertically or obliquely on vegetation, tree trunks, rocks or the ground. When they fly, they fly at low to high heights, often rather erratically, over various habitats – especially ponds.

Pond Preferring Species

Some of the Skimmers, members of the *Libellulidae* family, are territorial insects that hunt from specific, preferred perches. These dragonflies are brightly colored, often with conspicuous color markings on the wings, making them one of the easiest odonate families for a beginner to identify. They do tend to be gender dimorphic though. Members of this family have a venation pattern in the hindwing resembling a boot with the toe pointed down.

“Darners” members of the *Aeshnidae* family, also spend a lot of time around ponds. These swift fliers tend to feed in swarms over fields and clearings. Some species are migratory.

Some “Clubtails,” members of the *Gomphidae* family, will also be found around ponds. These perchers are low flying and have short flight seasons.

Among the Damselflies, the Spreadwings are often associated with ponds. These damselflies have long & slender, mostly clear wings with a slight amber wash that they often hold slightly spread while perching. They are usually found in areas with dense emergent vegetation.

As their name implies, the Pond Damselflies are also associated with ponds. These brightly colored damselflies perch or fly low and are the most common, diverse and observed group of damselflies.

Binoculars

The development of close-focusing binoculars has enabled the observation of dragonflies and damselflies to develop from catch and release to allowing people the option of observing these intriguing creatures without disrupting the insect. These binoculars provide the Odonata enthusiast with magnification that clearly shows color markings, abdomen shape and wing structure making observation of this group much more rewarding. Just a few years ago the only demand for binoculars came from hunters, birders and others that did not require a focus distance of less than 10 feet. The enormous popularity of insect watching, highlighted by butterfly enthusiasts, has presented the optics industry with an opportunity to develop close focusing binoculars beginning in the late 1990s. Now one can ensure a good focus at close range.

The novice at using binoculars will probably want to use a pair that has a reasonably wide field of view. Narrow fields of view tend to make the object more difficult to find since only a small portion of the landscape is being seen. Lower power binoculars tend to have a wider field of view. Ease of focusing is another factor the novice may be concerned with. If one has to turn the focus wheel numerous times to change from close focus to distant focus, the user may become frustrated easily. The fewer wheel rotations needed to go from close to distant focus, the better.

Binoculars are characterized by two numbers, the power of the binocular and the diameter of the objective lens which indicates how much light the glasses can collect. The power of binoculars tells us how much closer an object will appear with those glasses, so a seven power binocular makes an object 70 feet away appear 10 feet away. Since most odonatae watching is done during the daytime hours, brightness is generally not a critical element and so the second number is not critical.

When purchasing binoculars, it is important that you are comfortable with the model you select. While weight and power may be important factors, personal preference is going to influence your selection. If you can try the model before your purchase, it may prevent unpleasant results. Butterfly enthusiasts have very similar optical concerns to those of dragonfly watchers. For more information, including a comparison of different binocular models, see Gary Fellers' *Binoculars for Butterflying – 2001* at www.naba.org/binocs.html.

Photography

Photography is the only reliable way to preserve color in Odonata for later reference and identification. A picture allows one to observe the insect long after the field visit is over. Studying a photograph in detail may reveal details in color, structure or behavior that were missed in the wild and that help contribute to the identification. Photography also provides you with the opportunity to share your experiences and to seek the input of other enthusiasts.

If you think you may have a new or unusual species for your area, photographs will be necessary to confirm and establish the record. Collection will be necessary to confirm and establish the presence of new species in the state.

Conservation

About 15 percent or one in six species of North American dragonflies are at risk of extinction in the foreseeable future, including some Gulf Coast species. Habitat features most important to odonate conservation include pristine streams, arid land streams and ponds, sand bottomed lakes, bogs and fens.

Development has predictably had a significant impact on some of the dragonfly and damselfly species. Stream and bog species, probably the most vulnerable to development, have declined considerably in recent years. Draining of wetlands for agricultural use, destruction of streams by livestock and housing subdivisions, and clear cutting along riparian right of ways have pushed many of these species out of their homes. Encouraging the maintenance of riparian green belts and buffer zones can benefit these species greatly by reducing runoff and siltation while providing perching and hunting habitat.

While these developments present direct threats to habitat, other human related activities are not so obvious. Sewage and organic chemicals encourage bacteria development reducing oxygen content in the ponds. Pesticides introduced to the water kill larvae. Fertilizers washed off our lawns encourage algae growth also reducing oxygen. Silt

changes the structure of the stream bed, blocks sunlight from the plants and may destroy eggs. Dredging and ditching, sometimes called “channelization” while possibly increasing water flow or providing access, may destroy a spring or stream biologically. Caution needs to be exercised in all of our water related activities.

Some species have thrived in human developments though. The popularity of garden ponds has pond loving species expanding dramatically. Backyard ponds should be in a sunny location, at least two feet deep, as large as possible with emergent plants. Plants that produce perching locations should be close by and on the pond edge. Fish reduce dragonfly density and diversity. Domestic or fed waterfowl quickly eliminate odonates from your pond. “Cleaning up” a pond by removing pond-side vegetation sterilizes the pond. Diversity can be increased in your garden by providing as many “microhabitat” conditions as possible in your water garden. This increase in diversity however, will continue only as long as the microhabitats remain diverse.

Global warming may be having an impact on diversity and density of dragonfly species. Southern species seem to be expanding their ranges as the earth’s temperature increases, while northern species, as would be expected, move further to the north.

Some capture and collection of odonates will be necessary as these animals continue to be studied by science and hobbyists, however collection of the rare species must be limited. Collection may be essential in establishing the presence of new species in an area. As numbers decline, every individual becomes valuable to the genetic diversity of the species, and collecting can threaten the entire population if genetic material is lost. Please exercise restraint in this needed activity.

Field Guides

Few comprehensive odonate field guides are currently available for Texas.

Sidney W. Dunkle. 2000. *Dragonflies Through Binoculars*. Oxford University Press. Oxford.

Sequenced by family depicting those thought to be most primitive first, this field guide provides the advantage of showing similar species side by side to allow easy comparison and facilitate identification

Blair Nikula, Jackie Sones, with Donald and Lillian Stokes. 2002. *Stokes Beginner's Guide to Dragonflies and Damselflies*. Little, Brown and Co. Boston.

Depicts more than 100 of the most common species found across North America in photograph format. These are all common, widespread and conspicuous species and at least one representative of each family and major genus is depicted.

Checklists:

Odonata Central by John C. Abbott

<http://www.esb.utexas.edu/jcabbott/Odonata>

This site provides a checklist and an on-line field guide with photos and range maps as well as verbal descriptions.

Dragonflies and Damselflies of Houston, Texas and Vicinity by Richard Orr, Bob Honig and Robert A. Behrstock

<http://www.io.com/~pdhulce/dragon.html>

Odonata (Dragonflies and Damselflies) of the Lower Rio Grande Valley by Fermata

http://www.fermatainc.com/nat_odonates.html

Official English Names Checklist of NA Odonata by Dragonfly Society of the Americas

<http://www.ups.edu/biology/museum/NAdragons.html>

Web Sites

Odonata Central – maintained by John C. Abbott

(jcabbott@mail.utexas.edu)

<http://www.esb.utexas.edu/jcabbott/Odonata>

This site is designed to make available what we know about the distribution, biogeography and biodiversity of dragonflies & damselflies in Texas and the surrounding states.

Texas Dragonfly Links

<http://home.satx.rr.com/txento/Dfly.htm>

Odonata Societies and Groups

Dragonfly Society of the Americas (DSA)

c/o T. Donnelly,

2091 Partridge Lane,

Binghamton, NY 13903 USA

Purposes of the DSA are to encourage scientific research, habitat preservation and aesthetic enjoyment of Odonata through (1) cooperation and comradeship among odonatologists worldwide; (2) fostered interchange between amateur and professional enthusiasts; (3) establishment of publications to disseminate information relating to Odonata; (4) support for wetlands and habitat preservation as the most effective manner for odonate conservation; and (5) cooperation with organizations sharing common goals of environmental preservation.

International Odonata Research Institute

c/o Florida Division of Plant Industry

1911 South West 34 Street

Gainesville, FL 32608

iori@afn.org

<http://www.afn.org/~iori/ioriintr.html>

The International Odonata Research Institute (IORI) was founded in 1986. The IORI maintains the Odonata Information Network (<http://www.afn.org/~iori/>) home page, where you can find information on events & meetings, e-mail directory of odonatists, odonata news items, requests for data/information and where to find supplies.

Notes



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