

A study of territoriality
in dragonflies
(Odonata: Anisoptera)
on the island of
Dominica, West Indies

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Abstract

Territorial behavior of dragonflies was observed over a period of approximately a week at Archbold Tropical Research and Education Center on the island of Dominica. The observation times were broken into small time periods and spread out during the daylight hours. Individuals were identified indirectly, through photography. Individuals were observed for territoriality and mating success. Results show that dragonflies are mainly territorial towards other dragonflies and that their behavior changes throughout the day.

Introduction

The Odonata are an order of predatory insects known commonly as dragonflies or damselflies. The larval forms are referred to as naiads and all are aquatic. The naiads emerge from the water to metamorphose into flying predators. The odonates are broken into two suborders: Anisoptera and Zygoptera. The Anisoptera are insects commonly referred to as dragonflies while the Zygoptera are known colloquially as damselflies. Most are relatively large insects and are often colorful. Odonates range in size from less than 9 centimeters in length to greater than 11 centimeters. They often have an enlarged thorax to facilitate their powerful flight muscles. They have two sets of elongate membranous wings. Their legs are modified for aerial catching of prey and perching. These insects do not rely on their legs for walking (Triplehorn and Johnson, 2005). There are estimated to be 500 species of dragonflies and damselflies in Central America and the Caribbean occupying at least 16 different families (Esquivel, 2005).

Territoriality displays are common in the animal kingdom. Dragonflies have been observed to be territorial in previous studies (Wolfe et al, 1996; Van Buskirk, 1986). A common reason for territoriality among same and related organisms in nature is for securing breeding territories or preferential habitats including food availability (Baird and May, 2002). Individuals defend their territory depending on a balance of benefits from keeping the territory (preferential mate selection or benefits in food presence) and the losses of defending the territory (Hinsch and Komduer, 2010). It has been shown that not only are the energy expenditures of flying and fighting, but also directly

confrontational species can sustain damage to their wings and legs. These damages can directly effect the survival rates for these species (Sherratt et al, 2011).

Previous studies have also shown that individual dragonflies vary in their duration of stay on a particular territory (Johnson, 1964). It is also known that the number of suitable territories is related to how much effort is put into defending territory. Other known factors include the time of day the male first acquires the territory, and whether he has had successful matings due to the position of the territory (Switzer, 2002). Prior studies have also shown that dragonflies have demonstrated three different types of territoriality: territoriality, non-territoriality and switching (Rahani et al, 2008). Territorial behavior is classified as the territory being actively defended from intruders (Van Buskirk, 1986). Non-territoriality is defined as an organism that does not actively defend a territory. Switching behavior is observed when an individual exhibits both territoriality and non-territoriality under different conditions (Rahani et al, 2008).

It has also been shown that intraspecific competition exists among birds and damselflies. It seems to be true that more closely related species or species that are similar in visual characteristics are more likely to display territoriality (Anderson and Grether, 2011). This shows that some organisms choose to be territorial based on visual cues and only choose to defend against others that they see as a threat, even if the organism in question is not a direct threat to its territory.

The purpose of this study is to provide insight into the territory defending tactics of odonates on a tropical island. Length of time of territory possession and encounters between individuals in the study areas will lead to a better understanding of the biology of the organisms.

Materials and Methods

Study Areas and Dates

The observations presented in this paper were made on the island of Dominica in the West Indies. The dates of this study were during a one week time period between 29 May and 5 June, 2013. The study site was the Bee Pond (N 15° 20' 52", W 61° 22' 04"), located on the grounds of the Archbold

Tropical Research and Education Center (ATREC). Upon arriving at ATREC, the pond was severely overgrown. A machete and a pitchfork was used to clear a circle with a diameter of approximately ten feet. Weeds were left around the edges as perches for odonates. The territory was allowed to attract odonates and naturalize without human disruption for two days before any observations were made. Odonates were only observed if their defended territory was at least bordering on the cleared area, or if they interfered with odonates whose territory was as described previously. Observations were made several times during different times of the day and different weather conditions. All of the variables were noted during observations. Observations were made during the morning, afternoon and evening, and also during sunny, rainy and cloudy conditions. Times reported in this paper are in Atlantic Standard Time.

Identification of Organisms

Identification of specimens was done to as narrow a taxon as possible on live specimens without disrupting their natural behaviors. This was accomplished using mainly a Canon PowerShot SX260 HS to photograph dragonflies sitting on perches. The images were then analyzed using Windows Live Photo Gallery on an HP Mini 110-37375DX running a Windows 7 Starter operating system. Visual identification characteristics were used to identify each specimen to family using Borror and Delong's Introduction to the Study of Insects and Dragonfly Genera of the New World: an illustrated and annotated key to the Anisoptera. If possible, individuals were identified to genus and species using Libélulas de Mesoamérica y el Caribe.

Analysis

Each dragonfly was monitored for displays of territoriality and benefits and costs of obtaining or keeping a territory. Actions were monitored for territoriality displays, feeding and mate selection. The duration of the stay on a territory was recorded if a dragonfly was chased from its territory.

Results

Observations

29 May 2013

Only two dragonflies appeared to hold territory near the cleared area of the pond during the one and a half hour observation period between 14:45h and 16:15 h. The two dragonflies were observed and photographed. During this hour and a half, the weather was overcast, with slight patches of rain. The dragonflies did not interact with each other and did not interact with other dragonflies that were observed in the territory. The only notable activity was feeding activity by both males A and B. Males A and B also changed perches, but remained in their own territories.

30 May 2013

Passing by the Bee Pond showed that male A was in his territory occupied the previous day, but no other observations were made.

31 May 2013

Four dragonflies were observed to hold territories during the one hour observation period from 09:43 to 10:43. Territorial activities were noted along with the possibilities for territorial behavior. There was quite a bit of territorial activity observed during most of the hour long watch period. The territoriality was most apparent when male E strayed too far towards male A's territory. Male A was occupying territory that he had occupied on 29 May as well. Only one male, E, was observed to successfully mate during this hour. Damselflies were observed in the territories of male A and male E. Male A only investigated the damselfly once, and made no attempt to chase the damselfly out of A's territory. Male E made no move to even investigate and damselflies in his territory, and was once observed sitting less than 20 cm from one. Both males A and E were defensive of their territory when another male, F, whose territory appeared to be further into the tall weeds on the far side of the pond, moved into and through the territories of A and E.

1 June 2013

Dragonflies were observed for fifteen minutes from 14:45h and 15:00h. They were identified as males A and B from previous days. They occupied their home territories. Male A was observed feeding and no other notable behavior was observed.

2 June 2013

The Bee Pond was watched for an hour and a half (10:40h-12:10h). Dragonflies previously identified as A and E displayed quite a bit of territoriality over a single perch that had been considered dragonfly A territory. The dispute over this territory went on for a while, but was never particularly urgent. A female was seen ovipositing on a submerged stump in dragonfly E's territory. An accompanying male was not observed and no territoriality was observed towards the female. Dragonfly E investigated and chased a pair of mating red damselflies. Dragonfly A and E displayed territoriality over the shared perch again. Dragonfly E secured successful mating. An unidentified dragonfly ended up in the water due to territoriality and mating dispute. After being sure the dragonfly would survive without assistance, it was handled to ensure proper identification. It was identified as male, and due to the dispute and landing in the water, the tip of his left hind wing was missing. After being photographed, he was released. A new species was observed hovering over open water. No dragonflies reacted territorially. At the end of the observation period, only dragonfly A and B were visible in their territories.

4 June 2013

The observations of Bee Pond were made during the time from 08:35h to 11:45h. Two 15 minute breaks were taken, one between 09:30h and 09:45h and the other from 11:11h to 11:26h. The observation period directly followed a long period of early morning heavy-moderate rain. During the first portion of the observation period, there was no territoriality and only two dragonflies, B and E, were visible in their home territories. During the second portion of the observation, a great deal of territorial disputes occurred. Dragonfly A returned to his territory, and was aggressively met by dragonfly E. Dragonfly A shifted his territory leftwards, and was aggressively met by dragonfly B. Dragonfly A stayed in his abbreviated home territory. A new dragonfly (dragonfly G) entered the area between dragonfly A and dragonfly E. Dragonfly A reacted to dragonfly G and chased it to dragonfly E's territory. Dragonfly E chased the new dragonfly for a minute, then returns to a perch. The two dragonflies (G and E) are perched within a foot of each other. Dragonfly E appeared to secure another

successful mating. While the female is oviposited with dragonfly E as guard, the pair strayed too far into dragonfly A's territory. A pursuit ensued and either dragonfly E or his mate ended up in the water. The affected party escaped almost immediately. Dragonfly G attempted to return to the perch near dragonfly E and was chased off. Dragonfly E continued to act more territorial towards dragonflies that most similarly resemble him, with quite a few more instances of territorial behavior from him during the next twenty minutes. Another battle over territory also ended in an intruding party landing in the water. Dragonfly E also successfully attained another mate. While he guarded his most recent female, a new dragonfly entered his territory and Dragonfly E did not react immediately. Once another intruder flew into dragonfly E's territory, he chased both, and at least one other that the territorial flight came in proximity to. The third portion of the observation period involved fewer territoriality disputes. Dragonfly A chased dragonfly E back to his own territory, but the dispute was short lasting. Dragonflies A, B and E were all observed on perches within their territory, but not acting territorially. At the end of the observation period, only dragonflies A and B were observed on their home perches. It was very strongly sunny on other portions of the pond.

5 June 2013

Dragonflies were observed for a twenty minute time period between 16:45 and 17:05. Upon first arriving at the pond, only dragonfly E was visible in his territory. After a short amount of time dragonfly E also left and did not return.

Identification of organisms

Dragonfly A



Dragonfly A was a male, with blue on black coloration. The wing veins of the hind wings displayed the characteristic foot-shaped anal loop of the family Libellulidae. The eyes were a distinct turquoise color. He occupied the territory on the left side of the cleared area.

Illustration 1: A photograph showing Dragonfly A in his territory.

Dragonfly B



Dragonfly B was male with the same visual characteristics as Dragonfly A. He was identified as a libellulid. He occupied territory in the uncleared area to the left of the cleared area.

Illustration 2: A photograph showing Dragonfly B in his territory.

Dragonfly E



Dragonfly E was male, with yellow and bluish markings on a dark color. He displayed the foot-shaped anal loops on the hind wings characteristic of the family Libellulidae.

Illustration 3: A photograph showing Dragonfly E in his territory.

Dragonflies A, B, and E were identified to be members of the genus *Micrathyria*. Members of this genus have bright blue or turquoise eyes. The Esquivel text states that this genus is generally active and highly territorial.

Dragonfly G



Dragonfly G was not identified to sex. This individual was a distinct pink-purple color. Foot-shaped anal loops were observed on the hind wings, allowing this individual to be identified to family Libellulidae. Using the Esquivel text, this dragonfly can be identified to the genus *Orthemis* and probably the species *ferruginea*.

Illustration 4: A photograph showing Dragonfly G on a perch.

Female with no accompanying male



Illustration 5: A female observed ovipositing.

This dragonfly was identified as female due to oviposition behavior being displayed. Her coloration was a bright green with a reddish-brown abdomen and matching stripes on the thorax. The eyes were also bright green, with the individual eyes appearing contiguous on the vertex of the head. The triangles in the wings were similar. No foot-shaped anal loop was observed and the

posterior margins of the eyes were not developed into lobes. These characteristics can be used to classify this individual into the family Aeshnidae. Using the Esquivel text, this individual most likely is *Coryphaeschna adnexa*.

Discussion

From the observations that were made, dragonflies (Odonata: Anisoptera) are clearly territorial during the morning hours and less territorial during the afternoon and early evening hours. The same dragonfly was observed to immediately pursue intruders late in the morning and early in the afternoon and then to not pursue other dragonflies in their territory during the late afternoon. This behavior has been classified as “switching” (Raihani et al, 2008). Dragonflies tended to pursue intruders that were the same family or species, with a more casual approach to dragonflies in their home territories if they were clearly different visually. These results were shown previously in “Territorialism and residentiality in a dragonfly *Oriheirum albistylum speciosum* Uhler (Odonata: Anisoptera)” published by Yosiaki Ito in 1960.

Territoriality can be taxing on the individual defending territory. It is quite obvious that flying to defend territory uses precious energy, but other effects are less easy to imagine. One of these was witnessed multiple time over the brief study period. Dragonflies can be knocked into the water while they are fighting over territory or mates. In the small scale that was observed, there were no large fish

to consume the helpless dragonfly, but on a larger scale, this would be possible. Even in the smaller pond at ATREC, organisms such as prawns or crabs would welcome the food source. Even without aquatic animals to eat the dragonfly, dragonflies could potentially drown if they were unable to struggle through the water to submerged vegetation where they were able to escape. Sherratt et al (2011) demonstrated that odonates that show territoriality experience higher levels of mortality than species where territoriality is not observed. These findings relate the injuries sustained during territoriality displays to an earlier death.

Other findings were that Anisopterans were not particularly territorial towards Zygopterans. Only in a few instances did any of the observed dragonflies react territorially towards any damselflies. Most of these instances involved individuals that were similarly colored. A few other instances occurred when the dragonfly had been actively defending their territory from other dragonflies and saw damselflies in their territory also.

Dragonflies were also observed to be active only during certain times of the day. Dragonflies did not return to their territories until the morning rains had let up and the sun was directly on their home territories. They also left after the afternoon hours during which the sun was strongest. Most dragonflies had left their territories by 16:45 with the final dragonfly leaving his territory before 17:00 local time. These findings are in agreement with findings reported in “Mating behavior and its relationship to territoriality in *Platycypha caligata* (Odonata: Chlorocyphidae)” published in 1982 by Hugh M. Robertson.



Illustration 6: A photograph showing Dragonfly G in Dragonfly E's territory, within a foot of Dragonfly E.



Illustration 7: A photograph showing an unidentified dragonfly that has fallen into the water during a territory dispute.

In order for a better understanding of male territorial spacing and territoriality displays, this experiment should be conducted under more controlled conditions. A small pool with evenly spaced perches should be designed and clearly marked, or distinguishable, individuals should be introduced. This method would ensure that the dragonflies can be studied without the possibility of confusing individuals or parts of the study group being killed or injured by outside variables. Territoriality can also be attributed to the sexual selection pressure placed on male odonates. Larger, stronger, more adapted males are more likely to defend more territory than smaller weaker individuals. This was shown in Conrad and Pritchard (1992) and would benefit from a more detailed study that could also be set up similarly to the control experiment.

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