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How will dragonflies adapt to a warmer Earth?

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Abstract

The Earth is getting warmer, and we can see the effects of it - destructive floods, severe droughts, and intense storms. Just as we must look for ways to adjust to our changing environment, animals and plants must also adapt if they want to survive.

We wanted to know how animals' reproductive traits change to help them survive in warmer climates. We looked at dragonflies because the males use dark coloring on their wings to attract mates and intimidate rivals. We created a database to compare dragonflies living in warm climates to those living in cooler climates. We found that male dragonflies living in warmer climates have less wing coloring than those living in cooler climates. We also found wing ornamentation in warmer areas to be lighter in color. This is because the darker coloring can overheat the dragonfly and they become unable to reproduce. Lighter or reduced ornamentation is naturally selected when climates are warmer.

Introduction

With the world getting warmer, knowing how organisms respond to temperature changes is important. All organisms have a specific temperature range in which they can survive and reproduce. Even humans can't survive if it gets too cold or too hot! As temperatures increase, some species migrate to new locations to stay within their temperature range. Other species are able to adapt to the warmer temperatures. Many scientists have conducted studies to see how survival characteristics (such as body size and life cycle changes) can help animals adapt to warmer temperatures. Our study focuses on how organisms adapt through changing **reproductive traits**. After all, both survival and reproduction are necessary for a species to be successful in a particular environment.

A common reproductive trait is **ornamental coloration**. Species use different colors and designs to attract mates and to intimidate rivals. In our study, we looked at dragonflies because the males have dark coloration on their wings. The darker the male's coloring, the more successful he is. Yet

A dragonfly with dark wing ornamentation.

Photo: Allison Gamzon

this same dark coloring also influences body temperature: it absorbs more **solar radiation**, increasing the body temperature of the male dragonfly. Females also have ornamental coloration, but they spend more time in the shade looking for food.

Based on our understanding of dragonflies, we hypothesized that only male coloration would decrease in warmer temperatures, not the female **ornamentation**. We tested this hypothesis by looking at how dragonfly species have changed over time and space.

Methods

We created a database of the male and female wing ornamentation for 319 different dragonfly species. They came from as far north as Alaska and Canada, and as far south as northern Mexico. We divided this area into 1° latitude by 1° longitude cells. We also used field guides and pictures on the community-science website iNaturalist to determine which species have wing ornamentation and which species do not. If a species had wing ornamentation, we indicated if it was dark (black or dark brown) or light (lighter brown or yellow). Next, we found the average yearly temperature for each species' geographical range. Then we analyzed the data to see if species with dark ornamentation usually occurred in areas with cooler temperatures.

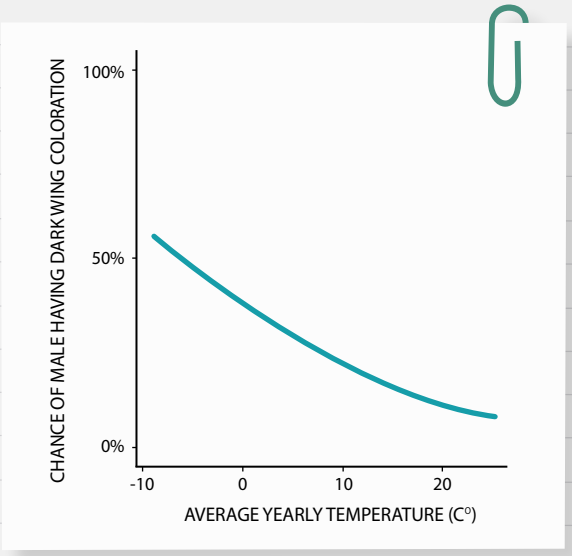
We focused on the populations of 10 species that each have wide geographic ranges. Using iNaturalist observations, we measured the area of the dark coloration on over 200 individuals in each species. We then calculated the ratio of ornamentation area to total wing area. We compared this ratio to the average yearly temperature for the location of each dragonfly observation. This comparison allowed us to see if dragonflies in populations that face warmer temperatures had smaller areas of dark coloration on their wings. We also tracked these species between 2005 and 2019 to see if dark coloration was less common in warmer years.

Results

First, we looked at the results from dragonflies from different species. We found that species that live in warmer climates were less likely to have wing ornamentation and, when they did, the male wing ornamentation was usually lighter in color (Figure 1). Then we looked at the results from dragonflies from the same species. We saw that the warmer the habitat, the smaller the wing ornamentation for male dragonflies.

Our analysis showed that between 2005 and 2019, male dragonflies had smaller ornamentation areas in the warmest years.

In both of our comparisons, the wing ornamentation of female dragonflies did not show any relationship to climate.



How can you describe the trend shown in the graph?

Figure 1:
The chance that a male dragonfly will have dark wing coloration based on temperature.

Discussion

There are four major takeaways from our study.

1. The wing ornamentation of male dragonflies is less and lighter in warmer climates. For other animals that also use dark coloring to attract mates, we expect similar changes as they adapt to increasing temperatures.

2. Because they have different roles, male and female dragonflies did not respond to their climate in the same way. We cannot assume that the males and females of any species will respond in exactly the same way when they face new environments.

3. The wing ornamentation changed in a relatively short period: 15 years. This probably means that climate change is the cause of **natural selection** on these important dragonfly traits. Warmer temperatures reduce the number of highly ornamented males from the breeding population.

4. Based on climate projections, the wing ornamentation of male dragonflies will most likely need to decrease over the next 70 years. If it continues to decrease, reproductive behavior might change over time.

Reproduction is a key component for a species to survive in an ecosystem. We need to conduct more research to understand how reproductive traits respond to climate changes. After all, if we want to conserve a species, we need to know how their reproductive behavior is changing with the changing climate.

Conclusion

The Earth's climate is changing. Through natural selection, some species will change their survival and reproductive traits to adapt to a warmer world. Why do we care? If species change, the ecosystems that they live in will change, and ecosystems support our way of life.

To preserve our ecosystems from climate change, we need to minimize the amount that the Earth warms. You can help by lowering your carbon footprint through energy conservation. Take shorter showers, use public transportation, lower the heat in the winter, or buy less stuff. Small changes can make a big difference if everyone does their part.

Glossary of Key Terms

Ornamentation – a characteristic of animal appearance used for decoration.

Ornamental coloration – decorative color used to attract mates and intimidate rivals.

Natural selection – a process through which a species evolves. Over time, the characteristics that help a species survive in their environment will remain, while those that limit survival will disappear. For example, light-colored peppered moths are visible when sitting on a roof covered in ash from industry. The light-colored peppered moths will more likely get eaten, so they will not reproduce to make more white peppered moths. However, the dark-colored moths will blend in with the ash and escape predators. They therefore reproduce and, over time, the peppered moth population will become darker in color.

Reproductive trait – a characteristic of an organism used to attract mates. A useful example is the color of male peacock feathers. Females are attracted to males with the brightest and most colorful tails.

Solar radiation – radiant (electromagnetic) energy from the sun. It provides light and heat for the Earth, and energy for photosynthesis.

Check your understanding

1. What are two ways that organisms deal with a changing environment?
2. Why is ornamental coloration considered a reproductive trait rather than a survival trait?
3. Why did the researchers select dragonflies for this study?
4. Based on the results of this study, how should we expect the wing ornamentation of male and female dragonflies to change in the near future?
5. Why is it important for us to understand how a species will adapt its reproductive traits to climate change?
6. We suggested some small changes you can make to your lifestyle to reduce your carbon footprint and slow climate change. Can you think of three additional ways you can prevent more warming? Of these possibilities, which change would you be most likely to make and why?

REFERENCES

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PhET: Natural Selection
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