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What can tree frogs in Chernobyl tell us about radiation?

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Abstract

Have you ever heard of Chernobyl? It was a nuclear power plant that released large amounts of radiation into the environment after an accident. While the people nearby left the area, the wildlife remained. Many plants and animals died because of the high levels of radiation. But others, such as tree frogs, adapted. We collected tree frogs from different areas surrounding the Chernobyl power plant. We analyzed their skin coloration. We found that the frogs closer to the power plant had darker skin coloration. That's because they have higher levels of melanin. Melanin is known to protect organisms from radiation. We think that darker colored frogs better survived the higher levels of radiation closer to the power plant.

Introduction

In April 1986, the Chernobyl nuclear power plant in Ukraine malfunctioned. One of the reactors melted down, causing an explosion and fires. The Chernobyl disaster led to the largest release of **radioactive** material to the environment in human history.

Radioactive elements are elements that have unstable nuclei. Examples include uranium and plutonium. These elements have a large number of neutrons compared to protons in their nucleus. To become stable, these elements break apart into new elements. When they do, they release large amounts of energy. They also release radiation as small particles, known as **alpha particles**. At high levels, radiation can cause the death of an organism. At lower levels, radiation can cause changes to an organism's body and can lead to DNA changes. Because radiation can negatively impact wildlife, it is a form of **pollution**.

While tragic, the Chernobyl accident provided scientists with an opportunity – to study the effects of radiation on wildlife. We wanted to explore how wildlife adapted to radiation. In particular, we wanted to learn about skin **coloration** in tree frogs. Skin coloration is caused by different pigments.

A. An Eastern tree frog.

B. Reactor 4 at the Chernobyl nuclear power plant in Ukraine, which caused the release of radiation in 1986. On top of it is the New Safe Confinement, a structure designed to contain the radioactive ruins of the reactor.

Melanins are the pigments responsible for dark brown or black coloration in skin and eyes. Studies showed that melanin can protect humans from **ultraviolet** radiation from the sun. We hypothesized that it can also protect vertebrates from radiation pollution. We hypothesized that Eastern tree frogs living in or near areas with high radiation levels would present a darker skin coloration.

Methods

We collected 189 adult male Eastern tree frogs during their breeding season from 2017 to 2019. We collected frogs from eight locations inside the **Chernobyl Exclusion Zone**. This zone forms a circle around the power plant with a radius of about 30 kilometers (about 18.6 miles). It has the highest radiation levels in the world. We also collected frogs from four locations outside the exclusion zone in areas without radioactive pollution. All the collection sites had similar environmental conditions. All sites were medium-small **wetlands** surrounded by forest and meadows. They had the same soil type and color. The water pH was also the same.

We placed the frogs in plastic bags and transported them to the laboratory. Here, we placed each frog into its own small plastic bucket with about three centimeters of water. The next morning, we took a picture of each frog to evaluate its color. We took pictures of each frog on a black background. We illuminated them with two LED lights. We analyzed the photos and determined color based on luminance (Fig. 1). **Luminance** describes the perceived brightness of an object. The higher the luminance, the lighter in color the frog.

We also measured their body dimensions – length, width, and depth – as well as their weight. We used this information to calculate the level of radiation exposure experienced by each frog.

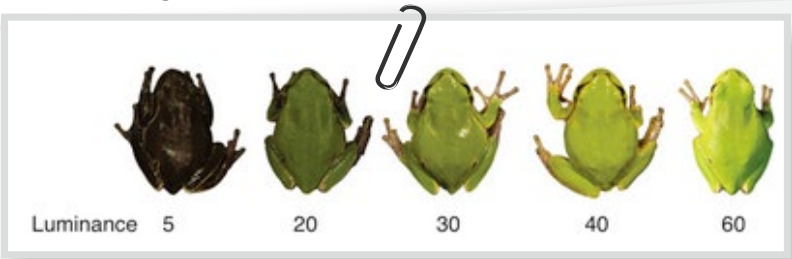

Figure 1:
Luminance describes the skin coloration of the tree frogs.

Results

We found that there was a lot of variation in skin luminance. We measured skin luminance as a percent. A frog with 0% luminance would be black, and a frog with 100% luminance would be white. Frogs within the exclusion zone had a skin luminance that ranged from 4.2% to 45.6%. The frogs outside the zone had a luminance that ranged from 22.4% to 63.9%. (See Fig. 2).

We also found a **correlation** between skin luminance and historical high radiation levels. Historical high radiation levels in 1986 were up to 100 times higher than current radiation levels. The closer the frogs were collected to an area with historical high radiation levels, the lower the frogs' skin luminance (the darker the frogs were). That means areas with higher historical radiation had frogs with darker skin coloration. We did not find a relationship between skin color and current radiation levels.

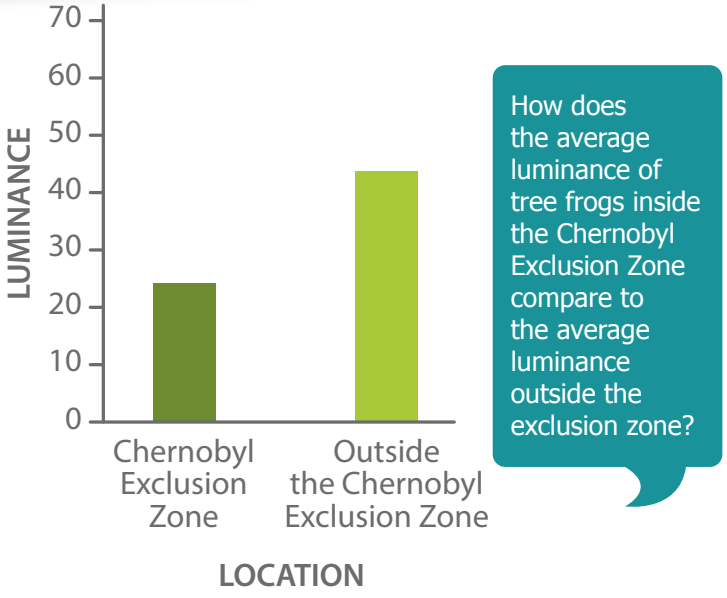

Figure 2:
A comparison of frog skin luminance inside and outside the Chernobyl Exclusion Zone.

Discussion

Skin coloration in tree frogs correlates to historic radiation levels, not current levels. This tells us that changes in coloration are not caused by radiation the frogs experience now. Instead, the changes in coloration are more likely a case of rapid **natural selection**. Natural selection is one of the main processes that causes a species to change over time.

Natural selection occurs when an environment favors certain **traits** over others. A trait is a characteristic, such as height, speed, or skin coloration. When the Chernobyl accident occurred, the environment favored frogs with darker skin coloration. Frogs with darker skin coloration contained high levels of melanin. The melanin protected these darker frogs from the high levels of radiation.

Some studies show that skin coloration is an inheritable trait in frogs. That means when a frog survives and mates, it can pass its skin coloration to its offspring. Over time, the population near the Chernobyl site became darker in color. Areas farther away from the Chernobyl accident site received less radiation. The tree frogs in this area remained lighter in skin coloration.

Conclusion

Radiation, like all forms of pollution, impacts wildlife. You can help minimize the impact of pollution! Do your part to reduce the amount of pollution that enters the environment. Use public transportation, walk, or ride your bike to reduce the amount of air pollution. To reduce water pollution, throw your garbage away rather than leave it on the ground. Reduce, reuse, recycle, and repurpose items so that they don't end up in a landfill. Through conservation, you can help reduce the need for wildlife to adapt to pollution.