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# WHEN PARASITES DAMAGE BIRDS' BEAKS, THE WHOLE ENVIRONMENT CAN CHANGE

***Didone Frigerio*** [1,2*], ***Diane Colombelli-Négrel*** [3], ***Lauren K. Common*** [1,2], ***Andrew C. Katsis*** [1,2] ***and Sonia Kleindorfer*** [1,2,3]

[1] *Konrad Lorenz Research Center, Core Facility for Behavior and Cognition, University of Vienna, Grünau im Almtal, Austria*

[2] *Department of Behavioral and Cognitive Biology, University of Vienna, Vienna, Austria*

[3] *College of Science and Engineering, Flinders University, Adelaide, SA, Australia*

YOUNG REVIEWERS:

KARUBAKEE
AGE: 12

MARIE-LOUISE
AGE: 9

Parasitism is the most common feeding mode on earth. But how do parasites affect the feeding behavior of their hosts? Darwin's finches of the Galápagos Islands have a parasite called the avian vampire fly, which lay its eggs inside bird nests. When the eggs hatch, the immature flies enter the nestlings' beaks via their nostrils and feed on their blood and tissue. The few nestlings that survive tend to have deformed beaks. We wanted to find out how this beak damage changes a finch's body condition and feeding behavior once it leaves the nest. This study was conducted in the Galápagos Islands over 10 years. We monitored four species of Darwin's finches and measured their body conditions. Overall, adults with damaged beaks were in poorer condition and changed their feeding behavior. This study shows that parasites can have long-term effects on the feeding behavior of their hosts.

## WHAT DO DARWIN'S FINCHES HAVE TO DO WITH CHARLES DARWIN?

**NATURAL SELECTION**

A key mechanism of evolution. Accordingly, characteristics that are more likely to foster survival will persist in a population.

Charles Darwin was a ground-breaking biologist who, in the 1800's, proposed the theory of evolution by means of **natural selection**. He shared the theory in his book *On the Origin of Species*. The basic idea of natural selection is that individuals with traits best suited to their surroundings survive and are most likely to have descendants (babies), while individuals that do not have those traits are more likely to die without leaving descendants. Therefore, when the habitat changes in a way that benefits individuals with certain traits, these traits become more common in the population over time. As a young man, Darwin traveled on a warship of the Royal Navy called the *HMS Beagle* around South America, including to the Galápagos Archipelago, a set of islands in the Pacific Ocean off the coast of Ecuador. Darwin collected data on local plants and animals, including small birds called finches, and took these back to Europe for analysis.

The Galápagos finches were a puzzle for Darwin because the populations on each island had strikingly different beaks, and yet they all belonged to one family of birds. Through natural selection, the finches from different islands had evolved to feed on different types of food and so had different beak shapes to suit their particular diets. Over time, these small differences between finch populations resulted in the formation of closely-related finch species from a shared common ancestor [1]. David Lack, a famous biologist working in the United Kingdom and who also studied the birds of the Galápagos, named Darwin's finches in honor of Charles Darwin.

## WHY ARE DARWIN'S FINCHES SO SPECIAL?

**ADAPTIVE RADIATION**

A process in which organisms rapidly evolve to be different from an ancestor species, generating many new species with different roles in an ecosystem.

Darwin's finches are a great example of what is called **adaptive radiation**, which involves the rapid evolution of new species, each playing different roles in an ecosystem. On the Galápagos Islands, 17 different finch species evolved over the course of 1.5 million years. That might sound like a long time, but it is super-fast for the appearance of new species. Each species of Darwin's finch has a different beak size and shape, which allows them to eat different types of food (Figure 1). These differences mean that they have less competition for food. This might be very important for surviving on a set of islands where resources are limited. But life on the Galápagos Islands has recently become much more difficult for Darwin's finches, because of the arrival of the avian vampire fly.

## HOW IS THE AVIAN VAMPIRE FLY AFFECTING DARWIN'S FINCHES?

The avian vampire fly is an insect that was accidentally introduced to the Galápagos Islands in the 1960's. We do not know exactly how the

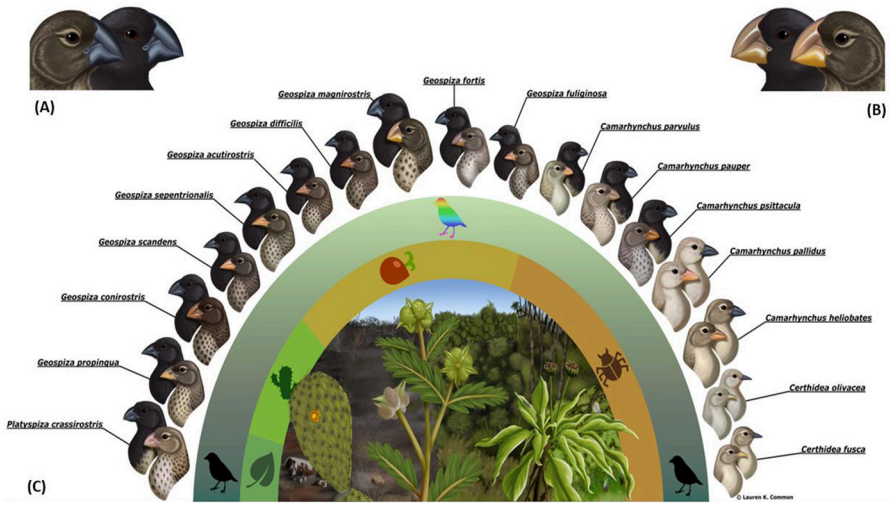


Figure 1

Adaptive radiation led to the 17 species of Darwin's finches on the Galápagos Islands. Finch beaks change color and are **(A)** black during the breeding season and **(B)** pink/yellow in the non-breeding season. **(C)** Finches eat a diversity of foods: leaves, cactus, seeds, and invertebrates. Some finches have generalist diets (middle), which means they eat a wide range of foods. Other finches are specialists (left and right sides), which means they usually eat only one type of food (drawing by Lauren K. Common).

flies first arrived there. It could be that they hitched a ride on boats loaded with fruits and vegetables from the South American mainland. It is also possible that they were hiding inside the nesting materials of other birds, such as pigeons, that were purposefully brought to the Galápagos Islands.

Although adult vampire flies are strictly vegetarian, their **larvae**—the baby flies that hatch from the egg as tiny wriggling maggots—are **parasites** [2]. Some parasites do more harm to their **hosts** than others: some cause very little trouble, while others may kill their hosts. The avian vampire fly larva is a deadly parasite. Mother flies lay their eggs inside the nests of Darwin's finches and other birds. When the eggs hatch, the fly larvae enter the nestlings' beaks via their nostrils and feed on their blood and tissue. Many nestlings die in the nest, eaten alive by the fly larvae. The few finches that survive must cope with deformed beaks for the rest of their lives (Figure 2) because the larvae ate parts of the beak [3]. The avian vampire fly was first discovered in Darwin's finch nests in 1997 [2] on Santa Cruz Island. It now occurs on 15 of the 17 major islands of the Galápagos and is known to parasitize 22 Galápagos land bird species [4]. Therefore, this **invasive species** not only affects Darwin's finches but is the biggest risk factor for the survival of all Galápagos land birds.

## HOW WE CONDUCTED OUR RESEARCH

Our data were collected on Floreana Island in the Galápagos Islands (Figure 3A). We sampled four types of Darwin's finches: small ground finches, small tree finches, medium tree finches, and hybrid tree finches. The hybrid tree finches are a special group consisting of birds whose mother is a medium tree finch and whose father is a small tree finch. We captured these birds using mist-nets, which are very

### LARVAE

The juvenile form in many animals. It differs from the adult form, which is achieved by a process called metamorphosis.

### PARASITE

An organism that lives on or inside another organism (its host) and causes it harm.

### HOST

An organism that nurses another organism. In a parasitic relationship, the host is being harmed by the other organism.

### INVASIVE SPECIES

A species that is not native to an area but is spreading quickly and successfully, potentially with negative consequences for ecosystems.

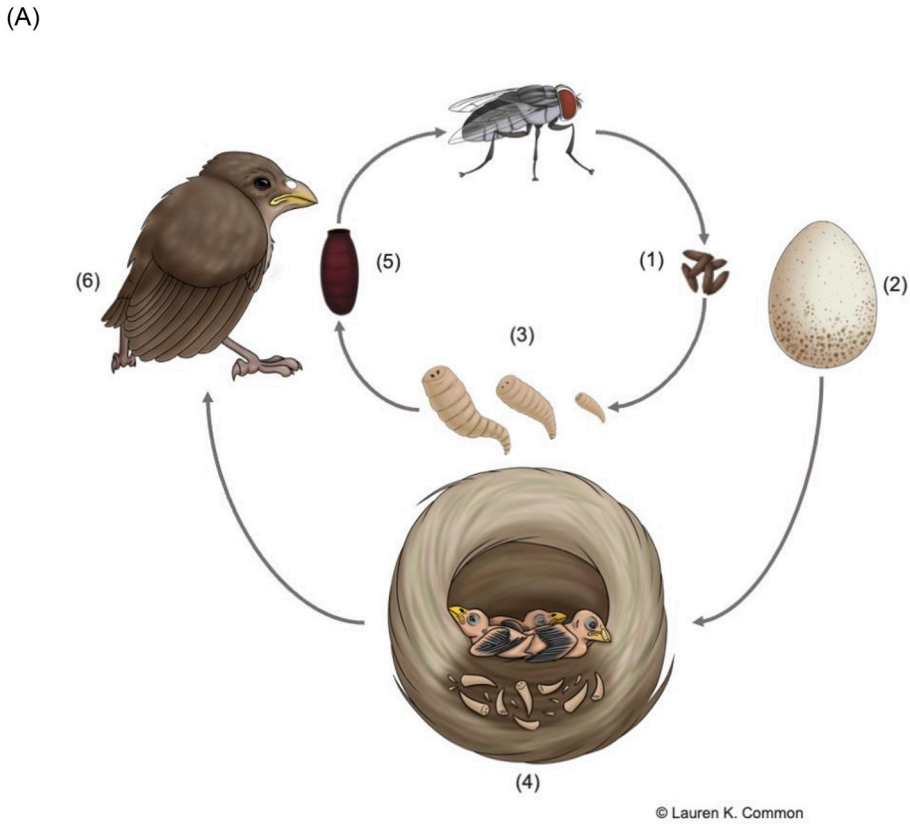


**Figure 2**

Life cycle of the avian vampire fly, whose larvae cause nostril enlargement in Darwin's finches. **(A)** The life cycle of the fly has several stages: (1, 2) eggs are laid in nests with finch eggs; (3, 4) fly larvae feed on the nestlings for 4–10 days; (5) fly larvae emerge as adults after 10 days; (6) if the nestlings survive, they get feathers after 14 days. **(B)** A nestling and an adult finch with enlarged nostrils from the avian vampire fly (drawing by Lauren K. Common).

fine nets strung between poles. The birds cannot see the net and fly directly into it, falling into the lower sagging pocket of the net. This does not hurt the birds (Figures 3B–E). We carefully removed finches from the mist-nets, rated their body condition, and fitted their legs with tiny colored bands that we could later use to identify them. We did this across 10 breeding seasons between 2004 and 2020. In total, we captured and fitted colored bands to 1,435 birds, including 744 small ground finches, 351 small tree finches, 191 medium tree finches, and 149 hybrid tree finches.

We also used binoculars to observe the feeding behavior of the color-banded birds. Most observations were made during February.

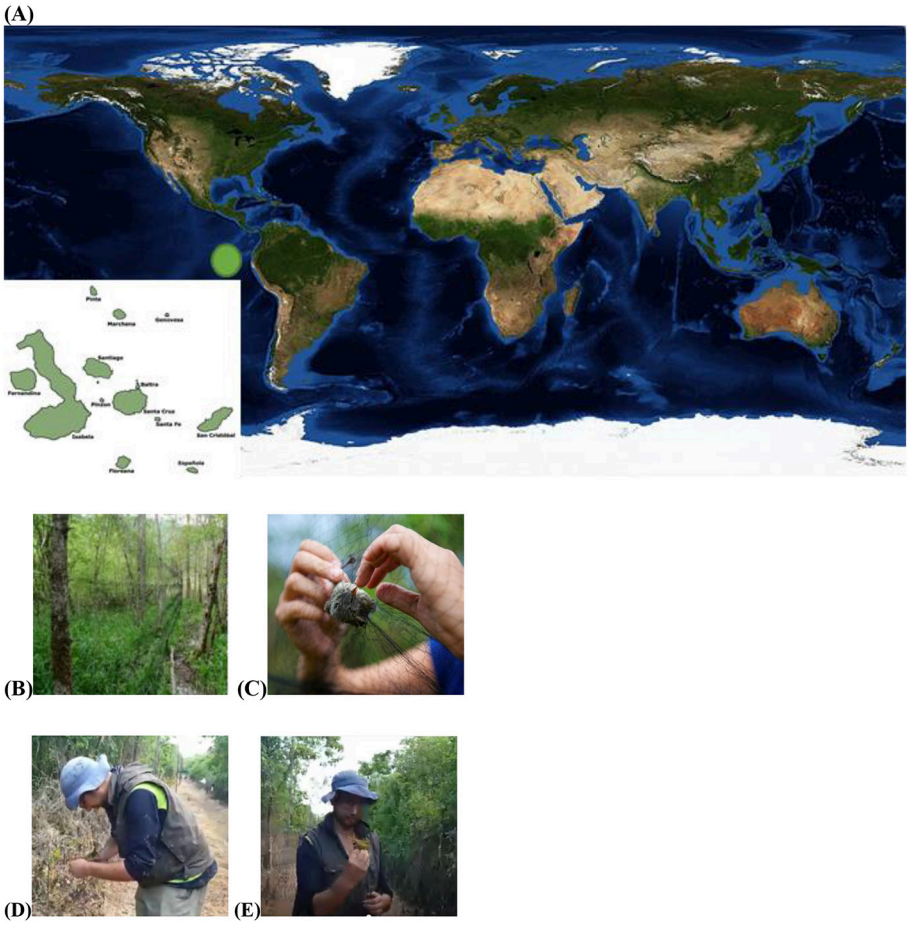


Figure 3

**Figure 3**

**(A)** Our study was conducted on Floreana Island in the Galápagos Islands, a group of islands located west of South America in the Eastern Pacific. They are part of Ecuador. **(B)** Finches were captured using mist-nets—very fine nets strung between poles. **(C)** The birds fly directly into the nets and fall into the lower sagging pocket. This does not hurt the birds, but they cannot escape. **(D, E)** After carefully removing the birds from the mist-nets, we collected data from them and then set them free [source: **(A)** NASA Earth Observatory (map); Lauren K. Common (drawing); photos by Josef Hemetsberger **(B)**, Bodo Peters **(C)**, and Lauren K. Common **(D, E)**].

We recorded the sex and age of each finch that was observed. We can usually tell whether a finch is male or female because males more than a year old have more black feathers, while females remain olive gray. We noted the type of surface on which birds were feeding, their feeding techniques, and what they were feeding on (plants, seeds, invertebrates, or unknown).

We also took into consideration the **beak loading stress** caused by different foraging techniques [5]. This might sound complicated, but it is actually pretty simple. Removing food from leaves and picking food off the surface puts very little stress on a finch's beak, whereas chipping pieces of bark off a tree branch puts lots of stress on the beak. It seemed very likely that nostril size might affect the birds' choice of feeding technique, as a bird with a large gaping hole in its beak (large nostril size) would not be able to exert as much pressure on the beak, and so may be less likely to chip at bark while searching for food.

**BEAK LOADING STRESS**

The amount of pressure put on a bird's beak during feeding.

## WHAT WE FOUND

More than one-third of adult finches (34%) had deformed beaks from parasitism! This beak damage changes the way that finches eat their

food. We observed that birds with deformed beaks removed prey from the surface of bark and leaves instead of extracting prey from beneath the surface. Usually, species of Darwin's finches differ in how they feed. We discovered that birds with deformed beaks caused by vampire fly parasitism all had similar foraging behavior: they gently removed prey from the surface. Also, birds with deformed beaks had much worse body condition: they weighed less for their body size.

Our findings suggest that early life experience with parasites can cause long-lasting changes in the foraging behavior of Darwin's finches. This leads to an imbalance in the lifestyle of the bird which, over time, can severely damage their ecosystems. Think of the trees that now have more grubs inside their barks, with no birds fit enough to remove them! The ecological consequences of a change in one organism can cause other changes that we sometimes do not see. The avian vampire fly is still causing problems on the Galápagos Islands. However, many teams of scientists are working together to understand the parasite and how we can help Darwin's finches survive its effects.

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## ORIGINAL SOURCE ARTICLE

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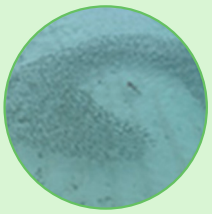
## YOUNG REVIEWERS

**KARUBAKEE, AGE: 12**
I like to read about space related facts and am highly interested in knowing about the world history. I also like to read fantasy books and listen to music.



**MARIE-LOUISE, AGE: 9**

My name is Marie-Louise (Izzy) and when I grow up I want to be a marine biologist. I have a pet tortoise named Heinz, like the ketchup and other sauces brand. For 3 years I have been living by the sea and already written two articles one of which was published on oceanographic magazine, here, besides marine biology I like STEM, skateboarding, and maths.

## AUTHORS

**DIDONE FRIGERIO**

Didone Frigerio is a behavioral biologist. Her main interest is the relationship between sociality and the processes that are going on inside the body (physiology) in group-living birds. She applies citizen science by involving pupils and citizens in her behavioral investigations. *didone.frigerio@univie.ac.at

**DIANE COLOMBELLI-NÉGREL**

Diane Colombelli-Négrel is a lecturer in animal behavior. Diane has been passionate about animal behavior since she was 7 years old and has moved from France to Australia specifically to study Australian birds. She studies how birds communicate, as well as how they can cope with changes in their environments.

**LAUREN K. COMMON**

Lauren K. Common is a parasitologist with an interest in birds. Lauren grew up loving all animals, including the gross ones, and now studies blood-sucking parasites and how they affect the birds that they feed on.

**ANDREW C. KATSIS**

Andrew C. Katsis is a behavioral ecologist. After growing up on an emu farm in Australia, he developed a passion for birds and their unique behaviors. He now studies personality traits in birds, and how seemingly small differences in behavior can affect survival and reproductive success.

**SONIA KLEINDORFER**

Sonia Kleindorfer is an expert in bird ecology and conservation with a main research interest in the role of individual differences for adaptive capacity and survival. She has long kept her eye on the impact of the avian vampire fly and is founding member of the Avian Vampire Fly Action Group with the Charles Darwin Foundation.