# Zoogeography

Lesson 23

# Islands: Getting There, The Challenges of Arriving

- Oceans are the most effective barrier to the distribution of land animals.

-organisms can normally only reach an island if they possess special adaptations for transport by air or water.

- Dispersal by a sweepstakes route.


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ntiago De
Caballeros
Las Terrenas
Dominican
Republic
Punta Cana
Santo
Domingo
La Romana
Aguadilla
Pueblo
San Juan
Puerto Rico
Caguas
Ponce
British
Virgin
Islands
US Virgin
Islands
Anguilla
Philipsburg
St Kitts
& Nevis
Antigua and
Barbuda
Montserrat
Guadeloupe
Basse-Terre
Dominica
Martinique

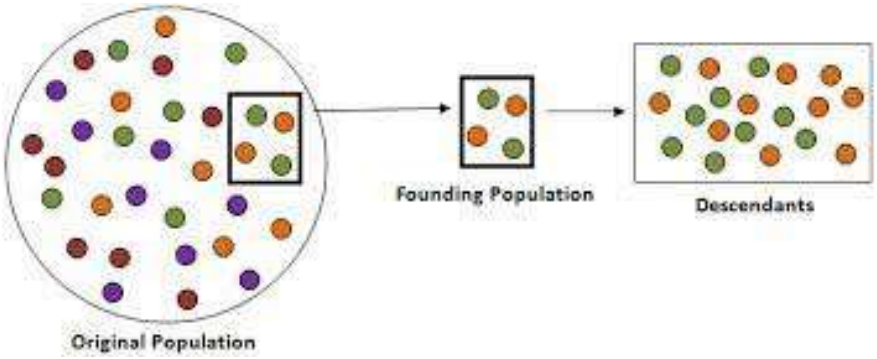
# Problems of Survival

- Island life is more hazardous than that on the mainland, for several reasons:
- - the small, isolated nature of many oceanic islands means that resident species do not have the option to move elsewhere when conditions deteriorate --> island populations are particularly sensitive to natural catastrophes.
- - An island will therefore contain a smaller number of species than an equivalent mainland area of similar ecology.



- for example, study of a 2 ha plot of moist forest on the mainland of Panama showed that it contained 56 species of bird, while a similar plot of shrubland contained 58 species.
- In contrast, the offshore Puercos Island, 70 ha in area and ecologically intermediate between the two mainland plots, contained only 20 of these species.

# Problems of Survival




- if the colonists are few in number, they can include only a very small part of the genetic variation that provided the mainland population with the flexibility to cope with environmental change; this is sometimes known as the **founder principle**.

- 1) **Random factors** such as fluctuations in sex ratios or age distribution, disease outbreaks or unusual weather events may wipe out the entire population.
- 2a) individuals in small populations inevitably end up breeding with close relatives – if they can even find a mate. This causes the phenomenon of **inbreeding depression**, resulting in lower fertility and less viable offspring.
- 2b) Even if a group avoids inbreeding depression, the effects of **genetic drift** (the process by which certain genes may disappear from a population, thereby reducing genetic diversity) are greater in small populations.

the extinction rate, in islands, is about 50 times as great as on the continents

- Chance extinction is a particular danger for predators, since their numbers must always be far lower than those of their prey. As a result, island faunas tend to be unbalanced in their composition, containing fewer predators and fewer varieties of predator than a similar mainland area.



- Less pressure on new arrivals or colonization by new species.

# Adapting and Evolving

- Colonists may encounter many difficulties when they first enter an island, but there are rich opportunities for those species that can survive long enough for natural selection to adapt them to the new environment.
- Opportunity for alterations in behavioural habits, diet and way of life provides in turn opportunity for the organism to become permanently adapted, through evolutionary change, to a new way of life.

# Due to the strong selection pressures, especially on small islands, dispersal traits can disappear remarkably quickly.

- 1. *Paratrechina longicornis* on the mainland normally nests only in open environments under, or in the shelter of, large objects; but on the Dry Tortugas (Florida) it also nests in environments such as tree trunks and open soil, which on the mainland are occupied by other species.

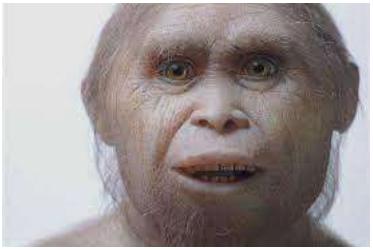

- 2. Another tendency is for island species (especially those on small islands) to **lose the dispersal mechanisms** that originally allowed them to reach their new home. Once on the restricted area of the island, the ability for long-distance dispersal is no longer of value to the species: in fact it is a disadvantage, for the organism or its seeds are now more likely to be blown out to sea (Many island insects are wingless – **18 out of the 20 endemic species of beetle on the island of Tristan de Cunha have reduced wings**).

# It is not unusual to find that island species are different in size from their mainland relatives

- this phenomenon has been discussed by the American ecologist Ted Case.
- Sometimes an island lacks a particular type of predator, because the size of the population of its prey is not large enough to provide a reliable source of food. This may decrease the death rate of the prey species and allow it to grow more rapidly.

- the Komodo dragon (*Varanus komodoensis*), a giant lizard which lives on Komodo Island and nearby Flores Island in the East Indies. These animals have dramatically **increased in size** to occupy niches which on the mainland are filled by much larger animals.

- fossils of what seems to be a dwarf species of human being, *Homo floresiensis*, only 1 m high and weighing only 25 kg, on Flores Island.



- The tendency for small island species to become larger and for large island species to become smaller is sometimes called the **island rule.**

# The Theory of Island Biogeography

- One of the most obvious characteristics of the biota of islands is that it is strongly affected by the **degree of isolation of the island**.

- the variety of the island life depends, in the short term, very much upon the **rate** at which **colonizing** animals and plants arrive.

- It depends largely upon **how far the island is** from the source of its colonizers, and upon the **richness of that source**.

# The Theory of Island Biogeography

- If the source is close and if its biota is rich, then the island in its turn will have a richer biota than another, similar island which is more isolated or which depends upon a source with a more restricted variety of animals and plants.

- Each sea barrier further reduces the biota of the next island, which in turn becomes a poorer source for the next.

Diversity is much lower in the more isolated island groups of the central and eastern Pacific.

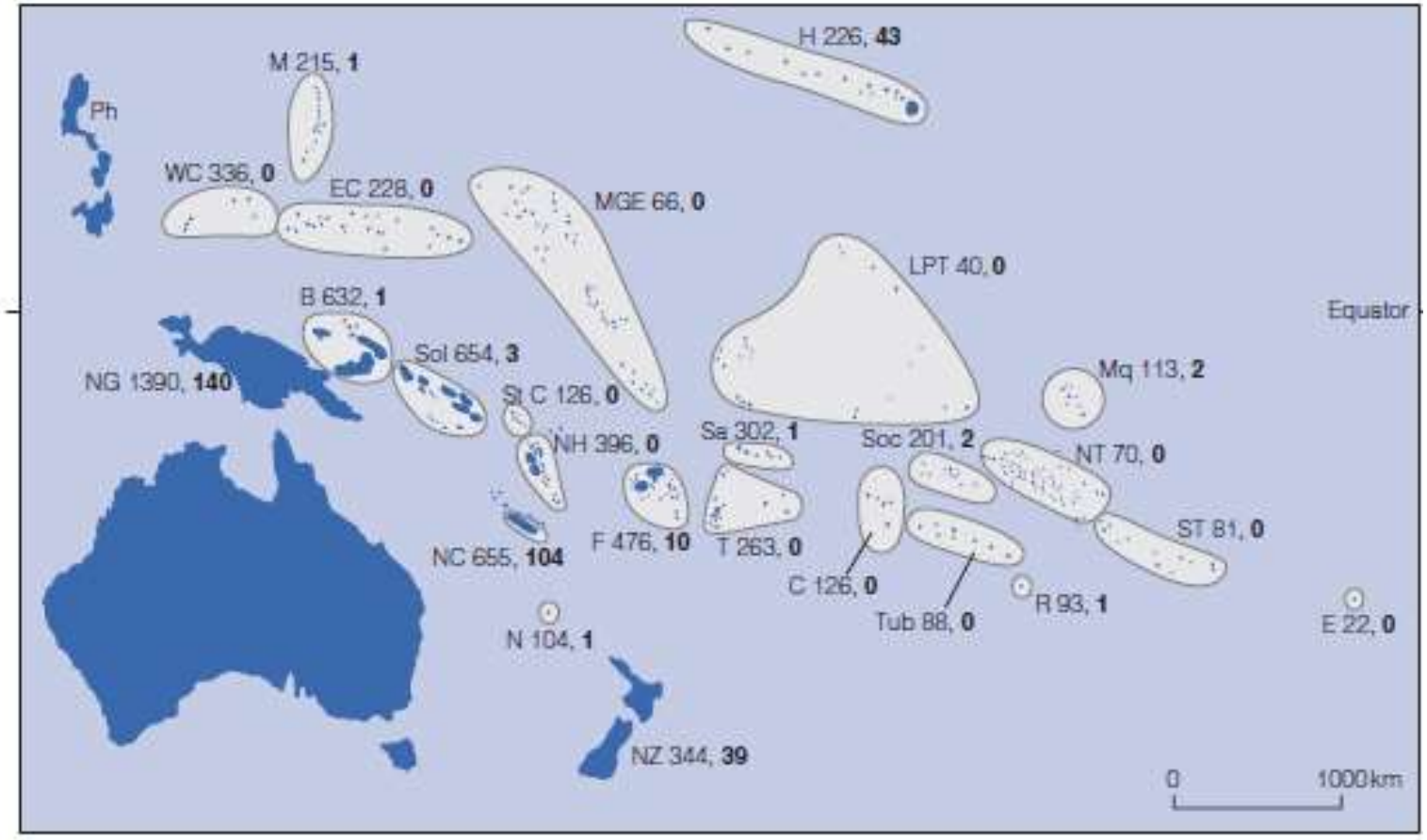



**Figure 7.6** The distribution of conifers and flowering plants in the Pacific Islands. The first number beside each island group is the total number of genera found there; the second is the number of endemic genera found there. B,

# The Theory o y

- the changing and ir l immigration would eventually lead to a rocesses.
- there is a strong co and and the number of species it contair
- the **rate of coloniza** ne island will be reached quickly by ersal, and because these will all be nev
- As time passes, imr species that have already colonized t **rance of new species will drop**

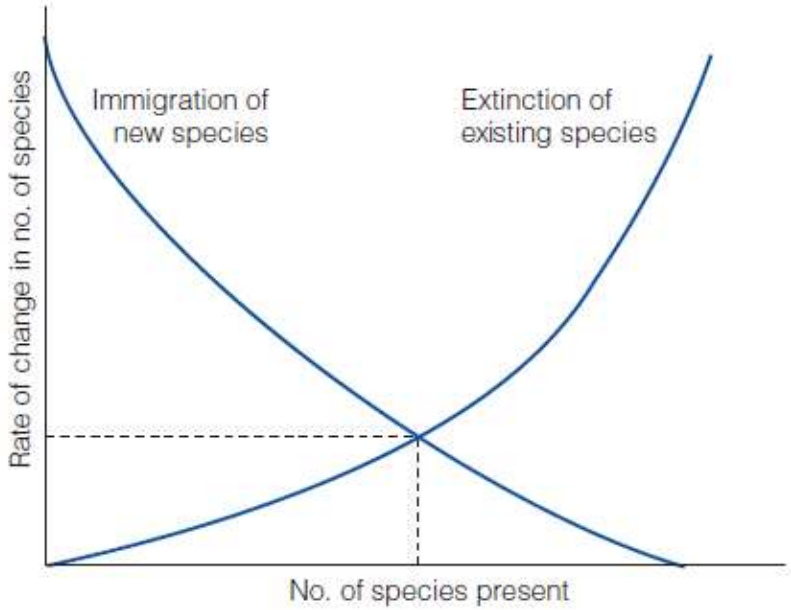



**Figure 7.8** Equilibrium model of the biota of an island. The curve of the rate of immigration of new species and the curve of the rate of extinction of species already on the islands intersect at an equilibrium point. The interrupted line drawn vertically from this point indicates the number of species that will then be present on the island, while that drawn horizontally indicates the rate of change (or turnover rate) of species in the biota when it is at equilibrium. Adapted from MacArthur and Wilson [72].

This effect of release from competition was especially noticeable in the antshrike (*Thamnophilus doliatus*). On the mainland, where it competed with over 20 other species of ant-eating bird, there were only eight pairs of antshrike per 40 ha; on Puercos Island, where there was only one such competitor, there were 112 pairs per 40 ha.


When considering the rate of turnover of species, the longevity of the dominant species is also important and its reproductive strategy

# Darwin's finches

**Figure 6.5** Galápagos ground finches with beaks of different size: from left to right, *Geospiza magnirostris*, *Geospiza fortis*, *Geospiza fuliginosa* and *Geospiza difficilis*.

- Two types of *Geospiza fortis*, with different beak sizes, live alongside one anot
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of Sou
Island
into 15 different species belonging to five
different genera.

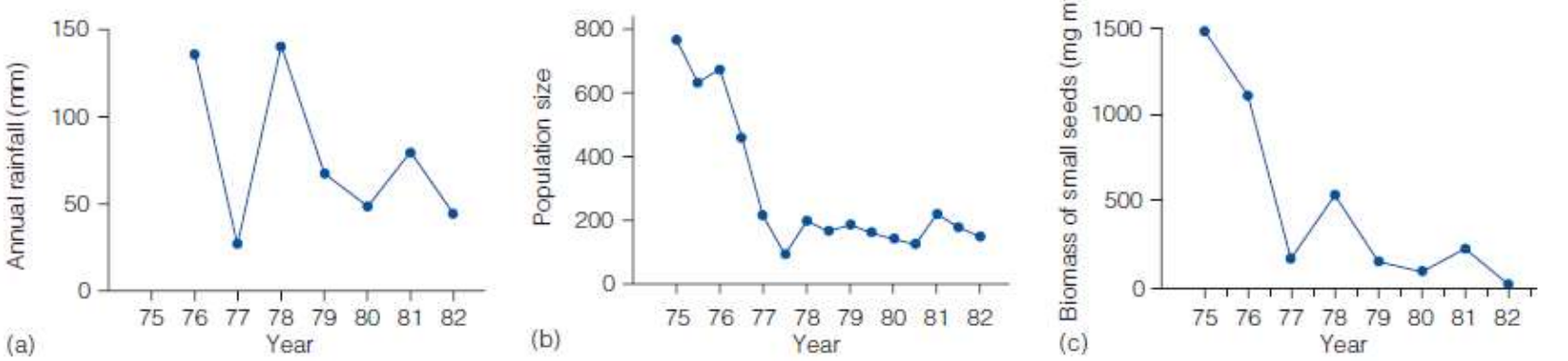



**Figure 6.7** Changes on the island of Daphne Major, 1975–1982. (a) Annual rainfall (that of 1975 is unknown). (b) Population size of *Geospiza fortis*. (c) Biomass of small seeds. Adapted from Grant [22].

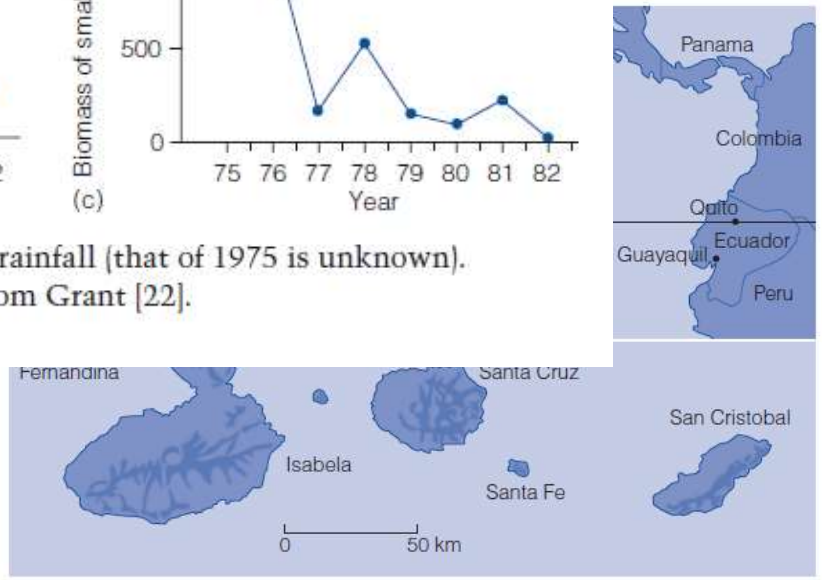



**Figure 6.4** Map of the Galápagos Islands.

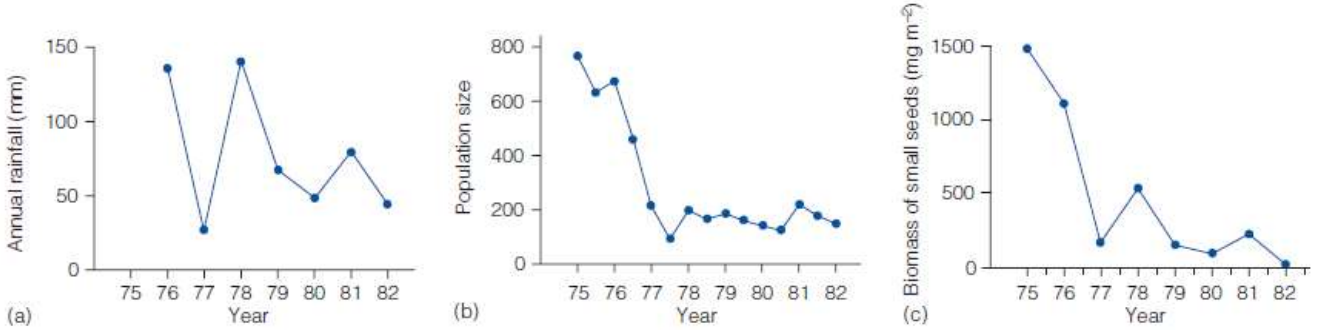



**Figure 6.7** Changes on the island of Daphne Major, 1975–1982. (a) Annual rainfall (that of 1975 is unknown). (b) Population size of *Geospiza fortis*. (c) Biomass of small seeds. Adapted from Grant [22].

1983: the year of the strongest 20th-century El Niño event; the rainfall was 10 times the previously known maximum. The island was drenched, and its plants grew rampantly – by June, the total mass of seeds was almost 12 times greater than in the previous year.

This time, small soft seeds predominated – they formed up to 80% of the total mass of seeds, up to 10 times more than the previous maximum.

By June, there were more than 2000 ground finches on the island, the numbers of *G. fortis* having increased by more than four times.
984 there was only 53 mm of rain, and in 1985 only 4 mm.

Now there was a new episode of drastic selection, but in the opposite direction from that which had followed the drought of 1973. Now it was selecting smaller birds, with smaller beaks, more suited to eating the plentiful smaller seeds.

# Mediterranean region; high biodiversity accompanied by a very long history of human activity

- The island of Crete is only 245 km long by 50 km wide and has been isolated as an island for about 5.5 million years.
- It has supported human populations since at least the arrival of Neolithic peoples about 8000 years ago.
- Since then, climatic changes have resulted in the development of very **dry conditions in summer**, and additional disturbance by **earthquake and volcano activity** has been experienced.
- The increase in human populations, their need for agricultural land and their intensive pastoralism have resulted in the stripping of much of the original vegetation.
- despite all this, Crete has 1650 species of plant, 10% of which are endemic to the island

It is possible that moderate human pressures can increase biodiversity as a result of diversifying habitats

## **ISLANDS** REPRESENT

**5.3%**

OF THE EARTH'S LANDMASS

UNEP-WCMC 2015

**75%**

BIRD, AMPHIBIAN, MAMMAL, AND REPTILE EXTINCTIONS

Tershy et al. 2015

**41%**

OF ALL CR AND EN TERRESTRIAL VERTEBRATES

Spatz et al. 2017

**19%**

AVIAN BIODIVERSITY

Tershy et al. 2015

## **INVASIVE** ALIEN SPECIES

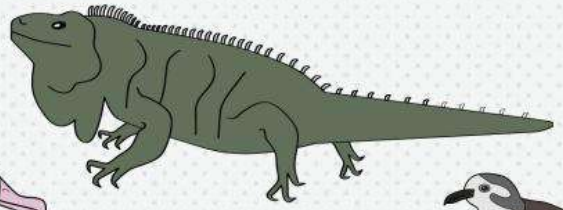
**86%**

OF RECORDED EXTINCTIONS LINKED TO INVASIVES OCCURRED ON ISLANDS

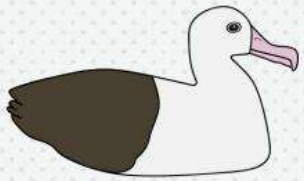
Bellard et al. 2015

# MAPPING THE DISTRIBUTION OF THREATENED ISLAND VERTEBRATES AND THEIR MAIN THREAT, INVASIVE SPECIES

## **1,189** HIGHLY THREATENED VERTEBRATE SPECIES



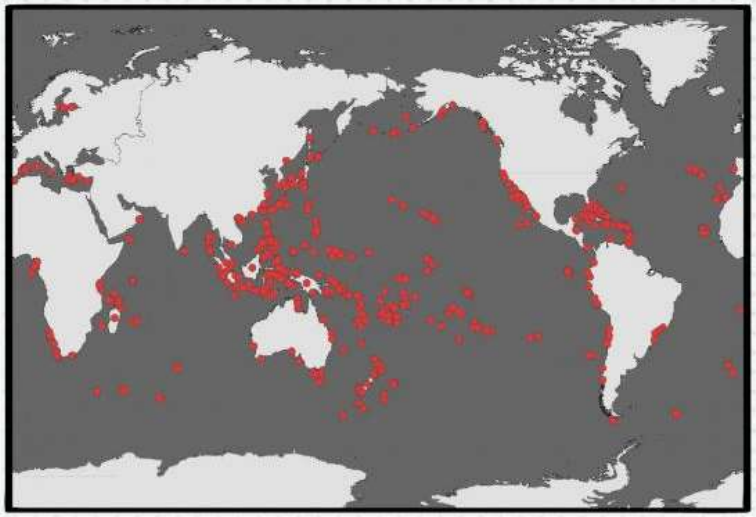
Mona Iguana



Tristan Albatross

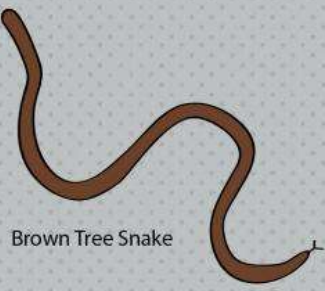
Polynesian Ground Dove

## LIVE ON **1,288** ISLANDS



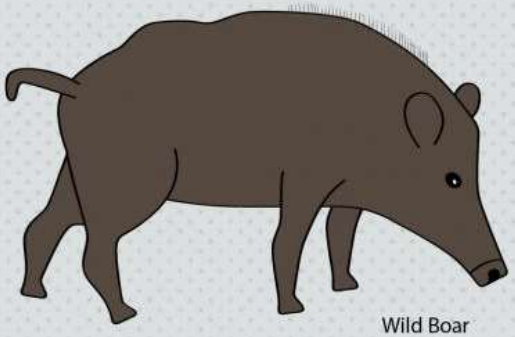
Cane Toad

Smooth-Billed Ani



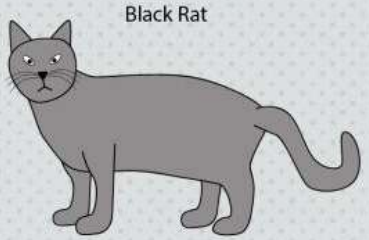
Brown Tree Snake

## INVASIVE VERTEBRATES ARE KNOWN TO LIVE ON **779** OF THE ISLANDS WITH HIGHLY THREATENED VERTEBRATES



Wild Boar

Black Rat



House Cat

## MAMMALS ARE THE MOST COMMON INVASIVE ANIMALS, FOUND ON **97%** OF THOSE ISLANDS

Spatz *et al.*, *Science Advances* (2017)

Science Advances | AAAS

Carla Schaffer/AAAS