

Island Biomes

PARADISE IN PERIL

BY BRENDA POSADA

Islands conjure up idyllic images of sandy beaches and swaying palm trees, but they are also home to some of nature's most extreme—and most endangered—life forms.

A plane



A plane crashes on a remote tropical island. Its marooned passengers soon discover that their new home is also populated by bizarre creatures—from marauding polar bears to a mysterious man-eating beast. This is the premise of *Lost*, currently one of TV's top-rated dramas. While the creatures on *Lost* may be fantastically fictional, the idea that islands

harbor unique and otherworldly creatures is very much rooted in reality. 

“Many of the world's gaudiest life forms, both plant and animal, occur on islands,” writes David Quammen in *The Song of the Dodo*, a book that engagingly examines island biogeography, the study of species distribution on islands.



BILL EDWARDS

“These improbable creatures...give vivid biological definition to the very word *outlandish*.”

Perhaps the creators of *Lost* had Quammen's words in mind when they plopped polar bears down on their uncharted desert isle. If the presence of arctic animals in the

▼ **The tiny Malay chevrotain or “mouse deer” inhabits the islands of Sumatra, Borneo, and Java.**



TAD HOTOYAMA

South Pacific setting seems utterly preposterous, imagine the Dutch pilot who in 1910 first reported seeing enormous “prehistoric” lizards living on the island of Komodo. Or the first humans to lay eyes upon the fearsome-looking “demon-headed” babirusa in the Indonesian archipelago.

Sometimes truth really is stranger than fiction.

THE BIG AND SMALL OF IT

It's impossible to discuss island creatures without employing the use of superlatives. From the dragons of Komodo to the devils of Tasmania, islands boast some of the world's biggest, smallest,

and most distinctive creatures. “Islands are the world's great repositories of biodiversity,” says Duane Silverstein, executive director of Seacology (www.seacology.org), a nonprofit organization devoted to preserving island habitats and cultures. A disproportionately high number of island species are also endemic—they're found nowhere else in the world. Take Madagascar, where more than 6,000 of its plants, 100 of its birds, and 80 of its mammals are found nowhere else.

Compared to their mainland relatives, island species tend toward either gigantism or dwarfism. The largest lizard, the aforementioned Komodo dragon, which measures up



TAD MOTOYAMA

▲ The Komodo dragon and Galapagos tortoise provide striking examples of the trend toward gigantism in island species.

to 10 feet long, lives on Komodo and neighboring isles. Giant tortoises weighing up to 600 pounds reside on the islands of Aldabra and the Galápagos. The fossil record is full of further examples, including dwarf elephants and pygmy hippopotamuses, which roamed the Mediterranean and Madagascar, respectively. California's Channel Islands were once home to a pygmy mammoth, the ultimate oxymoron.

The trend toward bigness or smallness on islands may seem arbitrary, but some patterns have emerged. Island mammals tend toward dwarfism; reptiles, birds, and insects toward gigantism. Many interrelated factors govern why a specific species grows bigger or larger, most importantly food availability, metabolism,

and the presence or absence of predators and competitors. To take one simplified example, if a small-bodied species has no predators and a plentiful food supply, over time it is likely to grow larger as the advantages of bigger body size (defense, better fat storage for lean times and body warmth) mean that the largest individuals of each generation are likely to produce more offspring that survive to reproductive age.

To take a counter example, for large mammals, food supply is more limited. The absence of predators leads to an overpopulation of the species, straining the available food supply. Smaller individuals, who need less food to survive, have a reproductive advantage. The result, over generations, is dwarfism.

Flightlessness is a common evolutionary outcome for island birds, and a logical result of the trend toward gigantism. Eventually, larger birds lose their ability to fly—or flee. When an island once free of predators is no longer so, flightless birds have a distinct disadvantage. The doomed dodo of Mauritius was the first recorded species to be driven to extinction by human activity, around 1692. The elephant birds of Madagascar and the moas of New Zealand fared no better, but some extant examples remain: The Galapagos cormorant is larger than all other cormorants, and the only one of its kind that can't fly.

In addition to big birds and miniature mammals are the just plain odd inhabitants of island biomes. Take Visayan warty pigs, found on only two



JACK JEFFREY

▲ Honeycreepers' bills are specialized based on each species' primary food source. The ʻIiwi mainly feeds on nectar from lehua blossoms.



TAD HOTOYAMA



▲ ▶ Male babirusa are known for their bizarre tusks, which, if they're not worn down or broken in combat, will eventually grow long enough to pierce the animal's skull.

islands in the Philippines. Males of this species grow long, floppy manes in November and shed them at the end of the breeding season. No other wild pig in the world is known to do this.

ISLAND INSPIRATIONS

Exactly why islands harbor the weird and wonderful of the world is a question that has prompted centuries of scientific investigation. History's most notable naturalists, Charles Darwin and Alfred Russel Wallace, who concomitantly hit upon the theory of evolution

by natural selection, both found inspiration in their travels to islands. Wallace made his most profound realizations in the islands of Southeast Asia; Darwin in the Galapagos.

Darwin and Wallace were not only drawn to islands for their unique creatures, but because their limited size and isolation render them veritable living laboratories. They allow patterns of evolution to be seen more clearly. What Darwin and Wallace realized is that from a single colonizing species, a number of different forms arise to fill

available ecological niches, each specially adapted to a particular environment or food source.

This process is now known as adaptive radiation. The finches of the Galapagos Islands, collectively called Darwin's finches, provide a classic example. In the Galapagos, 14 finch species arose from a common ancestor. Even more impressive are Hawaii's honeycreepers. From a single founder, a North American finch, at least 50 varieties arose to fill different available niches throughout the Hawaiian

Island Glossary

adaptive radiation: The diversification of a single species into several new species or subspecies that are each specialized to a specific ecological niche.

archipelago: A group or chain of oceanic islands.

atoll: A ring-shaped coral reef or string of coral islands.

biodiversity hotspot: Term coined by Dr. Norman Myers in 1988 to refer to a region characterized by high levels of both plant endemism and habitat loss.

biogeography: The study of the geographic distribution of species.

biome: An ecological community defined by climate and biology. Tropical rain forest, grassland, desert, and wetlands are examples of familiar biomes.

cay: A low island or coral reef.

colonization: The establishment and successful reproduction of a population in a place formerly unoccupied by that species.

continental island: An island that was at one time connected to a continent.

dispersal: The spread of animals, plants, or seeds to a new area.

endangered: A species that is in danger of extinction throughout all or a significant portion of its range.

endemic: Restricted to a specific geographic region.

islands. This specialization is most evident in the shapes of the birds' bills, from the slender, curved bill of nectar-gathering honeycreepers to the thick, stout bill of seed-eating species.

ISLANDS 101

Simply put, an island is a land mass surrounded by water. Despite the obviousness of this statement, there is ongoing debate over exactly what constitutes an island and whether larger land masses like Australia should be considered islands. Webster's dictionary defines an island as "a tract of land surrounded by water and smaller than a continent," which would rule out Australia. Though many of the same principles apply when discussing Australia's koalas and kangaroos as New Zealand's kiwis and kakaos, semantically speaking, Australia belongs in the realm of the continents.

An island's biological life has much to do with how and when it was formed. Generally speaking, larger islands have more species than smaller ones. Old islands have more species than young ones. Continental islands were once connected to a neighboring continent, and were therefore already inhabited by the flora and fauna of the mainland at the time they were formed. The similarity of life forms on a continental island to those on the mainland depend on the length of time since separation. If the separation occurred fairly recently, the island's flora and fauna will greatly resemble

that of the continent. Despite its close proximity to Africa, Madagascar harbors a wide array of species unlike any ever seen on the continent. Geologists estimate its separation occurred more than 160 million years ago.

Oceanic islands, on the other hand, evolve from a geologic process such as volcanic activity, and have to start from scratch. "A continental island begins with everything, and everything to lose," in Quammen's words, while "an oceanic island begins with nothing, and everything to gain."

How they gain is a process referred to as colonization. New species arrive mainly by flotation, being carried by wind, or in the case of birds and bats, flying. In 1883, the volcanic island of Krakatau erupted, killing off all living things on the island and creating a tsunami that destroyed 295 coastal towns and villages. But pretty much as soon as the lava cooled, the island—or what remained of it—began to rebound. Three years after the eruption, a visiting botanist recorded 11

different varieties of fern prospering on Rakata, the island's new name (the name was derived by removing the first and last letters from Krakatau). Ferns are good colonizers because their spores disperse easily on the wind. Twenty years later, a zoological expedition to Rakata noted the presence of birds, bats, and lizards. The number of species on Rakata is still increasing, under the watchful eye of scientists.

The first creatures to colonize an area after it has been devastated by volcanic blast are usually insects, which blow in on the wind and stick to cooling lava like flies to sticky paper. After the insects come birds, which usually arrive accidentally, blown off course during a storm, for example. Soon thereafter plants appear, either from buoyant seeds that make the journey by sea, lighter wind-borne seeds, or seeds carried on the wings or feet (or in the digestive tracts) of birds. Floating wood or vegetation acts as a raft for a variety of



▲ Oceanic islands (left) tend to be more isolated than continental islands, which are often found just offshore from the mainland.

exotic: An organism introduced to a region from elsewhere.

extinct: A species that is no longer in existence.

extirpated: A species that has been completely removed from a particular area, but which still exists in another area. Also known as locally extinct.

fauna: The animal life of a particular region.

feral: Formerly domesticated animals that have reverted to a wild state.

flora: The plant life of a particular region.

insular: Relating to, characteristic of, or situated on an island.

introduced species: An organism that has been brought into an area it did not previously inhabit, usually as the result of human activity.

Introduced species often compete with and cause problems for native species. Often called exotic, invasive, non-native, or alien species.

land bridge: A connection between two land masses, especially continents, that allows plants and animals to migrate from one to the other.

natural selection: A natural process tending to favor the survival of the fittest,the survival and reproduction of those individuals or groups best adapted to a particular environment.

niche: All the components of the environment with which an organism or population of organisms interacts, including its habitat and food supply.

oceanic island: An island that has never been connected to a continent. Oceanic islands usually arise as the result of volcanic activity.



RUSS SMITH

▲ Since its accidental arrival in Guam a half century ago, the brown tree snake has irrevocably altered the island's ecology and economy.

living things to make the journey.

Oceanic islands tend to be largely devoid of mammals, which don't travel as well across open water as birds and reptiles. Even if a mixed-sex pair does manage to make a sea crossing, the likelihood of them establishing a viable population in the new territory is slight. They just aren't as adaptable as reptiles, plants, and birds.

Continental islands are more likely to harbor mammals, which, if they weren't already present at the time of separation, may have swum over from the mainland or walked across a long-gone land bridge.

PARADISE LOST?

The very features that make islands hotspots of biodiversity also make them among the earth's most vulnerable ecosystems. "In the last 400 years, the majority of all plant and animal extinctions on this planet have occurred on islands," says Silverstein, who adds that in the United States, nearly three-quarters of all extinctions

have taken place on Hawaii, which composes less than 1 percent of our country's total land mass. Today, 85 percent of Hawaii's endemic plant species are in danger of extinction, according to the World Conservation Union (IUCN).

All island species are at risk, but life is much riskier for island birds and reptiles, according to the IUCN's recently released Global Species Assessment report. Of all recorded species extinctions since 1500 A.D., the report states, "In total, 62 percent of mammals, 88 percent of birds, 54 percent of amphibians, 86 percent of reptiles, and 68 percent of mollusks were island species."

The greatest threat to island species is the introduction of non-natives such as goats, pigs, cats, and rats. Invaders may directly prey on natives, outcompete them for food and space, destroy their habitats, or carry diseases for which locals have no natural resistance.

The combination of invasives and a small geographic range can be deadly for island species. "On an island, there's no place to run, no place to hide," explains Silverstein. "If a bird habitat is threatened on a major continent, there is very likely to be 50, 100, 1,000, or maybe only 3 or 4 other habitats for that bird on that same large continent. But more often than not on a small island, there will be just one little area where they live. And then a new predatory species is introduced, and that's it."

Perhaps the most dramatic example of this is the brown tree snake on Guam. Prior to the 1940s, Guam was home to only four species of snake; all were small and relatively harmless. At some point during the late 1940s or early 1950s, the brown tree snake—a

mildly venomous variety that grows up to eight feet long—was accidentally transported from its native range in the South Pacific to Guam, most likely as a stowaway on a military cargo shipment. With no natural predators and an abundance of small-bodied prey, this nocturnal climber proliferated in its new habitat. By the mid-1980s, the snakes had virtually emptied Guam's forests of their native birds and lizards. Twelve bird species, including the Micronesian kingfisher, were completely eliminated. Several others had their numbers drastically reduced.

The brown tree snake has become public enemy #1 on Guam, causing frequent power outages, killing domestic pets, and injuring children. They are responsible for millions of dollars in damage annually. Today, some forested areas contain an estimated 13,000 snakes per square mile, according to the U.S. Geological Survey. With little hope of ridding Guam of this pernicious pest, scientists are concentrating their efforts on keeping the snake from hitching a ride to other islands, like Hawaii. In the last five years, the USDA has trapped more than 5,000 snakes at Guam's international airport!

Whether they are introduced accidentally or intentionally, as in the case of the feral pigs on California's Channel Islands (see story on page 12), non-native species can wreak havoc on ecosystems.

Other factors contributing to the vulnerability of island species are habitat destruction, hunting, disease, the pet trade, and climate change.

Species inhabiting smaller islands are more vulnerable to extinction than those living large. If a population is small to begin with, the introduction of a new predatory species or the occurrence of fire, disease, or other natural event, may kill enough individuals that there is no longer a viable population left to perpetuate that species. Moreover, species on smaller islands may have weaker immune systems, according to a recent study by researchers at the University of Michigan. Small species' lack of immunity is a natural result of their being

exposed to fewer parasites in the course of their secluded existence. When new parasites are accidentally introduced to a small island, the native species are extremely vulnerable to infection.

The isolation that once protected island biomes has vanished, the victim of international air and boat traffic, commercial fishing fleets, and global communication and economy. Silverstein reflects, “The poet John Donne said, ‘No man is an island.’ If he were alive today, he might say, ‘No island is an island.’ They’re not really islands any more.”

THE HUMAN ELEMENT

The precarious state of island plant and animals species is mirrored by their human residents, according to Silverstein, who points out that island cultures and languages are also in dire straits. Rather than focusing solely on saving island wildlife, Seacology looks for solutions that address the needs of people as well.

With 109 projects throughout the world, Seacology works with island communities to figure out how to best help them protect their own environments. “We go to the island villagers and say, ‘What do you want? Not what we, sitting in an office in the U.S., say you should want, but what do you want in exchange for setting aside a forest reserve or a marine reserve for, say, twenty years?’ And typically they will say they want a school or a community center or a water-delivery system.”

Building such a facility in an impoverished region—where per capita income may be less than \$100 annually—helps villagers resist pressure from developers, logging companies, and commercial fishing fleets that seek to exploit their island’s natural resources. This in turn helps preserve those resources for generations to come. “You really can’t have effective conservation without taking into account people who live in the impacted areas,” says Silverstein.

How this equation works comes

home in one of several examples offered by Silverstein. The Hainan gibbon, the most endangered relative of the golden-cheeked gibbons housed at the Los Angeles Zoo, lives on Hainan Island off the coast of China. The biggest threat to its survival is deforestation, as the needs of the burgeoning human population for charcoal and lumber are fast depleting China’s forests. Working with a local China-based organization, Seacology reached an agreement with the four tribal villages on the outskirts of Bawangling Reserve, home to all known remaining Hainan gibbons (fewer than 20 individuals). In exchange for scholarships for roughly 200 middle schoolers (in a region where few kids stay in school past sixth grade), the villagers have promised to stop cutting down the trees. They are also being trained in alternatives like honey harvesting and herb farming. “So we’re helping to save arguably the world’s most endangered primate, and at the same time providing scholarships for every middle school-age child in four villages,” says Silverstein.

The Nature Conservancy (nature.org) and Conservation International (www.conservation.org) are among dozens of organizations that work to preserve fragile ecosystems, including some island regions. Among the Nature Conservancy’s projects are the Solomon Islands, the U.S. Virgin Islands, the Grenadines, Palau, and California’s own Santa Cruz Island. Conservation International focuses on saving biodiversity hotspots, areas that have already lost at least 70 percent of their original vegetation. Many of the 34 hotspots they have targeted are island regions, including Madagascar, Polynesia, and New Zealand.

While the plucky survivors of *Lost* continue their weekly struggle for survival, so too real-life island inhabitants face an uncertain future. Island species are about 40 times more likely to go extinct than their continental counterparts. Without widespread, collaborative conservation efforts between international and local communities, the fantastic flora and fauna of islands may soon only be the stuff of television and movies. □

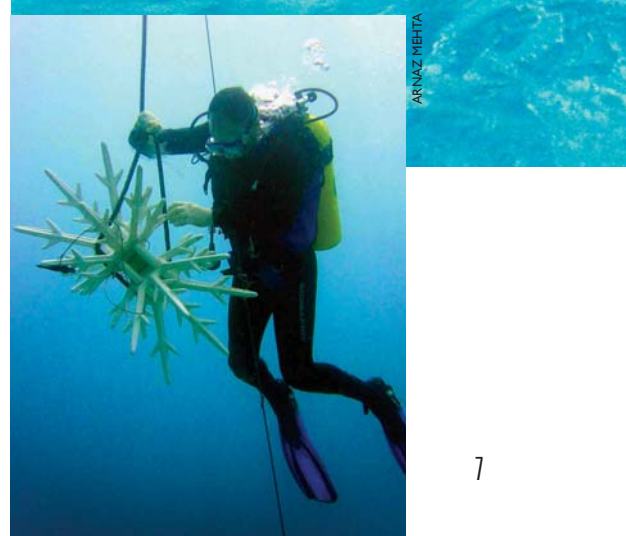


ZOOLOGICAL SOCIETY FOR THE CONSERVATION OF SPECIES AND POPULATION

▲ ► Seacology projects include guarding Vietnam’s Cat Ba langur, building community centers (like this one in Papua New Guinea) in exchange for rain forest preservation, and installing EcoReef modules to rehabilitate coral reefs in Indonesia.



DON ARNTZ



ARNAZ MEHTA