From Isolation to Globalization

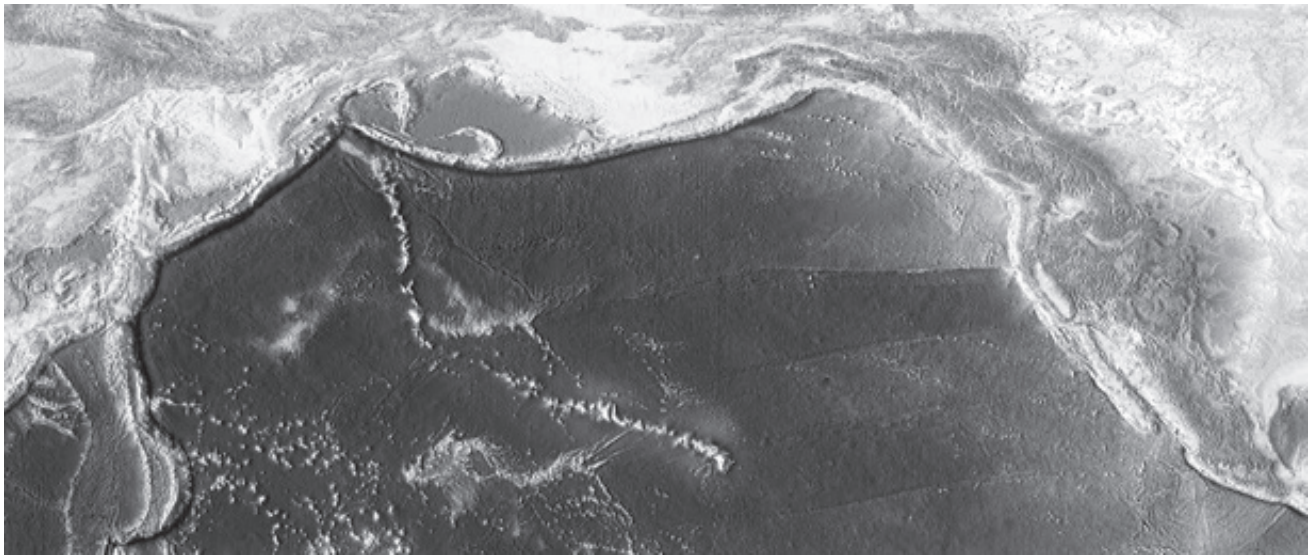


Photo courtesy of NOAA National Oceanic and Atmospheric Administration

The Hawaiian archipelago is the most remote high island group on the planet. Approximately 2,400 miles away from the nearest continent, the Hawaiian Islands arose as volcanoes from a hotspot on the ocean's floor. (The newest Hawaiian island, Lō'ihi, has yet to break the sea's surface.) After these islands emerged and cooled, how were they populated with plants and animals?

The first **native** Hawaiian species arrived here without the help of humans, via the three Ws: wind, wings, and waves. Birds flew and fish swam here, perhaps swept off course by storms. Seeds, spores, tiny snails, spiders, and insects were carried in the muddy feet and feathers, and digestive tracts of birds, blew over in strong gusts of wind, or drifted here atop ocean debris.

Spiders travel by ballooning—sending threads of web up into the air and getting carried up into the jet stream. Illustration by Shannon Wianecki

Soft-skinned amphibians didn't stand a chance of surviving this arduous journey. Reptiles and land mammals couldn't make it either. As a result, Hawai'i has many thousands of native insects but only two native mammals. Do you know what they are? One swims, the other flies. (Answer on the last page.)

Scientists estimate that a new species successfully established itself in the Hawaiian Islands once every three to five thousand years on average. After a plant, bird, or insect found its way here, it had to settle in, survive, and reproduce.

The Hawaiian Islands offered an assortment of terrains and climates with potential to nurture a particular colonizer — ranging from sunny beaches to dry, desert-like lava plains to mist-drenched rain forests and snow-capped-mountains. Each of these **ecosystems** supports a unique community of living organisms.

Evolution and Adaptive Radiation

The environmental pressures and opportunities of their new home caused many of the Hawaiian archipelago's first species to adapt and change. Over tens of thousands of years, some of the

original pioneers' descendents evolved into separate species, distinct from their ancestors. **Evolution** results from genetic changes occurring in populations over time. How does it work? With each generation, accidental, genetic mutations confer a benefit to a species. The mutation allows the species to live longer and produce more offspring, who in turn display the mutation. Soon the "mutation" becomes the new norm.

In the Hawaiian forest, birds with a genetic mutation for long, curved beaks were better able to reach the nectar of tubular flowers than those with short, straight beaks. On the summit of Haleakalā, shrubs with silver, hairy leaves could best resist the intense sunlight.

To thrive in the Hawaiian environment, species slowly adopted new characteristics and jettisoned others. Since ancient Hawai'i lacked most predatory mammals, defenses against them were no longer needed. As a result, raspberries lost their sharp thorns, mints lost their mint oil, and large ducks and geese lost the ability to fly. When a group of descendents becomes substantially different from its ancestor, it is considered a new species. These new species are **endemic** to Hawai'i. They evolved here and are found nowhere else on earth.

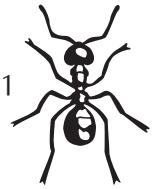
Some pioneer species evolved into not just one but many new species. This phenomenon, called **adaptive radiation**, happens when a species' descendants take advantage of multiple environments. For example, a Eurasian rosefinch arrived in Hawai'i about five million years ago. Over many generations, its descendants developed different beak shapes to occupy a slightly different niche, or ecological role. Some had long, curved beaks for sucking nectar, others had short beaks for foraging for small seeds, and still others had thick, parrot-like beaks for prying grubs from dead wood. An estimated 52 species of Hawaiian honeycreepers evolved from that single ancestral finch.

Hawai'i was uniquely suited to support evolution and adaptive radiation. Because of the Islands' extreme isolation, species could evolve without repeated introductions of new genetic material. They also had many, diverse ecosystems to occupy. Because of this, scientists consider Hawai'i an unparalleled showcase for the study of evolution.

Hawaiian sailing canoe. Painting courtesy of Herb Kāne.

Humans Arrive—Along with the First Invasive Species

Against this backdrop, the first humans landed in the Islands about 1,000 years ago. The Polynesian voyagers traveled here in seagoing canoes, and brought plants and animals with them. The thirty-odd plant species they brought are known as Polynesian introductions, or **canoe plants.**



While not native, they have special cultural status; they were critical to the survival of the first Hawaiians and continue to be culturally important.

In general, these plants did not have a major impact on the native environment of Hawai‘i, as most of them did not readily disperse into the wild on their own. Neither did the animals the early Hawaiians brought; relatively tame dogs, chickens and Polynesian pigs stayed within the villages—with one exception: the Polynesian rat. If you don't count humans, the rat was first **invasive specie**s to reach Hawai‘i.

Invasive species are non-native, or alien, species that directly prey upon or outcompete native species for resources. They tend to mature quickly and aggressively take over new areas. The Polynesian rat met these criteria dramatically. It preyed upon seeds, birds, and bird eggs, literally transforming landscapes and contributing to the extinction of numerous endemic Hawaiian species.

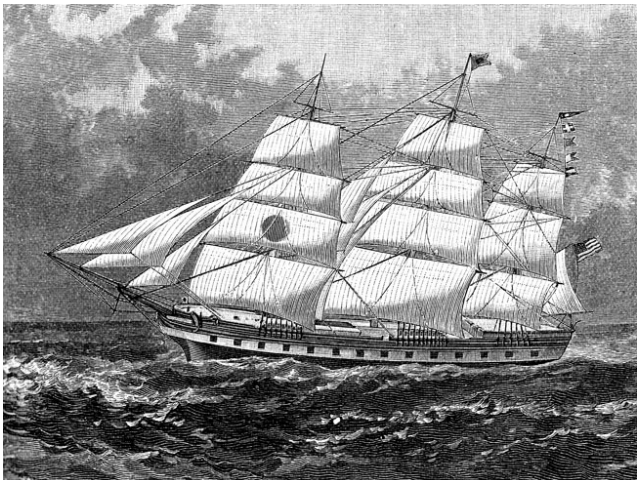


Photo courtesy of Wikimedia Commons/karenwhimsy

In 1778, when foreign ships starting calling on Hawai‘i, alien species began arriving en masse. Some species were brought intentionally; others came as stowaways. Some, like the canoe plants, did not cause much harm. Others jumped ship and immediately started wreaking havoc on the existing natural communities. Diseases carried by mosquitoes, such as avian malaria, further devastated the native forest bird population. Hawaiian honeycreepers had no resistance to the foreign disease. **Ungulates** (hoofed animals, such as cattle, sheep, and goats) caused considerable damage when set free in natural areas. They ate native herbs, shrubs and trees, and tore up the forest's blanket of mosses and ferns with their hooves, creating muddy wallows—perfect conditions for breeding mosquitoes.

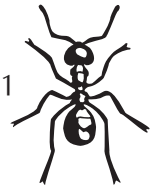
Hawaiian plants that had long ago abandoned their ancestors' built-in defenses against mainland predators were extremely vulnerable. Many native species became rare, surviving only in steep gulches and cliff faces where hungry goats and cows could not reach them. Even there they faced competition from aggressive new weeds.

These rapid and dramatic changes to the natural environment of Hawai‘i drove many of its native species to extinction. Many others are considered endangered: in immediate danger of becoming extinct. Hawai‘i is now known as the "extinction capitol" of the United States.

Defending our Natural Resources

To prevent further losses, government agencies such as the State of Hawai‘i, National Park Service, and private organizations such as The Nature Conservancy, work hard to protect the precious environmental resources of Hawai‘i. Natural resource management projects include fencing areas to keep feral (wild) ungulates out, replanting rare native plants, controlling the most damaging invasive plants and animals, and establishing and enforcing rules against the import of new pests.

Today, between twenty and thirty new species successfully colonize the Islands every year, originating from all points of the globe. While many of these newcomers are benign, causing no problems, some have become serious pests: invasive species capable of disrupting the natural, dynamic balance of native Hawaiian ecosystems.



Miconia, a fast-growing tree native to Central and South America, is considered one of the worst invasive species currently invading Hawaiian rain forests. A serious pest in Tahiti, miconia aggressively spread through the native forest there, driving fifty endemic Tahitian plant species to the verge of extinction. When miconia was discovered in an East Maui botanical garden in 1991, conservationists recognized the danger. Volunteers from many different agencies banded together to prevent it from spreading here. This led to the eventual creation of the Hawaiian Islands' invasive species committees (ISCs). Each county in the state of Hawai'i now has a team of people devoted to combating alien pests.

In the best possible scenario, invasive species are stopped at the border, before they reach Hawaiian soil. Prevention is the least expensive, most effective method for dealing with pest species. Early detection is the next best option. When species is discovered soon after its arrival, before it has had the opportunity to naturalize, or begin reproducing in the wild, it can be effectively controlled. In these relatively rare cases, a species can be eradicated, or removed completely from an environment.

Unfortunately, miconia was detected around thirty years too late for eradication on Maui. Birds had already spread its seeds far beyond original plantings, into the rain forest. Unless discovered early, pests become too widespread and resource managers must settle for containment—keeping an established pest from spreading to new areas.

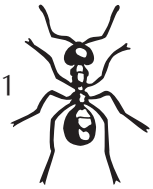
Field crews now go out regularly to pull miconia plants. Helicopters spray herbicide on larger plants from the air before they produce seeds.

Containment is expensive. Unless natural resource managers can employ another strategy, the grueling work of containing miconia and other invasive pests will be a perpetual, major expense for communities to bear. Other strategies do exist. From the time that miconia was discovered invading the Pacific Islands, scientists have been researching the feasibility of biological control: using natural predators from a pest's native habitat to slow the spread and lessen the damaging effects of an aggressive invader. Researchers have identified both a fungus and a stem-boring weevil that attack miconia. Ideally, these and other biological controls will slow the plant's unchecked growth, preventing it from dominating native Hawaiian forests.

Sam Akoi Sr. uproots a miconia tree in the Hāna rainforest. Courtesy of Maui Invasive Species Committee

Biological controls do not eliminate a pest, nor are they a quick fix. Scientists spend years carefully researching and testing a potential biological control agent before it is approved for release. They select species that will only attack the desired target.

Ultimately, protecting the Hawaiian Islands' natural environment will require a combination of strategies. There is still much worth protecting. Hawai'i still boasts the highest percentage of endemic land and marine species in the world. Considering its small landmass, the Hawaiian archipelago contributes disproportionately to global biodiversity, a collective term for all of the unique species on the planet.



For many millions of years, life on these islands evolved in isolation. Native Hawaiian plants, insects, birds, and marine species developed mutually dependent relationships over long stretches of time. Now, because of globalization, the modern development of a worldwide economy, complete isolation is impossible. New species currently arrive regularly. Some will become pests; others won't. Without human enterprise, these pests never would have found a way to these remote islands. Meanwhile, many native species continue a sad march towards extinction.

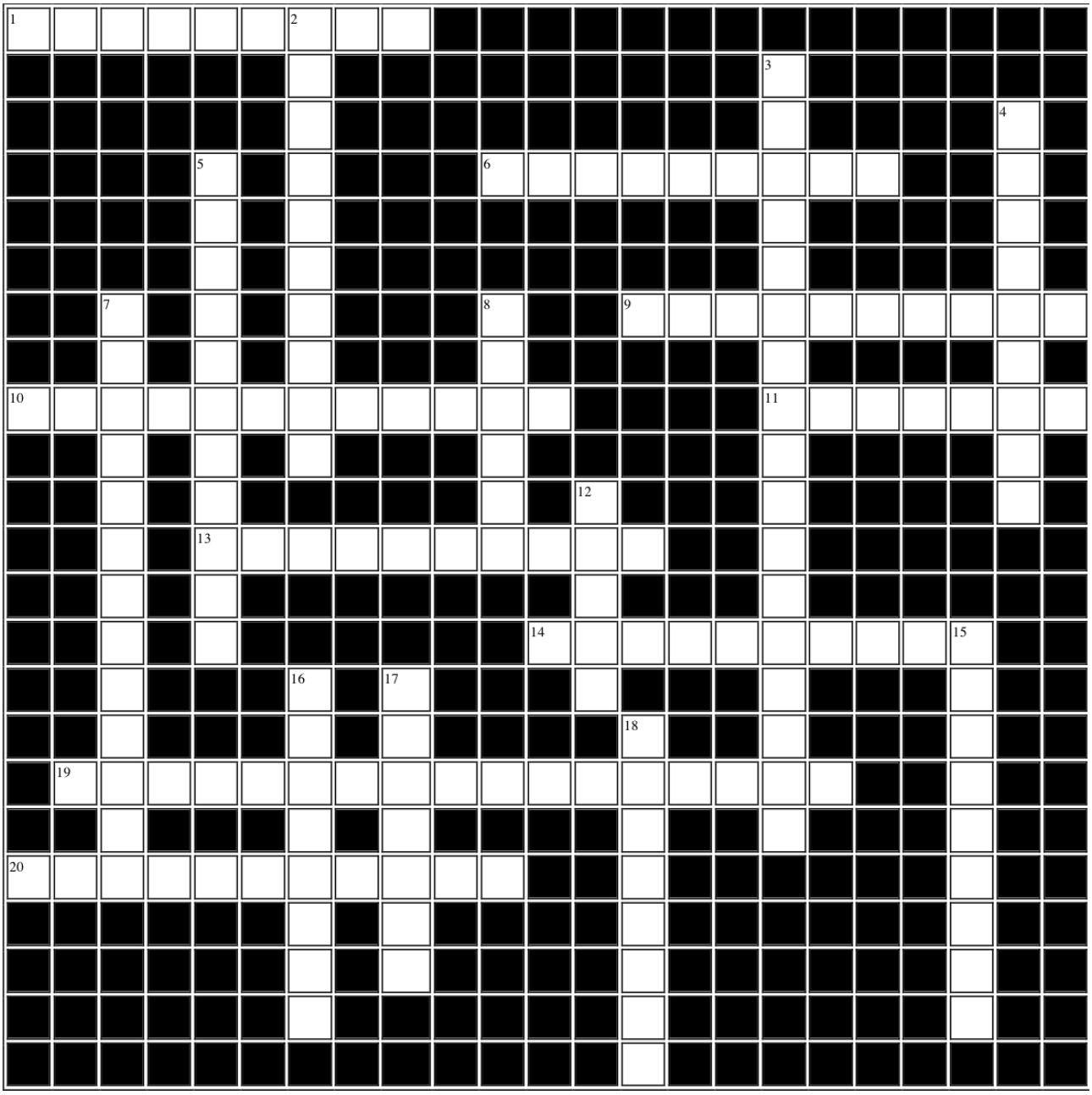
Stewardship can help. While we can't take Hawaii back to the pristine landscape it was prior to human contact, we can decide how we want to affect its future.

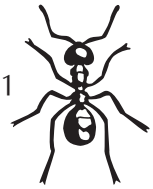
Answer from page one: The two native Hawaiian mammals: *ʻīholo i ka uaua*, the Hawaiian monk seal and *ʻōpeʻapeʻa*, the Hawaiian hoary bat.

Photo courtesy of Shannon Wainecki

Photo courtesy of the National Oceanic and Atmospheric Adminstration

Invasive Species Crossword





Down

2. non-native; brought from elsewhere
3. the development of many species from a single ancestral population (2 words)
4. genetic changes occurring in a population over time (usually accompanied by physiological and morphological changes)
5. a resource management strategy for keeping an established pest from spreading to new areas
7. the development of an increasingly integrated world economy marked especially by greater international travel and exchange of goods
8. a species that arrived or evolved in an area without the influence of humans
12. escaped from domestication and living in the wild
15. a community of living organisms and the nonliving environment they occupy
16. hoofed mammal
17. a fast-growing tree with large leaves, native to Central and South America; one of worst invasive species in Hawai‘i
18. a non-native species that directly preys on or outcompetes native species for resources

Across

1. the condition of being solitary, remote, not subject to frequent introductions of new species
6. to completely eliminate
9. native to an area
10. the various species of plants and animals in an environment
11. unique to a particular area; native to no other place on earth
13. in immediate danger of becoming extinct
14. to begin reproducing in the wild; said of non-native species that are becoming established
19. a method of mitigating the effects of an invasive species by releasing a natural predator from the species' native range into the environment (2 words)
20. plants brought with by the first Polynesian settlers, also called Polynesian introductions (2 words)