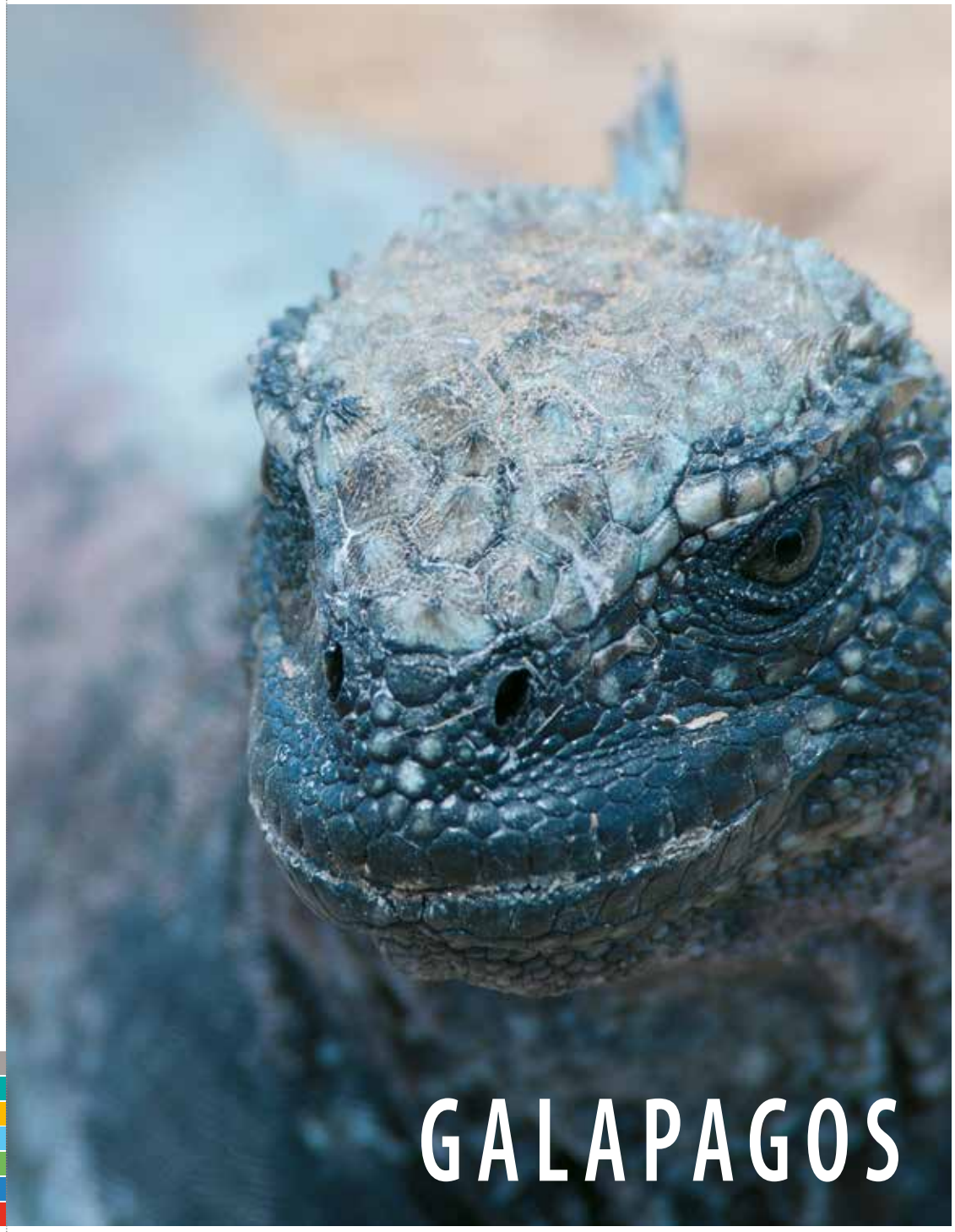
GALAPAGOS



GALAPAGOS

zoological
museum

University of Zurich

Companion guide book to the exhibition "Galápagos" of the Zoological Museum of the University of Zurich, Switzerland

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Galápagos

Companion guide book to the exhibition of the Zoological Museum of the University of Zurich, Switzerland

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"The Galápagos Islands is one of those places that has literally changed the way that we look at the world. Having been fortunate enough to visit there myself, I am delighted that so many others can now enjoy and be inspired by the natural treasures found there. I am so pleased that my Foundation for Building Community is working with the Charles Darwin Foundation, the Galapagos Conservancy and local authorities to address the huge challenges posed to the natural environment by ecotourism and human settlement on the Islands. I hope that their work to create new Eco-pattern books for buildings and infrastructure can ensure that people and Nature are in harmony in this very special place."

HRH The Prince of Wales

"I travelled from North to South and from East to West, all over the five continents. After thirty years of expeditions in the most incredible and inaccessible places, under the sea and above the water, where I filmed and studied nature, I can state that I loved Africa for the unique beauty of its terrestrial wildlife and I loved the Great Barrier Reef for its magnificent sea life.
But if I had one place to chose, just one place, this would be the Galápagos Islands. It is the only place, where both underwater and terrestrial biodiversity will take you beyond what you could ever dream. And as Charles Darwin wrote: "I am fully convinced.""

Grégoire Koulbanis
Geographer & Master in Environmental Sciences
Film Director
Expedition Leader for the late Captain Cousteau

"Several enjoyable years in Ecuador allowed me and my family the opportunity to discover the Galápagos Islands and their special and unique environment. The preservation of the islands should be supported by all of us for the benefit of future generations so that they may enjoy the diversity of its wildlife and its exquisite beauty."

Peter Brabeck-Letmathe
Chairman of the Board of Nestlé

„Galápagos – eines der letzten Paradiese: unberührte wilde Natur, endlose Strände mit hunderten von Seelöwen, Iguanas, Riesenschildkröten und eine grosse Vielfalt von exotischen Vögeln. Meine Lieblingsvögel sind die Boobies mit ihren herrlich blauen Beinen, die wie angemalt aussehen.
Hoffen wir, dass uns diese einzigartige Welt erhalten bleibt. Die Chancen stehen gut, gehören die Galápagos-Inseln doch zu den World Heritage Sites von UNESCO."

Renata Jacobs
Member of the board of Jacobs Holding AG, Zurich
Founder of the charitable project „Cartoneros y sus Chicos", Buenos Aires, Argentina

"Magma y piedra sin edad ni tiempo en sus recodos
palpita la eternidad y emerge la esperanza."

Tomás Ochoa
Ecuadorian visual artist

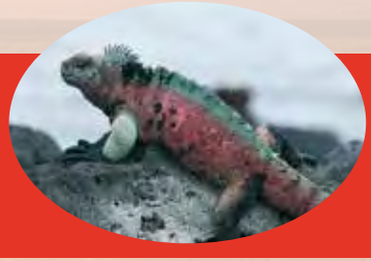
„Es gibt nur wenige Momente im Leben, die einem für immer in Erinnerung bleiben. Ein Sonnenaufgang vor einer kleinen Insel auf Galápagos war ein solcher. Von einem Augenblick zum anderen erwachten tausende von Vögeln – erst wenige, dann hunderte setzten sich in Bewegung und flogen von der Insel weg. Dies war unendlich eindrücklich und ich werde das Bild und die Stimmen der Vögel nie vergessen."

Reto Ringger
President of the board of WWF Switzerland,
Founder of Globalance Bank and SAM Group

"Quedé encantada con la belleza natural y el ambiente tan especial de las Islas Galápagos. Pocas veces en mi vida me he sentido tan conectada con la naturaleza y el universo. Fue maravilloso y me llenó de energía. Llevo ese mágico momento conmigo y desearía que todos pudiesen tener esta experiencia."

Patricia Guerra
Honorary Consul of Ecuador in Zurich
Partner of Meyerlustenberger Lachenal, attorneys-at-law

ISLANDS OF FIRE: BARREN YET DIVERSE



The Galápagos Islands were created by volcanic eruptions, which continue to shape them even today. Only a relatively short time ago, new habitats for plants and animals emerged – in complete isolation – in the middle of the ocean. The islands are located at the equator in the tropics, but the climate is subject to significant seasonal variations, because warm and cold ocean currents meet here and interact with each other. Above all, the region is extremely arid. That's why plants adapted to dry climates predominate. However, the higher an island, the greater the variety of plant communities. These, in turn, provide ideal conditions for land snails, which are herbivores and use the plants for shelter. A single snail species, originating from the South American mainland, evolved into over 60 species on the Galápagos Islands.

"... as far as the eye could reach we saw nothing but rough fields of lava, that seemed to have hardened while the force of the wind had been rippling its liquid surface [...] About half way down the steep south east side of the Island, a volcano burns day and night; and near the beach a crater was pouring forth streams of lava, which on reaching the sea caused it to bubble in an extraordinary manner." – This is how Captain Lord Byron described a volcanic eruption in 1825 as he lay at anchor off Fernandina during his long journey to the Sandwich Islands.

Volcanic islands

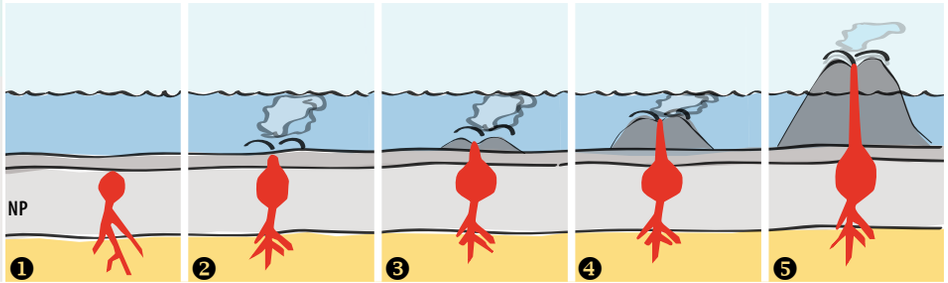
The Galápagos Islands are of volcanic origin. On Isabela and Fernandina, some volcanoes are still active. The westernmost island, Fernandina, is the centre of volcanic activity. Below it, a magma chamber of molten rock is located deep down in the earth's interior. This hotspot is the origin of the Galápagos Islands.

The temperatures below the plates are so high that they partially melt the rock. This subterranean molten mass is called magma. As soon as it is expelled to the surface of the earth, it is called lava.

❶ Hot magma presses into the fissures of the Nazca Plate (NP) and creates chambers close to the surface.

❷ The heat of the magma melts the earth's surface crust, causing a volcanic eruption on the ocean floor.

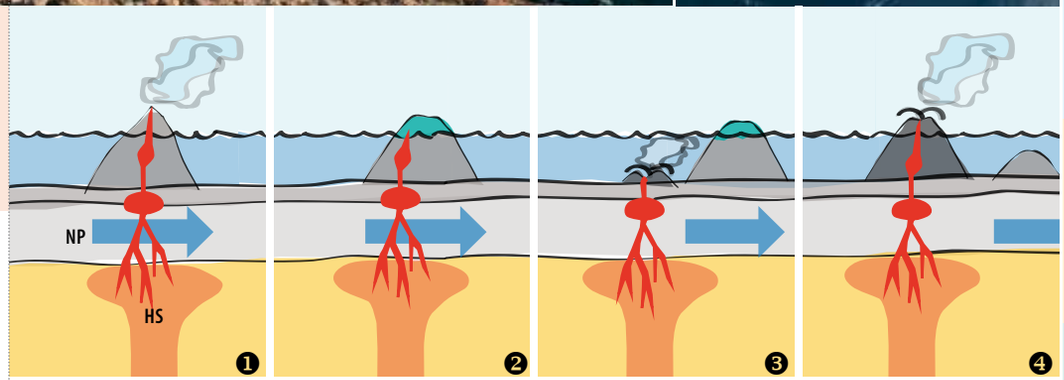
❸ – ❺ With every eruption, new layers of lava increase the size of the volcano until it breaks the ocean surface to form a new island.



The crust and the upper part of the earth's mantle (lithosphere) consist of plates: seven major plates and many small ones, which are more or less mobile. The largest plates carry continents such as South America, Africa or Eurasia. Smaller plates can carry islands, such as the Galápagos Islands on the Nazca Plate.

Completely isolated islands

The Galápagos Archipelago is completely isolated in the middle of the Pacific Ocean, about 960 km off the west coast of South America. It consists of 19 main islands (larger than 1 sq. km) and many smaller islands as well as numerous islets and rocks. They are spread over more than 120,000 sq. km of ocean and consist of a total land surface of about 8,000 sq. km.



Islands in motion

The Galápagos Islands are located on the Nazca Plate, which moves towards South America at a rate of about 6 cm per year. While the islands move, the hotspot – the origin of the volcanic islands – stays in the same place.

❶ The Nazca Plate (NP) moves above the fixed hotspot (HS), the magma chamber.

❷ On its journey atop the Nazca Plate, the volcano gradually loses its connection to the magma chamber and becomes extinct.

❸ The magma chamber creates a new volcano.

❹ The old island is eroded mainly by wind and weather, causing it to decrease in size until it disappears from the ocean surface.

Young volcanic islands

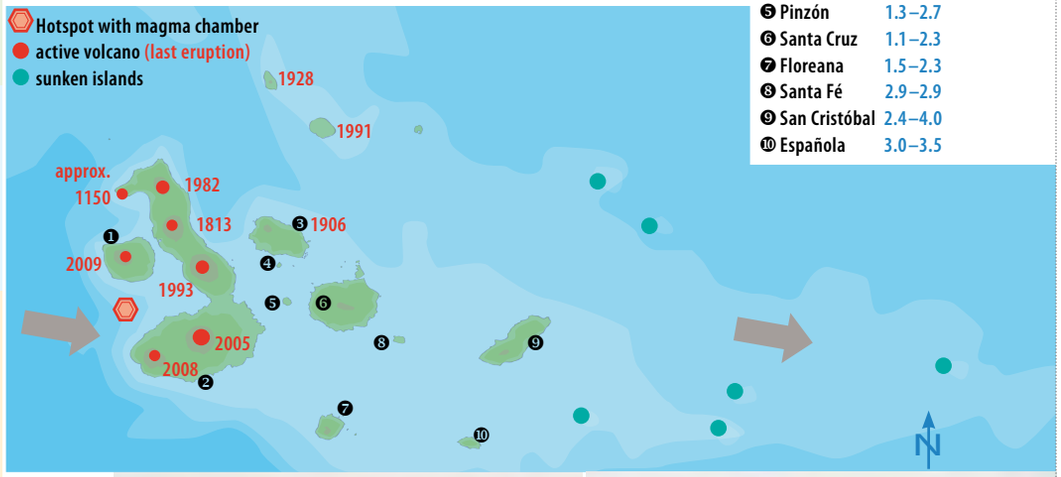
The Galápagos Islands are between 35,000 and 4 million years old. It is during this period that evolution occurred and new species developed. There are also sunken islands up to 2,500 m below sea level that are probably about 5 to 14 million years old. The most likely scenario is that evolution occurred on these islands while they were still above sea level. In fact, there is evidence suggesting that some of today's species have ancestors that go back more than 3 to 4 million years.

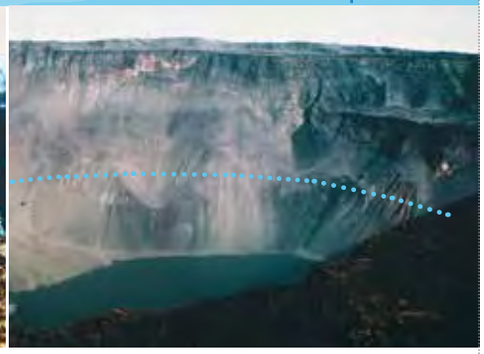
In comparison, Madagascar has existed for more than 100 million years and the Alps are about 35 million years old.

Read more about **evolution** on page 70

The Nazca Plate moves southeast over the hotspot, the origin of the volcanic islands. The oldest islands with the lowest elevations can be found in the southeastern part of the archipelago, whereas the youngest islands with the largest volcanoes are located in the northwest. On the islands of Isabela and Fernandina, there are still some active volcanoes. The last volcanic eruptions took place in 2008 (Cerro Azul volcano on Isabela) and in 2009 (on Fernandina).

Estimated age of islands in millions of years	
❶ Fernandina	0.035–0.07
❷ Isabela	0.5–0.8
❸ Santiago	0.8–1.4
❹ Rábida	1.3–1.6
❺ Pinzón	1.3–2.7
❻ Santa Cruz	1.1–2.3
❼ Floreana	1.5–2.3
❽ Santa Fé	2.9–2.9
❾ San Cristóbal	2.4–4.0
❿ Española	3.0–3.5





In 1968, the crater floor of La Cumbre volcano on the island of Fernandina sank by 350 m. In 1988, a lake started to form in the northern part of the crater. (dotted line: level of the crater floor before 1968)

Atypical: tropical islands with a dry climate

The dry climate on the Galápagos Islands is very atypical of the tropics. The same can be said of the warm season between January and May with frequent, heavy rains, and of the cool and very dry season between June and December with only little precipitation in the island lowlands. This anomaly can be explained by the ocean currents that meet and interact here in the Pacific Ocean. Two currents carry cold water: the Peru Current (Humboldt Current) from the Antarctic and the Equatorial Undercurrent (Cromwell Current) from the deep sea. Together they are responsible for the cool, dry season. The Panama Current brings warm tropical water from Central America and affects the warm season.

The little precipitation that does occur during the dry season is a light drizzle called *garúa*, which often stops around noon.

"El Niño" – both a blessing and a curse

At irregular intervals about every 3 to 6 years, significant changes in ocean current conditions lead to a much warmer and rainier season called "El Niño". "El Niño", which is Spanish for the Infant Jesus, is known by this name because the phenomenon is the strongest at Christmas time. "El Niño" is both a blessing and a curse: in the interior of the island, it leads to times of plenty, but it has severe consequences for the sea and the coastal areas. For example, the rising sea level floods bird breeding sites and the nesting grounds of sea turtles and Marine Iguanas. In 1982 and 1983, the water temperature became so warm that it caused the death of most of the green algae on which Marine Iguanas mainly feed. As a result, the populations of this species declined dramatically.

There are also very cold and dry seasons, which are called "La Niña".

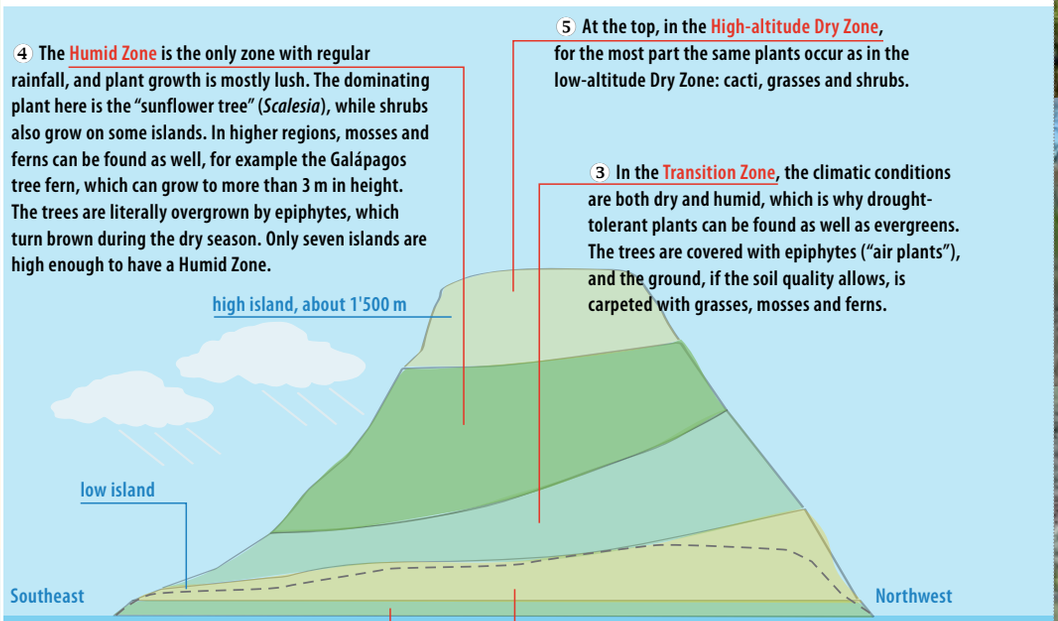
Read more about **Marine Iguanas** on page 60 and page 79

Greater plant diversity on high islands

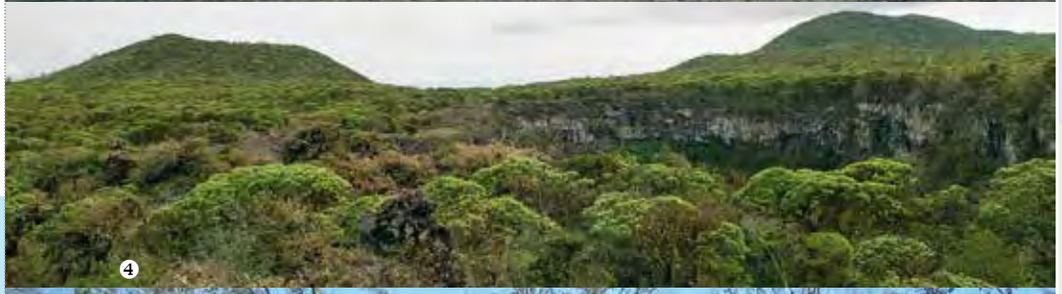
Most of the islands are not high and have a very dry climate. Only plants that are highly adapted to drought can be found on such islands.

However, on high islands, there are up to five different zones with different plant communities. These differ from each other in the amount of water they need. In the lowlands, the climate is very dry; only plants that are adapted to drought can survive here. In higher zones, the air is more humid, and there are more plants that need moisture. The reason why the air is more humid higher up is because it rains there more often: the air in higher areas is cooler, so the clouds that gather there cool down, causing precipitation. However, on very high islands another dry zone exists above the clouds.

The various zones do not run parallel to each other around the islands and they are not the same in all areas. For example, the dry zones in the southeastern part of the islands are rather narrow, because clouds accumulate mostly on this side, leading to more frequent rainfalls even at lower elevations.



Epiphytes, or "air plants", usually grow on trees, where they benefit from the light as there is hardly any shade. Since it is more difficult to ensure a supply of water and nutrients without contact to the ground, epiphytes have adapted to this situation in numerous ways in the course of evolution. For example, they collect rainwater with dense leaf rosettes or use bird-nest-like root networks in order to maximize the surface and absorb what few nutrients are available.



Plant diversity means snail diversity

Gastropods, more commonly known as snails and slugs, are not among the most spectacular creatures and therefore hardly attract the attention of Galápagos travellers. However, if they looked closely, they would find as many as 118 species.

Terrestrial gastropods depend on plants for nutrition as well as for cover. The greater the plant diversity, the greater the variety of habitats for snails and slugs. This is why more gastropod species have evolved on high islands than on low islands, because high islands have more vegetation zones. One example is the genus *Bulimulus*, which does not even have a common name.

Bulimulus, the inconspicuous record holder

Land snails of the *Bulimulus* genus are small and inconspicuous, with a shell less than 3 cm long and white to dark brown colouring. However, with over 60 species, this genus makes up more than 75 % of endemic land snail species, that is, land snail species that exist exclusively in Galápagos. Thus, it exhibits the highest degree of adaptive radiation (species diversification) of all animals in the archipelago.

Read more about **adaptive radiation** on page 37

Read more about **evolution** on page 70

Highly successful ancestor

The genus *Bulimulus* includes a total of 162 species and is found exclusively in Galápagos and South America. There is evidence to suggest that all *Bulimulus* snails in Galápagos originated from a single mainland snail species. Española, one of the oldest islands, was first populated by a single species; now there are 16. From Española, the *Bulimulus* snails found their way to Floreana and from there to Santa Cruz, San Cristóbal and the other islands. Almost every island was initially populated by just one or two species, and these are the ancestors of all the other species that developed on each island in the course of evolution. In this way, *Bulimulus* snails populated all the main islands and were very successful in adaptive radiation. They can be found in all vegetation zones.