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More Islands

Lizards, like this *Uranoscodon superciliosus*, are bitten by mosquitoes, and they suffer from parasites, such as malaria. Photo by Bill Magnusson.

Islands are special for biologists. There are generally only a limited number of options for evolution in the short term[167], so once a group of animals or plants have hit on a good strategy they tend to dominate that way of life, making it hard for other groups to compete. However, islands are often colonized by only a few species, allowing different groups to occupy ways of living monopolized by another lineage in other parts of the World, and these convergences reveal much about the opportunities and restrictions for the evolution of life.

Some biologists have made visiting islands the central theme of their studies. However, after my experience on Hopkins Island as a teenager, I have only looked for lizards and snakes on large, famous islands, such as those of the Galapagos and New Guinea, or incidentally while snorkeling on coral reefs. Nevertheless, the lizards and snakes of those few islands impressed me.

New Guinea is really only an honorary island. It is so big and so recently attached to Australia that its fauna is not as unique as those of other islands isolated by vast tracks of ocean. Nonetheless, it holds the remnants of a fauna that once covered most of Australasia and was eliminated as the Australian continent drifted into the dry mid-latitudes. I visited Papua New Guinea for a few weeks in 1988 with Marc Hero and Zilca Campos and we took the opportunity for quick trips into the interior. The area around the capital, Port Moresby, is dry, and the landscape dominated by grasslands and scattered eucalypts. It looked almost identical to the wooded savannas of northern Australia, only a few hundred kilometers away across the Torres Strait.

We took a local minibus into the highlands and across the dividing range to Lae. As soon as the bus started climbing into the mountains, we could see why the fauna and flora is so different from that found in Australia. Whereas most of Australia is covered by plains, the greater part of New Guinea is mountainous.

The country is so rugged that 50,000 people living in some of the central valleys were not known to the rest of the World until 1938.

Photo 14.1 *The Papuan death adder,* Acanthophis rugosus*, is a species of the family Elapidae that is convergent in form on the New World vipers. It is one of the deadliest species of snake in Australasia. Photo by Bill Magnusson.*

We spent time in the Varirata National Park, which is close to Port Moresby, and I photographed the local skinks. They looked much like the species in Australia, as did the local death adders. However, I was overjoyed when we went out at night and found an amethystine python[168]. I had never seen one in the wild before. This is the largest snake in Australasia, and said to be the sixth largest in the World. However, unlike most of the big boas and pythons, it is relatively thin. The one we found was about 2 m long, but it was not difficult to handle. Presumably, it is one of the major predators on the diverse marsupials and birds for which New Guinea is famous.

While the skinks and pythons were interesting, I could have found the same or similar species in northern Australia. What I wanted to see was a New Guinea ground boa[169]. They are also called viper boas, though their distribution does not overlap with that of any of the true vipers. Because they are short and fat, and have distinct triangular heads, they could easily be confused with a Papuan death adder, and this is possibly a case of mimicry.

The boas in New Guinea spend all or most of their time on the ground, and they may be ecological equivalents of rainbow boas in South America. We found one crawling sluggishly along the ground in dense rainforest, and I lay on the ground to photograph it close up. If I had to give a one-word description of the snake, it would be "nondescript". It had keeled scales, making it appear rough and allowing it to blend in with leaf litter. The ridges running along each side of its head that enclosed its eyes made it look much like a death adder, and I looked carefully at its tail to make sure it wasn't one before picking it up.

It was a strange snake in a strange land, so why did I find it so unexpected? The boas and pythons basically appear to have divided up the World. The live-bearing boas are almost all found in the New World and the egg-laying pythons are all found in the Old World. There are only two exceptions: a lineage of boas found in Madagascar and the genus *Candoia*, which includes the New Guinea ground boa, that occurs in New Guinea and other islands close by.

How did they get there? Nobody knows. Genetic studies indicate that New Guinea boas have been separate from the New World boas for at least 40 million years. Did their remote ancestors ride land masses as they shifted apart by continental drift, or did some ancestor take an improbably long sea voyage? Would there have been more species of boas there if the pythons hadn't got there first? I watched the snake crawl slowly into the undergrowth of the rainforest, not only strange, but a stranger in a strange world, and I wished

that I could see into the past to find out what its remote ancestors had done to put it so out of place.

Photo 14.2 *The New Guinea ground boa,* Candoia aspera, *is sometimes called the viper boa because it more closely resembles a death adder, which also isn't a viper, than South American boas. Photo by Bill Magnusson.*

Caribbean islands are just about the complete opposite to New Guinea. They are geologically recent, have depauperate faunas and are tiny. I did not start thinking about Caribbean islands because of their famous radiations of the little *Anolis* lizards, but because of correspondence with Jos Schall. I had started writing to Jos because of his studies on lizard malaria. We generally think of malaria as a human disease, but that is a limited and comparatively recent phenomenon. Birds and lizards have their own types of malaria and, since my experience with linguatulids in Merv Hay's death adders, I had been interested in the microscopic enemies that determine who lives and who dies.

I had hoped to bring Jos to Manaus in 1984 to collaborate on a study of malaria in rainbow lizards, especially to see whether the parthenogenetic species were more vulnerable than the species with two sexes. However, bureaucracy to obtain permission from the federal government, combined with my limited administrative capabilities, meant that we never got it together. Nevertheless, I followed Jos' instructions and put blood samples from lizards on microscope slides to see whether the local lizards were infected, and his technician examined images of the slides.

Sure enough, there was lizard malaria in the Amazon, and almost all the giant ameivas I collected carried malaria, including giant forms similar to those that Jos had studied in Africa. However, none of the rainbow lizards were infected, though there were haemogregarine[170] parasites in their blood. As all the lizards were in good condition, it seems that the blood parasites do not have any acute effects. The lack of malaria in the rainbow lizards also dampened Jos' interest in the project.

During our correspondence, Jos mentioned his interest in herbivory in whiptail lizards on Caribbean islands that were closely related to the rainbow lizards in the Amazon. I had associated lizard herbivory with large body size and slow habits, so I doubted that the relatively small and agile whiptails would eat significant quantities of vegetable material. All the species of teiid lizards I had studied occasionally ate fruits, but none of them ate many flowers or any leaves, and insects provided most of their energy needs. I suggested that he was probably mistaken about the prevalence of vegetation in the diet of the Caribbean whiptails.

Photo 14.3 Cnemidophorus flavissimus *on Los Frailes in 2005. Life on the desert islands is difficult and the* Cnemidophorus *species there often browse on leaves of succulent plants. Photo by Bill Magnusson.*

I was totally wrong, and Jos later published a paper on Bonaire whiptail lizards[171] with Denise Dearing showing that the species not only eats large quantities of flowers and fruits, its intestinal tract may be adapted to digesting the cellulose that constitutes most of the material in plant matter and makes it so indigestible for us. This got me thinking about my preconceptions in relation to what lizards can do. Convergence is ubiquitous in nature and very often one lineage of animals or plants does not take up a particular way of living because some other group is already doing it, rather than because of an inherent limitation in their design.

The Bonaire whiptail is fairly large for a species in the genus *Cnemidophoru*s, and I imagined that it was evolving into a large herbivorous morphotype. I have

never seen a Bonaire whiptail, but when I saw the bright blue whiptails on San Andrés Island, which are said to belong to the same species complex as the rainbow lizards I had studied, my preconceptions were confirmed. I didn't see what it ate, but it was much larger than the species that goes by the same name at Alter do Chão. I assumed that the island whiptails could eat a lot of vegetation because they were relatively big.

I was only forced to change my opinion when I went snorkeling on one of the Los Frailes islands off the north coast of Venezuela. There I saw *Cnemidophorus flavissimus*, a bright yellow whiptail with similar size and behavior to those at Alter do Chão. I filmed them as they clambered among the desert plants looking for succulent leaves, which they bit into, leaving characteristic semicircular holes on the edges of the leaves, similar to those made by leaf-cutter ants. These island lizards had taken on the role of grasshoppers or rabbits on the mainland. It may be that if another meteorite causes mass extinctions, as happened at the end of the age of the dinosaurs, it will be lizards and not cows that graze the meadows of the future.

New Guinea is a mainland, and the Caribbean islands are close to or have been attached to the mainland in the recent past. Ideas about the evolution of island faunas are generally associated with remote oceanic islands, and the most famous are those in the Galapagos Archipelago. In 1986, I went with Renato Cintra to the Galapagos to see what lizards could do when left to themselves for millions of years.

Photo 14.4 *The Galapagos land iguana,* Conolophus subcristatus, *eats vegetation that is in short supply on the arid Galapagos islands. Photo by Bill Magnusson.*

The Galapagos Islands lie in the Pacific Ocean about 900 km from South America. As they are the tips of extinct volcanoes, they originally had no land life, but a few hardy groups have made the ocean crossing. The only native mammal on the Galapagos is a small rat. There are no deer, kangaroos or elephants, so the role of large herbivores was taken over by the ancestors of giant land tortoises. Most of the birds are marine or estuarine species and the only dryland species are Darwin's finches, a dove, a flycatcher, a rail and a hawk. There are three to five species of snakes depending on the authority you consult. All are in the genus *Pseudalsophis*, and probably all derived from a single ancestral species, though this is also debated. They do what small snakes that are generally less than a forearm in length do in other parts of the world; they eat small fish, lizards and mammals. A famous video[172] made by the BBC

shows masses of snakes pursuing a baby iguana, but it is generally hard to find a snake on the Galapagos.

The Galapagos lava lizards[173] look like and act much like the Australian tree skink[174] and *Tropidurus* species in South America. They are about a hand span long, as wide as my thumb, and their generally grey color blends in with the lava rocks. However, they have one characteristic that sets them apart from just about all the other lizards, or for that matter almost all other animals; the females are more colorful than the males. Much like the males in many species of iguanids, the female lava lizards had bright-red throats.

Perhaps sexual selection for color in females could be stronger in the Galapagos because there were fewer predators. In other places, it should be just as advantageous for males to select brightly colored, and hence apparently healthy, females as it would be for females to select brightly colored males. However, at some times, females are laden with eggs and have to be cryptic to avoid predators. No point in selecting a healthy-looking female as a mate if she ends up dead before laying the eggs. Except in the few species that form stable pair bonds, a female does not lose anything if her mate dies soon after donating his sperm and she can thus afford to choose gaudy ones.

We suggested to the head of the research station that it would be interesting to see what would happen if a female lost her bright colors. She agreed and gave us some nontoxic paint to try a preliminary experiment. We painted female lava lizards with the dull-colored paint, never suspecting how disastrous that would be for them. The males not only no longer thought they were potential mates, they thought that they were competing males. The poor females approached the males figuratively batting their eyelids and the males attacked them mercilessly, driving them from one male territory to another. Renato and I decided that the possible scientific gains of a future experiment did not justify the stress to the lizards and we never took it any further.

Photo 14.5 *A female Galapagos lava lizard,* Microlophus albemarlensis. *This is one of the few species of lizard in the World in which the females are more colorful than the males. Photo by Bill Magnusson.*

Plant-eating iguanas are common over much of South America, but nowhere are they the dominant herbivores. Almost anywhere you find them, much more of the vegetation will be eaten by mammals, leaf-cutter ants, or even leaf-eating birds, such as rheas and guans. However, when the first iguanas reached the Galapagos, presumably by rafting almost 1000 km over the open ocean, they found a land with no large mammals, no leaf-eating birds, and no leaf-cutter ants. The vegetation was almost all theirs, and they only had to compete with the slow and ungainly tortoises.

The first colonizers diversified into several species of land iguanas and one species of marine iguana. The land iguanas all look much the same, but occur on different islands. In some places, they were so dense that we had to watch

where we stepped because they regarded us with disdain and expected us to go around them. They were about the same size as green iguanas on the mainland, but their dull grey or yellow coloring blended in with the exposed soil. I have seen photographs of masses of rabbits that proliferated after their introduction to remote islands without predators. The iguanas of the Galapagos have commandeered the rabbit niche.

The animals that I most wanted to see, however, were the marine iguanas. These large black iguanas are majestic as they sunbake perched on the black lava rocks overlooking the sea, but it isn't their appearance that makes them so special; it's their diet. Marine iguanas dive into the cold ocean water and can swim more than nine meters down to graze on algae growing on the rocks. They don't spend much time in the water and afterwards must bask to warm up and digest their meal.

No other terrestrial animal feeds mainly on marine algae. Fish are the only living vertebrates except for the marine iguanas that specialize on this food source, though Steller's sea cow[175], a giant marine manatee of the arctic, did so until it was hunted to extinction by sailors in the 1700s. I wondered if algae-feeding lizards have not evolved in other places because there are too many predators, or if it is just that there has not been anywhere else that huge numbers of herbivorous lizards have been so close to the sea for so long. Would the marine iguanas be able to establish if they ever rafted to a suitable coast on a continent? Maybe we will find out if the Galapagos Islands can be protected for a few more million years!

Photo 14.6 *A marine iguana,* Amblyrhynchus cristatus*, recently returned from diving in the sea. These are the only lizards, and possibly the only terrestrial vertebrates, that eat only marine algae. Photo by Bill Magnusson.*