

Letter from the Desk of David Challinor  
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For those fascinated with plants and animals, the first sight of an impressive specimen in its natural habitat often becomes indelibly printed in one's memory. This does not preclude enjoyment in watching the denizens of zoos and aquaria or the almost crushing beauty of botanical gardens and arboreta at the peak of their spring reproductive display. However, nothing can compete, I believe, with the excitement and awe generated by an initial spotting of a lion, a redwood or even a large field of Texas bluebonnets in their natural habitat. Not everyone, regrettably, shares the elation of a first sighting, but for those who do, I would like to tell of my excitement at seeing my first Nile crocodiles.

The small two-seater plane was piloted by a Ugandan police officer as we flew from Entebbe on Lake Victoria to Para, a government national park headquarters just west of the Nile's Murchison Falls. Below the falls on either side of the river are wide sandy beaches and during the dry season they are crammed with a sprawling horde of basking Nile crocodiles. They can be enormous, regularly growing to 5m (16 ft) and reportedly as long as 5.5m (18 ft). These behemoths evidently gather to reap the abundant harvest of fish in the deep pools of highly oxygenated water created by the falls. Their diets are doubtless supplemented by drowned ungulates washed over the falls. My vivid memory of this scene from 35 years ago has triggered the topic of this month's letter—crocodiles and alligators.

We think of these beasts as basically fresh water animals, yet the Nile crocodile frequents the coastal swamps and river mouths of Africa. Occasionally, they are washed out to sea by powerful floods; for one was sighted 11km (7 mi) off the south African coast. From east African rivers they have made it to Zanzibar 50km offshore. At one time, they must have made it to Madagascar, which is now 3 – 400km from the mainland.

Crocodiles, like marine iguanas and many seabirds, have specialized salt glands that concentrate salt for excretion without excessive loss of fresh water. Crocodiles have these glands on their tongues and they are evidently modified salivary ones. Interestingly, these glands are also present on the tongues of strictly fresh water species and thus may be a relic of a time before they moved from salt to fresh water. Alligators and their southern relatives, the caimans, lack salt glands completely and probably never lived or bred in salt water. They can, however, survive in salt water, because years ago my cousin rescued a two-foot young caiman from a beach at his house on Long Island Sound; it must have been someone's pet. He kept it in his bathtub until my uncle and aunt no longer accepted the caiman as an excuse for not taking a bath and, as I remember, it ended up at the Central Park Zoo.

Harking back to the basking crocodiles, they were sunning themselves to regulate their body temperatures (thermoregulation). Although both crocodiles and alligators have a four-chambered (two ventricles and two atrials) heart as do mammals, they are poikilothermic—that is their body temperature is controlled by their environment. This is an advantage when waiting to strike prey, because they can save so much energy by reducing their metabolism, compared to a warm-blooded predator. Crocodiles are strictly subtropical, but alligators are temperate zone beasts. In North America, they range from the coastal border of North Carolina and Virginia, south to Florida and west to east Texas. Furthermore, alligators can tolerate frozen ponds as long as they have access to a hole in the ice through which to breathe. The Chinese alligator, an endangered species, lives in the swamps at the mouth of the Yangtze River at the same latitude as Savannah, GA; here, on the east margin of a large continent, the climate is very similar to that of southeastern coastal U.S.

Current research indicates that the crocodylian four-chambered heart evolved when they were terrestrial and active hunters. When crocodiles became aquatic sit-and-wait predators, they no longer needed the capacity for prolonged strenuous activity and thus reverted to ectothermy (letting the outside temperature set their body temperature.).

Some crocodylians exhibit mammal-like behavior. Large bull alligators not only roar to attract mates, but also emit very low frequency sounds that travel through and around underwater obstacles. The frequency is so low that it is beyond the range of human hearing. In David Attenborough's documentary on crocodylians, he filmed an extraordinary close-up of a bull alligator emitting this low frequency call. No sound could be heard, but the water adjacent to the bull literally erupted in hundreds of little "spouts," each about a cm tall and easily visible. We know that elephants also communicate by ULF (ultra low frequency) rumbles beyond our hearing ability, but these can be easily felt by touching the pachyderm's side. The lower the frequency, the farther the sound will travel. The Navy exploits this law of physics by having enormous transmitting antennae (covering several square miles) that can send messages to submarines under water in almost any ocean of the world. As an aside, before the Zoo acquired Front Royal, I went with then Director Ted Reed to Northeast, VA, a town just south of Norfolk at the edge of the Dismal Swamp. Here we considered a deal with the Navy to use the grassy sward under the ULF antennae as a breeding facility for our hoof stock. It was an intriguing idea but too far from Washington to be practical.

The crocodylians in many respects behave like birds in that they build nests and lay eggs; the hatchlings actually chirp before and during egg emergence. They have been a particularly successful animal from an evolutionary perspective since they evolved in a form close to their present one some 230 million years ago.

Despite their seemingly ferocious appearance, the mother Nile crocodile, when hearing her young chirping, returns to her nest, digs out the emerging young with her hind feet, and carries them gently in her mouth down to the river for safety. How the mother knows exactly where to dig her nest so that the incubation temperature will be exactly right remains a mystery. Sex of the young is determined by the temperature at

which the eggs are incubated. The results of experiments on temperature-dependent sex determination (TSD) for alligators were first published in 1982. It was based on controlled incubation in a laboratory and also by carefully recording temperatures in natural nests in coastal Louisiana. Higher temperatures, 32°-34° C (90°-93° F), produced males while slightly lower ones (28°-30° C) resulted in females. Temperatures between these ranges produced mixed broods of varying proportions. Since no crocodylians have sex chromosomes, it is likely that all species are TSD.

As scientists have gained knowledge of the reproductive physiology of these reptiles, the results have been applied to elaborate captive breeding programs. The demand for their hides plus loss of habitat has driven some species close to extirpation. When hunting is controlled or even banned, however, many populations recover rapidly. The explosion of Florida's alligators is a good example.

Commercial farming for crocodile hides is developing slowly in Papua New Guinea where young Indopacific or saltwater crocodiles are collected by locals and sold to established farms. This species is the largest reptile and can grow to 7m (23 ft) and weigh more than a ton. It also has the justifiable reputation as a people eater.

Some 30 or more years ago I visited the Samutprakan Crocodile Farm located south of Bangkok at the mouth of the Chao Phya River, which flows through that city. It maintains some 14,000 crocodiles, the majority being the endangered Siamese species (*Crocodylus siamensis*). Next most abundant is the Indopacific one (*C. porosus*), and the third in number are hybrids between these two species. The farm operation is a popular tourist attraction and elevated walkways enable the visitors to look down on the artificial ponds teeming with these beasts. It reminded me of a scene from a James Bond movie. Periodically, I would see a giant dominant male dive into the pond to butt a subdominant one with his snout. The dominant males were easily identified by their pink noses, the result of scar tissue forming from the butting of rivals. I had tea with the owners who explained that the ponds were cleaned and flushed regularly by tidal action through a series of ditches connected to the estuary. The farm bought all trash fish from an adjacent fishing port and supplemented fish with chicken necks, legs and other unused parts from a nearby frozen chicken packaging plant.

The growth curve of the crocodiles slows after three years so most animals are slaughtered between ages three and five. Not only are skins sold, but meat as well, to restaurants as a delicacy. This successful commercial operation is an example of how conservation (breeding of two locally endangered species) can be financially exploited. From my cursory visit, I found the animals well-cared for; not only the crocodiles but also the elephants and a large collection of about 20 Siamese tigers.

Quite apart from any moral qualms about semi-domesticating wild animals for commercial gain as is currently done with mink, silver fox, salmon, etc., such endeavors have added to our knowledge of the behavior, reproductive physiology and genetics of the animals being raised. Offsetting such benefits, however, are the increasing problems of waste disposal, pathogen control in crowded conditions, spread of disease and

unfavorable genetic mixing of escapees with native stock. The insatiable human demands for exotic food and clothing will doubtless continue and entrepreneurs worldwide will exploit these perceived needs. We can only hope that the new knowledge gained from these breeding activities will offset the problems that will inevitably arise, and that the general public will begin to understand the environmental and social cost of catering to its "need" for luxury goods.

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