Endangered Crab Found In West Africa's Shrinking Forests

Neil Cumberlidge and Piotr Naskrecki

We were camped in West Africa, on the westernmost fringe of the Upper Guinea forest, a vast area stretching from Guinea to Sierra Leone and Liberia. As part of an international team of scientists conducting a rapid assessment of this historically biodiversity-rich region, we had come to survey invertebrates, particularly freshwater crabs. At first sight these damaged forests and parched savannas, degraded by agriculture and industry, seemed an unlikely place to seek rare aquatic animals. But we were there because of the imminent threat of further industrial expansion and additional ecosystem disruption.

Our campsite was in disturbed land under intense agricultural management in northwest Guinea, but by sheer luck our tents were pitched just a few kilometers from a thriving colony of some of the continent's most elusive crustaceans—purple marsh crabs (*Afrithelphusa monodosa*). This species is truly an enigma, previously known only from a single specimen collected in 1947. Yet, amazingly, just a day after we began our survey, a local farmer walked right into our camp holding one!

Purple marsh crabs belong to a diverse group of decapod crustaceans colloquially known as river crabs or freshwater crabs, which are abundant in the rivers, streams, and lakes of inland waters throughout the tropics. Despite their large size, attractive colors, and ubiquity in tropical aquatic ecosystems, the thirteen hundred or so species of freshwater crabs have somehow avoided the full attention of the scientific community. Interest in their biology and conservation is only now beginning to gain momentum.

The success of the world's marine land crabs—species that live in mangrove forests, on beaches, or further inland, but still need to return to the sea to breed—in the coastal fringes throughout the tropics is due to their well-developed abilities to breathe air, dig burrows, dehydrate slowly, and walk easily on land. These adaptations gave access to new food sources and living spaces in the coastal lands above the high-tide line, and this is where these animals now reign supreme.

Freshwater crabs evolved from marine crabs, but succeeded in breaking the connection to salt water with adaptations that enabled them to osmoregulate in low-salinity environments. These included ion pumps on their gills that move salts inward, antennal glands (kidney-like organs) that pump water out of their blood, and an impressively waterproof carapace. As a result, freshwater crabs complete their life cycle in fresh water and never need to return to sea water to breed.

Our newly rediscovered Guinean species was among the small subgroup of the freshwater crabs that we call fresh-

water land crabs, those species that can live and reproduce well away from permanent water sources.

Structural modifications in their gill chambers enable many species of freshwater crabs to breathe in air as well as underwater. Their gill chambers are so well adapted for aerial respiration that their ability to breathe is undiminished by being out of water. The bottom layer of each gill chamber has the usual set of gills that are seen in most crabs, which allow them to breathe under water. But it is in the upper layer above the gills where the truly remarkable adaptation is found. Here there is a spongy air-breathing organ, which is analogous to a vertebrate lung in function but structurally so different that it is known as a "pseudolung."

In purple marsh crabs, this respiratory structure works so well that they actually prefer to breathe air rather than water. These crabs immerse themselves in water only as a last resort, usually to avoid predators, and seem uninterested in using oxygen from water.

The abilities of the freshwater land crabs to breathe air, dig burrows, resist drying, and walk on land easily match those of marine land crabs. Freshwater crabs have a reproductive adaptation that opened up to them vast tracts of land in the inland tropical ecosystems of the world's continents that even the well-adapted marine land crabs had not conquered. In contrast to marine crabs, which release their eggs into sea water and whose larvae spend several weeks in an un-crablike, planktonic stage floating with the currents, larval development in freshwater crabs is completed entirely inside the egg case, with each egg releasing a fully formed miniature crab. The evolution of larval direct development has had big ecological consequences for freshwater crabs. For one thing, it meant that these crustaceans could complete

Land crabs have adapted to life away from water, but most still need to return to breed. Blue land crab (*Cardisoma guanhumi*), at water's edge, waiting to release her eggs. Photograph by Piotr Naskrecki.

their entire life cycle in their inland habitat, using fresh water for all of their needs. And it released female freshwater crabs from the need to spend valuable energy making migrations to the coast during the breeding season. This radical adaptation removed one of the last barriers to the colonization of land and gave them total independence from saltwater environments, which in turn led to the explosive radiation of freshwater crabs in the inland waters of the tropics around the world.

Today, these crabs are dominant inhabitants of warm fresh waters from tropical America to Australasia. Freshwater crabs have conquered not only more conventional freshwater ecosystems such as rivers and lakes, but some species, including the purple marsh crab, have colonized such marginal habitats as flood plains bordering rivers and streams, damp terrain in freshwater swamps and marshes, and dried-out river beds in parched savannas. In humid rainforests, further adaptations such as small compact bodies and long slender walking legs have enabled freshwater crabs to move easily through vegetation and even to climb tree trunks, thereby equaling or surpassing the feats of most marine land crabs.

Marine land crabs found in coastal Guinea, such as the rainbow crab (*Cardisoma armata*), and air-breathing mangrove crabs, such as the fiddler crab *Uca tangeri*, each are widely distributed along hundreds of miles of the West African coast from Senegal to Angola. These wide distributions are a direct consequence of their developmental strategy, in that the currents carry the larvae long distances from their release points during the weeks spent drifting in the surface waters. In contrast, most freshwater crabs have a narrow distributional range—except perhaps where a major river system is involved. The lack of larval stages means that freshwater crab hatchlings do not stray far

The purple marsh crab (*Afrithelphusa monodosa*) was recently rediscovered in West Africa by the authors. Photograph by Piotr Naskrecki.

Purple marsh crabs live in swampy areas, which are increasingly under cultivation. Photograph by Piotr Naskrecki.

from the place where they were born, and only adult crabs disperse any distance; as a consequence, speciation is common and endemism is high. The smallest distributional ranges of all are seen in those species of freshwater land crabs that live in marginal habitats in isolated mountain streams, rainforests, swamps, marshes, and dry savannas far away from major aquatic systems.

Once back home in our laboratories, we used DNA analysis to confirm that the purple marsh crab indeed belongs to the African family Potamonautidae, and learned that it lies on an evolutionary branch separate from most freshwater crab species in that continent. We also described the habitat requirements and behavior of this species for the first time: it prefers marshy wetlands, many of which are now moist farmland on which bananas, pineapples, and cassava are grown. There crabs live underground in burrows partially filled with shallow, oxygen-depleted fresh water, easily overcoming any oxygen shortages by switching from water breathing to air breathing. During the long dry season crabs emerge from their burrows in the colder nocturnal air, scavenging the nearby land for vegetable matter or the remains of plants and animals. The first storms of the wet season inundate the burrows and prompt the crabs to crawl onto land in the daylight hours, as well as the night. On the surface the air is cooler and more humid, and the new undergrowth provides both concealment from predators and shade from the sun. As the rains continue, extensive wetlands develop and crabs congregate in the muddy, shallow waters of the newly formed pools and marshes.

The secretive purple marsh crab of Guinea seems to lead a burrow-bound life in perennially marshy ground, a specialized niche that limits its population density and distributional range. Its inclusion as an endangered species on the Red List of Threatened Species by the International Union for Conservation of Nature (IUCN) shows that its long-term survival is at risk. Indeed, it may be making its last stand in that small area of Guinean farmland, and the chances of this fragile species' survival are slim if its wetland habitat continues to be destroyed at the present rate.

Freshwater crabs have long legs and small bodies that make it easy for them to move through vegetation or climb trees. *Sylviocarcinus pictus*, photographed by Piotr Naskrecki.

Our chance rediscovery of the purple marsh crab gave us an opportunity to observe and learn about a little-known species from a fascinating lineage of terrestrial crustaceans. Freshwater land crabs such as *A. monodosa* and its red-listed relatives in Guinea, Sierra Leone, and Liberia live in the increasingly disturbed habitats of West Africa's Upper Guinea forest ecosystem—a biodiversity hotspot with an incredible richness of endemic plants and animals that makes it one of the world's priority conservation areas. Time is running short for that remarkable ecosystem and many of its unique species of flora and fauna—including its rare and barely studied freshwater land crabs—could be threatened with extinction. Unfortunately, should we return to the Upper Guinea forest, our campsite is increasingly less likely to be so fortuitously located.

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