Crocs rocked pre-Amazonian Peru: New research uncovers 7 crocodile species in single 13-million-year-old bone bed

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This model is a life reconstruction of the head of *Gnatusuchus pebasensis*, a 13-million-year-old, short-faced crocodile with globular teeth that was thought to use its snout to "shovel" mud bottoms, digging for clams and other mollusks.

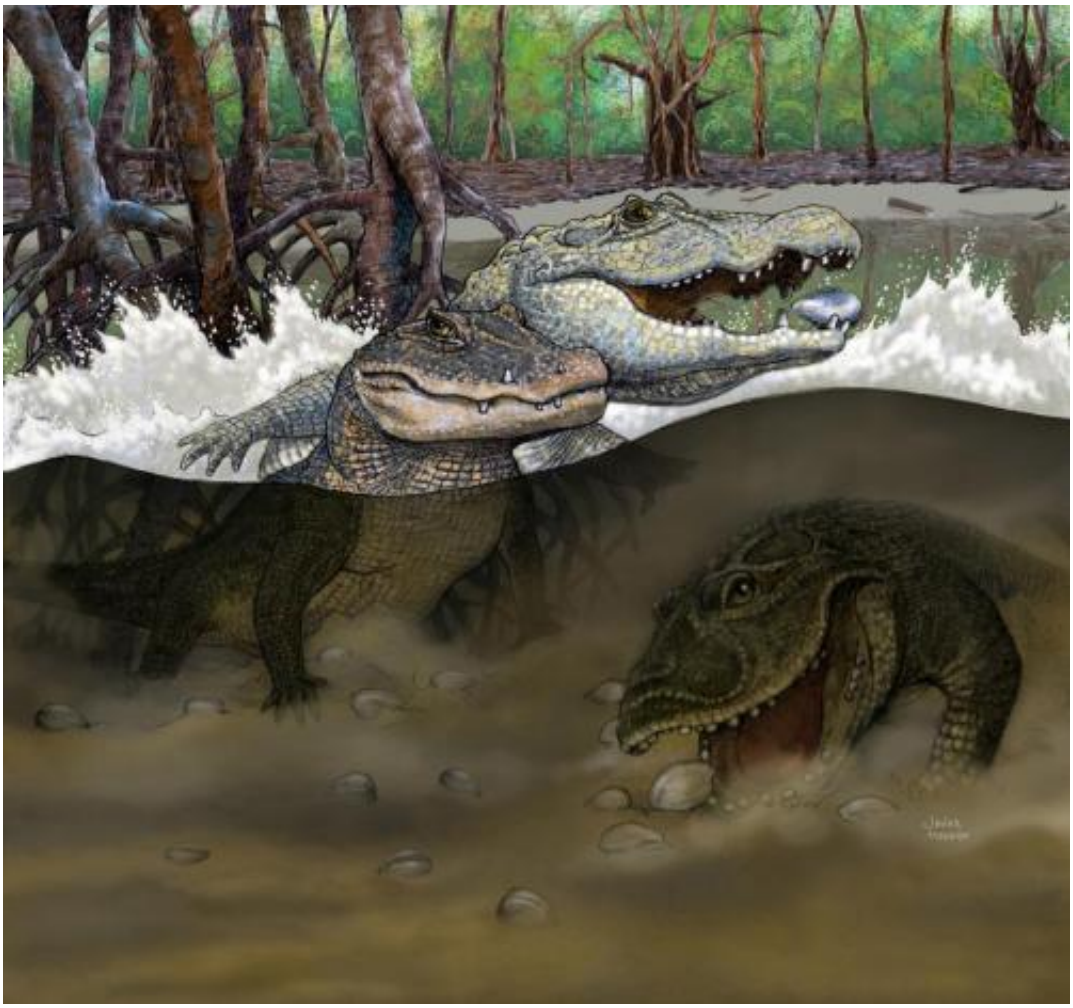
Model by Kevin Montalbán-Rivera. Credit: Aldo Benites-Palomino

Thirteen million years ago, as many as seven different species of crocodiles hunted in the swampy waters of what is now northeastern Peru, new research shows. This hyperdiverse assemblage, revealed through more than a decade of work in Amazon bone beds, contains the largest number of crocodile species co-existing in one place at any time in Earth's history, likely due to an abundant food source that forms only a small part of modern crocodile diets: mollusks like clams and snails. The work, published today in the journal *Proceedings of the Royal Society B*, helps fill in gaps in understanding the history of the Amazon's remarkably rich biodiversity.

"The modern Amazon River basin contains the world's richest biota, but the origins of this extraordinary diversity are really poorly understood," said John Flynn, Frick Curator of Fossil Mammals at the American Museum of Natural History and an author on the paper. "Because it's a vast rain forest today, our exposure to rocks—and therefore, also to the fossils those rocks may preserve—is extremely limited. So anytime you get a special window like these fossilized "mega-wetland" deposits, with so many new and peculiar species, it can provide novel insights into ancient ecosystems. And what we've found isn't necessarily what you would expect."

Before the Amazon basin had its river, which formed about 10.5 million years ago, it contained a massive wetland system, filled with lakes, embayments, swamps, and rivers that drained northward toward the Caribbean, instead of today's pattern of eastward river flow to the Atlantic Ocean. Knowing the kind of life that existed at that time is crucial to understanding the history and origins of modern Amazonian biodiversity. But although invertebrates like mollusks and crustaceans

are abundant in Amazonian fossil deposits, evidence of vertebrates other than fish have been very rare.

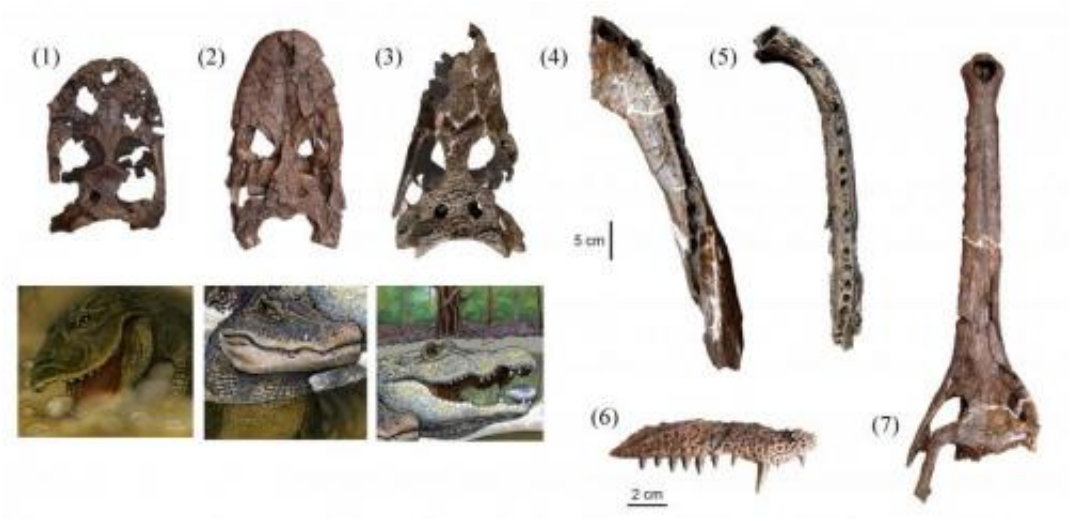


This reconstruction shows proto-Amazonian "mega-wetland" swamps from the late middle Miocene (about 13 million years ago) and the three new species of crocodiles discovered from fossils uncovered in northeastern Peru: *Kuttanacaiman iquitosensis* (left), *Caiman wannlangstoni* (right), and *Gnatusuchus pebasensis* (bottom). The extinct caimans are thought to have thrived on the unusually high abundance and diversity of mollusks like clams and snails that lived in the area. Credit: Javier Herbozo

Since 2002, Flynn has been co-leading prospecting and excavating expeditions with colleagues at fossil outcrops of the Pebas Formation in northeastern Peru. These outcrops have preserved life from the Miocene, including the seven species of crocodiles discussed in *Proceedings B*. Three of the species are entirely new to science, the strangest of which is *Gnatusuchus pebasensis*, a short-faced caiman with globular teeth that is thought to have used its snout to "shovel" mud bottoms, digging for clams and other mollusks. The new work suggests that the rise of *Gnatusuchus* and other "durophagous," or shell-crunching, crocodiles is correlated with a peak in mollusk diversity and numbers, which disappeared when the mega-wetlands transformed into the modern Amazon River drainage system.

"When we analyzed *Gnatusuchus* bones and realized that it was probably a head-burrowing and shoveling caiman preying on mollusks living in muddy river and swamp bottoms, we knew it was a milestone for understanding proto-Amazonian wetland feeding dynamics," said Rodolfo Salas-Gismondi, lead author of the paper and a graduate student at the University of Montpellier, in France, as well as researcher and chief of the paleontology department at the National University of San Marcos' Museum of Natural History in Lima, Peru.

Besides the blunt-snouted crocodiles like *Gnatusuchus*, the researchers also recovered the first unambiguous fossil representative of the living smooth-fronted caiman *Paleosuchus*, which has a longer and higher snout shape suitable for catching a variety of prey, like fish and other active swimming vertebrates.



Researchers uncovered fossils from seven different species of crocodiles that lived together about 13 million years ago in the Pebas Formation in what is now the Amazon Basin of northeastern Peru. Their skulls and jaws, shown here, are extremely diverse: (1) *Gnatusuchus pebasensis*, (2) *Kuttanacaiman iquitosensis*, (3) *Caiman wannlangstoni*, (4) *Purussaurus neivensis*, (5) *Mourasuchus atopus*, (6) *Pebas Paleosuchus*, and (7) *Pebas gavialoid*. The three new species (1-3) are shown in illustrations below the respective fossils. Reconstructions by Javier Herbozo. Credit: Rodolfo Salas-Gismondi

"We uncovered this special moment in time when the ancient mega-wetland ecosystem reached its peak in size and complexity, just before its demise and the start of the modern Amazon River system," Salas-Gismondi said. "At this moment, most known caiman groups co-existed: ancient lineages bearing unusual blunt snouts and globular teeth along with those more generalized feeders representing the beginning of what was to come."

The new research suggests that with the inception of the Amazon River System, mollusk populations declined and durophagous crocodile species went extinct as caimans with a broader palate diversified into the generalist feeders that dominate modern Amazonian ecosystems. Today,

six species of caimans live in the whole Amazon basin, although only three ever co-exist in the same area and they rarely share the same habitats. This is in large contrast to their ancient relatives, the seven diverse species that lived together in the same place and time.

Provided by American Museum of Natural History