

Stone Age primates

What can the antics of tool-using monkeys and chimps tell us about our own evolution, wonders Erica Tennenhouse

A CASHEW is a tough nut to crack. You must carefully balance it on an anvil and bash it with a hammer, while avoiding contact with the caustic resin in its shell. This takes great skill. Yet bearded capuchin monkeys living in north-east Brazil take it in their stride. And their tool-wielding talents don't end there. They also dig for tubers and insects with rocks. Females sometimes even hurl them at males in what appears to be an unusual flirting tactic. We used to think that using tools was the preserve of our hominin lineage and one of the remarkable talents that made us human. So much for that idea...

In fact, we have known for some years that our closest living relatives, chimps, employ a variety of tools, including some made of stone. Recently, primatologists have been intrigued to discover that this also applies to two more-distant cousins – the capuchins and macaques living in a coastal region of Thailand. The findings have attracted the attention of archaeologists keen to explore the so-called Stone Ages of non-human primates. Digging through layers of dirt, they have already unearthed the remains of tools made thousands of years ago.

Their discoveries usher in the new discipline of primate archaeology, which has the potential to give novel insights not just about these species but also about our distant ancestors. Before, it was assumed that we alone possessed an archaeological record containing material evidence of past behaviours. Now that three more such records are emerging, it is possible to make comparisons for the first time and shed light on the evolution of tool use. We can look at how different environments influence the development of technological sophistication. And we can see what characteristics all tool

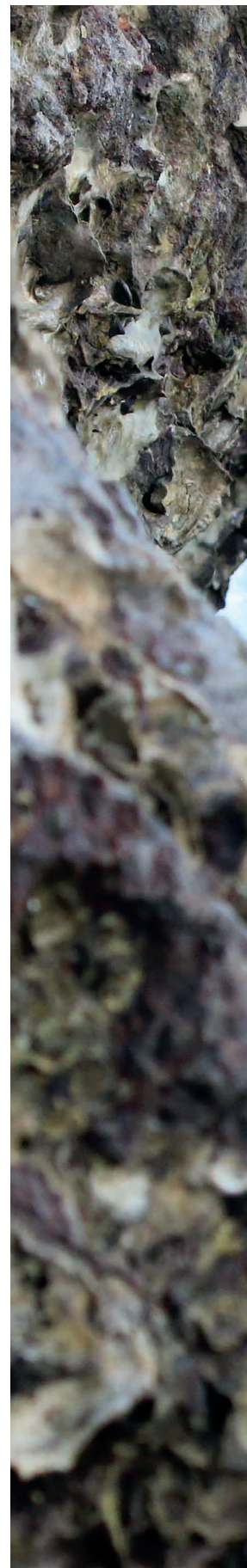
wielders have in common. This could be the key we need to unlock the mystery of why the behaviour is so rare among animals.

The man at the helm of primate archaeology is Michael Haslam at the University of Oxford. Haslam started out as a “normal archaeologist” preoccupied with aboriginal stone tools in Australia. His epiphany came during a chance encounter with Bill McGrew, an expert in chimpanzee tool use from the University of Cambridge. The conversation got Haslam wondering what chimp technology might have looked like in the past. “It just seemed like something that needed to be investigated,” he says. “We had all of these techniques from archaeology that help you understand the past and they were only being applied to humans.” So, in 2012, he decided to do something about it and set up the Primate Archaeology project (PRIMARCH).

In fact, by this point, one attempt to excavate non-human tools had already been made. A team led by Julio Mercader at the University of Calgary, Canada, had broken ground in 2002. Working at a site deep in the Tai Forest of Ivory Coast where chimps had been spotted smashing open nuts with stones, they unearthed 479 stone pieces. Some resembled the flakes that chip off during chimps' nut-pounding sessions. Others had starch grains still lodged in their crevices – residues of the same nut species chimps eat today. In 2007, the team reported that they had discovered the remains of a 4300-year-old chimpanzee settlement.

There have been no further digs since then. But, with the foundations of primate archaeology already laid in West Africa, Haslam decided to look across the Atlantic to Brazil where evidence of tool use in wild capuchins was just starting to emerge. Like

Got it: a macaque prides shellfish from a rock in Thailand





MICHAEL HASLUM

Mercader, he and his colleagues were interested in tools used for nut cracking. They decided to start digging at the base of a tree where the monkeys kept a stock of stone tools and, less than a metre down, they found what they were after. Some of the stones resembled modern-day capuchin hammers, which are much larger than the average rocks in the area. Others looked like anvils, which are four times the size of the hammers. Carbon dating put the tools at 700 years old, meaning they were in use well before the first Europeans arrived in the New World, making them the oldest non-human stone tools found outside Africa.

Like the Tai Forest chimps, the monkeys have clearly been cracking nuts in the same way for a long time (see “Starting a revolution”,

STARTING A REVOLUTION

The oldest stone tools we know of date to about 3.3 million years ago. They were made by our hominin ancestors living in what is now Kenya. Recently, three living non-human primates have been found to use rocks as tools. When did their Stone Ages begin?

For the long-tailed macaques of Thailand, that remains a mystery. However, in the case of chimps and capuchins, genetic analysis can help answer this question. The western subspecies of chimps, which includes the nut-cracking communities of Ivory Coast, are the only chimps known to use stone tools. Sequencing their DNA reveals them to have branched off from central African chimps – the oldest remaining chimp population – hundreds of thousands of years ago. Assuming that stone tool use was invented some time after this split, researchers conclude that it may have originated between 200,000 and 150,000 years ago.

Genetic analysis also reveals that the tool-wielding capuchin species appeared in Brazil's semi-arid interior, where rocks are plentiful, in the middle Pleistocene around 700,000 years ago. So their handiness probably originated after this time. But the story doesn't end there. Some of these monkeys then moved north into the Amazon forests and their descendants do not appear to use tools – a salutary lesson that technological sophistication can be lost as well as gained.

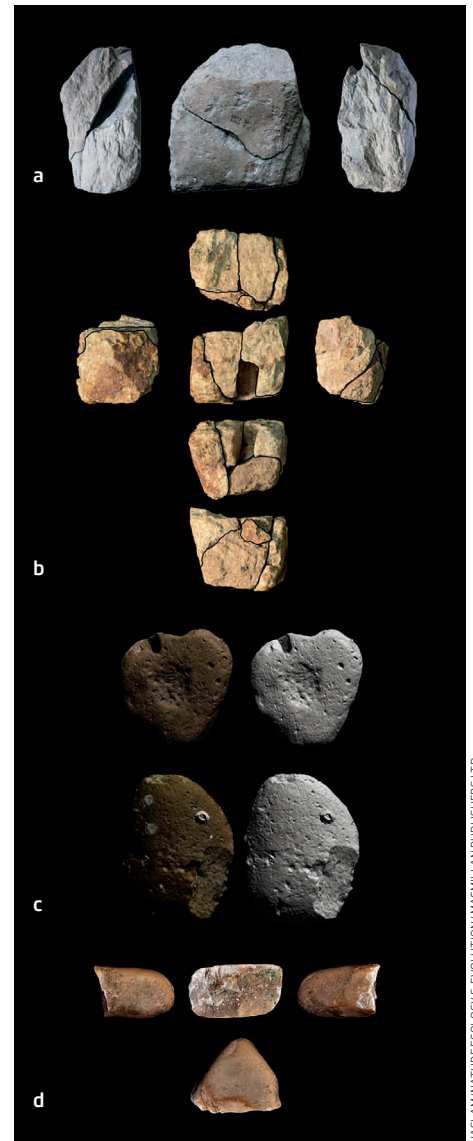
below). The tools unearthed in both cases are remarkably similar to those used today, but that doesn't necessarily mean their technologies have stagnated since then. “Even 4300 years is actually not a long period if you're talking about simple stone tools,” says archaeologist Tomos Proffitt from University College London, who collaborates on PRIMARCH. To put things in perspective, the sharp-edged stone flakes used by early *Homo* 2.6 million years ago are identical to those they were manufacturing 1 million years later. Similarly, once flat, refined stone axes came on the scene, these went unchanged for another million years. “It's still early days,” says Proffitt, “and we're still taking the primate stone tool tech further back in time.”

Of course, these archaeological records will never match the sophistication of our own, but they are superior in one way. “For traditional archaeologists, the behaviour is long extinct and they can only work with the remains that they find in the ground,” says Lydia Luncz, a postdoctoral fellow in Haslam's lab. “We have the advantage of being able to go out there and observe the behaviour of our primates.” That doesn't just help when trying to interpret their past technologies, it can throw new light on the behaviour of hominins living millions of years ago too.

Mystery percussion

For example, when the capuchins aren't using rocks to crack nuts, poke in the dirt or woo mates, they sometimes bang them together. The purpose of this percussion is a mystery: they often stop to lick mineral dust off the rocks, so they could be ingesting the sharp particles to cut up intestinal parasites. “We are still trying to figure out why exactly they're doing this,” says Proffitt. But the behaviour is interesting for another reason. “Occasionally they will produce flakes that are incredibly similar to the flakes hominins made.” These are inadvertent by-products, and the monkeys don't use them. This raises the intriguing possibility that our ancestors originally produced flakes by accident through a percussive behaviour, before adopting them as tools.

Further insights into the origins of hominin tool use could come from studying the archaeological record of Burmese long-tailed macaques. Troops of these monkeys living on a series of islands off the west coast of Thailand use rocks predominantly to break open oysters, crabs and sea snails, rather than nuts. This behaviour was only discovered a decade ago, but when Haslam heard about it he was keen to carry out a dig. This one would



prove trickier than the others, however. “The big challenge with macaques is the sea. It washes away all the remains of their tool use,” says collaborator Michael Gumert of Nanyang Technological University in Singapore.

Undeterred, Haslam, Gumert and their colleagues spent days on a boat off Piak Nam Yai Island waiting for the tide to recede and macaques to emerge from the forest to forage along the rocky shoreline. They observed the monkeys place their catches on big boulders and whack them with rocks until the shells loosened and released the soft meat inside. After their meal, the monkeys would retreat back to the forest. At that point, the team swung into action, descending on the beach and digging as fast as they could. “We can only excavate for a maximum of about four hours before the tide comes back, so that limits how deep we can go,” says Haslam.

Carbon dating of oyster shells in the deepest deposits revealed that they are only about 65 years old. But the trenches they dug do



It has been a revelation comparing tools made by the earliest hominins (a) with those by chimps (left, b), macaques (c) and capuchins (below, d)

give these rocks to chimps living in a sanctuary, and the chimps use them as anvils until they accumulate unique damage patterns. A side-by-side comparison with anvils found at the hominin sites can then reveal if these were used for nut cracking or not. A similar approach could help with the perennial problem of distinguishing ancient tools from stones damaged by natural forces.

With three new tool-users on the block, the primate archaeologists can also start to do comparative studies. To this end, they have compiled a list of “stone-tool-use universals for primates”. The key similarities are that they all transport their tools to special activity areas; all group members use tools; juveniles spend years honing their techniques; and they always use stone anvils as pounding surfaces. Given that our hominin ancestors were members of the exclusive group of stone

“Like capuchins, our ancestors may have first made flakes by accident”

tool-using primates, Haslam believes we can extend these universals to them. Intriguingly, the trio of primate tool users all lack traits long associated with the origins of tool use in hominins, including language, handedness, bipedalism and a savannah environment.

But we mustn’t get carried away. Although there is no doubt that primate archaeology offers exciting new ways to peer into our own past, Luncz cautions against drawing too many conclusions. “What we observe in a chimp did not necessarily happen in early hominins. They are not the same species; there are millions of years of evolution dividing them,” she says. That applies even more so to capuchins and macaques, with which we share ancestors far further back.

Nevertheless, primate archaeology has come a long way in a few years, and Haslam wants to extend the approach even further. In his spare time, he has been analysing the handiwork of sea otters in California’s Monterey Bay, which use stones to break open their hard-shelled prey. He has also been excavating in New Caledonia in search of stone anvils used by the local tool-making crows. He believes archaeological methods can bring a time dimension into the study of animal behaviour that has been lacking. “What animals do now is not what they always did, so they shouldn’t be treated as these frozen things,” he says. “Especially when we know how much humans have changed.” ■

contain telltale signs of shellfish processing in the shape of pitting and fracture marks on hammer-sized stones, often discovered near a massive boulder. Gumert hopes to find more of these stashes and to figure out how stone tech emerged and is maintained in macaque society. He’s convinced that it is an adaptation to life on the coast – a lifestyle which, it has been suggested, prompted some groups of early humans to settle down, establish complex societies and develop technologies geared towards foraging on the seashore. The macaques might provide a glimpse at the circumstances that led to these developments.

Back in West Africa, PRIMARCH researchers are finding that their archaeological approach can help reveal how cultural traditions are maintained. The Tai chimps live in communities, favouring one of two nut-cracking tools: some primarily use hammers made of stone, others prefer wooden clubs. These differences are maintained despite females frequently moving between groups.

By studying tools made in the past by females but left behind when they migrate, Luncz has discovered that they tend to adopt the tool of choice of their new group, even if that means abandoning one they have spent years mastering. She notes that this tendency to conform to local traditions is also “an essential feature of human culture”, and one that allows communities to retain their distinct customs despite an influx of new members.

Like monkey, like human?

In another ingenious study, the chimps are helping researchers work out what hominins used their tools for. The archaeological record is full of rocks that look like anvils, but no one knows whether a given slab was for cracking nuts, bones, or both. To address this problem, archaeologist Adrian Arroyo and colleagues from University College London, are collecting stones from Olduvai gorge in Tanzania, where early hominin tools have been found. They

Erica Tennenhouse is a science journalist in Toronto