NHM, LONDON

DIGGING FOR DODO

No one has seen a dodo in three and a half centuries, but that hasn't stopped the bizarre speculation about this extinct bird. **Henry Nicholls** investigates whether recent excavations in Mauritius could reveal the real creature.

The dodo is perhaps the most famous symbol of extinction, yet no one knows exactly when or how it went extinct. In fact, no one knows much of anything about the flightless creature, which lived on the Indian Ocean island of Mauritius until soon after Portuguese and Dutch sailors showed up in the sixteenth century. Popular images perpetuate the notion that the dodo (*Raphus cucullatus*) was a tubby, pigeon-like bird with a huge bill, gaping nostrils and bulging eyes.

Yet this clumsy apparition may be pure fiction, created from secondhand stories and poorly preserved specimens (see 'Dodo fiction', opposite). Thousands of dodo bones, hundreds

of dodo studies and countless dodo enthusiasts have done little to illuminate how the dodo really lived and died. "We still know virtually bugger all about the dodo," says Julian Hume, a bird palaeontologist at the Natural History Museum in London.

That may soon change, thanks to new excavations in a Mauritian swamp called the Mare aux Songes. For the second year running, a team led by Dutch geologist Kenneth Rijdsdijk has been visiting the most important site ever to turn up dodo bones. The spot has languished untouched for decades, but in the years to come, mud from this dig could increase the number of known dodo bones by an order of

magnitude. And there is an entire ecosystem, from bacteria to giant tortoises, preserved alongside the dodo remains. Together, the studies promise an unparalleled glimpse into the life and death of this enigmatic bird — perhaps even providing, for the first time, a faithful picture of the long-dead dodo.

It may seem surprising that scholars disagree about so many basic facts, including what actually drove the dodo to extinction. There are many possibilities. The newly arrived sailors may have eaten so many birds that they caused the population to crash. Or perhaps the sailors destroyed its habitat beyond repair, or brought mammals — notably rats, pigs and

goats — that trashed the landscape. Or a natural disaster, such as a tropical cyclone, may have pushed the bird to near-extinction before the sailors even arrived. The smart money is on the rats, but without the luxury of travelling back in time, it's impossible to be sure.

Opinion is also divided over the date the dodo finally disappeared¹. Hume has argued in *Nature* that detailed hunting records from a chief of Mauritius suggest his men bagged at least a dozen dodos between 1685 and 1688 (ref. 2). Others disagree, including Hume's friend and colleague Anthony Cheke, leader of a 1970s expedition to Mauritius by the British Ornithologists' Union. Cheke says that the word in the hunting records — *dodaersen* — was used by the 1660s to describe another flightless bird on the island, the red rail (*Aphanapteryx bonasia*)^{3,4}. The last reliable dodo sighting, he argues, dates from 1662, when a band of shipwrecked sailors waded out from Mauritius to a small islet and hunted down several birds "larger than geese".

Up in smoke

Whenever and however it vanished, the dodo did not leave much of itself behind. Sailors brought back stories, sketches and stuffed birds. Only one bird is known to have been brought to Europe alive; it may be this creature whose skeleton wound up in the Ashmolean Museum in Oxford, UK. Tragically, in 1755, all but the head and one foot of this precious specimen went up in flames. One account of the story involves a heroic curator, who dived into the flames and hacked off the bits, saving them from certain destruction. The more widely accepted version is that the fire was no accident, but was deliberately lit to destroy a deteriorating specimen.

The salvaged body parts remained the world's most important dodo relic for more than a century. Then in 1865, engineers were carving out a railway line alongside the Mare aux Songes on the east coast of Mauritius

(see map). Local schoolteacher George Clark chanced upon dodo bones exposed during the digs, and he organized local workers to feel their way through the nearby swamp in search of more material.

Clark eventually uncovered an impressive cache of dodo bones, which he sold to the Natural History Museum in London. It is largely this and other Mare aux Songes material extracted towards the end of the nineteenth century — a few thousand bones in total — that informs modern understanding of dodo anatomy. But because of the crude techniques used by Clark's crew, the Mare aux Songes has never produced a complete skeleton of a bird. Instead, almost all the dodo skeletons on display in the world's museums are the remains of several birds unearthed from the swamp by Clark and his immediate successors, and cobbled together into a dodo-like form.

There is one exception, and it stands inside a six-foot glass case in the Mauritius Institute in the capital city of Port Louis. This specimen, found in the 1890s by a hairdresser and dodo enthusiast named Louis Etienne Thirioux, is the only known fully articulated specimen. It probably came from a cave at Le Pouce just south of Port Louis, says Hume. But Thirioux seems to have kept the exact location a secret, and the few people who have bothered to retrace his steps have turned up nothing as the valleys are now overgrown with impenetrable weeds.

Scant remains

Others have continued to search for dodo remains elsewhere on the island. In 1974, a handful of dodo material came out of a borehole at Mare Sèche, but the landowner would not allow palaeontologists to excavate. "You can find bones in other places, but in very limited quantities," says Anwar Janoo, an ornithologist and consultant for the National Heritage Fund in Mauritius. He has found, for instance, some dodo fragments in cliffside caves at Baie du Cap at the southern tip of the island. Slaves and convicts used these caves as refuges, he says, and the bones are probably the remains of dodos captured and eaten by fugitives. Janoo has also found some bones at the bottom of a collapsed lava tunnel on Plaine des Roches in the north⁵.

He claims to know of another dodo site in the north where French palaeontologist and filmmaker Didier Dutheil exhumed the back of a dodo skull in 1999. But neither Janoo nor Dutheil are letting on precisely where it is. The secrecy is frustrating, says Cheke: "It's amazing they haven't gone back or at least told somebody else where it is."

A few thousand bones from Mare aux Songes, the Thirioux skeleton and Janoo's fragments are clearly not a lot to go on. But it wasn't the need for more specimens that led to the recent digs at the Mare aux Songes. Instead, a series of coincidences brought Rijdsdijk, who is based at the Netherlands Institute of Applied Geoscience in Utrecht, and his colleague Frans Bunnik there

DODO FICTION

Despite a wealth of popular writing about the dodo, secondhand or conflicting stories have led to plenty of misunderstandings about what the bird was really like⁷.

Colour All firsthand reports agree that the dodo was grey or blackish, but seventeenth-century Dutch paintings of white dodo-like birds led to confusion. Some of these pictures may have shown the now-extinct white ibis (*Threskiornis solitarius*) from nearby Réunion Island. Others may have portrayed an albino dodo, perhaps singled out because of its unusual colour.

Shape The popular image of the dodo — a squat, short-legged, awkward-looking beast — probably derives from one image created by Flemish painter Roelandt Savery around 1626 (opposite), says dodo expert Julian Hume. Earlier illustrations show long, powerful legs and a more upright stance. But copying soon became rife. "After 1638, you cannot trust any image of a dodo as being genuine," says Hume.

Nostrils In many illustrations, the dodo has huge, gaping nostrils. This is probably because almost all artists based their work on dead specimens, says Hume. "When the skin dries, the holes open up," he says. In the only pictures unequivocally based on live or recently dead dodos, such as that dating from 1601 below, the nostrils are almost invisible.

Diet With virtually no information on what dodos ate, speculation has been rife. One theory, proposed in 1973, held that the seeds of the tambalacoque tree needed to pass through a dodo's digestive tract before they would germinate, and without dodos, the tambalacoque was declining. The recent rediscovery of tambalacoque seedlings in Mauritius dealt a final blow to this fable.

Edibility The dodo probably didn't taste as awful as popular legend holds, says Hume. One of the earliest accounts describes the birds as having "very good meat" but goes on to say that sailors preferred to eat pigeons and parrots, as the dodos were "loathsome and fulsome birds". Hume suggests that this phrase may have been misread: dodos tasted fine, he thinks, but were so rich and fatty that sailors quickly tired of the meat.

H.N.

R. JAYASENA

R. JAYASENA

Skeleton key? Julian Hume (right) holds up one of the many dodo bones retrieved from rich soil samples (left) taken from a Mauritian swamp.

in October 2005. They were looking not for dodo, but for pollen samples that might help them reconstruct the vegetation and climate of Mauritius before the Dutch settled the island in 1638.

Rijsdijk and Bunnik identified several spots of interest, but neither of them realized that one of their sites — a marshy valley not far from the sea and surrounded by sugar-cane plantations — was the swamp Clark had excavated 140 years earlier. In the 1940s, the then British authorities ordered the Mare aux Songes to be filled with volcanic rubble, to combat the spread of mosquitoes and malaria on the island. Rijsdijk and Bunnik realized where they were when a local landowner told them that five boreholes had been drilled into the swamp in 1992, at the behest of a dodo devotee from Japan. The person who commissioned the work never claimed the cores, and the Dutch scientists were the first to see them.

They were stunned by the richness of material in the cores. “They had an alternation of different types of sediment that showed we were dealing with a really dynamic environment,” says Rijsdijk. There was one small problem: knowing where the cores had come from. A crude diagram made by the drill engineers sketched out the sea, a road, four palm trees and the boreholes — with no scale or direction. “It was like a treasure map,” he says.

Dodo hunt

Locating a likely spot, they began to drill a speculative core. “It took us one and a half hours to get through 80 centimetres of rocky rubble,” says Rijsdijk. But beneath they found dozens of dodo bones.

This past July the team returned, armed with radar to locate the most promising areas, a digger to remove the top layer of rubble, and drills to bore into the peaty soil to depths of some eight metres. The cores came back up chock

full of microbes and plant matter, along with bones from skinks, giant tortoises, parrots, owls and bats. Radiocarbon dates should soon pin down the age of these deposits, but the cores were completely free from introduced species — suggesting that they represented the dodo’s world before humans arrived. “This provides us with a great opportunity to reconstruct this world,” says Rijsdijk.

In fact, the Mare aux Songes may capture more than just a moment in the life of the dodo, says David Burney, a palaeoecologist at Fordham University in New York. “I’m predicting it’s not just a snapshot,” he says. “It may be a kind of movie, sampling the landscape more or less continuously back in time.” Burney works in Hawaii, studying how the ecosystem was changed by the arrival of the

Polynesians; similarly, the studies on Mauritius may reveal the effect that natural forces and human colonization have on island ecosystems.

This summer’s excavations focused on an area of swamp about the size of a small room. It yielded about 4,000 bones, of which a few hundred belonged

to the dodo; early results will be presented at a conference in Oxford later this month. All told, there are three basins in the Mare aux Songes with palaeontological promise; they cover about 5 hectares and could contain tens of thousands of dodo relics, says Rijsdijk.

Such bounty could plug some of the holes in scientists’ understanding. Were male and female dodos different sizes? Did males sport an exaggerated bill or another trait to attract partners? How big were the dodos’ eggs? And how did the Mare aux Songes end up with so much interesting material — was it a natural disaster? If so that would lend credence to the idea that dodos had been battered to near-extinction before humans arrived.

Some hope that the swamp could even yield dodo DNA. An earlier study of dodo genetics, with DNA taken from the foot of the Oxford

dodo, illustrates the potential of this research. It suggested that the dodo’s closest living ancestor is the Nicobar pigeon (*Caloenas nicobarica*), and that the two diverged more than 30 million years ago⁶. But this date is long before volcanic Mauritius emerged from the sea. New studies could help clarify this relationship, or even yield new information, says Beth Shapiro, a specialist in ancient DNA with the University of Oxford. “If we were able to get ancient DNA from a lot of dodos from a long time period, we might be able to see how the population size changed as it approached extinction,” she says.

But the hot climate and acidic conditions of the Mare aux Songes will not have helped DNA preservation. Early analysis of the mud yielded DNA sequences from several different plant species, but so far nothing that looks as if it could have come from a dodo. “We have not yet given up,” says Shapiro.

But the dodo will remain the star of the show even without DNA. Some 350 years since the last dodo picked its way through the Mauritius undergrowth, opinions on the bird continue to change. “It may be dead, but it is very much alive,” says Rijsdijk.

The dodo attracts money even now. Rijsdijk has created the nonprofit Dodo Research Foundation, hoping to fund an expedition to the Mare aux Songes next year. He plans to excavate with painstaking care, avoiding the destructive mechanical techniques used this summer. And in the years to come, there could be boxes full of dodo bones to study — and perhaps, finally, enough material to dispel the many myths that have latched onto this bird.

Henry Nicholls is a freelance writer in London.

1. Roberts, D. L. & Solow, A. R. *Nature* **426**, 245 (2003).
2. Hume, J. P., Martill, D. M., & Dewdney, C. *Nature* **429**, doi:10.1038/nature02688 (2004).
3. Cheke, A. S. in *Studies of Mascarene Island Birds* (ed. Diamond, A. W.) 5–89 (Cambridge Univ. Press, Cambridge, 1987).
4. Cheke, A. S. *Ibis* **148**, 155–158 (2006).
5. Janoo, A. *Ann. Paleontol.* **91**, 167–180 (2005).
6. Shapiro, B. et al. *Science* **295**, 1683 (2002).
7. Hume, J. P. *Hist. Biol.* **18**, 65–89 (2006).

“We have a great opportunity to reconstruct the dodo’s world.”
— Kenneth Rijsdijk