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DREAMING REALITY
Baku's Ancient Heart
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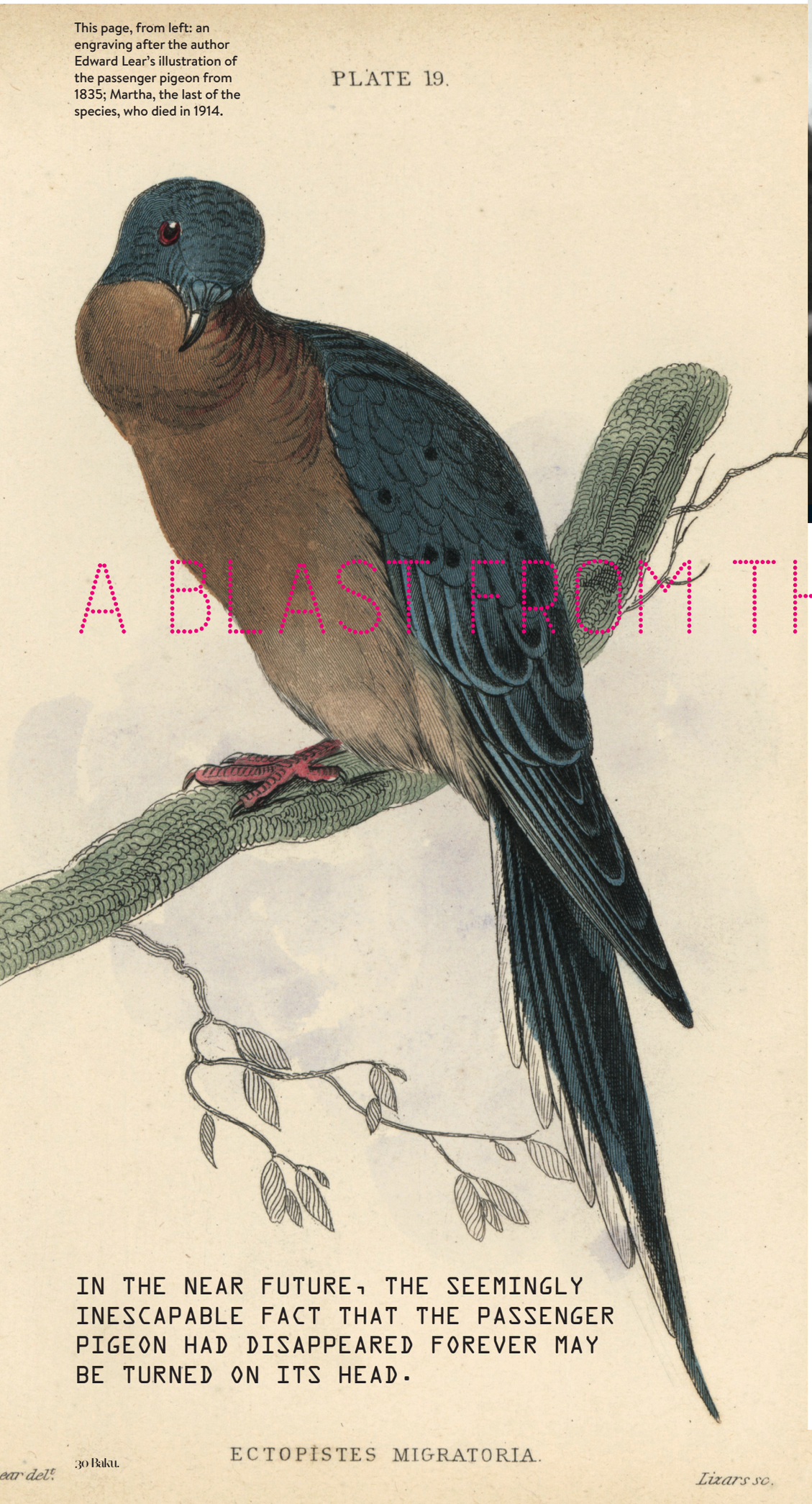
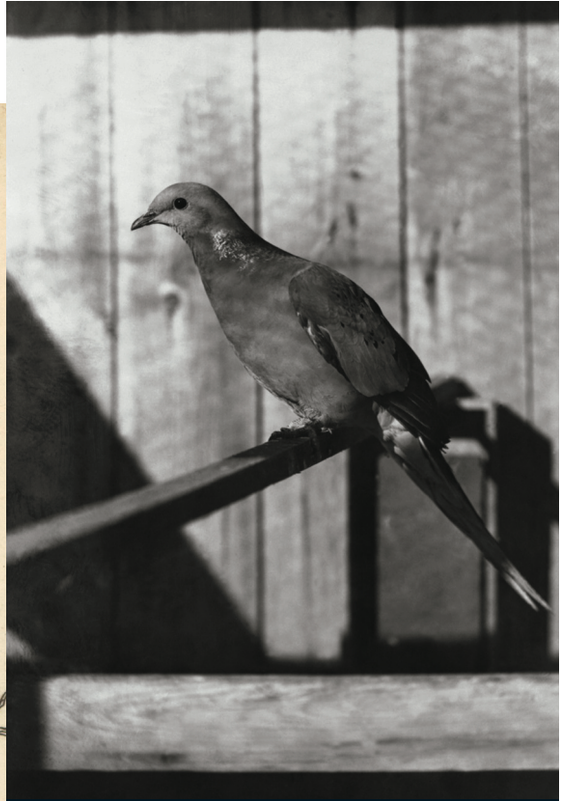
FEATURING
F1 GRAND PRIX * (VERY) ENDANGERED SPECIES * RUSSIAN HIPSTER POETS * MERCEDES AMG

This page, from left: an engraving after the author Edward Lear's illustration of the passenger pigeon from 1835; Martha, the last of the species, who died in 1914.





DECLARED EXTINCT IN RECENT YEARS:

A BLAST FROM THE PAST

September 1914: the bird keeper at Cincinnati Zoo in Ohio, US, passes a cage and notices that Martha, a passenger pigeon, has fallen off her perch. She's lying on the floor, dead. Not a huge surprise, as Martha was 29 years old – a grand age for a bird. But Martha was the last survivor of her species. With her demise, *Ectopistes migratorius* became extinct.

Passenger pigeons formerly roamed across much of North America in flocks of many millions, blocking out the sun as they flew and alighting on trees in such numbers that their weight brought down swathes of forest. Once the most numerous bird on the continent, it was subject to uncontrolled hunting with nets and guns by the late 19th century, and destruction of its habitat had reduced the population to a few scattered individuals. A few decades later the bird was extinct.

But in the near future, the seemingly inescapable fact that the passenger pigeon had disappeared forever with the death of Martha may be turned on its head. Advances in genome technology and DNA manipulation are opening up theoretical possibilities, including the mind-boggling return of species thought to be irretrievably lost. Think dodo, woolly mammoth, Tasmanian tiger and Madagascan elephant bird. The race to achieve 'de-extinction' has begun.

Genetic scientists have been involved in saving endangered

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SCIENTISTS ARE RUSHING TO SALVAGE MAMMOTH MATERIAL IN AN AUDACIOUS ATTEMPT TO RECREATE THE MODERN ELEPHANT'S WOOLLY ANCESTOR.

EASTERN COUGAR (2015), FORMOSAN CLOUDED LEOPARD (2013), JAPANESE RIVER OTTER (2012), WESTERN BLACK RHINOCEROUS (2011),

Dead as a dodo? Not for much longer, if cutting-edge genetic engineering has its way. **James Parry** reports on how extinct animals may be about to make a comeback.

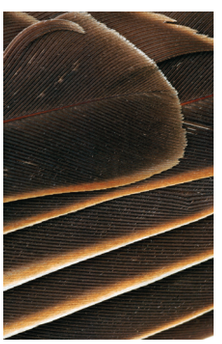
flora and fauna for decades. But their focus has usually been on selective breeding to promote the characteristics or features of a particular species considered to be worth continuing. With horses, this has been carried out for centuries to ensure the development of qualities such as endurance, strength and temperament. Through techniques such as the sequencing of the horse genome (the complete set of equine genes), science has bolstered this tradition to protect the bloodlines of endangered breeds, such as the Karabakh horse in Azerbaijan.

"The Karabakh has retained many of its original genes," says horse expert Doris Lütz, an adviser on the 2016 film *Sarylar – A Journey to the Karabakh Horse*, which traced the history and qualities of the breed. "Without careful selective breeding, these could be diluted and the genetic purity of the Karabakh compromised or lost entirely. Science is an essential part of this process."

Selective breeding can only go so far, though. Sometimes a creature is in such dire straits that a much more radical approach is called for. Take the northern white rhino. Wiped out in the wild by poachers, this subspecies survives only in the form of three captive individuals, living under 24-hour armed guard on a ranch in Kenya. The lone veteran male, called Sudan, is 43 years old and no longer able to mate with his two female companions, Fatu and Najin. He has a low sperm count anyway, and it's not clear if Fatu and Najin can conceive naturally. Without human intervention, the northern white rhino is doomed. Stem cell specialists, who have grown mice from simple skin cells, are now looking to harvest natural gametes from this last-chance threesome and multiply them alongside stem cells to create viable embryos. These could then be implanted in a surrogate southern white rhino, the northern rhino's closest relative. No one knows for sure if this will work, but a lot of time, effort and money are being spent trying to ensure that the northern white rhino doesn't go the way of the dodo.

Yet now it seems that not even the dodo is necessarily past the point of no return. Conservationists are actively discussing the possibility of 'de-extinction', recreating lost species through techniques such as cloning. Also dubbed 'resurrection biology', the approach marries salvaged fragments of DNA from the vanished creatures with live cells taken from closely related living species and tries to create new organisms resembling the extinct ancestor. It is a difficult process. Forget *Jurassic Park* boffins extracting DNA from mosquitoes 'frozen' for millions of years in bits of amber. DNA decays rapidly and so finding viable genetic material in something that is centuries-dead is a needle-in-haystack affair at best.

About 10,000 years ago, humans co-existed with mammoths. Many of



This page, clockwise from top: the last woolly mammoths died out about 4,000 years ago; a boy holds an extinct elephant bird egg; the enormous creature reached up to 3m in height; passenger pigeon feathers, up close.

FLORILEGIUS/SSPL/BETTMANN/GETTY, PRIVATE COLLECTION/© LOOK AND LEARN/BRIDGEMAN IMAGES, MICHAEL DOOLITTLE/FRANS LANTING STUDIO/ALAMY.

CASPIAN TIGER (2003), PYRENEAN IBEX (2000), LEVUANA MOTH (1994), JAPANESE SEA LION (1994), DESERT RAT-KANGEROO (1994), 24-RAYED

"THE CHANCES OF FINDING MAMMOTH SAMPLES WITH ENOUGH SUFFICIENTLY INTACT DNA FOR SUCCESSFUL CLONING ARE EXCEEDINGLY REMOTE."

these goliaths, long extinct, lived on the Siberian taiga, where scientists are now rushing to salvage mammoth material in an audacious attempt to recreate the modern elephant's woolly ancestor. Every summer, a research partnership between China, Russia and South Korea sends teams to remote areas to retrieve samples of mammoth DNA from carcasses frozen in the permafrost.

Cloning a mammoth, or any extinct creature, requires finding viable cells with a complete, intact genome. A potential "Eureka!" moment came in May 2013, when a pair of mammoth tusks was found protruding from a slab of melting ice. They proved to be attached to an exceptionally well-preserved specimen, nicknamed 'Buttercup', which, when first dislodged from the permafrost, was actually oozing blood. There was hope that Buttercup would retain some living cells, but when extracted blood was examined, the cells were no longer intact. An autopsy was carried out as the carcass slowly defrosted and revealed that Buttercup had died 40,000 years ago, eaten alive by wolves after getting stuck in a peat bog.

"The chances of finding mammoth samples with enough sufficiently intact DNA for successful cloning are exceedingly remote," says Professor Love Dalén, an expert on evolutionary genetics at the Swedish Museum of Natural History. Dalén believes that it's more productive to focus on identifying the genetic differences between mammoths and their nearest living relation, the Asian elephant. Together with teams from Harvard Medical School in the US and McMaster University in Canada, Dalén and his researchers have mapped the first complete genome of a mammoth, opening up the prospect of a future cut-and-paste exercise to help create 'mammoth' embryos using stem cell genomes from an elephant. The end product remains the subject of speculation, however. "It could just be a hairy elephant," admits Dalén.

Similar issues loom large in the Great Passenger Pigeon Comeback project, a central plank in a 'de-extinction' programme called Revive & Restore, funded by the non-profit San Francisco-based The Long Now Foundation. By comparing fragments of passenger pigeon DNA with the genome of its closest living relative, the band-tailed pigeon, Dr Ben Novak and his team are hoping to assemble a genetic approximation of an actual passenger pigeon. "Our projected goal is to have some form of passenger pigeon by 2022," he enthuses. "The bird we create will hopefully be a bird that looks and acts like a passenger pigeon, but at a genetic level it's a band-tailed pigeon that's been adapted into being a passenger pigeon."

Perhaps not quite the real thing, then? De-extinction is nothing if not controversial. Critics argue it's little more than headline-grabbing

From far left: a Karabakh horse; the last Tasmanian tigers, in 1933; the striped tiger pelt.

sensationalism that diverts precious resources and can provide excuses for habitats to be destroyed on the basis that the creatures there can be 'recreated' elsewhere. Professor Stuart Pimm, Doris Duke Professor of Conservation Ecology at Duke University in the US, has railed against the whole de-extinction concept. "Conservation is about the ecosystems that species define and on which they depend," he said. "[It's] about finding alternative, sustainable futures for people, for forests and for wetlands. Molecular gimmickry simply does not address these core problems. At worst, it seduces granting agencies and university deans into thinking they are saving the world [and] it distracts us from guaranteeing our planet's biodiversity for future generations."

Professor Dalén sees profound ethical issues, as well. "Impregnating Asian elephants with manufactured embryos is fraught with risk, not least for the elephants," he explains. "The rate of rejection and complications would be high, and the surrogates might suffer in the process. They're an endangered species, so I just don't think we should do it."

"IMPREGNATING ASIAN ELEPHANTS WITH MANUFACTURED EMBRYOS IS FRAUGHT WITH RISK… THEY'RE AN ENDANGERED SPECIES, SO I DON'T THINK WE SHOULD DO IT."

Yet with up to 40 per cent of the world's living species estimated to be at serious risk of disappearing by the year 2050 as a result of global warming, habitat loss and other human activities, the support of geneticists is likely to prove invaluable in helping species survive. "Stem cell research on mammoths and other extinct animals could have really useful wider benefits," says Dalén, "both for endangered wildlife and humans as well."

Some de-extinction techniques will likely end up in the toolbox of conservation science, and may also inform the wider debate. "The real point of de-extinction as an emerging field beyond mammoths and passenger pigeons is this notion of revolutionizing conservation," stresses Dr Novak. "Conservation has done 40 years of save the pandas, save the rhinos. It's been a lot of doom and gloom, with not much emphasis on, 'Here's a problem, how do we solve it?' What we are trying to bring to the floor are solutions to new challenges."✿

SUNSTAR (1984), JAVAN TIGER (1975), ARABIAN OSTRICH (1966), BARBARY LION (1965), BERNARD'S WOLF (1952), TASMANIAN TIGER (1936).

Clockwise from above: Sudan, the last male northern white rhino; guards in Kenya with another of the three surviving rhinos of this species; a mammoth tusk at the Swedish Museum of Natural History; a woolly mammoth skeleton; a preserved Tasmanian tiger pup, whose DNA may help bring back the species.

EMIL KHALILOV; WORLD HISTORY ARCHIVE/CHARLIE NEUMAN/SAM DIEGO UNION-TRIBUNE/ZUMA PRESS/REUTERS/ALAMY; HENDRIK SCHMIDT/DPA/PA IMAGES; LOVE DALÉN; BRENT STIRTON/MICHELE SOBECK/THE WASHINGTON POST/GETTY.