

News

Mongoose teamwork hides darker side



Mark Machem/OSF

BANDED mongoose society looks harmonious and cooperative, but research over a decade and a half shows this is just a thin veneer hiding fierce competition.

Mongoose groups have an unusual social structure that is helping scientists understand why some animals are willing to make sacrifices to help others, and what the limits are to this kind of cooperation.

The findings are emerging from a long-term study monitoring ten mongoose packs living in Uganda. The research inspired BBC documentary *Banded Brothers: The Mongoose Mob*.

Unusually, mongoose mothers synchronise their childbearing. In meerkats and many other social animals, only one female at a time gets to breed, and those further down the pecking order have to content themselves with looking after the breeding female's young.

But among banded mongooses,

several females breed at the same time, and they give birth on the same day. This helps protect their pups. If young mongooses are born too early, higher-status females are likely to kill them in an effort to increase the chances their own young will survive. Once these high-ranking females have young of their own they won't kill pups – female mongooses don't seem to be

Mongoose groups have an unusual social structure.

able to tell one pup from another, and so they don't risk killing their own offspring.

But there are also costs to giving birth too late: if pups are born later than their peers, there's a good chance they'll lose out to older pups in the competition for food and adult attention. The result

is a remarkable degree of birth synchrony, whereby up to ten females all give birth at the same time.

By dosing female mongooses with contraceptives to limit the number of births, the researchers have learned that the optimum number of females that can give birth at the same time is around three. A mongoose born with no peers of the same age has almost no chance of living to adulthood.

'The adults just don't seem to take things seriously if there aren't enough pups,' says Dr Michael Cant of the University of Exeter, who initiated the project in 1995. 'They don't spend much time looking after them, or feeding them, and they sometimes fail to leave babysitters behind to protect them when the group goes off to find food.' But if there are too many pups, there is not enough food to go round and several will starve.

Because it lets more pups avoid death by infanticide, synchronised childbirth improves low-ranking females' chances of breeding successfully. But it is also likely to push the number of pups in the group well over the optimum total, so it harms the group as a whole. If the food supply runs out, middle-aged females are driven out in often-violent ejections.

So while synchronised birth looks on the surface like a cooperative way to let more individual mongooses bear children, it seems to have evolved in response to routine infanticide and is effectively a way for young females to seize advantage at the expense of their more senior rivals.

'Birth synchronisation seems to be a cooperative behaviour, but as you look deeper you see lots of conflict beneath the surface,' says Cant. 'Mongoose society is balanced on the edge between cooperation and conflict.'



Sea squirts spotted in Scotland

THE sea squirt isn't just ugly – it's also an invasive species that poses a serious threat to UK marine life. Now the critter has been found in Scotland.

Carpet sea squirts (*Didemnum vexillum*) come from Japan, but they have travelled the globe causing havoc in ports and marinas. The brownish, tube-shaped animals live in colonies and spread fast once established on the seabed. As a colony grows, it smothers local marine life and becomes a serious threat to biodiversity.

Colonies are also a problem for port authorities and fish farms, as they are 'especially good at growing over underwater structures such as boat hulls and pontoons', says Dr David Donnan, Policy and Advice Manager at Scottish Natural Heritage.

'We have been on the lookout for this species in Scotland as it was found in Holyhead Harbour in North Wales in 2008 and more recently in the south of England,' he says. 'This recent finding in Largs Yacht Haven is the first sighting in Scotland.'

The sponge-like leathery creatures were spotted during a routine survey by Christine Beveridge, a support scientist at the Scottish Association for Marine Science. 'This is one of our target species, so when I spotted a mussel on a pontoon, covered with a fawn-coloured growth, I immediately suspected the invasive sea squirt,' she says, adding that the animals may have arrived on the hulls of boats. Readers can find out more and report any sightings at <https://secure.fera.defra.gov.uk/nonnativespecies>.

Reefs grow in spurts



CORAL reefs do not grow continuously and some reefs off Australia are dead relics from past periods of growth. But this is not necessarily a sign of ecological catastrophe – when the opportunities arise, reefs know how to make the most out of it and can grow very quickly.

Reef growth depends on several environmental factors, but two are especially important – sunlight and space to expand. This means that reefs can grow extensively in clear, mud-free water where sunlight penetrates deep. In the long term, rising sea levels also come in handy as they provide vertical space for reefs to grow into.

'Our recent studies demonstrate that whole suites of reefs on the innermost parts of the Great Barrier Reef grew very rapidly between about 8000 and 5000 years ago, but not much since,' says Professor Chris Perry, a specialist in tropical coastal geosciences

at the Manchester Metropolitan University.

Perry analysed two reef areas off Queensland to see how reef growth has changed there over time.

With Dr Scott Smithers, from the Australian James Cook University, he extracted cores from them to analyse mud content, carbonate sediments and coral species.

'We found two distinct areas of coral-reef development within this area,' says Perry. Radiocarbon dating shows that the reefs grew at very different times, one between about 6500 and 4500 years ago, and one much more recently, in the last 1500 years or so.

'Both, however, have grown rapidly to sea level and have reached the end of their natural life under present sea-level conditions,' he adds. The reefs cannot continue to grow up because the sea level is stable, and further seawards growth is limited by muddy water conditions around the island that

restrict sunlight penetration.

Some of these reefs look alive and are covered by a thin layer of coral. But scratch the surface and you find an old, relict reef.

The findings, published in *Geology*, show that these reefs grew only at certain depths. But when the time comes, 'these reefs can grow very quickly – they appear to be very good at making the most out of their opportunities,' Perry says.

Although the studied coral reefs are dead, if the conditions change they may be able to return to growth. And this might happen sooner rather than later with the sea-level rises predicted for the next few decades.

In practice rising sea levels could give corals new space to grow, but Perry says global warming and climate change may also bring other less beneficial effects, such as coral bleaching and ocean acidification.

News

How the butterfly got its spots

THE SAME small portion of DNA, dubbed a 'hotspot of evolution', defines the wing spots of two different species of butterfly that have evolved to copy each other's wing pattern. This means evolution may be concentrated in small regions of the genome, while the rest does not change very much.

Heliconius butterflies have striking wing patterns, often with yellow and red spots and bands to warn predators they are toxic. Some species are remarkably similar because it pays to mimic patterns and bank on each other's toxic reputation with birds.

'When two species are very similar they reinforce the warning signal and gain an added protection against predation,' explains Dr Chris Jiggins, leader of the Butterfly Genetics Group at the University of Cambridge.

Heliconius melpomene, known as the postman butterfly, and *Heliconius erato* are a good example; they are only distantly

related but their wing markings are almost identical.

Scientists knew about the practical benefits of copying warning signals, but not how it happens. The same wing pattern evolved separately in separate species, but is it controlled by the same genes? Or are different genes doing the same thing? To find out, the researchers isolated the genes that control wing-pattern variation in the butterflies.

Their results, published in *PLoS Genetics*, suggest a small number of genes control major changes. 'It seems that evolution might be concentrated in small hotspot regions of the genome, while the rest does not change very much,' says Jiggins.

'This tells us something about the limitations on evolution, and how predictable it is,' he says. 'Our results imply that despite the many thousands of genes in the genome there are only one or two that are useful for changing this colour pattern.'



Ocean acidification accelerates

CARBON dioxide released from fossil fuels and dissolved in the ocean is making seawater more acidic and causing trouble for marine life. Now a new model suggests that seawater is acidifying at a rate that exceeds anything seen on Earth in 65 million years. The change may be too fast for marine animals to adapt.

Scientists from the University of Bristol developed a model to compare current predictions of ocean acidification with what happened during a greenhouse gas event 55 million years ago, called the Palaeocene-Eocene thermal maximum. Their research

appears in *Nature Geoscience*.

During this event, which saw a 5-6°C increase in surface water temperature, the oceans acidified and dissolved large quantities of carbonate rocks. All this happened over thousands of years – very sudden from a geological viewpoint.

The tiny animals and plants that make up the plankton at the surface of the sea did not suffer much during the event, perhaps because they moved to cooler waters or had time to adapt to changing conditions. Even so, the Palaeocene-Eocene acidification was severe enough to kill off many benthic foraminifers, tiny organisms that live at the

bottom of the sea protected by calcium carbonate shells.

This mass extinction has been linked to the high levels of carbon dioxide dissolved in seawater making it difficult for foraminifers to build their shells.

Nowadays, ocean chemistry may be changing even faster. 'What we found was a geologically unprecedented rate of acidification,' says co-author Dr Andy Ridgwell. The change seen today is taking place over hundreds of years, and this could be too much for marine life to handle.

'Given that we had an extinction in the past, it's quite possible that this will happen again in the future,' Ridgwell explains.

Benthic foraminifers might not attract as much sympathy as giant pandas, but their demise 'has implications for the cycling of nutrients and it's a good indication of the extent to which we're affecting the oceans,' he adds, suggesting that even ocean organisms may struggle this time.

Scientists have an idea of the consequences of ocean acidification on marine animals such as foraminifers or corals thanks mainly to experiments. But how will animals adapt to changing conditions? 'Experiments don't tell what will happen over 100 years,' says Ridgwell. 'And we can't wait 100 years.'



Springing forward – changing seasons threaten wildlife



BRITISH springs and summers are starting sooner, a new study shows. Winter now ends 11 days earlier on average than in the mid-1970s.

The research is the first systematic attempt to survey long-term trends in phenology – the science of seasonal timing – in ecosystems spanning freshwater and marine environments as well as dry land.

It examines more than 25,000 such trends between 1976 and 2005, covering 726 species ranging from plankton to plants and from insects to mammals.

More than 80 per cent of these trends show seasonal changes happening earlier. On average, events like the start of animals' breeding seasons are starting 11 days earlier than in 1976, and the trend seems to be accelerating. This is probably a response to climate change.

'This is the first time that data

have been analysed with enough consistency to allow a meaningful comparison of patterns of changing seasonal timing in the UK among such a diverse range of plants and animals,' says Dr Stephen Thackeray of the Centre for Ecology & Hydrology (CEH), one of the project's leaders.

Changes have been fastest for species near the bottom of food chains, such as plants and herbivorous animals. Plants saw the fastest changes on average, while predators have experienced slower changes in the timing of the important events in their life cycles.

Reproduction is often timed to happen when there's plenty of food around, to ensure young animals don't starve in their vulnerable first few weeks. At present we don't know how well the animals further up the food chain will adapt to the changing schedules of the organisms below them.

If they don't respond quickly, they will find it harder to raise their young, as their breeding seasons become increasingly mismatched with the periods when their food supply is at its most abundant – often, these are the breeding seasons of their prey.

'The recorded changes need urgent investigation, particularly for species with high economic or conservation importance,' adds Professor Sarah Wanless of CEH, the report's other lead author.

Scientists have broadly agreed that seasons are moving forward across much of the northern hemisphere, but this research, published in *Global Change Biology*, is the first detailed investigation of how this is affecting different species. Its authors argue that its findings may be applicable throughout mid-latitude regions, and may even be relevant worldwide.

In brief

Cutting fishing can help reefs bounce back

Protecting coral reefs from fishing could help them recover from damage more quickly than previously thought possible. Reefs are some of the planet's richest habitats, but they are threatened by climate change, ocean acidification and destructive fishing methods. Because corals grow slowly, scientists have feared reefs are doomed. But researchers compared reefs in marine reserves with similar habitats elsewhere, and found that in the reserves, where fishing isn't allowed, coral cover area increased much more quickly than in unprotected areas, perhaps because grazing fish protected the corals from competition from plants.

Scientists probe Southern Ocean black smokers for first time

Scientists on the British research ship RRS *James Cook* have explored deep-sea volcanic vents in the Southern Ocean for the first time with a remotely operated vehicle. The team have been working a mile and a half deep on the ocean floor to understand the extreme environment around the vents. They found complex ecosystems and are now studying the animals they recovered, which ultimately depend not on sunlight but on energy in the chemicals vented from the Earth's interior.



News

Dinosaur colours revealed



Chuang Zhen and Lida Xing/Institute of Vertebrate Palaeontology and Palaeoanthropology, Beijing

WHAT colour were dinosaurs? We've never known, so artists have been free to use whatever outrageous colours they fancied. But no longer – scientists have found the first evidence of colour in fossil feathers.

A British-Chinese team found that the dinosaur *Sinosauropteryx* had a feathered tail striped with ginger and white rings, and that *Confuciusornis*, an early bird, had

patches of reddish, black and white feathers.

For Professor Mike Benton, a palaeontologist at the University of Bristol, the discovery opens up an exciting new field of research. 'We can now go back and look for evidence of colour in other fossils. This will bring new insights on the behaviour of dinosaurs and on the evolution of feathers and birds,' he says.

Feathers' colour comes mainly from a protein called melanin. It is probably not preserved in the fossil record, but the tiny organelles that encase it, called melanosomes, can survive for millions of years, long after the protein is gone.

Modern bird feathers have two kinds of melanosomes: sausage-shaped structures which give a black colour, and spherical casings that provide reddish-brown tones. 'If no melanosomes, or other colouring agents, are present, then the feather is white,' says Benton.

The team looked for melanosomes in fossils of dinosaurs and early birds collected from north-east China. The 125-million-year-old remains were so well preserved that they could recognise the different types of melanosomes in their feathers.

The feathers along *Sinosauropteryx*'s tail have rings with spherical melanosomes alternating with bands with no visible casings. This suggests that the tail was striped ginger and white. Some hues remain elusive, though. Bright yellow, blue or green shades come from other proteins. These are not contained in casings, so they are less likely to be preserved in fossils.

Published in *Nature*, the findings aren't just a relief for dinosaur artists interested in accuracy. The feathers along *Sinosauropteryx*'s tail are closer to whisker-like filaments than modern feathers with a central quill and barbs. Some researchers concluded they weren't feathers at all, just skin tissue.

'The discovery of melanosomes embedded within the *Sinosauropteryx* filaments is the definite proof that they are indeed feather precursors,' says Benton. 'This is a very important conclusion to our understanding of the evolution of feathers and birds.'

Scientists have debated the function of feathers and filaments in dinosaurs. Since they did not have wings, the feathers weren't there to help them fly. Some have suggested they evolved as insulation to keep the animal warm.

But the feathers in the *Sinosauropteryx* fossils cover only part of the body, as a crest, along the midline of the back, 'so they would have had only a limited function in thermoregulation,' says Benton. He suggests feathers were originally for display, but were later adapted to insulation and flight.

First visitors to the Galápagos were European

THE first visitors to the Galápagos Islands were 16th-century European explorers, not pre-Columbian voyagers as was previously suggested.

The findings, published in *Vegetation History and Archaeobotany*, come from the radiocarbon dating of charcoal remains found close to pottery shards in old coastal campsites.

The pottery remains were identified as of South American origin by Thor Heyerdahl, the Norwegian archaeologist who rafted across the Pacific from

South America to Polynesia in the *Kon-Tiki* expedition during the 1950s. Heyerdahl suggested the Galápagos were colonised by South Americans before their official discovery in 1535.

But later research cast doubt on this conclusion. 'The pot shards were mixed with later European remains,' explains Dr Cynthia Froyd, a palaeoecologist working at the University of Oxford. So the pottery was probably brought from the South American mainland by European seafarers.

One way to solve the

conundrum is to discover when these historic campsites were occupied. Froyd and colleagues radiocarbon dated nine charcoal samples found near the pottery. They found that all were burned between 1575 and 1825. 'These campsites are too young for the pottery shards to be interpreted as evidence of pre-Columbian visitors,' says Froyd.

The findings add to other clues provided by the archaeological evidence. Drs Atholl Anderson and Simon Haberle, archaeologists from the Australian National

University and co-authors of the recent study, analysed coastal campsite locations in detail and concluded that there is no evidence humans were in the Galápagos before the Europeans' arrival.

So it seems that Europeans were indeed the first people to set foot on the remote Galápagos, about 1000km west of South America. These first visitors were mainly buccaneers, whalers and traders who set up camp near the few freshwater springs available.

Stunning photos reveal rich Antarctic marine life

CLOSE-UP photographs of bizarre marine animals in one of the fastest-warming seas on Earth show the area is home to a huge diversity of life.

The creatures include ice fish, octopus, sea pigs, giant sea spiders, rare rays and basket stars.

An international team of scientists collected the creatures in West Antarctica while on an expedition to study the diversity of life in the continent's shelf seas.

Expedition leader Dr David Barnes from the British Antarctic Survey reported the team's findings from Antarctica.

Comparing the area to coral reefs, Barnes says, 'Few people realise just how rich in biodiversity the Southern Ocean is – a single trawl can reveal as fascinating an array of weird and wonderful creatures as would be seen on a coral reef.'

One of the expedition's aims is to figure out how some of these marine animals will respond to environmental change.

'These animals are potentially very good indicators of environmental change. Some live in the shallows, which are changing fast, while others live in deeper water which will warm much less quickly,' says Barnes.

► Amphipod (sand-hopper). Gigantism (due to high oxygen levels in polar waters) was first demonstrated in amphipods. This important group often fills the ecological niche of animals like crabs, which are almost unknown in Antarctica.



► Sea pig (sea cucumber or holothuroid). This was one of the most common animals.



► Scale worm, *Laetmoice* sp. Polychaete worms like this are often the most abundant large organisms on the continental shelf around the region.



News

Taking a tern round the globe



Carsten Egevang/ARC-PIIC.COM

ARCTIC terns make the longest migration of any animal on the planet, scientists can confirm. They fly up to 80,000 kilometres every year while migrating from the Arctic to the Antarctic and back again.

As Arctic terns can live for 30 years, this is like making three trips to the moon and back over their lives.

Scientists have long suspected that Arctic terns top the list of long-distance migratory birds, but previous estimates suggested they averaged about 40,000 kilometres every year. Now, technology has doubled this distance.

'This is a mind-boggling achievement for a bird that weighs just over 100 grams,' says the lead author of the research, Dr Carsten Egevang from the Greenland Institute of Natural Resources.

Egevang and colleagues from the British Antarctic Survey, Greenland, Denmark, the US and Iceland describe in *Proceedings of*

the National Academy of Sciences how they tracked the birds using tiny instruments called geolocators.

They attached them to 50 Arctic terns' leg rings towards the end of the breeding season on Greenland in July 2007. Another 20 instruments were attached to birds breeding on Iceland in June 2007.

The geolocators weigh just 1.4 grams and, including attachments, make up around 1.9 per cent of an adult's body weight. They record light intensity; when this data is fed into a computer program, scientists can calculate when and where the birds travelled.

The following year the team managed to retrieve ten of the logging devices from the Greenland birds and one logger from the Iceland colony.

As well as confirming their wintering grounds in Antarctica, the researchers discovered that after leaving Greenland and Iceland in August, the terns

stop over in the North Atlantic for around a month en route to Antarctica.

'This part of the Atlantic is a region of high marine productivity so it's clear they're using the area to refuel before crossing less productive parts of the Atlantic Ocean,' explains Dr Richard Phillips of the British Antarctic Survey, co-author of the paper.

While birds from the same colony followed either the African or South American coastlines, all of the birds followed the same route home. This means that birds from different breeding colonies mix when they're in the Antarctic.

'It looks like these incredible birds are exploiting the prevailing global wind systems in the Atlantic, which go clockwise in the north and counter-clockwise in the south, making their trip north that much easier. Interestingly this is the same strategy used by Manx and Cory's shearwaters,' says Phillips.

Call for new members of the NERC Science and Innovation Strategy Board

NERC is calling for nominations to its key advisory board, the Science and Innovation Strategy Board (SISB), to commence 1 September 2010 for a three-year period.

Applications with the following backgrounds would be particularly welcome: relevant business, public and voluntary sectors, climate modelling, ecology, geomorphology and marine science. NERC recognises that women, disabled people and those from ethnic minorities are currently under-represented on SISB, and we are especially keen to receive applications from these areas of our community.

SISB is the key source of advice to NERC Council on science and innovation-related issues. Members are appointed to SISB as individuals, rather than as representatives of a particular organisation, and NERC aims to see that SISB membership is balanced across science areas wherever possible.

Deadline

Monday 24 May 2010.

Interviews

London on 7 and 8 July 2010.

Further information

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Isotopes – weapons of mink destruction



John McAvoy

THE BATTLE to remove the American mink from the Hebrides is almost won. Now scientists have analysed the invasive creature's whiskers to find out where the last feral populations are lurking, and where the last push for eradication should be focused.

The team collected whiskers from American mink (*Neovison vison*) killed during the eradication programme and analysed the ratios of carbon and nitrogen isotopes.

Isotopes are different forms of the same chemical element, and the proportion between light and heavy isotopes is a 'chemical fingerprint that can tell us about what animals have been eating and where they have been feeding,' explains Dr Thomas Bodey from the Queen's University Belfast.

'This is because the ratios of heavy to light isotopes vary according to a range of biological and physicochemical processes,' he adds. Whiskers collected from mink feeding inland have a higher proportion of the lighter carbon-12 isotope than those from animals living near the coast on seafood.

The research, published in the *Journal of Applied Ecology*, shows that as the cull proceeded, inland mink moved towards the vacated territories on the coast. Mink are semi-aquatic mammals, and in the Hebrides they prefer coastal habitats with access to plentiful seafood.

This means that 'if trapping can be focused on coastal areas, then inland areas on larger islands do not become an increasingly difficult logistical challenge requiring more and more traps and man hours to cover,' says Bodey.

American mink are not native to the Hebrides and became a problem after animals that escaped or were released from fur farms adapted well to the islands and quickly multiplied.

'The Hebrides are a very important breeding area for many sea and shorebird species, with internationally important numbers of several species,' says Bodey. 'The breeding birds are under threat now because mink eat eggs, nestlings and adults if they get the chance,' he adds. 'They have been implicated in the extirpation of many small seabird colonies on the west coast of Scotland.'

Eradicating mink is hard because they are spread over a wide area and can easily swim to new islands. But the main difficulty is trapping the last few individuals – without this, the population will gradually recover.

'Isotopes allow us to identify the types of places in which most mink are feeding and thus target the trapping campaign more efficiently,' says Bodey. He says these techniques aren't just relevant to mink, and could help control many other invasive species.

Earth's atmosphere may have come from meteorites

THE GASES that formed the Earth's atmosphere may have come from outer space and not from gases spewed from ancient volcanoes, according to a report published in *Science*.

Scientists have long thought that the gases in our atmosphere came from the mantle inside the Earth and were released when huge volcanoes erupted.

The theory is that our solar system formed when a huge cloud of dust and gas collapsed under its own weight. The Sun was the first to form and then the planets followed. So it makes sense that gases inside the Earth must be similar to gases in the Sun.

'But no-one has proved this and we haven't had the technology to test this out until now,' says Dr Greg Holland from the University of Manchester, lead author of the report.

An alternative possibility is that our atmospheric gases may have come from comets, meteorites and other dust from outer space. A team of scientists led by Professor Chris Ballentine from the University of Manchester collected ancient gases from a commercial carbon dioxide (CO₂) mine in the Bravo Dome gas field in New Mexico in the United States. The gases

come from 600 to 700 metres down and have been trapped for several million years.

These gases are 99.9 per cent CO₂; the rest contains traces of noble gases like helium, neon or krypton. Noble gases are chemically inert, so scientists can use them to understand what happened inside the Earth millions of years ago.

The researchers found that the chemical fingerprint of krypton showed more of the heavy isotopes (different types of atoms of the same chemical element) krypton-86 and krypton-84 than the light isotope of krypton-82. This ratio is essentially the same as scientists find in gas-containing meteorites.

'We thought that mantle gases would come from the Sun, but we found that the noble gases in the mantle are like the gases you'd find in meteorites,' says Holland.

'This was a big surprise. It's difficult to make models of the Earth's atmosphere without a solar composition. Gas has to come out of the Earth when volcanoes erupt. But our results suggest the atmosphere couldn't have come from the inside of the Earth. So it must have come from outside, from meteorites,' adds Holland.

► The findings mean textbook images of ancient Earth with huge volcanoes spewing gas may have to be redrawn.



Mark Gattick/Science Photo Library