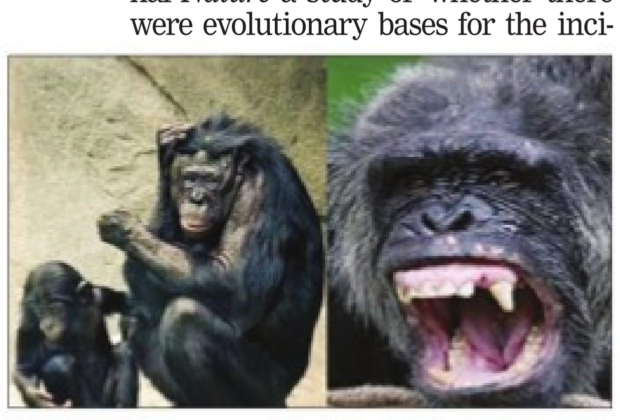
Is there violence in our genes?

IT IS DIFFICULT TO RESOLVE WHETHER SAVAGERY IN HUMANS IS HARD-WIRED OR ARISES FROM CIRCUMSTANCES, WRITES **S ANANTHANARAYANAN**

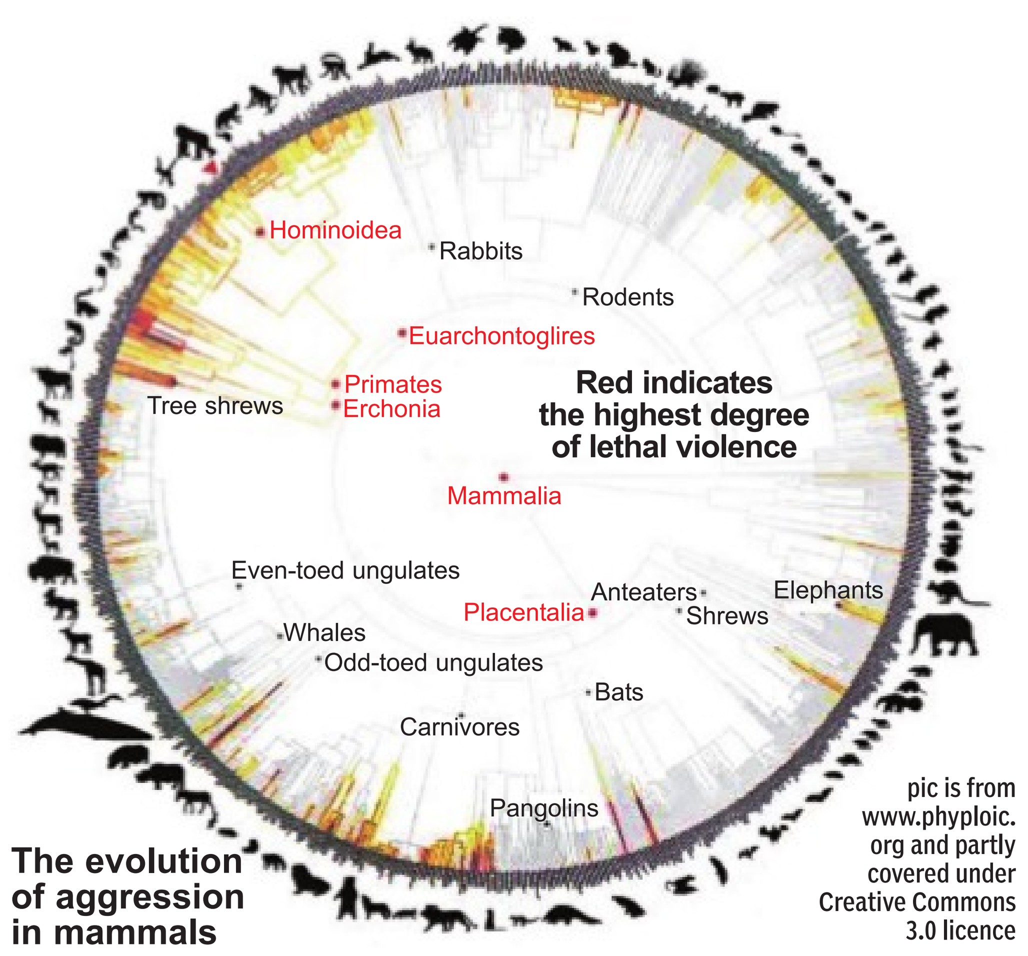
Seventeenth century English philosopher Thomas Hobbes held that men and women were acquisitive and grasping and orderly society was impossible without a sovereign power, or a political community, to impose a set of laws. In the "state of nature", he said, all persons would lay claim to everything, they would be in "continual fear and danger of violent death" and their lives would be "solitary, poor, nasty, brutish and short".

A century later, Jean Jacques Rousseau of Geneva thought differently, that "… nothing is so gentle as man in his primitive state" and that a sense of morality was "natural" and "innate" and had to be nurtured in isolation from decadent civilisation. Hobbes' view could be understandable in the context of the violence in Western society during the preceding centuries and as a premise to explain the "social contract as the basis of the state". Rousseau, on the other hand, was the forerunner of enlightened ideas and methods of education, which have helped moderate savagery in human affairs and even lessen disastrous wars in recent times.

José María Gómez, Miguel Verdú, Adela González-Megías and Marcos Méndez, from institutes and universities in Almeria, Grenada, Valencia and Madrid in Spain, describe in the journal *Nature* a study of whether there were evolutionary bases for the incidence of lethal violence among humans. The *Nature* paper analyses the records of lethal violence in more than 1,000 animal species and 600 human populations, ranging from the Paleolithic era to the present, to look for patterns, over the progression of species, in the incidence of death caused by violence of a member of the same species.



Bonobos and a chimpanzee



The evolution of aggression in mammals

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From the perspective of evolutionary bases for human brutality, the paper says, violence can be viewed as an adaptation that leads to reproductive success through more mates, status and resources. But in the human context, a brace of ecological, social and cultural conditions affect the value of violence as a means to promote fitness and survival, and it is difficult to separate the different factors, the paper says.

Same species violence, however, is not excusive to humans; it is there among monkeys, chimps and gorillas, and carnivores like tigers or wolves, for instance, kill others of different packs or even in the same pack when there are leadership struggles. Even apparently peaceful animals like hamsters or horses are known to kill others of their species, the paper says. For this reason — that violence appears to be there in all animal species — the study estimated what level of violence humans could be expected to show, given their position in the evolutionary tree.

The study collected information of more than four million instances of death and death due to violence by a member/s of the same species in 1,024 different species. While different kinds of records were relied upon, in the case of archaeological instances the nature of injury of the skeletal remains was the indicator. While this could lead to some cases of death where there was no damage to bones being excluded, verification in the cases where there were also written records, like statistical yearbooks, shows that there is no serious difference, according to the study.

In this way, the levels of lethal violence were calculated as the percentage of cases of death by same species violence, out of the total number of deaths. In the case of humans, same species killing included infanticide, cannibalism, inter-group aggression, war, homicide, execution and any other kind of intentional slaughter. Six hundred human communities, starting from stone-age tribes and bands of more than 30,000 years ago were studied, using hundreds of published data sources.

Widespread

The findings are that almost 40 per cent of the mammal species studied show some degree of lethal violence. Overall, including the species with little violence, the average comes to 0.3 per cent of all deaths, or three out of 1,000 deaths are due to intra-species violence. "These findings suggest that lethal violence, though infrequent, is widespread among mammals," the paper says.

Next, the team examined whether related species seemed to have similar levels of lethal violence. The tendency of related species resembling one another is measured by the "phylogenetic signal", which is related to how closely a shared trait is restricted to related species. The signal for lethal violence over a field of 5,020 extant mammals and 5,747 extant and recently extinct mammals was at more than 60 per cent, which is a high figure. The figure not being even higher indicates that inherited traits are not shared by all members of species; for example, the bonobo (*Pan panicus*), a close relative of the chimpanzee (*Pan troglodytes*) is markedly less aggressive, even gentle, compared to the chimp, at least in captivity.

This variability suggests that other factors, like territoriality and social behaviour, modify aggression, the paper says. When these factors were considered in the statistical treatment of the cause-of-death data, it was found that the level of lethal violence was higher in social and territorial species than in solitary and non-territorial species.

This measure of the extent of expression of traits in related branches of the genetic tree enabled an estimation of the level of lethal violence that should be expected in humans, who evolved from primates and share a great part of the primate genome. The level

Cain killing Abel, by Jocopo Palma (c 1590) — from posting in *Mystery Planet*.

of lethal violence inferred comes to two per cent, or two of every 100 deaths arising from non-specific violence.

The path of variation of this level, over the course of evolution, is that it has been generally low but rising to 2.3% in evolutionary branch points near the beginnings of primates (apes, monkeys, lemurs, etc), dropping to 1.8 per cent in the ancestral ape (gorilla, orangutan). "These results suggest that lethal violence is deeply rooted in the primate lineage," the paper says.

Actual levels

This inferred level of lethal violence was then compared with what is actually observed in human populations. While the levels at prehistoric periods were little different from those predicted, they were considerably higher during most historic periods. Violence, however, seems to reduce when we come to the modern and contemporary times.

Changes in the cultural and environmental conditions may be responsible for the pattern, the study says. It is notable that population density, a factor that raises levels of lethal aggression in animals, was lower during periods of high violence in human societies compared to the modern and contemporary ages, the study says.

As for the effect of socio-political organisation, it is seen that violence levels in prehistoric "bands and tribes" that were comparable with inferred levels, were higher in the present day. While the reasons for this may be the competition for resources, which may have promoted the formation of the groupings, a significant observation is that in state societies, the violence is less than the inferred levels. "It is widely acknowledged that monopolisation of the legitimate use of violence by the state significantly decreases violence in state societies," says the paper.

This may be a somewhat cynical explanation, but Steven Pinker, professor of psychology at Harvard University, in his book, *The better angels of our nature*, connects the rise in rationality in modern times with the decline in violence. Current levels of education and communication and interdependence are clearly environmental conditions that diminish the value of violence as a means of getting on.

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TWO-WAY BODY TRAFFIC

DNA CAN BE INTERCONVERTED BETWEEN RELAXED AND SUPERCOILED FORMS, SAYS **TAPAN KUMAR MAITRA**

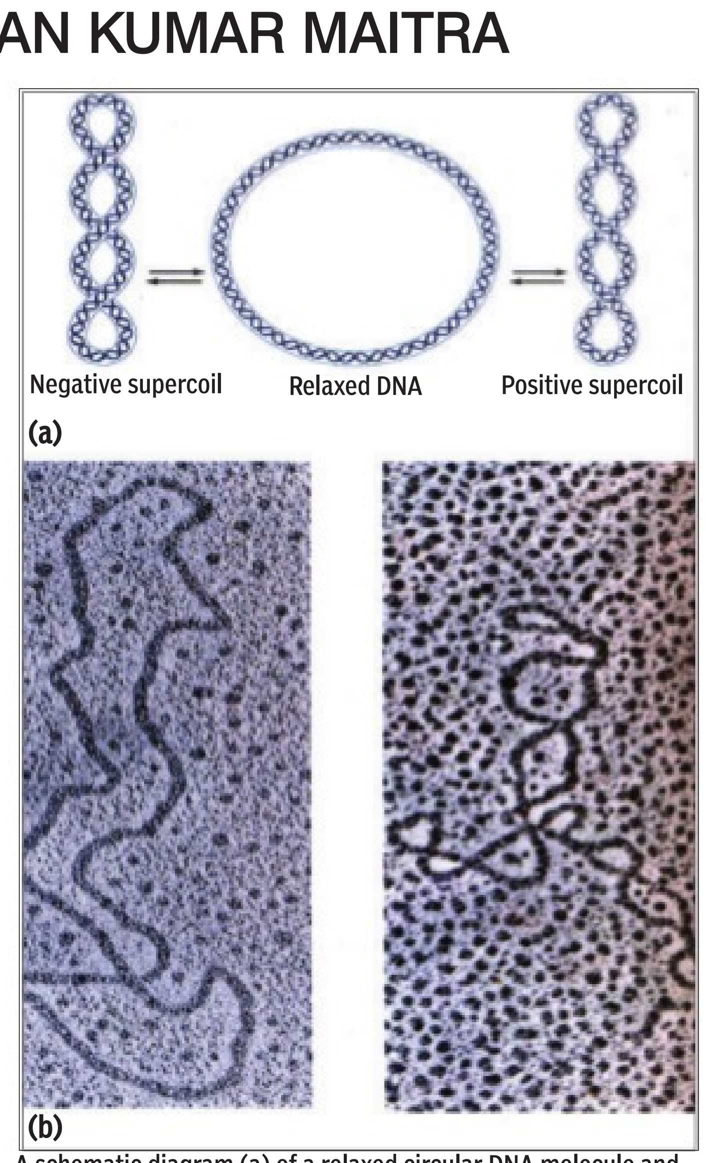
In many situations, the DNA double helix can be twisted upon itself to form a supercoil. Although now known to be a widespread property, supercoiling was first identified in the DNA of certain small viruses containing circular DNA molecules that exist as closed loops. Circular DNA molecules are also found in bacteria, mitochondria and chloroplasts. Although supercoiling is not restricted to circular DNA, it is easiest to study in such molecules.

A DNA molecule can go back and forth between the supercoiled state and the relaxed, state. To understand the basic idea, you could perform the following exercise: start with a length of rope consisting of two strands twisted together into a right-handed coil; this is the equivalent of a relaxed, linear DNA molecule. Just joining the ends of the rope together changes nothing; the rope is now circular but still in a relaxed state. But if, before sealing the ends, you first give the rope an extra twist in the direction in which the strands are already entwined around each other, the rope is thrown into a *positive supercoil*. Conversely, if prior to sealing, the rope is given an extra twist in the opposite direction, it is thrown into a negative supercoil: In similar fashion, a relaxed DNA molecule can be converted to a positive supercoil by twisting in the same direction as the double helix is wound and into a *negative supercoil* by twisting in the opposite direction.

Circular DNA molecules found in nature, including those of bacteria, viruses, and eukaryotic organelles, are invariably negatively supercoiled. Supercoiling also occurs in linear DNA molecules when regions of the molecule are anchored to some cell structure and so cannot freely rotate. At any given time, significant portions of the linear DNA in the nucleus of eukaryotic cells may be supercoiled, and when DNA is packaged into chromosomes at the time of cell division, extensive supercoiling helps to make the DNA more compact.

By influencing both the spatial organisation and the energy state of DNA, supercoiling affects the ability of a DNA molecule to interact with other molecules. Positive supercoiling involves tighter winding of the double helix and, therefore, reduces opportunities for interaction. In contrast, negative supercoiling is associated with unwinding of the double helix, which increases access of its strands to proteins involved in DNA replication or transcription.

The interconversion between relaxed and supercoiled forms of DNA is catalysed by enzymes known as topoisomerases, which are classified as either type I or type II. Both types catalyse the relaxation of supercoiled DNA, but type I enzymes do so by introducing transient single-strand breaks in DNA, whereas type II enzymes introduce transient double-strand breaks. Type I topoisomerases induce relaxation by cutting one strand of the double helix, thereby allowing the DNA to rotate and the uncut strand to be passed through the break before the broken strand is resealed. In contrast, type II topoisomerases induce relaxation by cutting both DNA strands and then



A schematic diagram (a) of a relaxed circular DNA molecule and its conversion to supercoiled forms by twisting it in the opposite direction as the double helix is wound (negative supercoiling) or by twisting it in the same direction as the double helix is wound (positive supercoiling). Electron micrographs (b) of circular molecules of DNA from a bacteriophage called PM2, with a relaxed molecule on the left and a molecule with negative supercoils on the right (TEMs).

passing a segment of uncut double helix through the break prior to resealing. Unlike the type I reaction, this action of type II topoisomerases requires energy derived from the hydrolysis of ATP.

Type I and type II topoisomerases are both utilised for removing supercoils from DNA. In addition, prokaryotes have a type II topoisomerase called DNA gyrase that can induce as well as relax supercoiling. DNA gyrase is one of several enzymes involved in DNA replication. It can relax the positive supercoiling that results from partial unwinding of a double helix, or it can actively introduce negative supercoils that promote strand separation, thereby facilitating access of other proteins involved in DNA replication. DNA gyrase requires ATP to generate supercoiling, but not to relax an already supercoiled molecule.

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Why I lived like a badger...

SINCE EVOLUTION HUMANS HAVE WALKED ON TWO LEGS AND MISSED OUT ON 80 PER CENT OF THE SENSES BY USING ONLY VISION. **CHARLES FOSTER** LIVED AS A VARIETY OF ANIMALS TO EXPERIENCE THE DIFFERENCE

I have lived as a badger in a hole in a Welsh wood, as an otter in the rivers of Exmoor, an urban fox rummaging through the dustbins of London's East End, a red deer in the West Highlands of Scotland and on Exmoor and, most hubristically, a swift oscillating between Oxford and West Africa. For this I was recently awarded an Ig Nobel Prize for "achievements that make people laugh, and then think". Why I did this is not an unreasonable question. There are many answers. One is that I wanted to perceive landscapes more accurately.

As a badger, Foster was trying to triumph over his cognitive biases.

We have at least five senses. By and large we use only one of them — vision. That's a shame. We're missing out on 80 per cent of the available information about the world. I suspect it's responsible for a lot of our uncertainty about the sort of creatures we are, our personal crises and the frankly psychopathic way in which most of us treat the natural world. If we only perceive 20 per cent of something, we're unlikely to be able to relate appropriately to it.

In fact, it's rather worse than this. Vision — the sense by which we're tyrannised — is intimately related to cognition. Listen to how we speak. "Seeing is believing," we tell ourselves. If we understand someone, we'll say, "I see." This is a consequence of our evolutionary history. We grew up as a species on the plains of East Africa. When we hoisted ourselves for the first time onto our hind legs, some glorious and disastrous things happened.

Most of our senses are embedded in our heads. Those heads were now a long way from the ground. We suddenly lost the perspective that we'd shared with all our evolutionary forebears. We lost our relationship with the ground. Neither we nor the natural world has ever recovered. The best of us feel bereavement and alienation. Most of us feel colonially superior and strut around looking literally and metaphorically down on what we were and the place from which we came.

Our new bipedal perspective was useful — as disastrous things so often are. It gave us big vistas. We could see how things that had been hidden in the long grass were connected. In some ways, by seeing the patterns made by the wildebeest as they wandered, we understood the lives of the wildebeest better than they understood themselves. It wasn't surprising that we crowned ourselves king of creation.

We don't know whether bipedalism generated our magnificent cognitive software, or whether the software was there waiting to exploit the bipedal information revolution. But there's no doubt that cognition and bipedalism went well together. Bipedalism meant a shift to visual processing. Our cognition and our vision were partners for a while, and then cognition became the senior partner. We're now dismally unsensual creatures. Not only do we not smell, touch, hear or taste — we barely see.

When I walk into a wood I see a tree only for a millisecond. The visual information about the tree that surges in through my eyes is almost immediately translated into abstract code. When I try to describe the tree I'm describing not the tree at all, but my thoughts about the tree. That's bad news. We see neither the wood nor the trees.

And part of the personal crisis is that most of my thoughts about the wood are thoughts about my own thoughts. I am achingly self-referential. When I think I'm relating meaningfully to the natural world, it's probably onanism. In crawling through the wood, swimming in the rivers, mooching round Bethnal Green at night, shivering on the moorland and mapping the archipelago of air currents at the top of trees, I was trying to triumph over my cognitive biases. Trying to escape the tyranny of the visual and the cognitive. Trying to let my nose and ears and tongue and palms have a say in my brain's reconstruction of the world. Trying to use some of the overlooked 80 per cent of data. Trying to marinate myself in sensation, rather than being dabbed pathetically by it.

I didn't do very well. But it was well worth a try. It's work in progress. Have a go. It's rather embarrassing, so wait until you're next in a quiet wood. Drop onto all fours. Sniff the ground, lick a leaf, let your highly sensitive fingers play over the earth. See if you can hear a bird over the cognitive tinnitus that will be hissing in your head.

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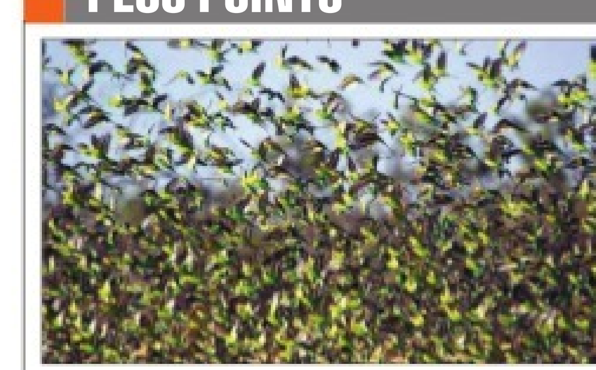
PLUS POINTS



The flyaway code

Scientists may have discovered why birds never seem to crash into one another — they appear to always veer to the right. Just like cars drive on the right of the road in France or the USA to avoid collisions, budgerigars were found to turn the same way when they sensed they were on a collision course. Discovering the "basic rules" of safe flying that have evolved in birds over millions of years could help programme drones to avoid collisions as the skies become more crowded.

Professor Mandyam Srinivasan of Queensland University in Australia, who led the research, said, "Birds must have been under strong evolutionary pressure to establish basic rules and strategies to minimise the risk of collision. But no previous studies have ever examined what happens when two birds fly towards each other. Our modelling has shown that birds always veer right — and sometimes they change their altitude as well, according to some pre-set preference. As air traffic becomes increasingly busy, there is a pressing need for robust automatic systems for manned and unmanned aircraft, so there are real lessons to be learned from nature."

Two budgies were released at opposite ends of a tunnel and their flight path was filmed by a high-speed camera. In more than 100 flights by 10 different birds, there was not a single crash. "Another finding was that birds would rarely fly at the same height, and this raises the question of whether individual birds have a specific preference for flying higher or lower," Professor Srinivasan said. "It might be that their position in the group hierarchy determines their flight height. This is a question for further research."

The research, described in a paper in *PLOS One*, was partly funded by Boeing Defence Australia.

IAN JOHNSTON/THE INDEPENDENT

Nanotech bandage

Egyptian researchers have developed a bandage embedded with nanoparticles for treating wounds using the anti-epilepsy drug phenytoin, known for its capacity to treat skin injuries. Wounds normally take several days to a few weeks, even months,

to heal completely, but this bandage accomplishes the job in a few days, after just one application to soft tissue. Even though phenytoin is known for its potential to accelerate wound healing, some of its properties limit its effectiveness. For example, a low percentage can be absorbed into the blood circulation. It also doesn't cover the entire wounded area, which interferes with the efficiency of healing.

To overcome these challenges, a research team from Zewail City of Science and Technology in Egypt, led by Ibrahim M El-Sherbiny, director of the Centre for Materials Science, embedded the drug into a bandage consisting of nanoparticles carried on nanofibres. El-Sherbiny said, "This allowed a well-controlled release of phenytoin, distributing it effectively, which boosts its efficiency." He clarified that embedding the drug into nanoparticles and then loading it into nanofibres was one of the most important advantages of the bandage design, distinguishing it from other bandages. "It acquired a greater ability (to heal) by increasing the surface area available to kill the bacteria, as well as by increasing porosity (of the skin), thus increasing its ability to absorb the drug."

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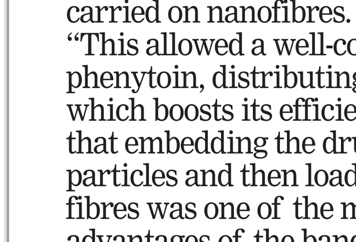
Genetic diversity

An examination of species-level genetic diversity by researchers at the University of Copenhagen's Natural History Museum of Denmark provides a global map of intraspecific genetic diversity for two classes of animals — amphibians and mammals. The team's findings, published



on 29 September in *Science*, confirm that tropical regions harbour more genetically diverse species and show that the presence of nearby human settlements has diminished genetic diversity within the amphibian and mammalian species studied.

The researchers pulled publicly available genetic sequence data on amphibian and mammal species, comparing cytochrome B sequences for the mitochondrial DNA (mtDNA) that included geographic information (about 27 per cent of available mammal sequences examined, and 38 per cent of amphibian sequences). This gave them almost 93,000 mtDNA sequences to work with, covering some 4,700 species. "What we are detecting here is that not only are these areas rich in the number of species, but they also harbor populations of species that are more diverse," said study coauthor Andreia Miraldo, a postdoc at the Natural History Museum of Denmark.

THE SCIENTIST