2019 ANNUAL REPORT

ROYAL BELGIAN INSTITUTE OF NATURAL SCIENCES

CONTENTS

FOREWORD

From the midst of the coronavirus outbreak, it is not easy to look back at 2019 objectively. Never before has our social system come under so much pressure from a global health crisis. In addition to the immense human suffering, it will also cause serious economic aftershocks. It is too early to accurately assess its impact, but there is no doubt that we have turbulent years ahead of us. In this sense, 2019 can certainly be described as a calmer year. Still, some substantial changes made an impact on our Institute and its surroundings.

First of all, there was a change in leadership of the organisation, with the retirement of Camille Pisani after 14 years. After such a long time, her farewell had a profound impact, but the overwhelming atmosphere was that of gratitude. Under her leadership the Institute went through a very positive period: a successful all-encompassing renovation project for the Museum, improved quality of our scientific research, the continuous digitisation of the collection management and the implementation of an effective organisational structure. Thanks to her impetus, the Institute has adapted smoothly to scientific, technical and social developments, allowing us to look to the future with confidence.

In terms of politics, an interim government was set up to manage the country until a new government is formed. This was still the situation at the end of the year, which meant our Institute could not be involved in new initiatives for a whole year. The difficult budgetary situation at federal level was another key issue for the Institute. Cuts made during the last legislature and conditional access to reserves left us little room for manoeuvre, financially. Additional budgetary restrictions under the next government could make it more difficult for the Institute to function properly.

Many of you will also remember 2019 for its focus on climate change and declining biodiversity. There was outcry, particularly from young people, about the significant effect of human activities on our planet. This impact was illustrated by the outbreak of a number of serious natural disasters. For our Institute, monitoring biodiversity is a core task. This call underlines the importance of our related role in supporting policy. It demonstrates the increasing relevance of our mission to ensure citizens are well informed about these challenges and to inspire them to take a more thoughtful and respectful approach to nature.

And yet 2019 was also a year that enchanted our visitors. We ended the year with over 350,000 people coming to the Museum. Many enthusiasts came to our Bear exhibition, but it was also the unveiling of the new dinosaur predator *Arkhane* in our *Gallery of Evolution* that convinced visitors to come and take a look. The current exhibition *Antarctica* got off to a flying start as well.

The construction of the new research vessel Belgica made good progress and we eagerly await its launch, along with the extensive possibilities it will bring for scientific research.

Our numbers also bear witness to a good year. There was an increase in both the number and quality of our scientific publications and progress with regard to our own funding sources.

All this inspires confidence: confidence in a future that may be fickle, but where there is a determination within the Institute to deal with challenges in a creative, agile way, that draws on our strengths.

Patricia Supply,
General Director a. i.

2019
AT A GLANCE

08.02

Biologists describe six new geckos that live in Vietnam and Cambodia. The discovery of so many new species of vertebrates is quite exceptional, published in the specialised journal *Zootaxa*.

22.02

The *European Journal of Taxonomy* publishes its 500th volume. This peer-reviewed diamond open access journal on descriptive taxonomy is published by a consortium of ten European natural history institutes and botanical gardens, including our Institute.

23.02

The Museum went Stateside for the 12th edition of Museum Night Fever: our enthusiastic visitors are met with athletes, cheerleaders, mascots, orchestras and of course hot dogs and popcorn.

27.03

After cutting the steel in February, laying the keel is the second key step in the assembly of our new oceanographic research vessel Belgica.

30.03

We celebrate a Family Day at our exhibition *Teddy and Bear:* nearly 1,000 children and adults attend the activities, guided tours and stands from various associations.

03.04

Success for the *Doing It Together Science* pan-European Forum: 113 participants from 17 countries sign up to the good practices initiated by the DITOs project and discuss the policy and financing of citizen science.

21.04

82 participants from 7 countries meet in Brussels for the international Annual Phasma Meeting organised for the fourth time in our premises.

25.04

Sophie Wilmès, Minister for Science Policy, announces on board the RV Belgica: Belgica II is the name of our new research vessel. The competition winners are the class of the Athénée M. Desenay from Liège.

06.05

'One dinosaur welcomes another!' Jacky Ickx, its prestigious patron, comically welcomes Arkhane, a 155-million-year-old *allosaurus*, for its world premiere in our *Evolution Gallery*.

10.05

Publication of the Atlas of the distribution of dragonflies in the Brussels-Capital Region, with data collected by citizen scientists. Dragonflies are very good indicators of wetland quality.

24.05

Sound of Science is an outdoor science festival, the perfect place for the geeky (and not-so-geeky) to gather with family and friends. The line-up includes music and lots of science: of course the Museum has to be there!

25.05

To launch Insect Week, we celebrate minibeasts at the Museum: many activities for all ages, to discover these little-known bugs that represent 80% of animal species and are so useful to human beings.

25.05

Bioblitz: 48 volunteers, supervised by three scientists, collect and inventory the insects and spiders of Leopold Park to analyse the impact of biodiversity work that has been carried out there in recent years.

14.06

For the European Archaeology Days, four of our colleagues organise behind-the-scenes guided tours and present our archaeozoological, archaeobotanical and anthropological research.

02.07

Belgium hosts the annual conference of the European Association of Vertebrate Palaeontologists for the first time. This 5-day congress saw 125 papers presented with a remarkable total of 160 participants.

17.07

Belgica II is making good progress. The tunnels for the bow thrusters are in place. There is still some work to be done before they can accommodate the thrusters in December.

01.08

Publication of the book 'Abeilles de Belgique et des régions limitrophes *(Insecta : Hymenoptra : Apoidea)* Famille *Halicitidae'* in the collection *'Faune de Belgique'*.

01.09

The much awaited publication of Volume 19 of the Abc Taxa collection *'Field guide to the brittle and basket stars of South Africa'*. The last study was published in 1976. This book is distributed free of charge to the relevant professionals in the field.

01.09

114,574 visitors and the Silver Award at the 22nd Communicating the Arts conference in Copenhagen: our interactive exhibition *Teddy and Bear* is met with unanimous acclaim from public and professionals alike.

10.09

Over three days, 70 palaeontologists and specialist geologists at the *PalEurAfrica International Congress* have 51 papers presented, visit our collections and have a day in the field at the historical sites where they come from in Belgium.

04.10

The Van den Broeck Medal is awarded by Geologica Belgica to four geologists who work or have worked with us, for their contribution to the mapping of the rich subsoil of Wallonia.

07.10

Antarctica, an immersive exhibition at the heart of a continent exclusively accessible to scientists opens its doors. It features superb films on large screens and in 360° by Oscar-winning director Luc Jacquet.

15.10

Michaël Fettweis receives the *JJ Mehta Award* for outstanding contributions to the study of cohesive sediment dynamics in the marine or estuary environment.

24.10

The INVAXEN project *'Invasive biology of Xenopus laevis in Europe: ecology, impact and predictive models; 2013-2016'* funded by Belspo wins the BiodivERsA Prize for Excellence and Impact.

07.11

700 visitors join in the various activities of the Brussels Museum's Nocturne. 40 of them even take part in the premiere of the travelling play *'Bernissartentis'*.

22.11

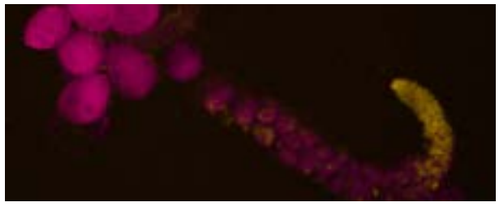
Feathered dinosaurs inspire aeronautical engineers at Tsinghua University in Beijing. They are working with our in-house expert Pascal Godefroit to build autonomous flying robots.

01.12

A packed agenda for Antarctica Day: experiments, activities, screening of the film Deep Ocean narrated by Sir David Attenborough, meetings with scientists and even a live Skype session from the Princess Elisabeth Station.

04.12

When nature becomes a work of art: a photo taken by our scientists Isa Schön and Koen Martens on the presence of bacteria in the ovary of a parthenogenetic ostracode wins the photo competition of the *Marine Biological Laboratory* at Woods Hole (University of Chicago, USA).



13.12

'A truly passionate team' are the words used by David Clarinval, the new Minister for Science Policy, who is very enthusiastic after visiting the Institute and meeting our staff.

24.12

One of our staff members joins the Peruvian scientific team on board the icebreaker BAP Carrasco to reach Antarctica and take part in the 27th research cruise to study ecology and evolution of marine organisms.

1 RESEARCH

ON THE CUTTING-EDGE

Scientists at our Institute don't only carry out research - they are constantly developing new tools using the latest technology to equip our laboratories. *These tools come in handy for our own work, but also for cooperation with our partners and helping us contribute to building Europe's research infrastructure.*

Sequencing: the next generation

Unravelling DNA code can be an expensive business. Researchers at our Molecular Systematics Laboratory are always working to keep up with the pace of next-generation sequencing technology, and applied an efficient way to keep the costs down: a development which is now helping to reveal some fascinating results. Sequencing a whole genome is not always necessary.

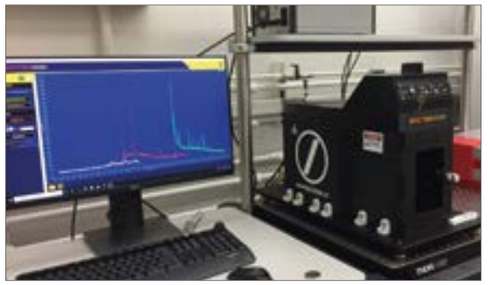
Reduced-representation sequencing offers an accessible way of identifying important parts of the genome, by only sequencing a sample of short, unconnected fragments of DNA, scattered at random across the genome. This means that our researchers can scale their projects up, maximising the number of samples that can be processed relatively cheaply and quickly, while still retaining high genetic resolution. The DNA of a hundred specimens can be processed in a day or two.

This kind of sequencing data is proving extremely useful to gain new insight from specimens in our collection. One example is a new project looking at tilapia - an aquaculture fish that is a major food source in developing countries and therefore has huge economic importance. By sequencing the DNA of wild-caught tilapia as well as those from fish farms, we can learn about the origin and population structure of introduced tilapia populations. Such studies often need big data which is possible thanks to our next-generation sequencing tools.

A call from NASA

It's not every day our institution has the chance to provide new technology for NASA. In 2019, geologists at our Institute developed an ultra-robust rock scanner to analyse the chemical composition of rocks which is now part of NASA's Jet Propulsion Laboratory in California, helping the American space agency to study the origins of life on Earth.

Our geologists were invited by Impossible Sensing, an American company, to develop the SpectroGRID for NASA, following earlier successful partnerships. The tool itself is a laser scanner that analyses the chemical composition of the surface of small rock samples. One of its main strengths is that it has very few moving components, making it particularly robust and reliable. NASA is now using it to study the chemistry of rock samples from deep-sea hydrothermal vents, where Earth's earliest life forms may have emerged.

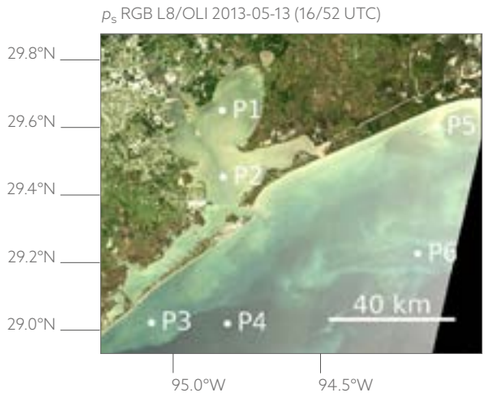


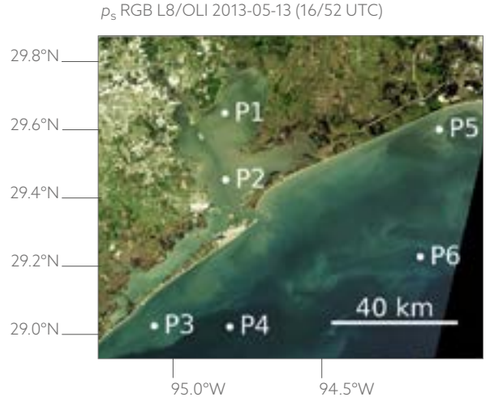
The development process had tight deadlines to be met, culminating in a last-minute dash across the States for our team. The tool was a success and NASA already requested a follow-up. Now back in Belgium, our geologists are working on a sister scanner to be hosted within our institution for use on our own projects.

Gathering **40 years of satellite data**

Satellites have been orbiting the planet for decades, recording all kinds of data about water on Earth: how it reflects light, for example, or how cloudy it is. But over the years, the ways we process that data have changed. How do we ensure we are making the most of all this information? Researchers at our Remote Sensing team have developed a new algorithm and software that finally make it possible to produce unified image series for parameters like water reflectance and turbidity.

Since the launch of Landsat 5 in 1984, a number of different satellites have been recording images of the Earth's landmass and coastal zones at regular intervals. By putting this data together, we can identify changes over time. The problem was that not all satellite sensors were the same, and the image formats they produced varied, which made it hard to align the data over time. Thanks to this new method we can produce data series and image series that are standardised, easily interpretable and also beautiful, helping us map the state of the ecosystem. In the Belgian coastal zone, we can for example observe the impact of the extension of the ports of Zeebrugge and Ostend on the sedimentation on both sides of the port walls.





LIFE AS OUR ANCESTORS LIVED IT

Under our feet are clues to the lives of people that lived here hundreds, thousands or even tens of thousands of years ago. *By looking at the remains of what humans ate and the tools they used, we can learn more about their way of life and the role they played in their ecosystems at the time.*

Europe's first modern humans and their ecological footprint

Our researchers participated in a new study that shows the first modern humans in Europe hunted mammoths more intensively than Neanderthals did. At the Goyet Caves just east of Namur, skeletal remains of the last Neanderthals and very early modern humans in Europe were found. The research team analysed and compared these remains, alongside others from Spy and Scladina in Belgium and Lommersum in Germany. By looking at the isotopic ratios of nitrogen, carbon and sulphur in the bone collagen, the research team was able to draw conclusions about how our ancestors ate and moved around.

100,000 years ago, there were at least two species of humans on the planet: the Neanderthals and us, the modern human. The study, published in *Scientific Reports*, shows that between 40,000 and 30,000 years ago the diet of the two populations was very similar: mammoths were a major source of protein.

But the results also make it clear that the first modern humans' hunting habits started to have a significant effect on mammoth populations. We also see from the results that the Spy Neanderthals found most of their prey locally, while most animals hunted by Goyet's Neanderthals and modern humans came from outside their local ecosystem. The study shows too that there was intensive cannibalism among Goyet Neanderthals and that the victims came from outside the local ecosystem.

The harbour hidden under a Brussels car park

It's a sight every Brussels resident is familiar with: when construction works begin, an archaeological dig soon follows. But when Brussels' iconic Parking 58 building was demolished in the city centre's St Catherine neighbourhood, it became clear this was no ordinary building site. For the first time in centuries, we were able to see remains of the 15th century Brussels harbour, including quays of the old River Senne and perfectly preserved organic remains.

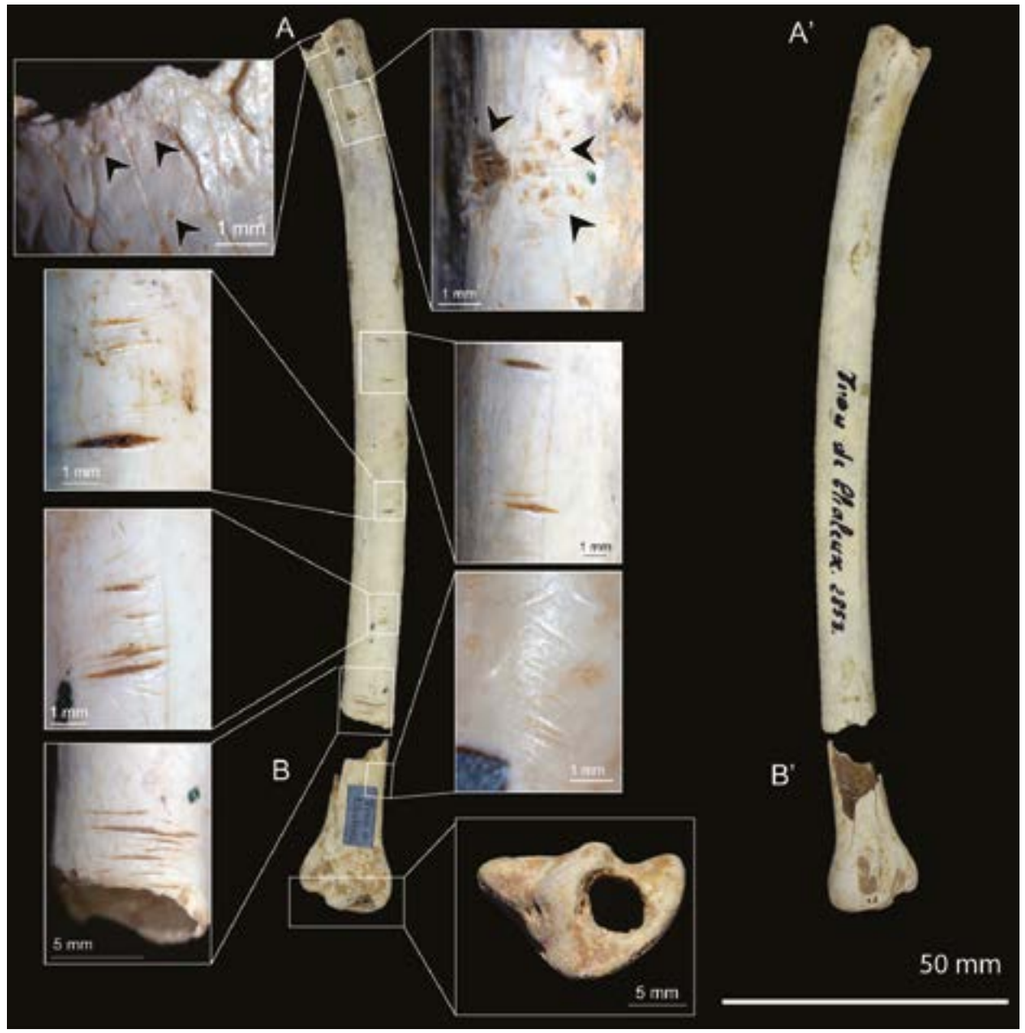
Our researchers worked with the team at Urban.Brussels to study the site, including several wickerwork fish traps made from willow twigs. They lay at the bottom of the Senne river, where the conditions were ideal to withstand five centuries. Food remains like seeds and bones told us more about people's diet in medieval Brussels, including the revelation that they ate frogs' legs. Wood chips in the sediment showed that tree trunks were brought in and used to make beams and planks for the quays.

The investigation of the many finds at Parking 58 will take some time to complete. Research over the coming years will help us to form a clearer picture of Brussels people's lives in the Middle Ages, while the works will continue to a depth of 15 metres for the construction of the new administrative centre of the City of Brussels.

Birds on the menu in the Chaleux Cave

In 1865, Belgian geologist Edouard Dupont made a discovery at the Chaleux Cave near his native Dinant: a whole host of skeletal remains of mammals, birds and fish, as well as a large number of prehistoric artefacts. Three years later he became director of our institution, where most of his finds were studied over the years - except the bird remains. 150 years later, they have now been analysed and the results shed light on the lives of hunter-gatherers at the end of the last Ice Age.

The 14,000-year-old bones are well preserved and show that birds were an important food source for humans at the time. As well as signs of gnawing on the bird bones, we see cut marks and incisions. Goose feathers were probably extracted with stone tools and the long wing bones were used to make objects, sometimes decorated. Swan and diver bones appear to have been used to make needles. A piece of ivory from the same site was found carved in the shape of a bird: another clue that birds played an important role in people's lives back then.



THE FOOTPRINT WE LEAVE BEHIND

Human activity is at the root of many of the biggest challenges the Earth is currently facing. *By studying what is happening in the natural world around us, we can gain insight on how better to tackle these threats. These findings inform our choices on a whole range of issues, from waste disposal to urban planning to climate change.*

Insight about carbon storage from a sparkling source

Carbon capture and storage has great potential to help us reduce emissions as we attempt to combat global warming. Research from our geologists on carbonated water sources in Spa is shedding new light on how this technology could eventually be used to store carbon in the deep subsurface.

We don't quite know how the water that bubbles up in Spa came to be so rich in carbon. It could be caused by volcanic activity or calcium carbonate in the rocks. What we do know is that it makes Spa a great natural laboratory in which to study how carbon is exchanged between the atmosphere, water and the rocks. And by measuring CO_2 dissolved in water at the source itself, we don't lose carbon or contaminate the water samples.

Our researchers had been working on the Spa site for a while, largely out of scientific curiosity to discover what happens there. But in 2019, new equipment was acquired and a field campaign was set up as part of the GeoERA GeoConnect^{3}d project. By using this tool and fine-tuning this method, our team is now able to make fast and accurate measurements at this so-called geomanifestation. This helps us to get a clearer picture of how the carbon could interact with rock underground as part of carbon storage processes.

Urbanisation drives a dramatic decline in biodiversity

Does the spread of towns and cities really have such a big impact on the number and abundance of species living there? Until recently, research had painted a mixed picture. But a new study shows startling evidence that urbanisation drives down species diversity and numbers in ways that had not been measured before.

For the study, published in *Global Change Biology,* our researchers worked with four universities to compare populations of a wide range of animal species, from water fleas to butterflies, and across a range of spatial scales, in built-up and rural areas. The results may seem unsurprising at first: the more densely-built the area, the lower the numbers of spiders and insects. But what is important about this study is that it also looks at green spaces within cities and shows they too are strikingly low in species abundance, compared to in the countryside. A second key finding is that species diversity is lower for most animal groups in more urbanised areas. Even if you find some biodiversity in the city, you find similar species across the city, whereas the countryside shows more variety from area to area.

So how can we stop this loss of biodiversity through urbanisation? The results suggest that stopping new building projects and the preservation and protection of natural habitat is the most effective way. Green space in the city has its benefits, but cannot compensate for the loss of nature around us that urban development brings with it.

Could the closure of Spanish rubbish dumps spell disaster for storks?

In summer, the Zwin Nature Park area in Knokke-Heist is home to a population of 30 breeding pairs of white storks. Every year most fly south for the winter. The Park works with our Institute to track the birds' migration patterns as conditions change, with a particular eye on the effects of EC regulations around waste disposal.

Belgium has always been active in the field of bird ringing, and our Institution coordinates BeBirds, the Belgian Ringing Scheme. By ringing the storks, we can track hundreds of them, right across their lifespan. But to get more detailed data on the movements of individuals, solar-powered GPS transmitters were attached to the backs of three young storks at the end of June 2019.

A particular concern for researchers is what will happen to the storks in winter. Since the 1990s, many thousands of migrating storks have typically stopped in Spain and Portugal where they could easily find food among the rubbish tips. But since the European Commission took Spain to court for not closing their landfill sites, the storks will most probably suffer a sudden and dramatic shortage of food. Will populations decline rapidly? Will stork find new wintering grounds? The storks' journey can be tracked on the Zwin's website and will be documented by our research team.

HAIRY HISTORIES: MAMMALS AND THEIR ORIGINS

Wolves, bears and whales: the mammals around us today often have more complicated evolutionary histories than we might think. *In 2019 we made discoveries that revealed twists and turns in their ancestries, as well as uncovering a new species whose family history remains an enigma.*

A wolf cub frozen for 14,000 years

As global warming increases, the thaw of the Siberian permafrost is increasingly revealing remnants of a bygone era. An international research team including a palaeontologist from our Institute worked on a newly-discovered specimen: a young wolf dating from the last ice age, helping us trace the ancestry of modern-day wolves.

The analysis of the wolf cub specimen from Tumat, Siberia, focused on its RNA - a molecule like DNA that contains genetic information. What was remarkable about this research, published in *PLOS Biology*, was that this was by far the oldest RNA ever to be extracted from a fossil: 14,300 years old. Until now the oldest had been just 700 years old. The research team was able to demonstrate that the RNA obtained from the liver of the Tumat cub contained many sequences that matched those from the livers of recent wolves and dogs. Further analysis should make it possible to establish whether the cub was wild or domesticated.

European bears survived the ice age

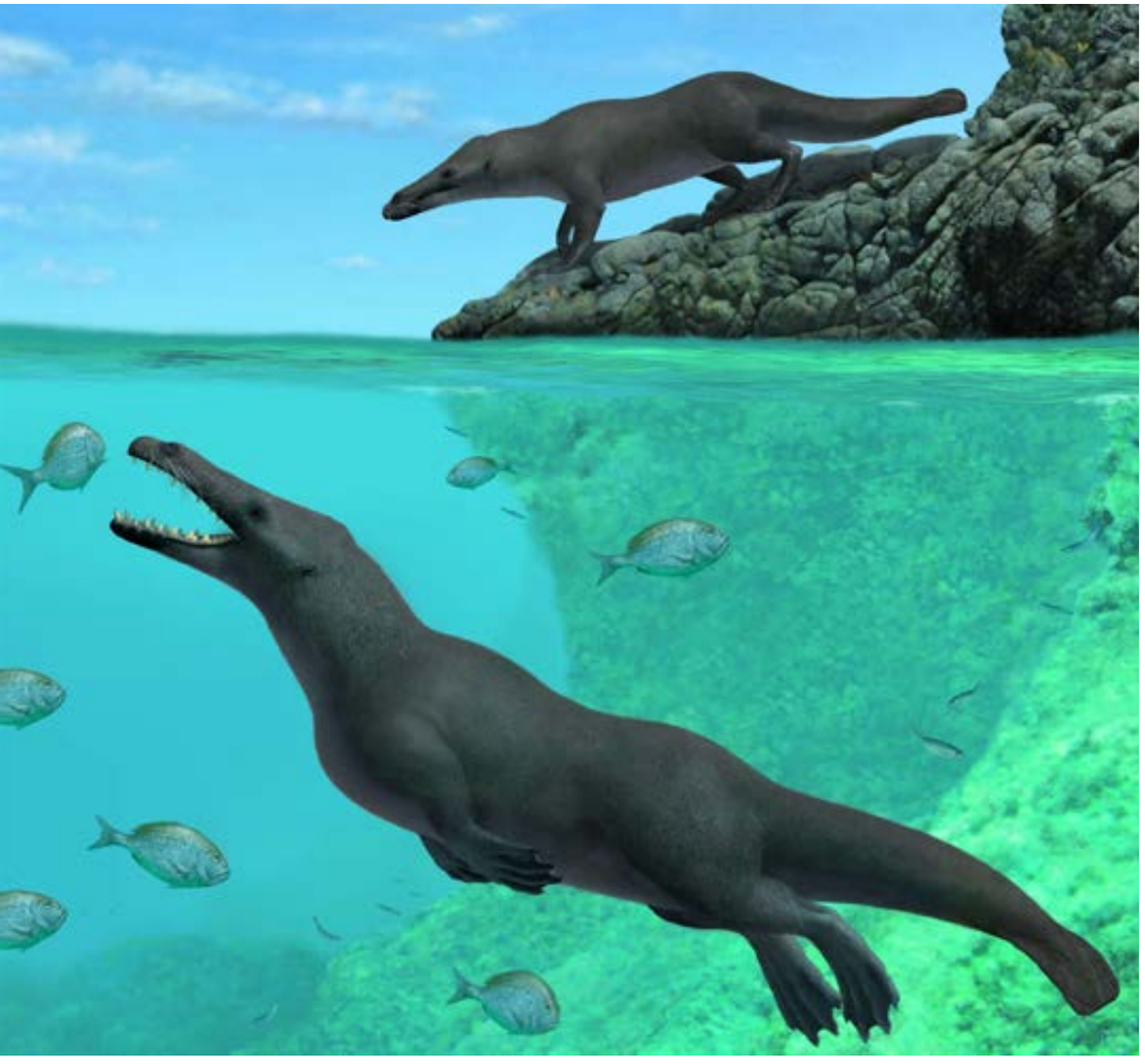
Fossils in our collections have revealed that Europe's brown bear populations are descendants of bears that survived the peak of the last ice age, 22,000 years ago. Dating of our bone specimens proves there were still bears in Belgian and French caves at the time. Their mitochondrial DNA matches that of later populations in Northern Europe, the British Isles and Southern Europe.

This study, published in *Ecology and Evolution*, contradicts the earlier theory that the current European population was descended from populations that survived the last ice age by retreating to the warmer regions of the Mediterranean. Further analysis of the bones also shows that the brown bears had switched to a more plant-rich diet even before glacial peak. This change is probably due to the extinction of the herbivorous cave bear 30,000 to 25,000 years ago, which opened up a new ecological niche for the brown bear.

An early Atlantic crossing by a **four-legged whale ancestor**

Analysis of a skeleton excavated in Peru tells us not only about the journey of this whale ancestor; it also tells us about how it swam. The new find was described in the journal *Current Biology,* is about 43 million years old and provides a missing piece of the puzzle explaining how whales evolved from four-legged hoofed mammals. It was excavated in the Pisco Basin by a researcher from our Institute along with Peruvian, French and Italian colleagues. Named *Peregocetus pacificus*, it is the oldest cetacean ever discovered in the New World.

We see from the skeleton that it could carry its own weight and crawl about on land on four legs, but also that it was a strong swimmer - most likely propelling itself along with its tail and webbed feet like an otter. Its ancestors crossed the Atlantic Ocean between West Africa and South America. At that time, the distance between the two continents was half what it is today.

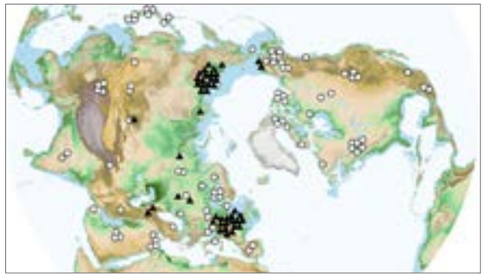


Tracing **the history of today's grey wolf**

The Tumat cub was not the only wolf we worked on in 2019. Our collection contains a great number of historic grey wolf specimens and what is more, we have the technology in-house to be able to analyse ancient DNA. This combined expertise was essential in our role in a major collaborative research project tracing the ancestry of the grey wolf, *Canis lupus*.

Large scale studies on ancient DNA are a particular challenge as the samples are often damaged and contaminated. But by using specialised equipment, the international team was able to sequence DNA from 56 ancient specimens, including 11 from our collection, and compare them to 90 fresh samples of modern wolves.

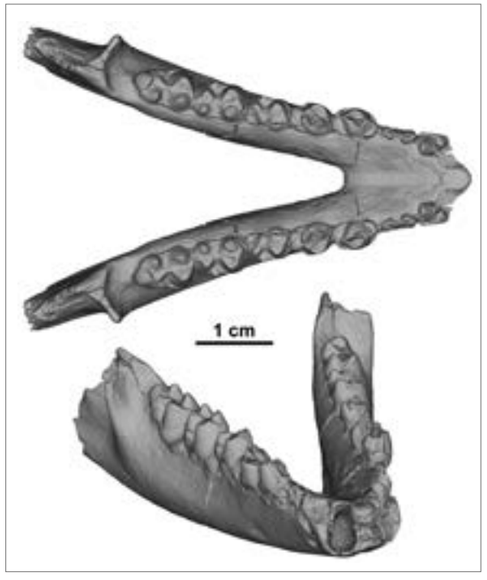
By using a modelling framework, the study shows that today's wolf populations have their origins in Beringia 14,000 years ago, and that this process was most likely driven by ecological changes in the Late Pleistocene period. We see clearly that long-range migration has always played an important role in the history of grey wolf populations.



An Indian hoofed animal shrouded in mystery

A team of Belgian, American and Indian paleontologists excavated three pieces of jawbone at the Tadkeshwar mine in the West Indian province of Gujarat. But when they compared them to bones from known mammals of the early Eocene from India, Africa and Europe, they noticed marked differences. According to the study, published in Papers in Palaeontology, the Tadkeshwar jawbones belong to a new species and even to a new genus and family. They named it *Pahelia mysteriosa:* Paheli is Hindi for riddle, in a reference to its uncertain ancestry.

There are three possible scenarios: either this animal originates from African ancestors who migrated to India when the land mass was still attached to southern Africa, 88 million years ago. Or it came from mammals that evolved in India when it was an island adrift in the Indian Ocean. Alternatively, it could have ended up in India after it collided with Asia, when a route was opened up to Europe. In that case, the animal has European ancestors, or vice versa: European hoofed animals could be descendants of this Indian grazer.



TAXONOMIC SURPRISES

Classifying the living world into groups of related species and compiling catalogues of these organisms is crucial to understand the nature around us. *Much has already been described by science, but millions of species remain undiscovered. Among them lie some unexpected discoveries, as our researchers found out.*

The "small" lake with hugely diverse inhabitants

Tanganyika, Malawi, Victoria: the East African Lakes are a clear biodiversity hotspot for cichlid fishes. And for evolutionary biologists, they are a source of particular fascination, with almost 2,000 species of cichlid - almost all of which are unique to a particular lake.

Edward is the smallest of the lakes at a mere 77 km long. Until recently it had remained largely unexplored, with around 30 cichlid species recorded. But new research, conducted in the framework of the Belspo-funded BRAIN project HIPE and published in the journals *Fish Biology and Great Lakes Research*, described the presence of two to three times this diversity, including seven new species described.

Cichlids as a family are known for evolving rapidly into many closely related but morphologically diverse species, through a process called adaptive radiation. And the species identified in Lake Edward are no exception: all have a peculiar morphology that indicates highly-specialised behaviour. Some have specialised teeth to wrench snails from their shells. Others have evolved thickened lips to suck prey out of their hiding places – even juveniles from their mothers' mouths. By describing these species we can also start to explore how this high diversity came about.

An underground clue to **Benin's geographical history**

Inhabitants of the water deep underground hold secrets about the shape that Africa took, millions of years ago. Our Institute has been working closely with the University of Abomey Calavi in Benin to study the biodiversity of the country's groundwater and drawn some surprising conclusions about where the sea used to be.

During an exhaustive sampling of the large Ouémé basin, researchers were surprised to discover specimens of an aquatic oligochaete ('earthworm') and a crustacean, attributable to new species, all derived from marine ancestors. This shows clearly that the sea was present there at some point in history, hundreds of kilometres north of the current coastline.

Geologists knew that 66 million years ago, the sea formed a narrow corridor through Africa, from what is now the Mediterranean right through to the Gulf of Guinea in the south. But the presence of these species suggests the geologists need to drastically review the extension of the western edge of this marine corridor.

Untangling **a knot of earthworms**

Soil ecosystem engineers. Nutrient recyclers. Ecotoxicological sentinels. All of these job titles apply to the humble earthworm. Taxonomists estimate there are at least 20,000 species on earth, but only 6,000 of those have been described. To help unlock this huge, hidden biodiversity, our Institute was invited by researchers from Chulalongkorn University in Bangkok, Thailand to identify semi-aquatic earthworms of the genus *Glyphidrilus* using morphological studies and DNA barcoding techniques. The results were published in *Molecular Phylogenetics and Evolution*.

Before this research, the genus *Glyphidrilus* was a taxonomic chaos, with 48 species named but poorly defined. Now, after four years of intense joint research efforts, 26 species are retained as valid, nine of which are new to science. The results also point to the fact that DNA barcoding alone can overestimate species diversity. Classical morphology is a necessary complement to confirm the presence of new species.

DNA BARCODES THAT SOUND THE ALARM

To protect biodiversity we need to be able to identify the living things around us - particularly when some species pose a threat to ecosystems. *Invasive species can be introduced accidentally or deliberately - either way DNA sequencing can be crucial in signalling their presence so their spread can be controlled.*

Tools for a rapid **response to invasive species**

When biological material arrives at customs, identification needs to be quick and it needs to be accurate. Most exotic species are not a cause for concern, but a number have been identified as invasive. This means they could reproduce and spread rapidly, establishing populations in Europe and even outcompeting species in our current ecosystems. Invasive species affect not only farms but also human health and socio-economic activities, through disease or parasites for example. An EU regulation imposes measures to protect against invasive species and our DNA barcoding facility BopCo aims to support the Belgian authorities in identifying them.

In 2019 BopCo produced a set of factsheets, tailor-made to help inform the authorities about all the plant and animal species in the list of EU concern. They are clear and concise, with illustrations, informing on the species' classification, distribution and how it can be identified using DNA data. Putting them together was a challenge: there was a lack of data for some of the species on the list, and you need data from the native range as well as the invasive range, plus closely-related species, to be able to see the genetic variation.

The factsheets are already proving very useful. In 2019, the Flemish Agency for Nature and Forests contacted BopCo to help identify some droppings they found in the province of Antwerp. The factsheet allowed for a quick selection of the most applicable DNA markers and best laboratory procedures, helping to confirm that they did indeed come from an invasive species: Reeves' Muntjac, a deer native to Asia that can have a devastating effect on native woodland ecosystems.

Slugs and snails that are threatening pets

Slugs and snails are usually considered more of a concern for gardeners than for cats. But recently parasites from gastropods have started to spread in populations of pets and wild animals across Europe. And these parasitic roundworms are a serious threat: they can cause illness and even kill.

To understand how these parasitic worms are spreading, we need to be able to identify their hosts. Our DNA barcoding facility BopCo is working with the Aristotle University of Thessaloniki to study these nematode parasites in gastropod populations in Greece and results were presented at the 25th Zoology Congress in Antwerp.

Of the 122 specimens collected in Greece, 14 contained parasites and needed to be identified. Classical morphological identification, using body shape and measurements, is not always effective with slug and snail species that can look very similar. Plus, to check for parasites, the specimen has to be opened up.

So BopCo also uses DNA barcoding: a technique that matches genetic sequences in tissue, taken from the foot of the gastropod, with reference sequences in databases.

This confirmed that the samples collected in the Greek study contained five common, widespread species plus one probable recent introduction. All these species are known to be efficient colonisers of new areas and have been introduced in several parts of Europe. Among the parasites they carried were species that are new for Greece and species that are new for Europe.

The more we know about how their population is expanding, the better equipped authorities are to help to control the spread.

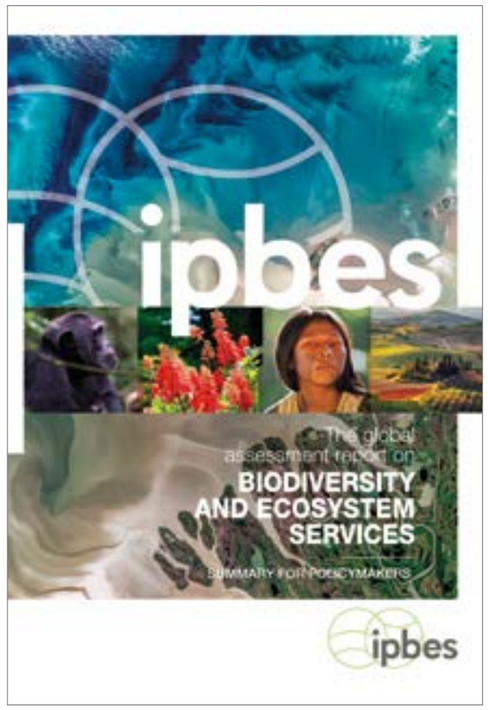
BRIDGING THE GAP BETWEEN **SCIENCE AND POLICY**

One of the things that makes our Institute unique in the world is the key roles it plays in providing policy support. *At regional, national, European and global level, our scientists are stepping up to ensure that policy decisions are based on the best evidence available. The impact of our work is wide-ranging: from protecting biodiversity to preventing marine pollution and making the most of renewable energy.*

Belgium's role at the forefront of biodiversity policy

When negotiating international treaties on biodiversity, every country sends its representatives. For most countries, negotiators are legal experts from ministries. For Belgium, our experts are actively involved in the negotiations team. Our reputation for scientific excellence means that our voice stands out in a crowd.

The result is that for a small country, Belgium often takes key roles in the development of global policy agreements: the UN Convention on Biological Diversity or the UN Convention for the Law of the Sea, for example. This work is made possible by BIOPOLS, a knowledge platform within our Institute that brings together a range of entities that all work on linking science and policy in different aspects of biodiversity.



The fact that we play a key role in several treaties and international biodiversity initiatives creates a unique opportunity to increase synergies and connect the dots.

One such example this year was the work of the Belgian Biodiversity Platform, coordinated by our Institute, The Platform acts as Belgium's national focal point for the Intergovernmental Platform for Biodiversity and Ecosystem Services (IPBES). IPBES is to biodiversity what the IPCC is to climate change and as head of delegation our team coordinates the Belgian position and ensures it is represented at international level.

Thanks to BIOPOLS, we could also ensure close links with the work under the Convention on Biological Diversity. Years of hard work came to fruition in 2019 with the release of the Global Assessment Report, bringing biodiversity into the spotlight internationally with significant policy impact. The report's message is strong: if we want to halt biodiversity loss, slow the deterioration of nature and meet biodiversity, climate and sustainable development goals by 2030, 'business as usual' is not an option. This crucial work is transforming the way the EU deals with biodiversity - it provides a basis for the European Green Deal, the roadmap for making the EU's economy sustainable.

50 years **battling North Sea pollution**

Oil pollution in the North Sea has fallen sharply over the years, mainly due to fewer ships illegally discharging oil at sea. This is the result of coordinated efforts within the framework of the Bonn Agreement, the regional agreement that commits countries around the North Sea to combat pollution from ships and other maritime activities.

Fifty years on from its signature, Belgium took the initiative to have the scope of the agreement extended to include not only the prevention of marine pollution but also the prevention of illegal air pollution by shipping. A new ambitious Strategic Action Plan of the Accord for the next six years was completed and Spain joined the agreement, extending its influence to the Bay of Biscay.

Belgium's expertise and pioneering role is thanks to the work within our Institute of the MUMM (Management Unit of the Mathematical Model of the North Sea), cooperating with the federal government to monitor marine pollution. Our Institute implements this through our Coast Guard aircraft, fitted with sensors that detect ship-source surface pollution as well as, more recently, sulphur emissions. The innovative 'sniffer' sensor technology not only enables more efficient monitoring of aspects of air quality over the sea, but also allows identification of potential offenders that can then be inspected in the port.

It is based on the success of this process that the Bonn Agreement was extended to cover the prevention of air pollution from ships at sea. This groundbreaking work is providing a model for other North Sea countries as well as countries further afield looking to tackle air pollution from ships.

Going deeper into **Belgium's geothermal energy potential**

There is no doubt that heat from within the earth can play a key role in helping Belgium achieve its renewable energy goals. But significant investment and risk are involved. Scientists from the Geological Survey of Belgium at our Institute worked with the University of Antwerp to develop an investment model to determine the effect of policy measures on risk and profitability, published in the journal *Energy Economics*.

Extracting heat for direct use is one of the ways that the temperatures deep in the earth can be used to provide us with geothermal energy. This technique delivers a significant and constant source of sustainable energy. However, it requires massive investments to kick off and involves some level of risk, as there are always uncertainties related to both the geology and the market. This tends to discourage investors.

This type of barrier contributes to Belgium's difficulty in making the most of renewable energy. As Flemish Minister of Energy Zuhal Demir recently declared, Flanders will not meet its renewable energy goals in 2020. Planned investments in geothermal energy production are lagging behind the development path set out in the National Renewable Energy Action Plans.

The researchers brought together expertise in geology and environmental economics to build a model that shows how political measures could reduce risks linked to investments and increase profitability. It proposes for example a government loan that should only be refunded if the project proves to be profitable. This type of model provides concrete recommendations to Belgian policymakers that can help work towards the development of a stable geothermal sector.

A WATCHFUL EYE ON THE NORTH SEA

Our team may be based on land, but the focus of much of our work is out at sea. *As a federal institute, we are tasked with the responsibility of North Sea monitoring, modelling and broader research: a challenge that we are well-equipped to carry out, with our marine chemistry labs, Coast Guard aircraft and the research vessel Belgica.*

Listening in for **the sounds of the sea**

In 2019 our monitoring teams began to keep an ear, as well as an eye, on the North Sea. Underwater noise may not seem to be a cause for concern but human activity like shipping and construction can pose a threat to marine ecosystems. The first step in detecting any effects on marine wildlife is to start measuring, and with the launch of our underwater acoustic recording station we now have a steady supply of data.

Until now, most monitoring focused on impulsive sound. This includes pile-driving during the construction of wind turbines, for example, which can be harmful for marine fauna and has been seen to cause relocation of harbour porpoises *Phocoena phocoena*. Belgium has put legislation in place to regulate impulsive noise. What is less well studied is continuous, ambient, low-frequency sound. With the new station we will be able to monitor this noise from shipping, dredging and sand extraction.

The Westhinder platform proved to be the best location for our underwater device. It is an automatic electronic light platform out at sea, just off the main shipping route. Technicians from the Maritime and Coastal Services Agency and our scientific divers took care of the installation, 12 metres below the surface. This work was part of a cooperation with European partners: the Joint Monitoring Programme for Ambient Noise North Sea (JOMOPANS). It works towards European cooperation in monitoring and modelling to get an audio snapshot of the North Sea.

10 years of wind farms: what impact?

Recent years have seen 318 new offshore wind turbines installed in the Belgian part of the North Sea that have made a significant impact on our move towards renewable energy. But what effects have these wind farms had on the North Sea and its ecosystems?

As coordinators of WinMon.BE, our Marine Ecology and Management team is responsible for investigating the environmental impact of wind turbines at sea. For this we work closely with the Research Institute Nature and Forest (INBO), the Research Institute for Agriculture, Fisheries and Food (ILVO) and the Marine Biology Research Group of Ghent University. And in ten years, our study methods have changed a lot, from observing to understanding using the latest techniques. This allows for the measurement of a wide range of impacts across a broad ecosystem approach, from benthic invertebrates to birds and marine mammals.

A ten-year period reveals some striking findings. Artificial hard substrata such as wind turbine foundations used to be considered to be reasonable alternatives for species-rich natural hard substrata - our findings show that this is not the case. We learned that wind farms deter some bird species but attract others; and that the number of stranded harbour porpoises correlates with periods of high intensity underwater sound. The data also demonstrates that offshore wind farms only subtly changed fishing activity and has not reduced catch rates of the main target species. All these outcomes help to inform policy and industrial practices on how wind farms can be designed in an environmentally-friendly way.

Helping our coastline face a changing climate

2019 will be seen by many as the year that public dialogue finally began to recognise the seriousness of the climate crisis. For our Institute, it was also a year of progress towards ensuring the North Sea coast remains resilient to the effects of global warming, thanks to the outcomes of the CREST project.

For many years now Belgium's North Sea coastline has relied on supplies of sand being brought in to protect it. But the effects of climate change on wind, waves, tides and sediment transport are complex. CREST, coordinated by the KU Leuven, brought a wide range of Belgian expertise together over four years to increase the scientific knowledge about coastal processes nearshore and landward, based on field measurements, laboratory tests and numerical modelling. Our Institute's specific role was to assess the role of climate change on the coastal protection and was a continuation of work that was performed in the framework of the Belspo CORDEX.be project.

We were able to show through a range of models and climate change scenarios that we do not expect climate change to result in an increase in storm surges or wave height in the southern North Sea due to changing atmospheric conditions, for example. Our work also demonstrated that due to the rise in sea level, waves will propagate further into shallower waters, resulting in higher coastal waves, and that changes would occur in patterns of sediment deposited along our North Sea coast.

Overall, CREST underlined the fact that there are many uncertainties to take into account when it comes to long-term planning. The various climate scenarios, models and results developed by the project will equip authorities to deal with a wide range of possibilities, preparing our coastline to withstand the impacts of a changing climate.

WWI weapons cemetery under close surveillance

Less than a mile from the Belgian coastline lies an estimated 35,000 tonnes of unexploded ammunition left over from the first World War, buried deep in the seabed for more than a hundred years. In 2019 our marine chemistry lab ECOCHEM in Ostend detected signs of a leak, sparking concerns in the media. Fortunately our researchers were able to reassure the public: the data showed the leak was at very low concentrations, posing no threat to health.

Divers from the Belgian Navy have been sampling the seabed in the North Sea for years, bringing sediment back up to the surface where it is safely triple-packed on board the research vessel Belgica, before being sent to the labs for analysis. Several years ago, our team established an early warning method specifically to monitor the Paardenmarkt site with its underwater munitions dump. It is thanks to this system that our team was able to successfully detect the leak: degradation products of TNT and mustard gas that were present in the surface sediments. The concentration was only just at detectable levels: around 1 microgram per kilo.

As a result, monitoring efforts have now doubled to ensure that the authorities can take action if a threat is detected. Our Institute continues to play a key role not only in monitoring but also as scientific spokesperson on the topic on behalf of the Ministry of the North Sea, combining our scientific expertise with our knowhow in communications.

2 COLLECTIONS

A HISTORIC NEW HOME
FOR OUR GEOLOGICAL CORES

The specimens in our collection stretch from the microscopic to the gigantic. *But perhaps our biggest challenge in terms of space is our geological collection of drill cores: up to 42 kilograms each in weight, and with a total length of 40 kilometres, they tell the story of Belgium's subsoil over the years. They have now moved south to find a new home with some history of its own.*

Our geological collection of drill cores has come together over the past 100 years and contains a wealth of information about the ground under our feet: where groundwater can be found, which areas are suitable for geothermal energy and where we could store carbon. It is managed by our team of experts at the Belgian Geological Survey. And the cores' new home is on the site of an emblem of our industrial heritage: the former coal washhouse in Péronnes-lez-Binche in the Walloon province of Hainault. It was here that in the fifties and sixties, coal from neighbouring mines was separated from shale and other impurities. Abandoned for decades after its closure, it was later classified as a historic monument. Between 2014 and 2017, the Régie des Bâtiments built a modern 9,000-square-metre storage hall beside, where our collection now finds itself.

Up until now the cores had been stored in Laeken in Brussels. Moving 550 pallets of drill core from Laeken to Binche was no easy task. Each box can weigh up to 42 kilos and has to be lifted onto shelves. To keep these cores intact for future generations, the temperature and humidity in the storage spaces have to be kept as constant as possible. Moving the collection was a welcome chance to conduct an inventory as well - after 100 years there were some doubts about what it contained and the condition and details of each core.

Almost all geological eras are represented in the collection. The drill cores also explore the seabed, with almost one and a half kilometres of cores harvested in the North Sea by research vessels which helped to establish a 3D model of the Belgian seabed. And as well as telling us about the geological profile of the area, cores can help researchers date archaeological sites or discover traces of past climate change. Taken from the bottom of lakes, they can even tell us about past tsunamis.

In the past, geologists could drill for purely scientific purposes, just to explore the subsoil. These days, the budget for scientific research is so limited that coring has to be part of a project with some economic value. The drilling is therefore mainly done in preparation for major infrastructure works or to locate resources for geothermal energy, carbon storage or the storage of radioactive waste. This makes our collection all the more valuable for research.

The cores' new home also makes them more accessible for researchers. Scientists have a workspace there with a well-equipped laboratory to study the collection. PhD students in particular have been taking the opportunity to come and conduct their research. One day a month there is a member of staff present to welcome them, and appointments can be made at other times for visitors to come and work on the cores. Data from these researchers enriches the collection. Plus, having all this space means our collection can grow. Until now, when private companies or universities offered us their drill cores, we had to refuse. Now they are welcome, as long as the cores are useful and in good condition.

The new conservatories of Péronnes-lez-Binche were originally meant to house collections from the Belgian Royal Archives, the Art & History Museum and the Royal Museum of Fine Arts. However, expensive collections can pose additional security issues and in the end, all changed their minds. We share the site with the Royal Museum for Central Africa and the Royal Library alone. Some of our paleontological collections are stocked there too, previously stored under the Finance Tower in Brussels. One room contains 6,000 trays of fossils from the coal mines alongside enormous fossil whales. Another contains large mammals, including an elephant and a buffalo: our drill cores are therefore in good company.

OUR EVER-GROWING COLLECTION

The third-largest natural sciences collection in Europe takes some work to maintain. *This is where the expertise of the team at our Scientific Service Heritage comes into play. Managing collections is about more than conservation - it is about ensuring our specimens are made accessible to ensure research on them can continue, so their value lives on.*

The legacy of one of our most prominent colleagues

In 2015 we lost a renowned paleontologist whose work lives on in his collections. Our colleague Dr. Paul Sartenaer dedicated sixty years of his life to the study of brachiopods: marine organisms that are rare in today's oceans but can be found in great numbers in fossil form. Sartenaer started his career at our Institute in the fifties and by 1990 he was Head of Paleontology. The focus of his research was to identify fossils that could determine limits in rock strata from the Devonian and the Lower Carboniferous periods across many regions of the world.

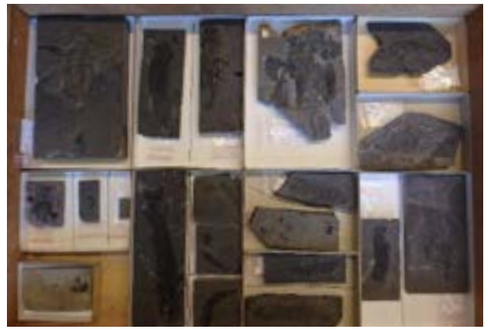
When he passed away in July 2015, our Scientific Service Heritage received countless specimens he collected throughout his scientific career. Requests to study this rich collection soon arrived, but it was not so easy for us to comply: the fossils were wrapped in newspaper and stored in cardboard boxes. Three years later, thanks to the help of two young volunteers, these specimens are now unpacked and stored in 120 easily searchable trays. The collection has already been prospected and interesting fossils discovered with the potential for a scientific publication.

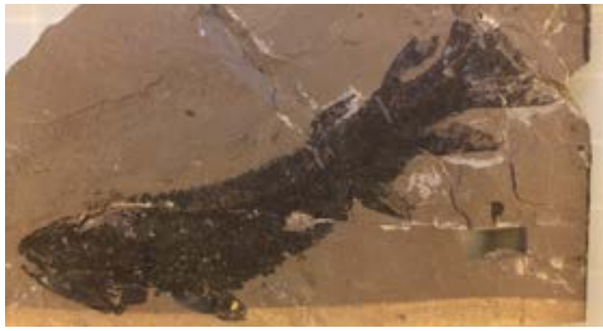
A fossil fish collection with a twist in the tail

Some collections continue to grow even after they have been donated to our Institute. In 2016 the Scientific Service Heritage was contacted by a colleague to inform us that Mr. Jan Den Blaauwen, a Dutch amateur, wished to donate his collection of Belgian and Scottish fossil fish from the Devonian period, over 350 million years ago. The collection included 350 specimens distributed in nine trays.

Two years later, we had another call from our colleague with some news: there was a sequel to the Den Blaauwen collection. It turned out that the collector had entrusted additional specimens to another institution who eventually decided to entrust them to us - that way the entire collection could be kept in one place. This saw our Den Blaauwen collection almost double in size to 608 specimens across 35 trays.

And the saga is not over yet. 285 specimens from this collection are still unidentified. Among these, one specimen could correspond to a particularly rare fossil shark of which only ten specimens are known in the world.



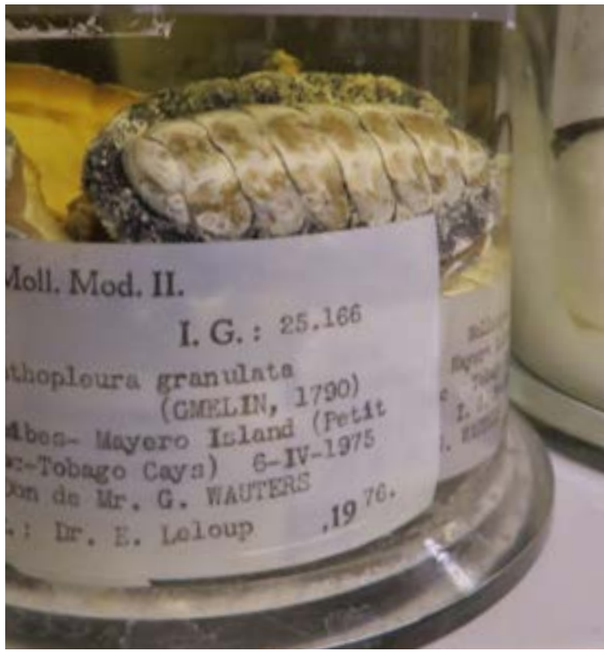


Europe's largest chiton collection gets a revamp

Chitons, or *Polyplacophora,* are molluscs whose shells are made up of eight plates resembling a coat of armour. And our Institute is home to one of the world's largest collections of these distinctive marine creatures, gathered together over the years by scientists including our former colleague Dr Eugène Leloup, who worked at the Institute for over four decades.

Now in 2019, our team has finished repacking and digitising this important collection in order to make it fully accessible for scientific research. Due to the size of the collection, this was a mammoth task - every single pot in the wet collection had to be carefully opened, which in some cases required some serious muscle.

Specimens were checked for their physical state and relabelled wherever needed. Any damaged pots or outdated packaging were replaced to ensure long-term preservation. All the specimens have additionally been encoded in our database, DaRWIN, ensuring open data alongside excellent conservation to facilitate the work of any researcher studying this historic collection.



MODELLING OUR SPECIMENS
SLICE BY SLICE

2019 at our Institute was a great year for microtomography. *More specimens than ever before were modelled in 3D with our specialised micro-CT scanners, making them available virtually to researchers that could not otherwise have access to them.*

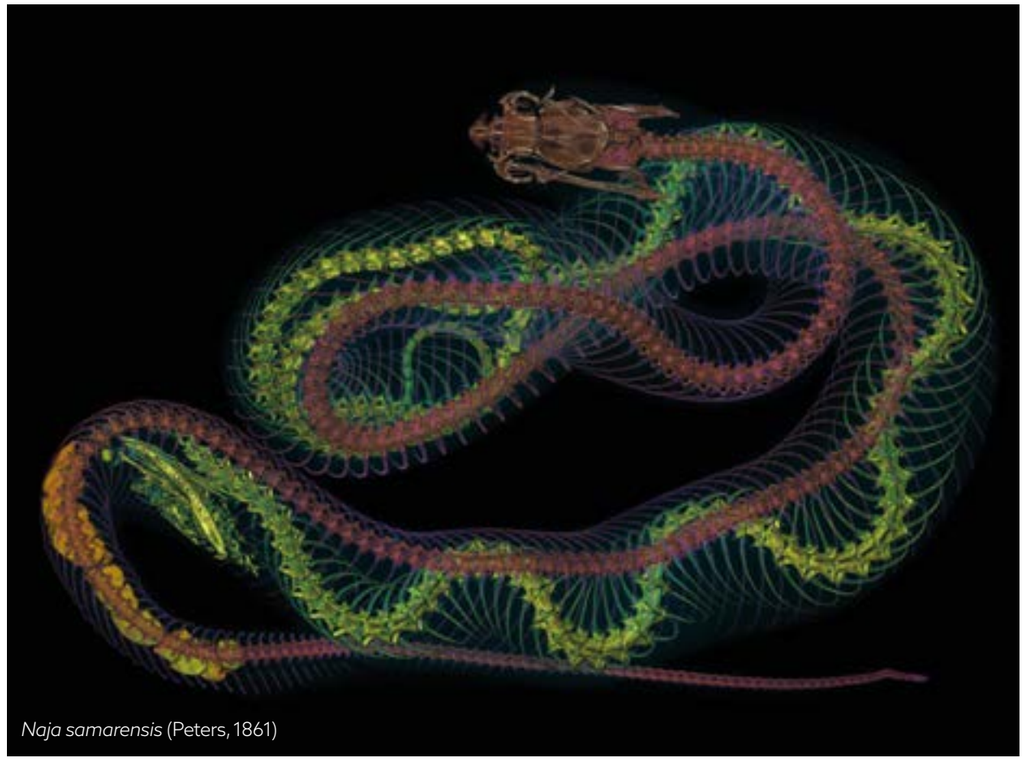
Microtomography, or micro-CT scanning, is a technique that uses x-rays to create cross-section images of a specimen. These slices can then be put together to recreate a 3D virtual model. The beauty of the technology is that it means our valuable specimens are not damaged at all in the process and there is no reassembly needed, unlike processes like taxidermy which are extremely invasive and where skeletons often have to be reconstructed from scratch, sometimes with inaccuracies. It also means researchers in other countries can study our specimens from the comfort of their computer screens, without risk of them being lost or damaged in the post.

Our Scientific Service Heritage has two microtomography scanners at its disposal which are unique in Belgium for the purposes of digitising specimens. They require scientific expertise to function: a scan of a skull, for example, can be two to three thousand slices, and a specialist is needed to select what needs to be kept. We are working our way through our entire collection: the aim is to digitise 2,000 per year, and in 2019 we almost met the target. Type specimens take priority, as these are the most sought-after for research.

Tools like the micro-CT scanners are a real asset to the Institute when it comes to cooperating with local partners: in 2019 we worked with the University of Montpellier, the University of Ghent and the Royal Museum for Central Africa. And it was the RMCA's collection that was the source of one interesting specimen in particular. It began when a colleague asked to look at a specific set of herpetology specimens collected in the Congo, which had been in the collection since 1897. Our team noticed during the handling of the specimens that one of the snakes was particularly rigid: a Ubangi Centipede-eater, *Aparallactus modestus ubangensis*. The micro-CT scan revealed its secret: four eggs within the snake, each 2-3cm long, fully intact. Thanks to the scan, researchers were able to draw conclusions about the reproductive process of the snake - until then, it had not even been clear that the species was an egg-laying snake.

Another unusual snake specimen scanned this year was a rare species of Philippine cobra, Naja samarensis. The scan showed that inside it was another rare snake, just as long as its predator: *Cyclocorus nuchalis nuchalis,* the Southern Triangle-spotted Snake. This added to our knowledge of the diet of this little-known cobra, which previously had only ever been observed feeding on toads in the wild. These are just some of the ways that visualising internal structures greatly increases the value of each of the specimens in our collections.

Holotype of *Aparallactus modestus ubangensis* (Boulenger, 1887)



Naja samarensis (Peters, 1861)

3 PUBLIC

TAKING BACK THE POWER
WITH OPEN ACCESS

When it comes to scientific publications, how can open access be the key to bringing publicly-funded research to the forefront? *Not only do our scientists publish in journals across the world, but our Publications Service has its own journals, series, monographs and handbooks and a great deal of expertise in open access publishing. In 2019 we took more steps towards opening up our publications to all.*

"Publish or perish", the old saying goes, and our Institute has to live by that rule as well. We have been publishing since the Institute began. In the past, the scientists used to do it all themselves, on their own budget, liaising with the publishers of international journals and producing their own series. But scientists speciality is their research, and publishing requires a completely different set of skills.

In 2015, this all changed with the introduction of our in-house Publications Service. Suddenly the researchers were free to spend their time doing what they do best. And at the same time, we were able to coordinate our publishing activity more strategically, focusing on our strengths and spreading good practices throughout the organisation.

It has also allowed our in-house publications to grow in scale. We publish journals: the *European Journal of Taxonomy* and the *Belgian Journal of Zoology;* as well as eight series that include scientific reports, impact assessments, monographs and handbooks across a range of domains.

As a publicly-funded institution, our publishing is not designed to make a profit. But our publications compete with those of private publishing houses who publish journals with the highest impact factor like Nature and Science. Publishing in these journals typically involves costs at several stages of the process. The research published in these journals is usually conducted by scientists whose salaries are paid by public money. Scientists give their work to the publishers for free. The publisher then has to pay a desk editor to prepare the work for publication. But the rest of the editing is done by volunteers: peer reviewers from other scientific institutions, again largely funded by public money. Once the article is published, scientists then have to pay to publish directly in Open Access, for which fees have to be paid, or, to access the publications via subscriptions to the journals and their contents.

In recent years, the European Union has been behind a movement to encourage open access. Its aim is to encourage journals to make articles more widely available, taking the burden off European researchers. But this move has resulted in private publishers coming up with the so-called hybrid model. These are subscription journals which require a publication fee from the authors for some articles to be published online printed in open access, while still requiring a subscription fee for readers of other papers.

These systems are costly and create a competitive environment where scientists work to raise their profile to have a better chance of securing future research funding. For our Institute, having a Publications Service in-house is proof that commercial business models are not a requirement for the production of excellent quality publishing. The *European Journal of Taxonomy* is a great example: it is the first journal ever to be owned and run by a consortium of natural history institutes. And it takes a strong position in terms of its business model. It is Diamond Open Access, meaning that neither the author nor the reader has to pay anything. And the journal has gone from strength to strength, with five additional institutes joining the consortium over the years and an endorsement from the Consortium of European Taxonomic Facilities (CETAF), a research network made up of 60 institutions of reference.

In 2019 the *European Journal of Taxonomy* started to implement a method for encoding its articles in a machine-readable format, Extensible Markup Language (XML), and extracting material citations. This allows the taxonomic treatments and specimen data from each article to be distributed immediately to biodiversity databases worldwide and linked back to the article, explicitly crediting the original author. This is open data in action: free, findable, accessible, interoperable and reusable (FAIR).

The journal put together a set of editorial standards to ensure the rich data in its articles can be harvested and disseminated as accurately and efficiently as possible. An e-publishing working group (within the CETAF consortium) is now using the *EJT* as a pilot case to set up a platform that collaborative journals can use on any subject.

Another new development in open access this year concerns our institutional repository. For years our Institute has been uploading everything our scientists publish to an internal repository to keep it accessible to our researchers. Two years ago, we started to use the same technology to provide access to digital versions of our publications from across our history. This platform now contains over 13,000 documents in total. Meanwhile at national level, the Belgian Federal Science Policy Office (Belspo) developed a federal repository, Orfeo, opening up access to all research funded by the Belgian government. This year we developed a system to make the data and full texts automatically transferable from our own repository to open access in Orfeo.

We have no doubt that open science and open data are the future. As a single publicly-funded institution we may not have the power and influence that commercial publishing companies can offer, but as a network of publicly funded research institutes worldwide, open access can help us push towards a world where science is available to all of us to learn from and build on.

MUSEUM ON FILM: THE YEAR OF THE VIDEO

125 years on, there is something about the moving image that still has a unique ability to captivate us and tell a story. *Video as a medium may be nothing new, but the latest advances in 360° projection technology, the smartphone and social media are allowing us to get even more creative about how and where we bring these stories of natural sciences to the public.*

A spectacular trip **from Brussels to Antarctica**

Our 2019 temporary exhibition Antarctica aimed to take our audiences to this mysterious continent, usually only accessible to scientists. We wanted to bring the sights and sounds of the South Pole to Belgium. And what better way to do that than through moving images?

Antarctica is also an important area for our Institute's research. As our Institute continues to find ways to bring our scientific work and public engagement closer together, we saw a great opportunity with this exhibition. Video was a tool to let our visitors and social media fans stand face-to-face with our scientists in situ, showing the work that they carry out.

Throughout our exhibition, co-designed by the Musée des Confluences and Wild Touch, visitors follow a French team on a diving expedition, studying the biodiversity below the ice as well as above it. You can peek through portholes to picture life under the sea ice alongside the Weddell seals, as well as marvel at large screen projections unveiling spectacular landscapes. The highlight is the final 360° immersive experience, using technology to surround our visitors completely. The stunning cinematography is thanks to the work of Luc Jacquet, the Oscar-winning director behind the renowned documentary *The Emperor's March*.

Our team developed three short, catchy videos, 3-5 minutes in length, which were integrated into the exhibition and uploaded to our YouTube channel. The challenge was to find the narrative within each set of research that would be engaging for the general public, looking for hooks that could serve as a way in. The researchers co-created each film, as well as appearing in them personally. This ensured the accuracy of the data visualisations within them, and the end result has been particularly useful for them too as a tool to communicate their research to other audiences.

The first looked at micrometeorites, showing how the untouched landscapes of the Antarctic are the ideal place to gather space dust that is all around us. Viewers get a sense of adventure as they board the skidoo from the point of view of the camera, traversing ice sheets. The second brings the Institute's collections into the picture, demonstrating what Antarctic ecosystems tell us about the effects of climate change. A third uses video to see what would otherwise be invisible to the naked eye: the impact of climate change on microorganisms, as modelled by our remote sensing team.

Up close and personal with our scientists

2019 at our Museum truly was the year of the science video, with more being produced in a single year than ever before. Our YouTube channel saw a surge in views, with one of our 2019 videos breaking our own record. And it is unsurprising, since increasingly our Museum visits begin on people's screens. With the rise of the smartphone, short, snappy videos are an excellent medium with which to engage huge numbers of our audiences before they even think about setting foot in the Museum. We see this as an opportunity to bring nature not only into everyone's lives, but into everyone's pockets.

Our Bernissart iguanodons are the stars of our *Dinosaur Gallery,* but it's true that visitors can't get quite as close to them as many of them might like to. These national treasures are protected by a 300m² glass case. But now our audiences finally have a way to sneak inside, thanks to our new video series, Inside the cage of the Iguanodons. Our paleontologist guides viewers through four short talks, expertly presented from in between the enormous dinosaur fossils. What is more, some of the episodes are filmed using a 360° camera, meaning that as our narrator tells us the story, we can turn around and gaze up at the 7-metre-long beasts around us and see the evidence for ourselves. These clips have already been in demand - they were used last year by a teacher in the US.

One of our paleontologists this year came to our communications team with a request for a different kind of film. His work on a four-legged ancestor of the modern whale, explained on page 16-17 of this report, was to be published, and the journal asked for a video abstract. Seeing the potential of this research to reach large audiences, our team got to work. The result is a five-minute video that neatly captures the key findings of the research alongside clear graphics and visualisations developed in-house. And this is the video that broke our record, with over 40,000 views on our channel and over 80,000 on the site of the journal *Current Biology*.

Another way we harnessed the power of video this year was Science Figured Out. This collaborative initiative from a non-profit called 'Scriptie' has a simple aim: to get scientists from a range of research institutes in front of cameras, pitching their research to the general public in just three minutes. The process itself takes a little longer: twelve researchers from our Institute attended a whole-day workshop where they were trained on how to present their work. For three weeks they developed their script, in close collaboration with communications experts. The end result was filmed and distributed far and wide, ensuring great visibility for our work. The learning process was particularly satisfying for the researchers. For many of them it was a chance to discover their inner science communicator thanks to the project. But it has also proved valuable in making their work more visible to other researchers, adding clear value to their studies.

SPECIMENS IN AND OUT OF OUR DOORS

It's not only our researchers that venture outside our walls as ambassadors for our institution. *In 2019 some of our specimens were sent out on adventures as well, reaching new audiences and giving them a glimpse of our collections. One very notable specimen made the opposite trip: entering the Museum to be seen by public eyes for the first time.*

A new *allosaurus* makes a very public appearance

We think of Museums as a natural home for dinosaur fossils: surrounded by experts who can study and conserve the specimens while also opening up their doors to visitors from across the world. But private collections mean there are many fossils out there that the public never has a chance to see. In recent years, however, we welcomed a magnificent new *allosaurus* skeleton from a private collection to our *Evolution Gallery*, and what's more, it is a new species.

Named Arkhane, this fossil comes from a 9-metre-long predator that would have roamed the planet around 155 million years ago. It is also 70% complete, making it a rare find indeed. It was dug up in 2014 in Wyoming, USA, in a region our paleontologists know very well, and bought at auction by a collector who was keen for the specimen to be studied and displayed, and who was aware of our expertise in the field.

Arkhane was therefore brought in to our Institute to be carefully prepared and analysed by our specialists with the agreement that the specimen would also be exhibited in our galleries. It was during this analysis that our team was able to conclude that it was indeed a new species. In May 2019, The Museum first welcomed visitors to see Arkhane lit up against the back wall of our beautiful *Evolution Gallery*, among its Jurassic contemporaries, where it will remain at least until 2021.

Over the moon at the Royal Palace

When the Royal Palace of Brussels organised a summer exhibition entitled "The Moon: Between Dream And Reality", it was logical that the Museum played a key role: who else could bring a piece of the moon itself? Science and Culture at the Palace is an annual event offering a unique perspective through Belgium's cultural and scientific heritage collections. Working with the Belgian Comic Strip Center we were able to display Peyo's famous comic The Moonstone alongside the moon rock, as well as another impressive lunar specimen from our collection: the *Mola mola* (or "poisson lune" in French). The exhibition was a big hit with tourists in particular, helping people from outside Belgium to discover what we have to offer.

Our collections actually contain several pieces of moon rock gathered in 1969 by the Apollo 11 team themselves and one of them remains on display in our Mineral Hall. It was to commemorate the 50th anniversary of this mission that the summer exhibition was held. The rocks have a particular significance to the Palace - they were actually a gift from President Nixon to Baudouin back when King Philippe was a little boy.

"Look, a familiar whale..."

Another specimen that we helped to exhibit in 2019 was actually making a return visit, although under very different conditions. A massive 18-metre-long fin whale carcass was spotted off the Belgian coast in October 2018. Since it was in a busy shipping lane, authorities had to act fast. They finally managed to bring the 30,000kg body ashore to the town of Wenduine-De Haan at 2am the following morning, where our staff coordinated the scientific investigations. An autopsy showed that it probably died a natural death. The mayor of De Haan asked for parts of the skeleton to be prepared and the press and public settled on a name for the specimen: Antonius.

Antonius' return to Wenduine-De Haan came in summer 2019 when the exhibition "Look, a whale!" was held at the community centre 't Schelpestik. Several parts of the fin whale skeleton were shown alongside some of our specimens from longer ago and with a relationship to this coastal community: a mid-19th century skull of a stranded killer whale, two skulls of Sowerby's beaked whales, a mother and juvenile that washed ashore in 1933, and one of a long-finned pilot whale from 1995. A porpoise skull was added as a homage to the fact that this species appears on the coat of arms of Wenduine.

SEEING OUR MUSEUM FROM NEW ANGLES

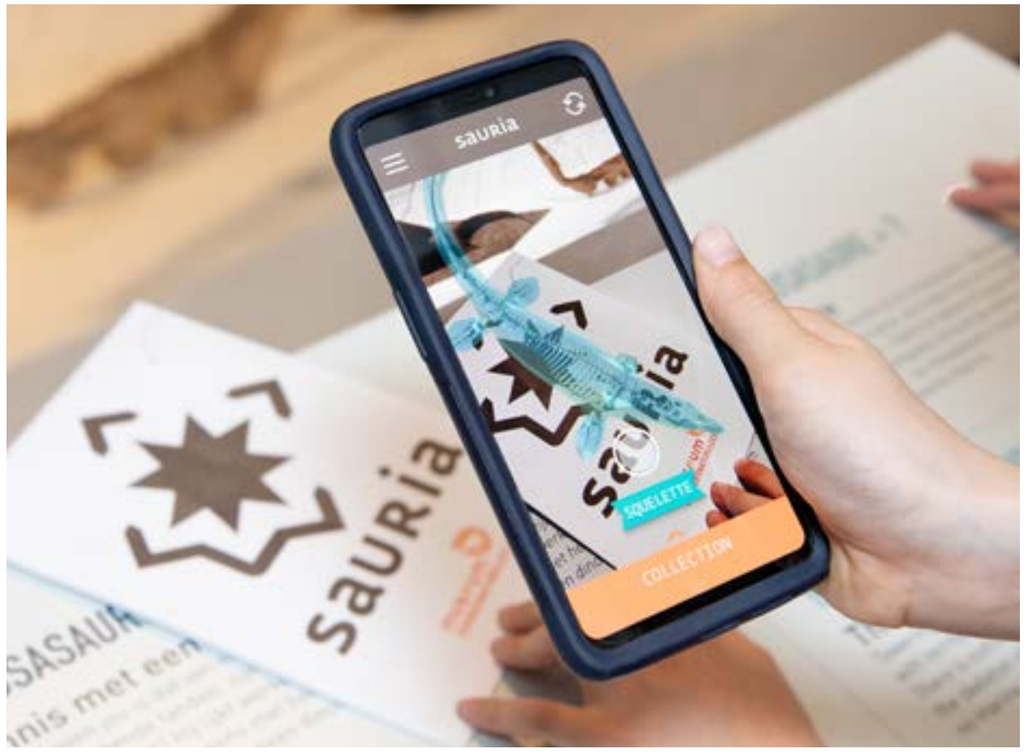
Diversifying our audiences is a key focus for our Museum. *To engage groups of people that wouldn't ordinarily come through our doors, we embrace the challenge of rethinking the visitor experience: how do our exhibits look through other people's eyes, and what fresh perspectives can we gain?*

Gamifying **our saurians**

How could we visit the biggest dinosaur gallery in Europe differently? This was the challenge our team took on in the development of Sauria, a new, free game to be played in our halls, thanks to an app that uses augmented reality to get a better look at some of the stars of our collection.

The experience itself is simple: grab a map at the gallery entrance and connect your phone. Answer questions to collect exhibits modelled in 3D and viewable in augmented reality through your smartphone camera, from the pteranodon to our mosasaur. The development was a lot more complex. Our team made most of the digital models from scratch, streamlining each and adding substance and skin to the bones. The gameplay development was a challenge too, to tell the stories of the fossils while ensuring an engaging experience.

With 2,000 downloads in 2019, what we saw with Sauria was that families started to work as a team to experience the Museum in a new way. Rather than running off around the gallery, children stayed with their parents to tackle the challenges on the app all together.



Getting happy at our Nocturnes

In 2019 we came up with a Happy Hours offer that provided a great evening out for our visitors: opening up our *Dinosaur Gallery*, *250 Years of Natural Sciences Gallery* and *Antarctica* exhibition until 10pm. A smartphone tour brought visitors in from our neighbours, the Parlamentarium and House of European History, to the sounds of accompanying brass band Jour de Fête.

The more theatrically-minded of our visitors were in for a treat with 'Bernissartensis: Unfinished Business,' a wandering play in French and Dutch that popped up in surprising spots around our halls, telling the story of the Bernissart iguanodons from their discovery in 1878 to what we can learn from them today. With 700 spectators, the success of the show was thanks to a great cooperation with Belgian theatre company Passeurs de Rêves.

Antarctica at the Nocturne was also a chance to present our partnership with APECS, the Association of Polar Early Career Scientists. We worked with them to organise an event on International Polar Day where the public had a chance to meet the researchers and participate in a range of workshops. At the Nocturne, a marine biologist from our Institute brought the public down to the extreme temperatures of the Antarctic Ocean with a talk on expeditions.

Fresh activities for diverse audiences

Our Education Service is a hotbed of experimentation with new audiences, constantly coming up with creative new ways to approach our collection and exhibitions. In 2019 we diversified in terms of linguistic backgrounds as well as age groups, as well as expanding our selection of teacher training courses.

Our Toddlers Workshops have proven to be a great success, helping 2-4 year olds to explore the nature around them. Having piloted them in French as Tout-Petits Ateliers, in 2019 we rolled them out into Dutch for the first time, with our debut workshop Allerkleinsten. Our Coffee Workshops for adult audiences went bilingual for the first time in 2019 too, with Taxidermy, Murder in the Museum and Entomology - Preparing Insects all developed with one French-speaking facilitator and one Dutch-speaking.

We also put together a new guided visit on sexuality for teenagers, thanks to a new collaboration with Sensoa, the Flemish expertise centre for sexual health and the association on gender and sexual diversity for young people Wel Jong Niet Hetero.

As for training, four thematic workshops are now on offer for teachers or future teachers looking to bring their knowledge up to date with the latest research, develop and adapt activities and make the most of the wealth of resources the Museum offers to complement work done in the classroom.

Our Animal Classification training day works with teachers to build up phylogenetic trees from zoological groups. In our Evolution workshop they explore the mechanisms behind the adaptations we see in nature around us. Finally our Biodiversity day helps teachers get to grips with a crucial topic for the future of the world around us, helping students to understand the role they can play.

4 FIGURES

FINANCES

In 2019, we saw a slight drop in revenues and a slight increase in expenditure. The financial balance showed a positive result of €370,981, less than in 2018. We can identify two primary reasons for this. In 2019 we started to include a provision for holiday pay in the accounting. In addition, the Ministry of Defence invoiced the outstanding operational costs for the last few years in relation to the research vessel Belgica.

On the revenue side, it should be noted that the overall endowment is largely identical to that of 2018.

The revenues from the Museum have increased overall by €1,278,005 compared to 2018. Revenues from tickets sales, the Museumshop and educational activities have increased, but the increase in grants is particularly significant. This is due to a number of factors. The renovation works to construct the permanent *Living Planet* exhibition progressed well, so the corresponding resources from Beliris were added to the receipts for this financial year. Our travelling 'science truck', XperiLAB.be, was supported financially by Belspo. And our temporary *Antarctica* exhibition also received subsidies from various partners.

The Institute's research activities generated a total of €9,890,284: a decrease of €1,789,480 compared to last year, but in line with the research revenues of 2017. This is primarily due to the difficulty experienced in billing the second semester of the Belspo research projects before the end of the financial year.

It is also notable that European subsidies vary greatly from year to year, which is indicative of a varying success rate among European projects. For 2019, this entails a drop of €1,504,863 in comparison with 2018.

What appears to be a drop in revenues from the private sector is similarly the consequence of a reclassification of the revenues from scientific expertise provided to public bodies.

In addition to these revenues from Museum and scientific activities, a number of other revenues should be mentioned, such as those associated with the staff canteen, royalties from copyrights and administrative fees charged to third parties.

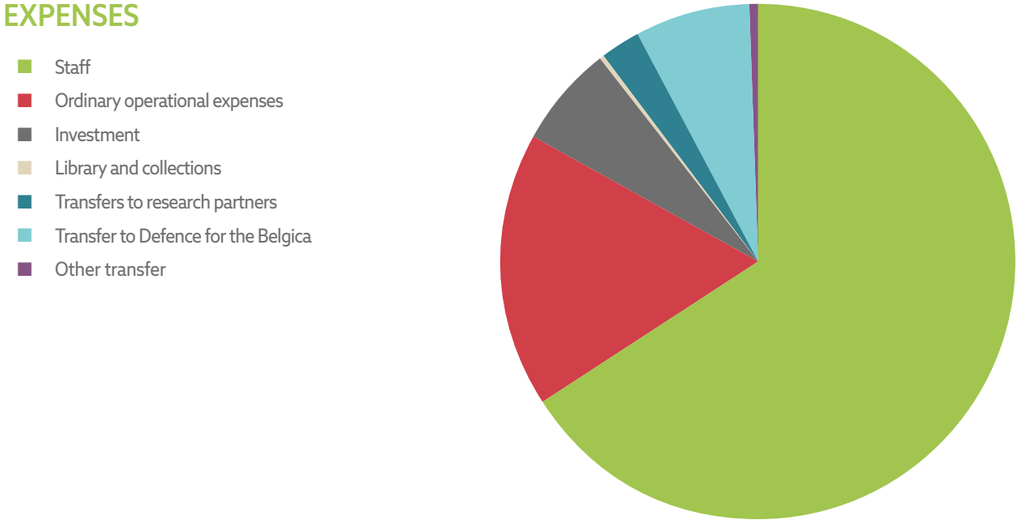
On the expenditure side, the total expenditure increased from €33,451,652 to €34,032,683. As is the case every year, salary costs made up the largest share of the expenditure. Furthermore, this was increased by the inclusion of the provision for holiday pay. Human capital is at the heart of any research institute. The quest for resources in order to maintain this during ongoing periods of budgetary restriction remains a constant challenge. The overall operating costs were €5,851,529, which is a reduction of €739,151 compared to 2018. The drop in regular operating expenditure has not led to a decrease in expenditure in general, considering that there was a considerable increase in investments to the tune of €1,064,872. This is a logical consequence of the construction of the permanent *Living Planet* exhibition.

As far as transfers to the partners are concerned, transfers to research partners have decreased compared to 2018 by €1,824,313. This has to do with the coordinating role within European projects which varies from year to year. The transfer of funds to the Ministry of Defence, on the other hand, has increased from 2018 and is now in line with the 2017 level.

BREAKDOWN OF EXPENSES (IN €)

	2017	2018	**2019**
Staff	**21,655,864**	**21,631,365**	**22,476,880**
Ordinary operational expenses	**6,138,251**	**6,590,608**	**5,851,529**
Investment	**1,367,352**	**1,057,306**	**2,122,178**
Scientific	315,174	194,234	455,530
Museum	69,748	233,734	1,043,964
Others	982,430	629,338	622,684
Library and collections	**226,189**	**222,771**	**176,388**
Transfers to research partners	**388,745**	**2,639,276**	**814,963**
Transfer to Defence for the Belgica	**2,394,075**	**1,310,326**	**2,434,422**
Other transfer			**156,323**
Total	**32,170,476**	**33,451,652**	**34.032.683**

EXPENSES

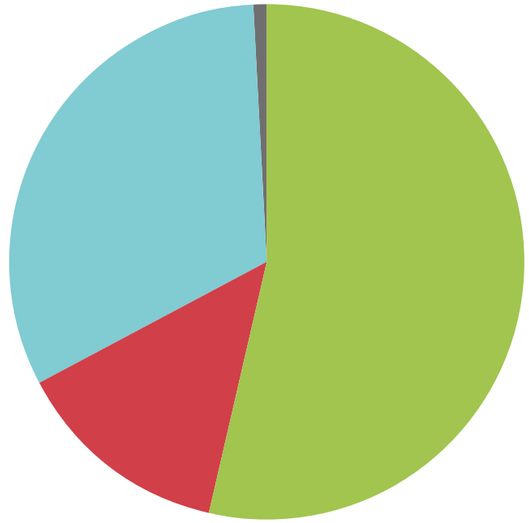


BREAKDOWN OF INCOME (IN €)

	2017	2018	2019
Staff budget	**10,311,692**	**16,833,000**	**16,580,000**
General grant	**6,457,555**		
Museum: own income	**2,417,472**	**2,916,035**	**4,194,040**
Museum renovation grant	0	343,891	1,027,492
Ticket sales	1,504,235	1,600,279	1,660,993
Exhibition hire and sales	63,000	80,510	77,000
Museumshop	408,148	418,195	502,847
Donations - sponsorship - grants	100,228	4,240	483,510
Education	127,730	157,804	178,535
Events	165,311	248,009	218,063
Dinocafé	48,820	63,107	45,600
Research: own income	**9,727,302**	**11,679,764**	**9,890,284**
Belspo	3,156,077	3,183,643	1,669,539
Federal administrations (excl. Belspo)	1,667,425	198,760	1,313,552
European Union	1,030,745	3,810,546	2,305,683
Belgian federated entities	1,313,615	1,579,670	2,051,345
Private sector	2,337,572	2,746,322	2,156,868
Outside the EU	221,868	160,823	393,297
Various: own income	**312,805**	**44,503**	**197,340**
Belgica Grant	3,109,000	3,134,000	3,134,000
JEMU Grant			274,000
Public Observatory Grant (all federal Museums)	132,000	134,000	134,000
Total	**32,467,826**	**34,741,302**	**34,403,664**

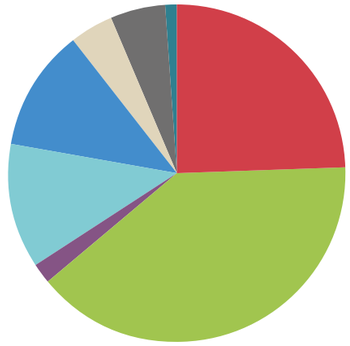
INCOME

- Staff budget and general grant
- Museum: own income
- Research: own income
- Various: own income



BREAKDOWN OF INCOME OF THE MUSEUM

- Museum renovation grant
- Ticket sales
- Exhibition hire and sales
- Museumshop
- Donations - sponsorship - grants
- Education
- Events
- Dinocafé



BREAKDOWN OF RESEARCH INCOME

- Belspo
- Federal administrations (excl. Belspo)
- European Union
- Belgian federated entities
- Private sector
- Outside the EU

STAFF

Our staffing level continued to decline in 2019. No additional cuts were imposed on staff appropriations in 2019 but an indexation of the appropriations was suspended. This fact combined with the complex recruitment procedure has delayed certain recruitments. Last year's savings have encouraged reorganisations within the departments, particularly within the support departments.

Whereas the reduction since 2017 was only really noticeable among the statutory personnel, we have also seen a decline within our research projects this year. This reduction can be attributed to the fact that the BRAIN research projects were not approved until the end of 2019.

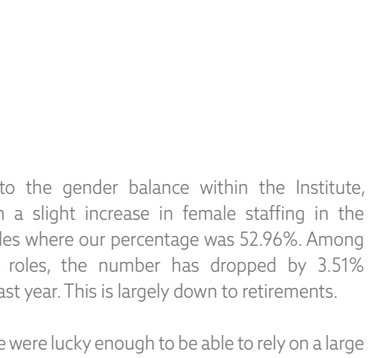
In keeping with the overall trend within the federal government, absenteeism has reduced from 6.51% to 5.30%. We have seen a decline in the number of absences over the past year. The implementation of reintegration programmes following long-term illness has certainly played a significant part in this. The number of work-related accidents has remained stable in relation to 2018 as far as workplace accidents are concerned, and fallen slightly for accidents during journeys to and from work.

With regard to the gender balance within the Institute, we have seen a slight increase in female staffing in the contractual roles where our percentage was 52.96%. Among the statutory roles, the number has dropped by 3.51% compared to last year. This is largely down to retirements.

Once again, we were lucky enough to be able to rely on a large number of volunteers in the last year, a welcome boost to the various departments within the organisation. We had a total of 208 volunteers in 2019.

STAFF BREAKDOWN BY STATUTE

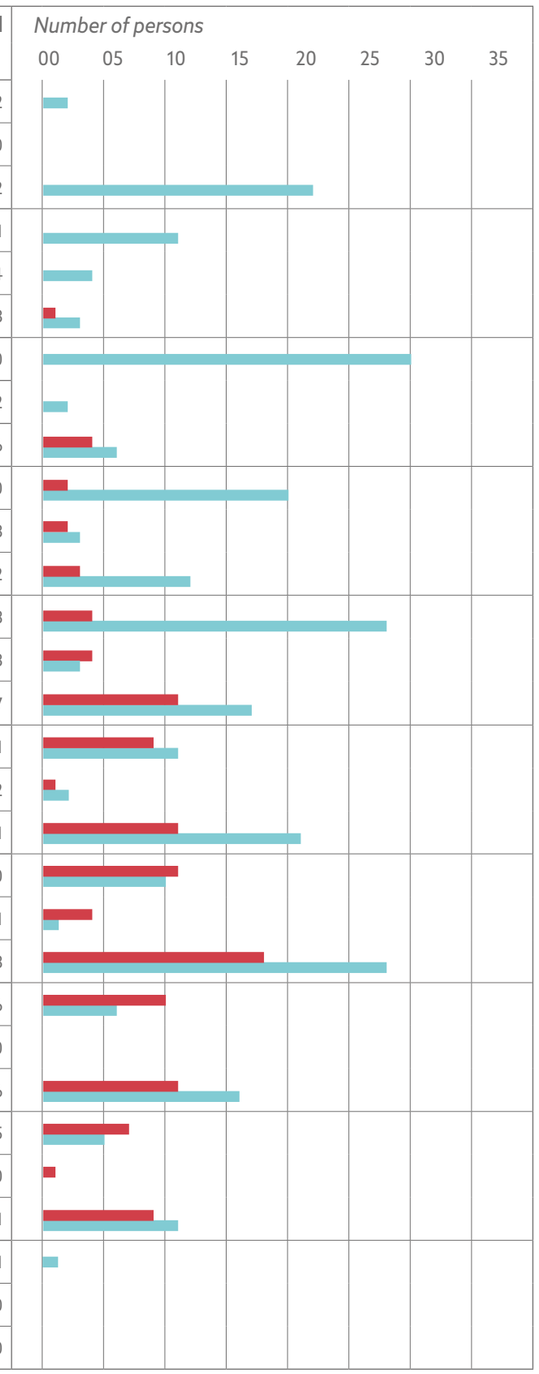
	2017	2018	**2019**
Statutory scientists	45 / 42.6	43 / 41.4	43 / 41.4
Statutory administrative and technical staff	90 / 81.26	85 / 78.16	80 / 72
Contractual scientists	132 / 121.35	133 / 120.6	124 / 113.1
Contractual administrative and technical staff	152 / 130.15	150 / 130.25	146 / 129.35
Total	**419 / 375.36**	**411 / 370.41**	**393 / 355.85**



The first number refers to the number of employees, the second to the number of full-time equivalents (FTE).

AGE DISTRIBUTION

		Statutory	Contractual
18 - 25	SW	0	2
	A	0	0
	BCD	0	22
26 - 29	SW	0	11
	A	0	4
	BCD	1	3
30 - 34	SW	0	30
	A	0	2
	BCD	4	6
35 - 39	SW	2	20
	A	2	3
	BCD	3	12
40 - 44	SW	4	28
	A	4	3
	BCD	11	17
45 - 49	SW	9	11
	A	1	2
	BCD	11	21
50 - 54	SW	11	10
	A	4	1
	BCD	18	23
55 - 59	SW	10	6
	A	0	0
	BCD	11	16
60 - 64	SW	7	5
	A	1	0
	BCD	9	11
65 +	SW	0	1
	A	0	0
	BCD	0	0



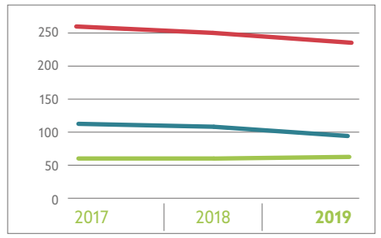
SW = Scientists

A = Level A (Master)

BCD = Levels B (Bachelor), C (secondary education) and D (no degree)

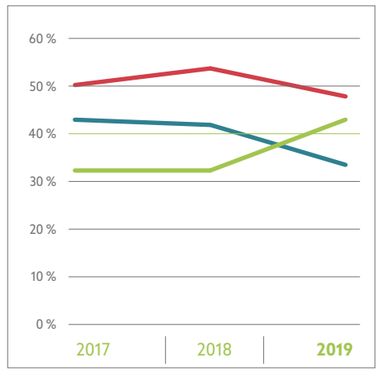
SOURCES OF **FINANCING OF THE STAFF** (NUMBER OF PERSONS / IN FTE)

	2017	2018	**2019**
Staff budget General grant	255 / 232,11	250 / 228.21	239 / 217.60
Ordinary income	57 / 47.5	57 / 47.9	59 / 52.65
External projects	107 / 97.75	104 / 94.3	96 / 85.60
Total	**419 / 377.36**	**411 / 370.41**	**393 / 355.85**



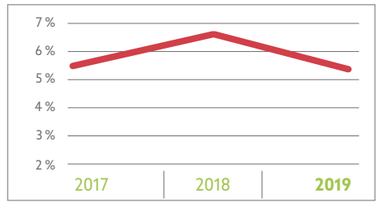
PERCENTAGE OF **FEMALE STAFF** (%)

	2017	2018	**2019**
Statutory staff	**34.07**	**33.59**	**30.08**
Scientists	26.67	27.91	25.58
Level A	35.71	38.46	41.67
Levels B, C and D	38.16	36.11	30.88
Contractual staff	**51.06**	**50.53**	**52.96**
Scientists	46.97	45.86	46.77
Level A	66.67	71.43	66.67
Levels B, C and D	53.28	52.94	57.25
Total	**45.58**	**45.26**	**45.80**



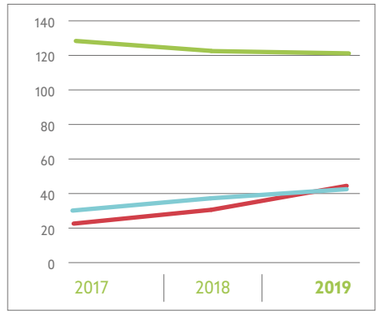
ABSENTEEISM AND **WORK ACCIDENTS**

	2017	2018	**2019**
Work accidents	7	5	5
Accidents on the way to **work**	12	9	7
Absenteeism RBINS	5.67 %	6.51%	5.30%
Absenteeism federal level	6.11%	6.61%	6.52%



VOLUNTEERS

	2017	2018	**2019**
Research volunteers	131	124	122
Collections volunteers	23	31	44
Museum volunteers	27	38	42
Total	**181**	**193**	**208**



ENVIRONMENT

After termination of the EMAS certification we have continued, as expected, to work with the existing integrated environmental and quality system. The table below shows the results of some of the indicators that have been monitored. What is notable here is the reduction in paper consumption, despite the relocation of our colleagues from the Gulledelle site. The ongoing digitisation of internal documents is likely to be a significant cause of this. As expected, we have seen a slight increase in electricity consumption.

The Ecoteam continued to be active in 2019. This year, its attention has been focused on the biodiversity around our buildings and gardens. In order to highlight this theme, we organised a number of staff workshops. Everyone was invited to build bee hotels during the first workshop. In the second workshop, we worked on bird feeders. Both of these animal-friendly creations were taken home in order to boost biodiversity in our own gardens.

Furthermore, during Mobility Week, the Ecoteam distributed information leaflets and cycle maps, drawing attention to activities like Car-Free Sunday and the Car-Share Salon. A test project was also set up for using bicycles for business travel. Staff were given free use of Villo bicycles for a week.

The hills of Brussels might have had a deterrent effect, as there were not many takers for business travel by Villo bike in Brussels. Finally, we also carried out a survey into commuter travel. This showed that less than 10% of the workforce comes to work by car. This is a far better score than that of the average Brussels-based organisation.

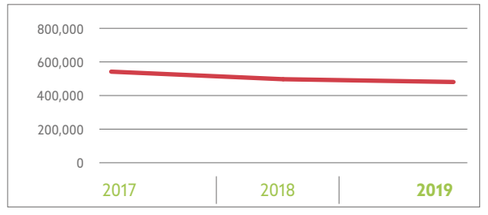
As we do every year, we also focused on our own waste production. Encouraged by the changes taking place in the sorting of plastics in Flanders, we highlighted the Brussels sorting guidelines once again.

Finally, we also founded a Climate Group within the organisation: an informal group of around 50 members of staff who wish to take action to reduce their impact on global warming. As both the Ecoteam and the Climate Group aim to reduce the organisation's ecological footprint, further collaboration was a logical step. An action plan was developed and approved and will be implemented in the course of 2020.

ENVIRONMENTAL INDICATORS

	2017	2018	**2019**
Electricity consumption in equivalent tonnes of CO_2 emissions	451.7	454.7	464.3
Electricity consumption in kWh	1,998,755	2,008,987	2,054,497
Gas consumption in equivalent tonnes of CO_2 emissions	943.4	941.8	Currently not available
Pages of paper printed	586,056	558,705	551,937
Percentage of commutes using public transport	Measured every two years	Enquête posponed to the first semester of 2019, in combination with action about mobility	65%

PAGES OF PAPER PRINTED



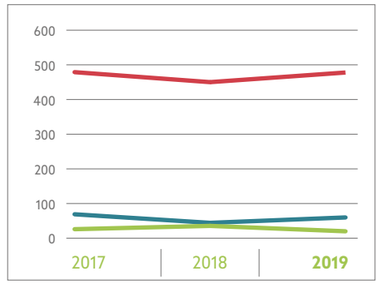
RESEARCH

After a decrease in the total number of publications last year, we see a strong increase in 2019, though not quite to the level of 2017. Sharp rises were seen especially in the number of publications with an impact factor (A1 publications) and those in Open Access (i.e. accessible to everyone). Our scientists also wrote 50% more expert reports than last year. However, the number of popular articles has halved. The number of publications per scientist has risen compared to last year. But it is mainly the number of A1 publications per researcher – by scientists involved in fundamental research – that has seen a strong increase (up 50% on last year), and this despite a decline in the number of scientists employed by the RBINS.

In 2019, there were 111 ongoing scientific projects, a slight decrease compared to 2018. We coordinated 72% of the projects we participate in, an increase of almost 10% on last year. The number of projects per funding source remains stable.

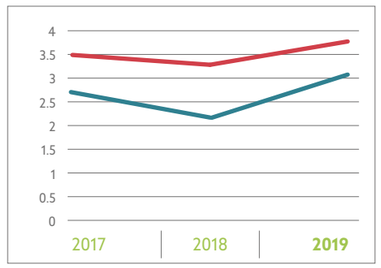
PUBLICATIONS

	2017	2018	**2019**
Scientific publications	484	450	483
of which Open Access	115	66	96
of which journals with impact factor	207	142	189
Popular works	23	38	17
Expert reports	71	41	62
Total	**578**	**529**	**562**



AVERAGE NUMBER OF PUBLICATIONS PER SCIENTIST (IN FTE)

	2017	2018	**2019**
All publications per scientist	3.52	3.42	3.63
All publications with impact factor per researcher	2.69	2.17	3.09



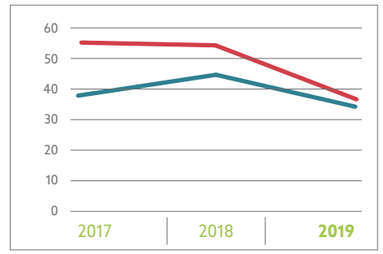
FUNDING OF CURRENT SCIENTIFIC PROJECTS

	2017	2018	**2019**	**2019**
	Number	**Number**	**Number**	**Amount (in €)**
Belspo Number of projects coordinated by RBINS	**61** 43	**60** 40	**41** **31**	1,669,539
Federal funding from other sources Number of projects coordinated by RBINS	**12** 12	**14** 14	**10** 9	1,313,552
European Union Number of projects coordinated by RBINS	**25** 3	**27** 4	**20** **2**	2,305,683
Federated entities Number of projects coordinated by RBINS	**21** 13	**25** 14	**24** 21	2,051,345
Private sector Number of projects coordinated by RBINS	**6** 6	**9** 9	**8** 8	2,156,868
Outside the EU Number of projects coordinated by RBINS	**9** 9	**9** 9	**8** 8	393,297
Total projects coordinated by RBINS	**134** 86	**144** 90	**111** 79	**9,890,284**

SUPERVISION OF STUDENTS

		2017	2018	**2019**
	PhD	54	54	38
	Master	37	44	36
	Total	**91**	**98**	**74**

The supervision of students, both doctoral and master students, is decreasing sharply compared to the past few years. Because not every scientist who leaves is replaced, less capacity remains to maintain the number of supervision of students.



LIBRARY AND COLLECTIONS

Our scientific collections comprise approximately 38 million specimens. 162,035 new specimens arrived in 2019. The number of visitors to our collections for the purpose of scientific research was 448, with an average visit of three days. The number of loans from the collection has been stable in recent years. We recorded 406 loans in 2019, which amounts to more than 100,000 specimens loaned out.

The digitisation of the specimens consists of two parts: the introduction of metadata on the specimens and the digitisation of the specimens themselves using no fewer than seven different techniques. Priority is given to the type specimens, i.e. the specimens that describe or help describe a species, or unusually illustrated specimens.

In 2019, metadata for approximately 20,556 new specimens were added to the database. More than 55,000 metadata were also imported from the former databases of the geological and entomological collections using new import tools developed as part of the 'NaturalHeritage' BRAIN project. This approach considerably improves the efficiency of the coding. In addition, 10,000 specimens from the palaeontology collections were added to an Access databank so that they could also be imported into our DaRWIN collection tool.

Data is now available for 100,944 type specimens from an approximate total of 200,000, or roughly 50% of the estimated total number. Data is available for 3,050,210 non-type specimens from an approximate total of 38 million, or roughly 8%.

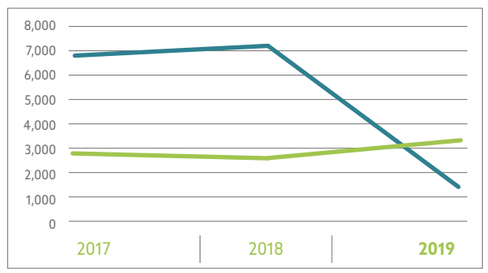
In 2019, the library continued its development into a dynamic knowledge centre and a study and meeting venue. By the end of 2019 the library contained 419,839 resources. 3,154 loans were recorded. The number of outgoing inter-library requests was 160. Incoming inter-library requests were 68. The number of reader cards increased to 110.

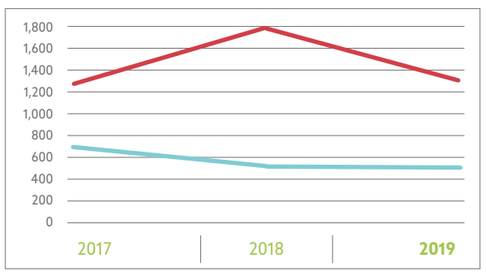
The number of electronic document consultations is incomplete for 2019 as we are no longer using the tools we used before. The number of digitised documents in the library catalogue depends on the retro-cataloguing projects carried out within a particular calendar year, which explains the fluctuations in the figures.

Numerous expansion activities have been on the agenda in the past year. The library took part in the 'Saviez-vous?' workshop on the antique books in our collection. This activity was a great success. Five classes from the Institut Sainte-Marie in Brussels came to participate in the documentary research workshop under their professor's guidance.
We received another special visit on 25 October. The librarians from the Maps and Plans department of the Royal Library of Belgium came to see our 19th-century maps by Philippe Vandermaelen, a Brussels cartographer and geographer.

CONSULTATIONS

	2017	2018	**2019**
Library			
Paper documents	2,879	2,676	3,154
Electronic documents	6,986	7,121	1,203 *(Web of Sciences and Zoological Record)*
Collections			
Number of scientist visits	648	477	448
Duration of scientific visits (days)	1,050	1,800	1,375
Number of loans from the collections	370	398	406
Number of loaned specimens	36,788	35,479	100,955





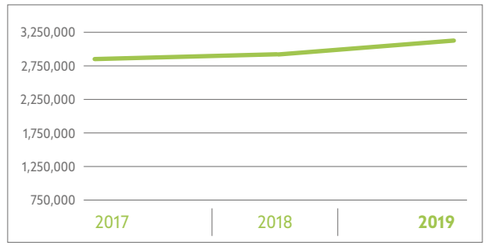
SIZE

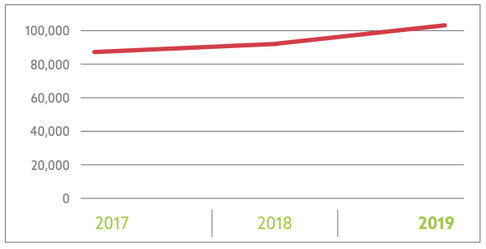
	2017	2018	**2019**
Library			
Size of the library	410,149 items	414,320 items	419,839 items
Growth of the library	Total growth of 1.2%	Total growth of 1.0%	Total growth of 1.3%
Collections			
Number of collections acquisitions	+300,936	+129,636	+162,035

* item = physical unit

DIGITISATION

	2017	2018	**2019**
Library			
Back-cataloguing	5,601	3,891	6,960
Digitisation of the catalogue of the library	60,000	380,000	47,859
Number of digitised pages	50,000	18,249	6,414
Collections			
Type specimens	1,811	2,270	2,602
Non-type specimens	195	2,900	1,191
Boxes + Drawers	341 + 2,625	154 + 991	264 + 5,133
The new registrations in the databases	24,409	23,496	20,556 (DaRWIN) 55,152 (Import DaRWIN) 6,669 (Pal Access)
The number of new types	748	1,039	3,609 (DaRWIN) 3,421 (Pal Access)
The total of digitised specimens (metadata)	2,764,880	2,874,685	3,050,211
The total of digitised type specimens	89,714	90,753	100,944
The total of digitised species (all specimens)	79,780	81,823	85,289
Scientific archives	24,943	70,693	51,878
Pictures			11,853





MUSEUM

With over 353,000 visitors, 2019 was a record year. The number of visitors surpassed that of 2008 (352,000), a year which benefited from the opening of the *Dinosaur Gallery*. In comparison with last year this was a 7.5% rise in the total number of visitors. They mostly visited the permanent exhibitions (234,000), whereas the temporary exhibitions (118,000 visitors to '*Teddy & Bear*' and '*Antarctica*') remained at a similar - highly respectable - level.

Obviously, high visitor numbers means excellent ticket sales. But on the flip side, some inconvenience at very busy times: we hope to deal with this in the course of 2020 by means of a new, faster ticketing system with an automatic sales terminal and online sales, and, in the longer term, a radical reorganisation of the reception infrastructure.

Looking at the profile of visitors in 2019 we see that the number of group visitors is stable (approx. 77,000), but their relative volume has dropped to 22% in relation to the overall increase in visitor numbers (compared to 28% between 2008 and 2014 and over 35% in the early 2000s). Slightly fewer than 50% of these groups took part in educational activities. Again, there is a decrease in relation to previous years (-5.1% compared to 2018), particularly in the number of tours booked. It is still difficult to establish whether this is a long-term trend or a short-term phenomenon caused by a temporary staff shortage.

The activities for family and adult audiences, are approaching 10,000 participants, which demonstrates the investment in new themes and formats. The open-air activities, workshop tours of the Brussels Environmental Education Centre and XperiLAB.be are still very successful.

The age distribution of the public seems to be shifting towards the older age groups. There were more 6- to 18-year-olds and adults than in the past three years. However, the phenomenon is too small to be able to draw any conclusions at the present time.

Finally, an honourable mention goes to our MuseumShop, which attracted 16% more customers compared to 2018 resulting in sales in excess of half a million euros.

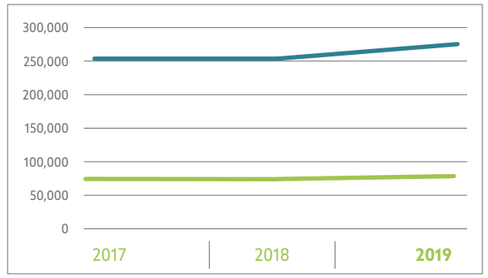
MUSEUM VISITOR ACTIVITIES

	2017	2018	**2019**
Total Museum visitors	**327,866**	**328,183**	**353,054**
Permanent galleries	191,877	209,802	234,161
Temporary exhibitions indoor	135,989	118,381	118,893
Museumshop customers	25,178	26,166	30,462
Expenses per customer	€16.21	€15.94	€16.26
Participants in educational and cultural activities	**54,626**	**54,068**	**50,341**
Participant per activity (global)	21	21.3	20.4
Guided tours	17,550	15,156	11,934
Workshops	14,435	15,408	13,908
Other indoor activities	8,791	9,190	9,917
Outdoor activities	13,850	14,314	14,582

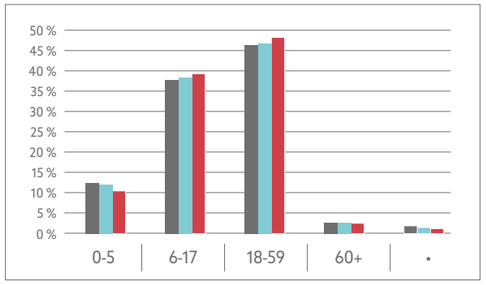
PROFILE OF THE MUSEUM USER

	2017	2018	**2019**
By type	**327,866**	**328,183**	**353,054**
Visitors in groups	77,398	77,631	77,915
Individuals and families	250,468	250,552	275,139
By age	/	/	/
Small children (0-5 years)	12.42 %	11.96 %	10.42 %
Young people (6-17 years)	37.42 %	37.88 %	38.36 %
Adults (18-59 years)	45.46 %	45.90 %	47.33 %
Senior citizens (60+)	2.73 %	2.72 %	2.62 %
Not known •	1.97 %	1.54 %	1.27 %
Participants in educational and cultural activities	**54,626**	**54,068**	**50,341**
Visitors in groups	48,534	46,840	42,524
Individuals and families	6,083	7,228	7,817
Average participants per activity	21	21.3	20.44

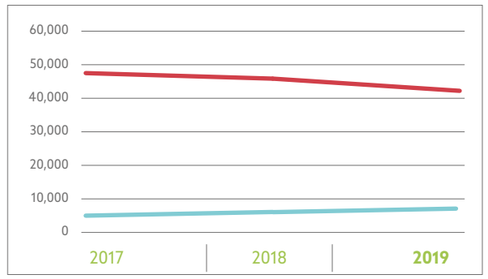
MUSEUM VISITORS: VISITORS IN GROUPS VERSUS INDIVIDUALS AND FAMILIES



MUSEUM VISITORS: AGE



PARTICIPANTS IN EDUCATIONAL AND CULTURAL ACTIVITIES



PRESS AND INTERNET

In 2019, as in the previous years, we were in the media four times a day, and some days we were even on national TV or radio, regional and international newspapers or magazines at the same time. In total, we were mentioned 1,502 times* in relation to Museum activities, research results or the findings of the scientific Institute. Throughout the year and across all channels, scientific topics and research were mentioned the most: more so than public activities.

Nationally, we received most attention for marine subjects (beached sperm whales and porpoises, wind turbines, beach and marine pollution and the naming of the new Belgica), ornithology in general and ringing (the Zwin nature reserve) in particular, the plague of midges in Schellebelle and our employees' solution (in the Dutch-language press), the Congolese skulls in the collection and the demand for their restitution (primarily in the French media) and the marble (Horta) collection in geology. In the Museum, the new dinosaur Arkhane, and the *Teddy & Bear* and *Antarctica* exhibitions attracted the most press attention.

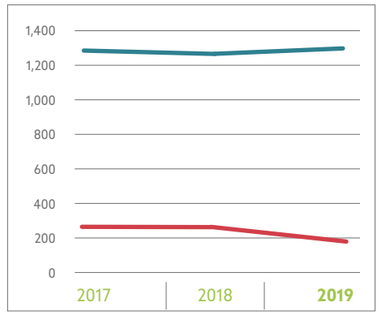
Internationally, the focus was on the four-legged fossil whale (over 200 articles) and the Mont Dieu meteorite that went to auction. The Leopold III Fund organised the world premiere screening of the Brazilian *'Documenta Pantanal'* on the rainforest, attended by Princess Esmeralda and Brazilian VIPs. This event received a great deal of attention in the Brazilian press (29), while the Dogger Bank in the North Sea and the Belgica were frequently mentioned on international sites and even foreign radio and TV.

In almost half of the reports on TV, radio and in the written media, a member of staff is interviewed or mentioned by name. The TV and radio journalists either interview someone from public relations (at the opening of the Antarctica exhibition or the inauguration of the allosaurus, Arkhane, for example) or speak to a scientist that we have put forward as a spokesperson. We notice that years of operating a media policy have borne fruit: when the quotes we offer in our press releases are cited they mention the scientist by name; journalists are in the habit of consulting 'regular' contacts for a quote. This indicates that the media places a great deal of faith in our news and press releases and our spokespersons.

Taken together, our websites – around 50 – reached approximately 740,000 visitors in 2019. There has been a slight downward trend since 2017. The figures for our corporate website naturalsciences.be on the other hand, improved on 2018: 433,282 visitors. Our followers on social media grew steadily to 13,021 on Facebook (+1,834 in comparison to 2018), 12,500 on Twitter (+1,000) and 2,650 on Instagram (+750). Our Facebook page reached approximately 1.7 million people this year, slightly down on the last two years, but still more than in 2016. Our Twitter numbers also fell slightly to 586,000 users.

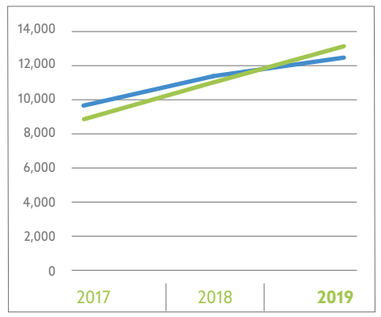
IN THE MEDIA

	2017	2018	**2019**
Printed press	**1,281**	**1,242**	**1,305**
Of which research	776	858	906
Of which Museum	505	384	399
Radio and TV	**229**	**224**	**197**
Of which research	109	178	138
Of which Museum	120	46	59
Total	**1,510**	**1,466**	**1,502**



ONLINE AND SOCIAL MEDIA

	2017	2018	**2019**
Websites			
Website visitors	764,829	755,644	736,401
Website visits	3,362,919	2,123,583	1,223,801
Visited pages	13,382,919	11,080,535	7,164,965*
Social media			
Facebook followers	8,861	11,187	13,021
Twitter followers	9,900	11,500	12,500



* For technical reasons, we have no figures available for the streaming of Falcons for Everyone (7.4 million pages in 2018). We estimate that there were more than 3.7 million visits to the streaming pages in 2019, based on the number of pages visited on the website falconsforeveryone.be There was no streaming of the peregrine falcons in the Brussels cathedral, as the nest was abandoned.

THE RBINS IN BRIEF

Missions

RBINS has been entrusted with four major missions:
- Scientific research into natural sciences;
- Scientific expertise at the service of the public authorities;
- Conservation and management of scientific and heritage collections;
- Dissemination of scientific knowledge in society.

Research & expertise

One out of every three people at the RBINS is a scientist. The scientific personnel includes mainly biologists, palaeontologists and geologists, but also oceanographers, anthropologists, prehistorians and archaeologists, as well as geographers, physicists, bio-engineers and mathematicians, which enables it to conduct multidisciplinary research.

Lines of Research;
- Biodiversity and geodiversity;
- Biological evolution and the history of life;
- Marine and freshwater ecosystems' management;
- History of the human/environment relationship;
- Applied geology.

Service Provision
- The RBINS provides scientific expertise under Belgium's international commitments in relation to environmental protection.
- It develops tools and methods for monitoring natural land or marine environments.
- It also offers useful advice for the development of national
- and European policies for the protection and conservation of biotopes and biodiversity and the use of natural resources.

Collections

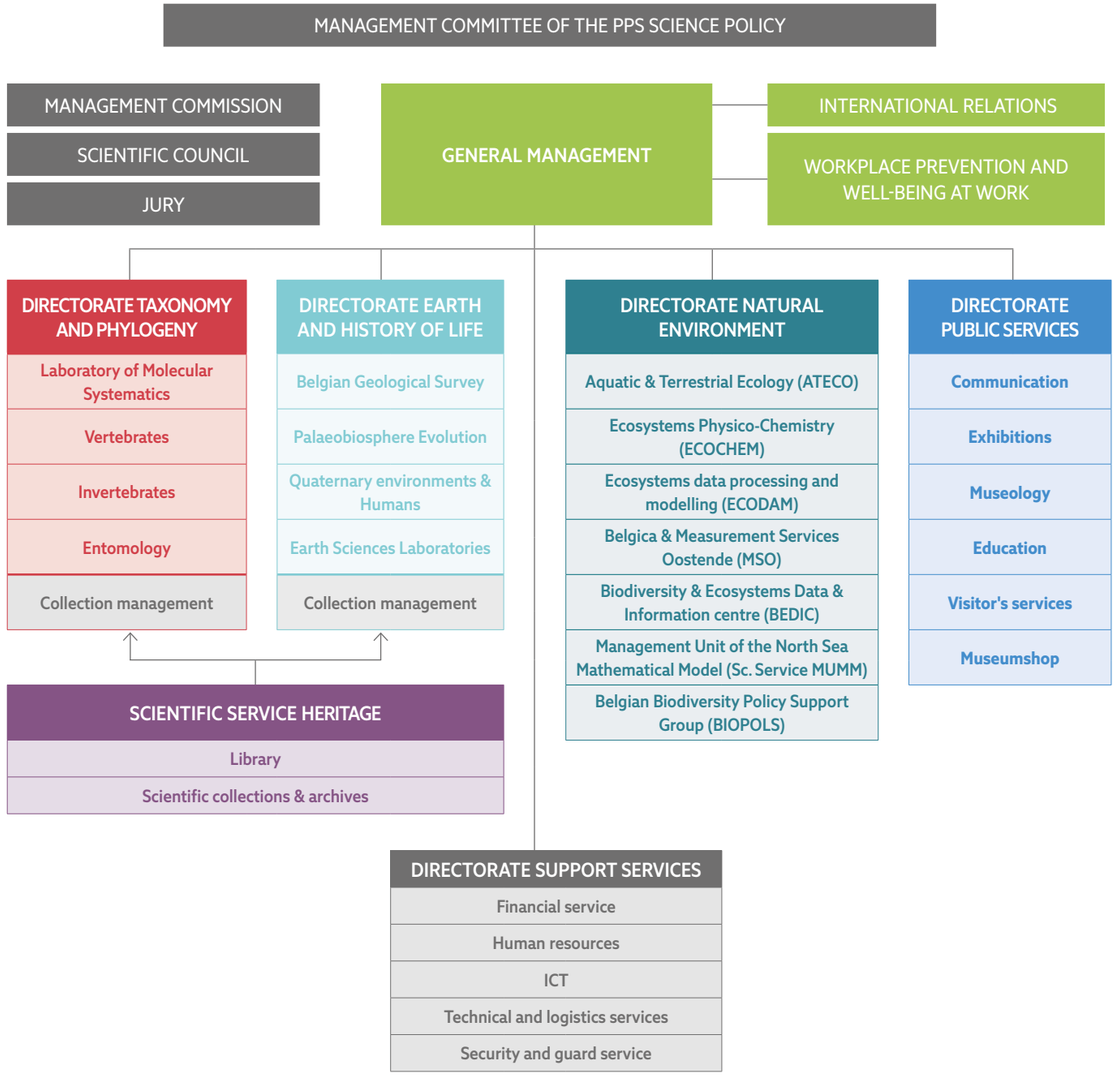
With their 38 million specimens conserved as Belgian heritage of universal significance, the RBINS's collections come just after London and Paris in the European classification, and belong to the top 10 largest collection in the world. They serve above all as reference and research tools and as such belong to the European 'major research infrastructure'. In this respect they are constantly being visited and studied by researchers from around the world. For several years now, the RBINS has been committed to an ambitious programme to digitise its collections and to do so has developed an open-source software, DaRWIN, which has made it possible to encode all the data on any collection of specimens, whatever their taxonomic group.

Museum

For the general public, the Natural Science Museum is the visible part of the RBINS. It has 16,000 m^2 of permanent galleries, temporary exhibition rooms and educational workshops, public spaces of all kind, enabling it to welcome more or less 300,000 visitors each year, approximately 25 % of whom are school groups. Its *Dinosaur Gallery* is world famous and the largest in Europe.

It plays a leading role in the promotion and dissemination of scientific culture, both within and beyond its walls, notably through travelling exhibitions and events. The RBINS is pursuing ambitious efforts to gradually renovate the premises, to make the Museum more convivial and better adapted to people's expectations. The Museum also takes a resolute position promoting a more respectful approach to nature.

ORGANISATION



The Royal Belgian Institute of Natural Sciences is one of the ten federal scientific institutions that are governed by the Belgian Science Policy Office (Belspo).

The RBINS is a State service.
It is managed by **three independent entities:**
- The **Scientific Council** offers advice on issues of a scientific nature that have an impact on the accomplishment of the tasks of the Institute.
- The **Management Commission** is responsible for the financial and practical management of the RBINS. It is the same body for the RBINS and the Royal Museum for Central Africa.
- The **General Director** is responsible for the day-to-day Institute's management. She is assisted by the **Management Board.**

Moreover the **Jury for recruitment and promotion** is responsible for recruiting the permanent scientific employees and monitoring their carreers.

The Institute's General Director is also a full member of the Management Committee of the Belgian Science Policy Office.

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