

GREENTECH WORLD

BIOTECHNOLOGIES
INTERNATIONAL
MAGAZINE
BY GREENTECH

#2

INTERVIEW WITH
BERTRAND PICCARD

INTERVIEW WITH
FRANCIS HALLÉ

EUROPE'S LAST PRIMEVAL FOREST

SOILS, SALT OF LIFE

WATER & COSMETICS

AND MUCH MORE...



BALANCE IN THE WORLD

SINCE 1992, WE SOURCE NATURE TO RESOURCE THE FUTURE

greentech-group.com

PIONEERING
ETHICAL
BIOTECHNOLOGIES **GREENTECH** GROUP

EDITORIAL

“The latest reports from major environmental agencies and scientists all agree that the Earth system, in all its complexity, is changing at an ever-accelerating pace. Fresh on the heels of our 30th anniversary, this edition of the magazine is more outward looking; in the following pages we give pride of place to nature, and to life itself, with tributes to well-known figures and outstanding actions and initiatives.

Action is the current buzzword, urgently calling us to go beyond the “raison d’être” that companies have brandished in recent years to green their image. We live in an age when all of us have “reason to act”.

We have built Greentech in a spirit of progress shared by all our stakeholders – people, the planet, our producers, suppliers and customers – with the idea of preserving the source, a global balance. From the very beginning, every one of our actions has considered the consequences: everything we do must be sustainable. We have pictured applied biotechnologies as part of the answer to today’s major environmental challenges: meeting needs rather than creating them, encouraging people to consume less and better, actions and innovations whose value lies in the costs avoided by society. We are contributing to the drive to produce better... without massacring nature.»

**Our credo “We source nature to resource the future”.
We are in an economy of life.**

Happy reading!

Jean-Yves Berthon,
CEO & Founder, Greentech



GREEN MA NI FES TO !

Our business model is deeply rooted in societal and environmental concerns; since our very beginnings, humans have cultivated the humble bearing of a world explorer, developing products that are both useful and sustainable. Climate, biodiversity and health are all inextricably linked and must be addressed in a holistic manner. We source nature to resource the future means respecting the source, the time involved, the correct balance, and forward-planning for impacts by adopting a systemic approach that combines sound science with a keen operational outlook.



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"We have underestimated the power of plants"

Erik Orsenna



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30 YEARS AGO, SAVING THE DNA OF
THE OLDEST BEECH TREE IN FRANCE

TO BEECH OR NOT TO BEECH

GREENTECH'S FIRST MISSION

1992, Greentech's first official mission won it a spot on the Journal de 13h on the main broadcasting channel of the time. The topic? A very special tree, the oldest Beech tree in France, planted during the reign of Louis XIV, weighing 25 tons and measuring 5 meters in circumference, is sick and will have to be felled. From the buds, Greentech raised the grafts in vitro, thereby saving its genetic heritage.

Today though, the beech tree, symbolic figure of French forests, fresh air and water, has become the perfect victim of global warming.

SPIRULINA, FOOD OF THE FUTURE

What do Olympic athletes, NGOs fighting malnutrition, the vegan diet and NASA all have in common? A passion for spirulina! Wrongly referred to as a “microalgae”, according to biologists, spirulina actually belongs to a category of cyanobacteria, one of the oldest on Earth. An intense blue-green colour, spirulina grows naturally in lakes in the intertropical belt. In 1974, the World Health Organization declared spirulina the “Food of the Future”, while UNESCO claimed it as “the ideal and most complete food of tomorrow.»

Over the last 30 years, Greentech has become the leading European producer of microalgae, along with its subsidiary Greensea, with recent demand for omega-3 fatty acids, polyunsaturated fatty acids essential for health, boosting the development of these crops. Currently, omega-3 fatty acids are sourced mainly from cold-water fatty fish, nowadays threatened by overfishing. We have known for many years now that certain microalgae can synthesize spirulina. So, all we have to do is develop a technique for farming it to be able to use it as a renewable source of omega-3s. The benefits of microalgae don't just stop at food... Greensea also converts them into innovative ingredients for several target markets such as animal and human nutrition, cosmetics, environment, agronomy and health.



DEALING WITH AN INVASION OF GREEN ALGAE

Our exploitation of algae goes much further though: Greentech is partnering with Eranova, an innovative French company which has developed a disruptive, patented process that converts green algae into several types of biobased resins adapted to various transformational processes in the plastics industry. Green algae is a widespread resource that proliferates uncontrollably, polluting beaches and the marine environment. Its management and elimination represent a major environmental issue for cities and states which must make every possible effort to combat this pollution. Following on from the success of its industrial pilot in Bouches-du-Rhône, the company has announced the opening of its first plant in 2025. Interesting market prospects lie ahead with this invasive plant, the nightmare of coastal communities.

WATER, FALSELY ABUNDANT

We are lulled by an illusion: 70% of the planet's surface is covered by oceans. But only 3% of the water on Earth (the hydrosphere) is fresh water. Nearly three-quarters of this fresh water is bound up in polar ice, while the other quarter is groundwater, meaning that surface water is only a tiny part of the whole. In fact, only 0.01% (one hundredth of a percent!) of the water on Earth is directly usable. A falsely abundant resource, water is consumed irrationally, even shamelessly wasted almost everywhere in the world. Freshwater withdrawals have tripled over the past 50 years, largely due to demographic pressure and the expansion of farmed and irrigated areas.

Most experts predict an explosion in water consumption, lower water quality (due to pollution and wastewater discharge), and serious water supply issues for an increasing number of people the world over. According to the United Nations, by 2030, half or even two-thirds of the world's population could be facing «water stress».

Water management and the preservation of drinking water: a key concern at Greentech which offers solutions to improve cultivation through better water management (e.g. by strengthening soil water retention), better treatment (technologies for wastewater discharges and effluent treatment), and better production (eco-extraction, use of plant water - an intrinsic plant quality).

SVALBARG, LAST BASTION OF DIVERSITY

Nowadays, 95% of our food is sourced from fewer than 30 species of plants, while up to 80% of vegetable varieties cultivated fifty years ago have disappeared...

The Svalbard Global Seed Vault, located on the island of Spitsbergen, in Norway's Svalbard archipelago, opened in 2008 and was designed as a global security storage facility, housing seeds from every agricultural crop on the planet. It provides insurance against the loss of genetic diversity in the event of natural disaster, war, disease or loss of a local gene bank, acting as a sort of bunker protecting 12,000 years of global farming. This global reserve safeguards nearly 1.2 million seed samples of the main food species such as rice, corn, sorghum, barley, wheat, peas... housed in rock vaults in the permafrost with an ambient temperature of -18°C , providing ideal conditions for seed conservation. Strangely enough, no seeds from French crops are stored in the Svalbard vault. Given France's status as the leading European seed producer, this absence might seem surprising. This situation is due to the decentralised nature of seed conservation management in France where there are a number of storage centres, as opposed to a single national seed bank.



MYCORRHIZAL FUNGI: CARBON STORAGE CHAMPIONS

According to researchers at the University of Sheffield, mycorrhizal fungi store 36% of the world's annual fossil fuel emissions in the soil. Their research, never previously quantified, provides valuable insight into the role of these vast networks of underground fungi, and also underlines the urgent need to preserve our soils, which form the largest carbon reservoir on the planet. Mycorrhizal fungi - which develop mutually beneficial symbiotic relationships with plant roots - play a key role within ecosystems. These symbioses, among the most widespread on Earth, have existed for millions of years and could even be at the origin of Earth's colonization by plants.

The international team of scientists, including experts from the School of Biosciences at the University of Sheffield, conducted a meta-analysis of hundreds of studies on plant-soil processes to understand how much carbon is stored by fungi globally. Their findings, published in *Current Biology* in 2023, revealed that an estimated 13.12 gigatons of CO₂ are transferred from plants to fungi every year, transforming the soil beneath our feet into a vast carbon reservoir, and making it the world's most efficient carbon storage unit.

ECOVADIS: GLOBAL STANDARD FOR CSR ASSESSMENTS



Since its creation in 2007, EcoVadis has become the world's largest and most trusted provider of corporate sustainability data, establishing a global network of more than 85,000 rated companies. France stands out in an especially promising area, corporate social responsibility (CSR), one of the top three countries heading the roll of honour in the Ecovadis rankings of best performing countries in this area; just behind Sweden and Norway and well ahead of Germany (15th) and the United States (25th). The CSR policy rating platform establishes its ranking using more than 80,000 assessments based on several criteria, covering social issues, corporate ethics and prevention of corruption, all areas where France shines. The criteria for scorecards published as from 1st January, 2022 are as follows:

Platinum - Top 1% (overall score between 75 and 100) Gold - Top 5% (overall score between 67 and 74) Silver - Top 25% (overall score between 56 and 66) Bronze - Top 50% (overall score between 47 and 55).

Greentech was awarded the Ecovadis silver medal for its CSR commitment in 2022.

BIOTECHNOLOGIES, ONE PART OF THE SOLUTION

“The best way to define biotechnologies might be as the development of the living world for the greater benefit of humankind”



PENICILLIUM NOTATUM

Penicillin – a first-generation biotechnology: in 1928, Alexander Fleming was studying cultures of staphylococci, a particularly virulent bacteria. Completely by chance - he forgot to clean his Petri dish - he discovered that a mould had killed off all his bacteria. This is how a toxin synthesized by fungi gave birth to the first antibiotic obtained from the living world...

The term “biotechnologies” covers all technologies and applications that use or modify living materials for the purpose of scientific research aimed at furthering human knowledge, or to create a product or service with the aim of marketing it. This definition is so broad, though, that it includes ancestral techniques used by humans for centuries to ferment foods or domesticate plants and animals. This is why “modern biotechnologies”, stemming from the development of genetic engineering after the discovery of DNA in 1953, and the countless subsequent research activities which followed from it, are referred to separately...

For Vanessa Proux, CEO of Sup Biotech, and author of the book “Les promesses du vivant” (Promises of the living world): “Biotechnologies remain largely unfamiliar to the general public or are viewed in a rather simplistic or controversial manner; GMOs or the development of biopharmaceuticals being a case in point. However, biotechnologies also open up tremendous opportunities: the creation of new food and cosmetic products, new medical devices, new ways of fighting pollution and improving our environment being just a few... They cover numerous fields of application and merit being put in the spotlight, both to demonstrate their inestimable value and to foster growing public awareness of our entry into the revolutionary era of the living world. While the late 20th century was marked by the arrival of the Internet, a key marker of the early 21st century will probably be that of biotechnologies.”

For all these reasons, defining biotechnologies is a complex task due to their ever-growing number of fields of application. Nowadays, they are even colour-coded to make it easier to distinguish between them: red (health), green (plants), yellow (environment), blue (marine biodiversity), white (industry). The OECD (Organization for Economic Cooperation and Development) defines biotechnology as: The application of science and technology to living organisms, as well as parts, products and models thereof, to alter living or non-living materials for the production of knowledge, goods and services. We prefer the more humanist vision of Vanessa Proux: “The best way to define biotechnologies might be as the development of the living world for the greater benefit of humankind”.

The author believes that “biotechnologies actually help us to improve our quality of life, through applications focusing on health, cosmetics, agrifoods, the environment, or on the search for alternative solutions to fossil-based raw materials... Looking forward, biotechnologies could actually open up avenues for meeting the needs of an exponentially growing world population by the end of this century.” Society therefore needs to embrace biotechnologies: it is so easy to stir up fears – especially in today’s world and the current context; pointing out individual risks alone without weighing up the collective benefit is perhaps a misleading oversimplification. There is, therefore, a real need to plough extra effort into informing, educating and raising the public’s awareness of this issue. Few people really understand what is happening, because the biotechnology revolution is less obvious than the digital revolution of recent years. Developed in laboratories, biotechnologies are less mediatised and provide few everyday

or household objects that are highly visible in everyday life. It’s true that biotechnologies can be scary, they can lead to abuses – the strong responses to GMOs illustrate the need to carefully consider how society perceives biotechnologies, and how they themselves are practised; this is why we need to mobilise a raft of actors including, among others, philosophers, politicians, religious leaders, educational sectors, journalists to help us change viewpoints. We have to set the marker of ethics. Greentech asserts its corporate focus in its brand signature which contains the statement “Pioneering Ethical Biotechnologies”. For Jean-Yves Berthon, the group’s founder, “there is a certain tendency to equate biotechnologies with GMOs. Our approach definitely doesn’t extend to GMOs. Our biotechnologies create the conditions for healthier consumption. It’s all about practical solutions. Our ethics-based approach is both sustainable and long-standing – 30 years already – and takes on an even greater significance when seen through the filter of the current health crisis. Today’s biotechnologies herald the emergence of a new era, closely following that of the digital technology revolution. We are living in a time of unprecedented changes to our way of life! In our case, biotechnologies open countless opportunities in every industrial field, with the replacement of the old chemicals based industrial model representing real progress. Biotechnologies offer us an opportunity to change the way we produce and consume, and as such, they may well be part of the solution to major environmental challenges.”



GREENTECH, A HISTORY OF GROUNDBREAKING PIONEERS

30 YEARS OF EXPLORATION



DEVELOPING THE LIVING WORLD: BACK TO THE FUTURE



INTERVIEW WITH
JEAN-YVES BERTHON

INTERVIEW WITH JEAN-YVES BERTHON, FOUNDER

You founded Greentech the same year that the Rio Earth Summit laid the foundations for better management of the planet, developing the concept of the rights and responsibilities of countries in environmental issues. This is where the term 'sustainable development' was first adopted. Is there a link between the two events?

JYB: «It was not a conscious decision, even if, since 1992, Greentech has faithfully followed the recommendations of the Earth Summit: conservation of biodiversity, sustainable use of its components; fair and equitable sharing of the benefits arising from the use of biological resources... Today, we can describe our company as a «responsive native». Our biotech developments are designed to be sustainable and beneficial to Humankind, reshaping our consumption habits by working with living organisms and using only natural resources. We started with plant life: initially, Greentech sought to provide effective raw materials, to improve plant quality without resorting to gene engineering, to ensure the quality of future pharmaceutical and cosmetic products... It's like a restaurant chef: to make good food, you need good ingredients. At the time, I thought we could create something around applied biotech; cosmetics, agronomy, pharmaceuticals, agri-food, the environment, etc. Thirty years later, this is exactly what we are doing.»

A recent book «Biotechnologies: les promesses du vivant» (by Vanessa Proux, President of SupBiotech) gives this definition of biotechnologies: «development of the living world for purposes useful to humankind».

JYB: «That's a very good definition; however, the general public is still largely uninformed about biotechnologies, or what they do know tends to be somewhat

controversial, reductive even, limited to GMOs. Despite this, biotech opens up extraordinary possibilities: the creation of new food and cosmetic products, new healthcare solutions, new processes to combat pollution and improve our environment... At Greentech, we refer to ethical biotech. This really is the 'promise of the living world'. After the digital revolution of the late 20th century, the next revolution will be biotechnological – less visible perhaps, but with widespread impact on all industries.»

Back in 1992, though, who could understand biotech?

JYB: «In 1992, enthusiasts of the 'green' approach were few and far between – both in industry and in people's minds – and there were no more than ten or so biotech companies operating in France, compared with over a thousand today in the healthcare, cosmetics, agronomy and nutrition sectors... We were forerunners, with all that that implies: exploring, persuading, proceeding by trial and error... Our pioneering approach, though, gave us a valuable head start. In 1992, we began our work with plants, with a very unusual first official mission: to save the genetic heritage of the oldest Beech tree in France, an exceptional tree planted under the reign of Louis XIV; it was sick and had to be felled. 5 metres in circumference, weighing 25 tons. We harvested the buds and raised the grafts in vitro. This earned us a mention on the One O'Clock news on the biggest TV channel at the time.»

Arriving at the Clermont-Limagne Biopôle – historically the first biotech cluster in France, north of Clermont-Ferrand – you immediately see the buildings of the Greentech Group, to the left, the right, everywhere, springing up like mushrooms. Is this where it all


began, in a small room, 30 years ago?

JYB: «It was INRA that first hosted us, at a time when the public-private relationship was still a new concept, not always well accepted. We then met with the promoters of the Biopôle: we said «If you create this Biopôle, we'll come,» and they replied, «If you come, we'll create the Biopôle.» Our first contracts involved research for the pharmaceutical industry; Sanofi and Roussel-Uclaf were among our first clients, together with a Swiss laboratory that wanted to develop an anti-malaria drug. With the latter, we started out with a seed that contained 0.2% of active ingredient and ended up with 1.8%. We produced it right here, in Limagne, and dried it nearby, at the Bourdon sugar factory...

Next, to secure our development – after all, we had to make a living – we had to trade; when you start winning ever bigger contracts, it raises both your visibility and your status: no longer just simple researchers, we were now a company capable of meeting industry needs...

We then acquired a Limagrain subsidiary, which supplemented our product range and extended our customer base, thus boosting our business. In market terms, we had achieved another milestone: Greentech was buying a company... In 1997, our growth impacted our working capital – so we raised money in the form of venture capital. Next, we won a large contract with an American company; our turnover tripled in one year, the team grew... It's vital to have a great team! We grew, everyone found their place and flourished, we learned together.»





At the heart of the TIM Mill, which plunges to -1131 m into the ice cap (Inlandsis). Exploratory, sporting and scientific mission organized in 2007 by the GMHM (Groupe Militaire de Haute Montagne). The record set a few years earlier by Janot LAMBERTON and his son Maël at -212 m was not beaten, but it was a great adventure and a tribute to a friend who had passed away a few days earlier. The mills are a well dug by the swirls of water coming from the torrents flowing in the hollows of the bédrières, canyons formed each summer by the melting snow and ice. As soon as the first frosts occur (generally from -25°C), the torrents freeze over. This allows glaciologists to descend into the mills. Each mill explored is often christened TIM.

In an interview a little over 10 years ago, you said «we arrived at just the right time, with some innovations, and a new discourse». It all sounds so simple...

JYB: «Innovations and a new discourse, yes: we have achieved year-on-year double-digit growth because we followed the long-term trend – now a necessity – for sustainability. This is our core business model: our biotechnologies open up numerous opportunities in every industrial field, with the replacement of the old chemicals based industrial model representing real progress; cosmetics was the first sector to limit the use of all-chemical products and new formulations now mainly use ingredients of natural origin.»

Was the real turning point the ability to supply the cosmetics industry?

JYB: «I wanted to develop a company that would achieve long-term success, not just a research company, but a producing company. When you master plant biochemistry, and biological processes in general, as well as plant sourcing and supply, the next step is to start producing cosmetic actives! In the mid-1990s, in the midst of the mad cow crisis, the cosmetics industry started to turn away from animal products and focus more on plants. We started to source little-known plants in unlikely countries. The use of natural ingredients rapidly became the general trend in cosmetics, which was the first sector to abandon animal testing and ban the use of parabens. We were also very quick to go global. Our first customer was Swiss, the second American. Then we found our first distributor... Today, 60% of our turnover is made on exports. Producing locally, as we do in Brazil, is becoming a necessity. Currently, we supply the world's top 10 cosmetics brands.»

You mention sourcing, an issue of real importance, especially in a post-Covid world.

JYB: «Sourcing is not about finding the right source, but about preserving that right source. Our environmentally-friendly processes and technologies require that our sourcing rationale englobes conservation of biodiversity and equitable sharing;

in particular, with all the producers in our worldwide supply chains, with a strong balance, and great respect for diverse cultures, peoples and economies; we adhere to the Fair For Life programme, we allow small producers and their families to live off their production, especially in South America where we are involved in reviving the Inca Inchi, a forgotten plant, the treasure of the Incas. Or in Madagascar with the planting of crops for the creation of a national chain of expertise leading to a local pharmaceutical industry... When we work with suppliers in distant countries, we talk face-to-face and shake hands. This means we must pay special attention to respecting the traditions, the know-how, and the living environment of these people, while bringing them a potential source of progress... We have travelled the world, like explorers, to root out sources, plants, micro-organisms; in the earth, in the water, even in the clouds at an altitude of 5,000 m...»

Let's go back to the beginning; how does a young scientist become an entrepreneur, able to federate partners and colleagues around biotechnologies unknown in 1992?

JYB: «I first developed a passion for biology from a teacher I had from my second year to the final year of high school. She introduced me to the magic of plant and animal biology. On completing the second year of my PhD in biology (Clermont-Ferrand, 1988), I left for a post-doctorate in Belgium with a grant from the European Commission, finishing and passing my thesis at the same time as my post-doc. While there, an extraordinary teacher, Thomas Gaspar, gave me a taste for business. I worked at Rhône-Poulenc in Lyon as a junior researcher, before joining Biolafitte in Paris, a fermenter manufacturer, as a business engineer. Next, I was asked to set up a biotech lab in Brittany. I was just over thirty years old, with a trend-setting outlook; I thought that, within ten years, I would know enough to get involved in biotech production processes although, in the end, I started earlier. I was fortunate to be surrounded by enthusiastic and experienced colleagues right from the start – many of whom are still with Greentech today. Our team has grown significantly. The company is involved both in research – around fifty patents, over 50 re-

searchers, 15% of turnover in R&D – and in industry, with annual production standing at 4,000 tonnes.»

So you have followed the same strategy from the outset, while expanding your research scope. Greentech has long since gone beyond the plant sector.

JYB: «Indeed, our various entities explore nature to find active principles, ferments or nutrients that will support human activity while preserving the balance of our ecosystem; this is our core focus, which we have effectively applied to marine and microbial biotechnologies. In 2000, we created Greencell, under the name Biovitis. Historically, the company's lead market was maturing flora, strains of bacteria and fungi for cheese maturation: the better the strain, the tastier the cheese. Today, Greencell produces microorganisms for a wide range of markets: agronomy, agri-food, environment, etc. In 2018, Greencell acquired a stake in the Montpellier-based company Bactolytix, which supplements our agro-ecology offer with targeted solutions that combat crop pathogens using bacteriophages. Our experience with bacteriophages allows us to plan other applications in the field of personal care, cosmetics and healthcare.

In 2005, we acquired a company in the south of France, Aquamer, specialising in the use of microalgae for fish farming. We named it Greensea, and opened it up to other markets: today, Greensea extracts, grows and produces in a reactor over 500 strains of marine or freshwater microalgae, converting them into innovative active ingredients for the cosmetics, pharmaceutical, agronomic and agri-food sectors. The Group has six plants, four of which are in France: one microalgae plant in Mèze, near Montpellier (Greensea), two microorganism production plants in the Cantal and the Puy-de-Dôme (Greencell) plus the original main plant-based extraction facility in Clermont-Ferrand (Greentech). The Groupe generates 55% of its turnover abroad, through its subsidiaries. Raw materials are obtained through agreements signed with local farmers and producers, meaning that our plant extracts can be sourced globally, and obviously also in France.»

“This is our core business model: our biotechnologies open up numerous opportunities in every industrial field, with the replacement of the old chemicals based industrial model representing real progress.”

“I wanted to develop a company that would achieve long-term success, not just a research company, but a producing company.”

You appear to be seeking answers to several environmental and societal issues; in 2021, Greentech acquired a stake in Eranova.

JYB: «Eranova is a French company specialising in the production of bio-based plastics, with a focus on innovation and environmental conservation that fully matches with Greentech's core principles. We urgently need to find a substitution for difficult-to-degrade plastics produced by the petrochemical industry; Eranova has developed a particularly innovative technology for producing plastic from algae. This is a 100% biodegradable plastic that is strong enough to be used to produce packaging, cosmetic tubes, etc. It breaks down in the environment in just a few months, leaving no toxins behind it. A pilot of 3,000 tons will soon begin production at a cost approaching that of petroleum-based plastic manufacture.»

When we look at your story, we find both a deep openness to the world and a fierce desire for independence. Innovation is an expensive business, though, and it is sometimes tempting to join with others or to be taken on.

JYB: «Greentech has been courted extensively throughout its history. We've had a lot of offers, some have even besieged us. Nevertheless, we maintain our independence, financially and intellectually; and we bought back the shares of our venture capitalists. I think that everyone at the company rejoices in this independence – we have very short decision-making circuits, flexible, highly responsive teams, the reactivity of which benefits our customers. Innovation is indeed expensive, our business model is built around it, and we devote at least 15% of our turnover to it. We try not to be dependent on innovation support systems, because they are increasingly difficult to manage. However, the Research Tax Credit system is a formidable tool for biotech companies, and one that France can be proud of because it drives the collective development of future technologies from which the whole nation will benefit in the coming years.»

One of Greentech's strengths, which impacts on innovation, is its cross-disciplinary capability.

JYB: «Absolutely, having researchers in many fields means we can effect a transversal approach. Agri-food, pharmaceuticals and agronomy are great sources of inspiration, all of which 'cross-fertilise' other domains; it's both thrilling and inspiring. We know how to revive the soil, through microorganisms, in the same way that we know how to revive the human body through the microbiota. This «cross-fertilisation» is the obvious consequence of our mutually stimulating range of skills and expertise. The living raw materials on which we work have similarities that can be useful to compare. For instance, many cosmetics inspirations derive from the food industry, and vice versa. Certain physiological reactions observed in cosmetics are found in medical pathologies. The skin microbiota differs from that of the intestine, but both act directly or indirectly on the brain... Our various companies feed off each other's expertise. Greensea's knowledge of marine microalgae has been exported to Greencell's biostimulants. This has also allowed us to create a cosmetic product that protects the skin against pollution and UV rays... This cross-disciplinary expertise fosters the sharing of knowledge and know-how. This is also what led us to invite young researchers to the Skin Physiology International Meeting (SPIM), which we organise every two years. There, they can express themselves and present their research, in a spirit of sharing that benefits everyone.»

The IPCC report reminds us that at least 70% of the environmental effort relies on the action of the State and, above all, of businesses. Do companies therefore hold the solution in their hands?

“Agri-food, pharmaceuticals and agronomy are great sources of inspiration, all of which ‘cross-fertilise’ other domains; it’s both thrilling and inspiring. We know how to revive the soil, through microorganisms, in the same way that we know how to revive the human body through the microbiota.”



«Agri-food, pharmaceuticals and agronomy are great sources of inspiration, all of which 'cross-fertilise' other domains; it's both thrilling and inspiring. We know how to revive the soil, through microorganisms, in the same way that we know how to revive the human body through the microbiota.»

“Businesses are supposed to generate progress: environmental, social, technological and economic progress.”



The general public displays distrust over whether businesses are genuinely committed, given the amount of greenwashing... Especially since the advent of the ongoing health crisis. Employees also are seeking meaningful action, a mission. There is a strong desire to contribute to doing something useful for the future.

JYB: «It all comes down to this idea of progress: is innovation necessarily progress? Is progress compatible with profit? Businesses are supposed to generate progress: environmental, social, technological and economic progress. Progress means profit. You need profit to finance the project... Key challenges include meeting the demands of consumers, who are increasingly demanding natural products, and, above all, feeding the planet's growing population. For instance, we are currently researching alternatives to animal proteins using plant or algae proteins. This is a paradigm shift that affects every sector: in agronomy, biofertilisers and bio-control products will meet the Ecophyto 2025 plan, which requires that chemical inputs to crops be limited to 50% of current volumes. Bio-control products to replace pesticides are also pending approval. In 2015, Greencell was the first French company to receive approval for a microorganism-based biofertiliser. Over 100,000 hectares are fertilised in France using our products; despite the slow-moving regulatory framework, the phytosanitary transition is underway – a major challenge after 70 years of massive reliance on chemicals in intensive farming models... In environmental terms, effluent treatment is a powerful lever to protect our water resources. Greentech has patented an innovative solution using fungi that both reduce by 30 to 40% the volume of unusable sludge discharged by the treatment plants of chemical plants, distilleries and paper mills, and increase by the same amount the volume of grey water that can be reused for crop irrigation...

In terms of nutrition, new ingredients are being developed from algae; the World Health Organisation refers to algae as «humanity's ideal food source»; by associating our company, Greensea, with the Portuguese company, Allmicroalgae, we have become European leader in the production and development of microalgae. Could seaweed be the plant of the future? We think so. Lastly, in the healthcare sector, innovation is targeting the use of natural

probiotics against neurobiological diseases, Parkinson's or Alzheimer's. We are continuing our research in this area while waiting for the regulations to allow the approval of therapeutic products against these terrible diseases. Numerous scientific publications discuss the interactions between probiotics and these diseases. It is the combined effect of all our efforts, of all these innovations, that will lead to a naturally better preserved and protected environment. This too is an essential form of progress. So, let's go back to this idea: that progress is the achievement of a positive, meaningful outcome for people and their environment, as we have just demonstrated with specific examples.»

Greentech is celebrating its 30th anniversary this year. That's a long period in the history of a business, but not much on the climate scale, with a 2050 deadline...

JYB: «The IPCC report is very clear: 30 years represents one generation; that's all that's left if we are to avoid the climate tipping point – if we are optimistic. Ten years ago, not all customers were necessarily interested in eco-responsible solutions. Today, it is the general expectation, a definite prerequisite. The health crisis is also accelerating awareness. Over these 30 years, we have proven our purpose: to make useful products for a sustainable future. Profit is no longer an end, but a means to an end. To find profitable solutions to the difficult issues besetting the planet and its inhabitants. In all this, then, businesses and their teams most certainly have a major role to play.»

The View From The Cosmetics Arena

In the mid-1990s, the cosmetics industry began to shift its focus towards plant-based raw materials. The use of natural ingredients quickly became an underlying trend in the industry – the first to abandon animal testing and ban the use of parabens. Greentech has played a key role in these far-reaching changes; the following quotes come from leading players in the cosmetics industry, speaking on the occasion of Greentech's 30th anniversary in 2022.

“I am very proud of our strong, historic partnership with Greentech, whose teams have consistently offered us plant-based active ingredients at the cutting edge of innovation, especially during the development of several of our patents. I would like to take this opportunity to extend my warm thanks and congratulations to Jean-Yves Berthon, and to celebrate Greentech's 30th anniversary alongside his teams!”

Aliza Jabès,
Founder and President
of the NUXE

«Always at the cutting edge of innovation, ever attentive to its ecosystem, Greentech and its visionary president is a key partner for the Anjac group.»

Aurelien Chaufour,
CEO
Anjac Group

“Sarbec Laboratories has been working with Greentech for over 15 years. It is a consistently reliable partner, offering us numerous plant extracts and high-tech active ingredients from the plant, marine and microbial worlds. We now have over 35 raw materials referenced by Greentech, with several dozen under study. We especially value their work with organically farmed plants grown in France. Our latest selection is a Cosmos-certified organic flax seed extract grown in Burgundy and Auvergne.”

Eric Jacquemet,
CEO Sarbec Cosmetics

“Diamonds are always easy to value. As is the case with Greentech. A remarkable company, renowned for its spirit of innovation, research, quality and love of nature. Run by a great visionary who I have had the good fortune to work with for many years.”

Christian Courtin,
CEO Clarins Group

“For Polaar, Greentech is more than just a supplier – it is a reliable and trusted partner, a valued advisor with an exceptional ability to discover new ingredients. Add to that Jean Yves’ deeply compassionate and human outlook and you have all the ingredients for a long-term collaboration.”

Daniel Kurbiel,
president, Polaar

“It goes without saying that I admire the quality and ingenuity that drives the company created by Jean-Yves, but what really connects me to him is his profound and ever-present humanity.”

Jean-Noël Thorel,
president of Naos

“(…) From day one, this outstanding company was already ahead of the game. Far from being a passing fad, it was worlds ahead – bang on target. Today, ‘ethical’ biotech heralds a new revolution on a par with the digital revolution. We are seeing an industry and consumer-led frenzy for biobased products, driven both by an environmental imperative and a non-negotiable demand for naturalness, respect for human health and protection of the planet. Greentech has paved the way in this challenging quest, thereby establishing itself as a key player. This success speaks of a strong team united around its founder, a Doctor of Biology (PhD), a visionary entrepreneur, a keen globetrotter, an innovation spotter, an outstanding manager and a man committed to a sustainable world. Cosmetic Valley has also benefited from this excellence, commitment and unfailing professionalism. Greentech supports the competitiveness cluster in one of its major growth drivers, the Cosmetopoeia, to secure its sustainable supply chains, and to identify traditional beauty recipes and ingredients that – paradoxically – are more eco-friendly and can be used to further innovation.

To sum up, this is why the company and its director are not only a key pillar and stimulus of the cluster’s innovation policy – a major partner, since its creation, of «Cosmetic 360», the cosmetic innovation trade show, but also an effective driver of intelligent discussion, resourcefulness and solution-finding in response to issues raised by the ecological transition.

Jean-Yves Berthon is, therefore, more than just a simple member, a trustworthy partner and a wise advisor. I am delighted with his achievements and wish him every success in the future! We need Greentech to meet the challenges ahead of us.”

Marc-Antoine Jamet,
president of Cosmetic Valley,
Secretary General of LVMH

A hand holding a green cosmetic tube in a store aisle. The background shows shelves stocked with various green and blue cosmetic products. The lighting is soft and focused on the hand and the tube.

Cosmetics: Respecting Sources

Water management, systemic approaches to skin care, protection and preservation of water sources... these are just a few of the issues and challenges we are going to be looking at in the following pages.

WATER IN COSMETICS, HOW BEST TO PROTECT THE SOURCE?

On 22nd March 2023, World Water Day, we were reminded that by 2050 at least a quarter of the world's population is likely to live in a country affected by chronic or frequent water shortages. Water is a vital ingredient in the cosmetics industry in terms both of the quantities used, and of its importance in formulations and its role in skin physiology.

Production or extraction of raw materials, processing and manufacture, presence in the final recipe, quantities of water used in cosmetic products, discharge into the environment... all these issues point to the cosmetics industry having a significant impact on water resources. Effective management of water consumption is a major challenge, which can be optimised across the entire value chain. As a responsible operator in the cosmetics industry, through both its choices and its production methods, Greentech is committed to preserving this valuable source: water, which is becoming increasingly precious and in short supply.



In cosmetics, water is essential to skin comfort

In cosmetics, water is essential to skin comfort

«Generally speaking, the first term in the list of ingredients for any given cosmetic is “Aqua/Water”. Given that this list is drawn up in descending order of concentration, this indicates that water is present in high quantities in most formulations. In fact, people frequently protest that cosmetic products contain nothing but water. This is because people are often misinformed as to its role and importance in formulations. For instance, a cream may contain 60-80% water, lotions, shower gels or shampoos up to 95%. Water’s omnipresence in formulations means that its quality is of vital importance. «Ordinary» water, such as tap water, used by the industry for many years, and perhaps even today in some cases, has often been replaced by water that has undergone certain purification treatments, and by what we could refer to as special waters. Water is perhaps the Earth’s most vital ingredient. Physiologically, as everyone knows, it is literally indispensable. The skin contains various compartments in which water is always one of the basic constituents. In the epidermis, despite being the compartment with the lowest water content, water nevertheless plays an important role in structuring the various components of what is known as the «barrier effect». This barrier effect is vital to a number of essential functions, such as regulating body temperature, or more specifically, organising the skin’s structural lipids, phospholipids and ceramides, so as to maintain good cell cohesion. Excellent at maintaining the flexibility and

suppleness of the stratum corneum (the outermost layer of the skin), water is quite simply the very basis of skin comfort.“

Why do cosmetics contain so much water?

In official EU documents, water is classified as a solvent, meaning that it «dissolves other substances». It is in fact the most widely used solvent in cosmetics, present in virtually every type of cosmetic product: face and body creams, lotions and toners, deodorants, cleansers, scrubs, shower gels, shampoos and conditioners, shaving and styling products, liquid foundations, mascaras, fragrances, toothpastes and mouthwashes, etc. Only dry products (powders, crayons, etc.) or totally oily products (oils, waxes, lipsticks, certain balms, deodorant or sun care sticks, etc.) are waterless. Water – being odourless and colourless, and perfectly suited to this function – can be used to dilute (and therefore transport) a whole range of water-soluble substances, such as minerals and trace elements, most vitamins, and other active ingredients or even components used as processing aids (excipients) needed, for instance, to obtain a desired texture.

The urban legend: water is “not needed” in cosmetics...

We often read, especially on social networks, that water is ‘not needed’ in cosmetics, that it is used primarily to reduce the cost price of products or that it is

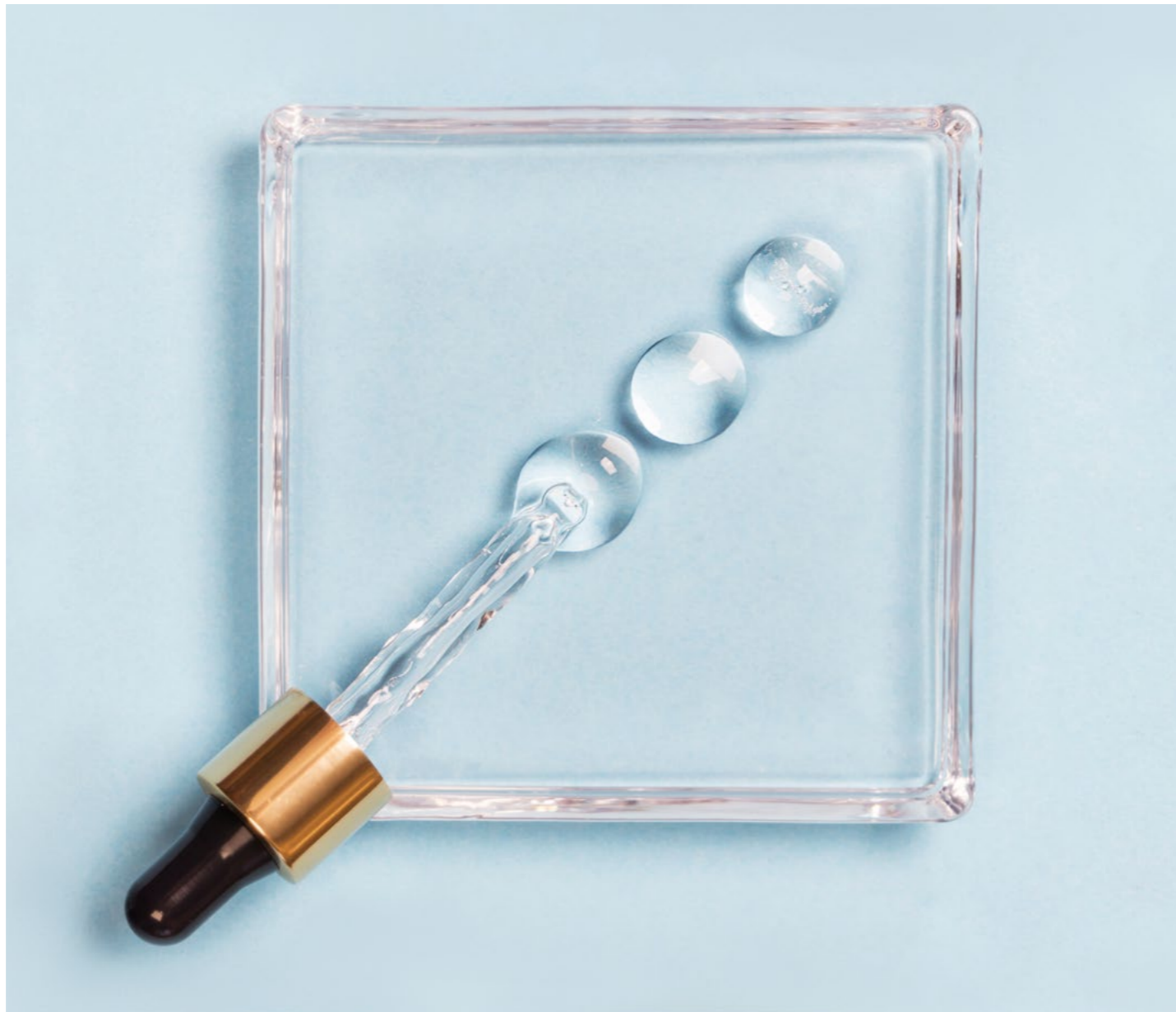
sold at similar prices to active ingredients, thus increasing the price of the final product. While everyone knows that water is one of the essentials for life and that the skin’s water content is essential to maintaining it in a healthy condition, it is argued that we cannot directly moisturise the skin by applying water directly to it. The epidermis acts as a barrier, protected by the famous ‘hydrolipidic film’ which covers its entire surface, forming a complex emulsion (of sebum and sweat, among other things). The best proof of this is that when we get out of the bath, the water just runs off our body, and that even if we spend hours in the bath, its level doesn’t drop, as the water is not absorbed by the skin. It’s true to say, then, that water in itself is not a moisturising agent. However, while pure water is not directly moisturising, it can be absorbed by the skin if it is combined with other substances (e.g. as an emulsion with lipids, or as a mixture of glycerine and water, etc.). Other hygroscopic (water-retaining) active ingredients can also be used for this purpose, such as liposomes or polymers (e.g. hyaluronic acid). Contrary to what is often written, although water is generally considered ‘inert’ in cosmetics, it would be wrong to say that it is not an ‘active ingredient’, even when it is not particularly rich in minerals. This is because water plays a key role in many respects, rendering the cosmetic product active and, therefore, effective.



Jean-Claude Le Joliff, former Director of Research at Chanel, who has devoted over 50 years to working in the cosmetics industry, took part in a debate on this topic at Greentech’s 30th anniversary event in 2022. He is currently working on his great project for a Cosmétothèque, a repository of cosmetics and a historical encyclopedia of the cosmetic industry’s expertise and know-how.

WATER MANAGEMENT AT GREENTECH: STRATEGIC ACTION FOCUS

To effectively reduce water-related impacts and risks, cosmetics companies can choose to act on certain specific areas likely to have the greatest effect, i.e. before, during and after product use. As such, Greentech deploys a holistic, three-stage water management scheme structured around: improving farming practices, allied with a new approach to agronomy; improving production, by promoting eco-extraction; and improving management of waste and effluent treatment.



A new approach to farming: agroecology and hydroponics

The first step towards better farming involves embracing the notion of agroecology, harnessing the power of microorganisms to rejuvenate soil and improving its structure through the use of natural biostimulant products and polymers that enhance the soil's water-holding capacity. The resulting replacement of chemical fertilisers leads to cleaner production and reduced water consumption. Improved growing techniques also involve the management of irrigation water. Hydroponics, a soilless cultivation technique, is an effective solution that reduces water consumption by 70-90% compared to conventional growing methods. Convinced that this plant growth system offers an effective water saving solution by ceasing our reliance on natural resources, Greentech has invested in a company specialising in vertical plant production: Prediv. This partnership will enable us to optimise growing practices in view of their implementation by our farmers.

An alternative production outlook: eco-extraction

Eco-design is one of Greentech's core concerns. As explained in Part 1 of the latest CSR report, eco-design involves sustainable and responsible sourcing, allied with the implementation of a production process based on eco-extraction principles. Greentech is dedicated to developing new, greener and more environmentally friendly processes on a day-to-day basis. Each stage of the process is optimised to select the conditions (development of novel green solvents or agro-solvents, extraction factors, tools, process intensification, etc.) best suited to increasing yields and reducing energy costs, with a special focus on preserving water resources through reduced water consumption. One example of this approach is the use of plant water – water that is already present in and intrinsic to the plant.

An alternative treatment outlook: the conservation of drinking water

Greentech is involved in the biotreatment of effluents using special microbial cocktails developed by Greencell, a Greentech group company that creates high-performance ecological treatment solutions aimed at preserving global resources. These microorganism-based cocktails (containing carefully selected bacteria, yeasts and fungi) digest pollutants (chemical or organic), compost organic matter, neutralise odours and clarify water to produce grey water that is suitable for irrigation, thereby enhancing effluent value while preserving drinking water supplies. This natural treatment technique is also far less energy-intensive, thereby reducing the carbon footprint and limiting the production of sludge in wastewater treatment plants.

There is a pressing need for the industrial world to reimagine its methods and processes, and to move towards a greener, more environmentally friendly industry. Biotechnology forms part of the solution, offering innovative sustainable approaches at every stage of the process. The preservation of this «Blue gold» is set to be a key challenge in the years to come.


“There is a pressing need for the industrial world to reimagine its methods and processes, and to move towards a greener, more environmentally friendly industry.”

Fermented Beauty

More familiar in the food sector, fermentation is an increasingly pervasive presence in the world of cosmetics, driven in particular by the craze for natural cosmetics. Fermentation is a natural, age-old process that helps to uncover nature's hidden treasures to produce increasingly long-lasting, effective skincare products. This advanced biotechnology uses the metabolic capacities of carefully selected (safe, GMO-free) microorganisms, grown under controlled conditions in bioreactors. Novel microbial fermentation-based technologies can also be used to metabolically engineer and optimise the production of molecules of interest. Fermenting an ingredient helps to boost its capacities and multiply its benefits, by creating new molecules. The production of smaller active molecules that can penetrate the skin more easily produces actives that are richer and more effective, while easier assimilation unlocks the benefits of active ingredients, enabling effective, deep-down action in the skin. Another advantage of using fermentation in cosmetics lies in taking care of the microbiota. Just as fermented foods are good for our intestinal flora, fermentation processes are good for our skin flora. Fermented cosmetics help the skin to find the right balance between good and bad bacteria, thus strengthening the skin's defences against external aggression, reinforcing the skin barrier, moisturising or soothing it more intensely, or gently purifying it.

Fermentation is also good news for the planet – a non-waste natural process that is also energy-efficient and renewable/recyclable.

The pandemic has driven a marked change in beauty habits: consumers are abandoning multiple layers of cosmetics for a more minimalist, holistic routine, aimed at protecting the skin against harmful environmental factors such as pollution, smoking and the sun, while helping it strengthen itself. This has led to the boom in prebiotics and probiotics extending into another, very similar new trend, fermented beauty.



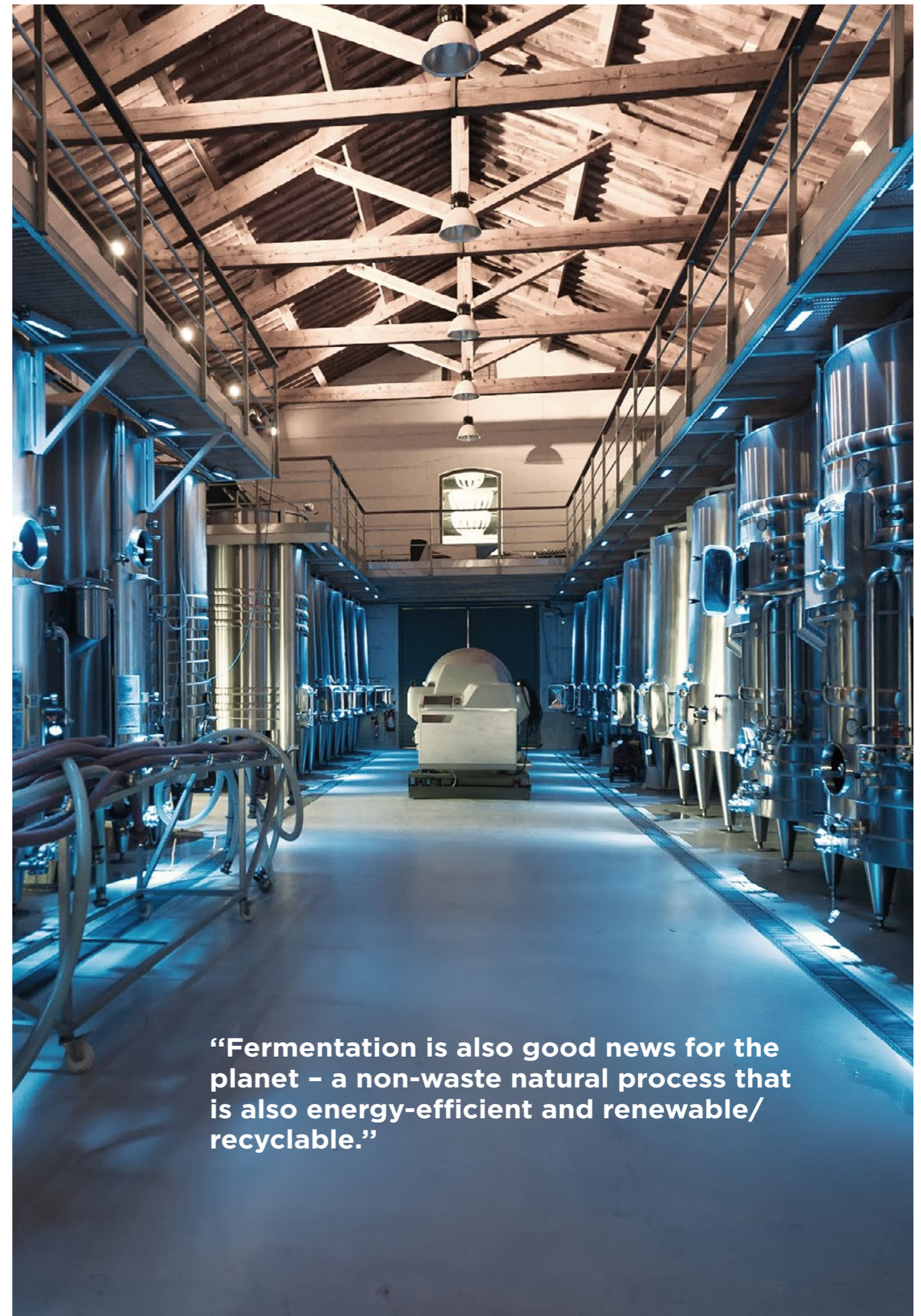
HEBELYS®
Sublimateur de peaux et d'émotions
Gardien de l'âge d'or cutané - Positive Aging
Fermentation optimisée de *Sphingomonas* sp., un microorganisme extrémophile doré capable de survivre dans des environnements stressants grâce à une haute plasticité métabolique.
Découvrir HEBELYS®

BIOTILYS®
Booster des défenses cutanées
Réparateur « microbiote-friendly »
Lysat du probiotique lactique *Lactobacillus pentosus* (fraction parabolique) et ses métabolites post-biotiques dont la souche provient de la saumure d'olive
Découvrir BIOTILYS®

HOLOBIOSYS®
Hydra-restructurant systémique
Revigorant de l'Holobionte cutané
Extrait purifié de racines de gentiane jaune sauvage Bio, potentialisé par un processus de fermentation upcyclé avec une bactérie rare de l'aérobote, tolérante au froid et à la sécheresse.
Découvrir HOLOBIOSYS®

LACTOPHYT®
Anti-odeur longue durée « microbiote-friendly »
Ferment de la bactérie lactique probiotique *Lactococcus lactis*, riche en molécules à l'activité antibactérienne spécifique (bactéricines, acides organiques), obtenu par biotechnologies avancées.
Découvrir LACTOPHYT®

PROBIOTIQUES & EXTRAITS VÉGÉTAUX FERMENTÉS À FAÇON
Les micro-organismes et les plantes offrent des possibilités infinies. Nous pouvons développer pour vous et avec vous des probiotiques ou ingrédients fermentés sur-mesure selon vos besoins.



“Fermentation is also good news for the planet – a non-waste natural process that is also energy-efficient and renewable/recyclable.”

Holobiont: The Whole is Greater Than The Sum of Its Parts

A novel systemic approach to creating the next generation of skincare actives.

The systemic approach studies systems in their entirety, focusing on the interconnections between their various components, rather than just each separate part. Research at Greentech now makes it possible to treat the skin as a coherent whole, thereby creating a new generation of skincare actives. Developing our understanding of the holobiont is a major scientific achievement, an innovative approach enabling in-depth study of the interactions between the host and the skin's microbiota. The holobiont is an association between a host organism and numerous other species living in or around it (symbionts), forming a symbiotic ecological unit that coexists and collaborates through a complex set of interactions.

Holobiosys, the tangible outcome of this approach:

- restructures the skin from the surface to the core,
- activates antioxidant functions
- significantly boosts the synthesis of hyaluronic acid, which decreases as the skin ages
- restores skin hydration, with visible smoothing effects

The skin's microbiota regains its youthful vigour while preserving its overall diversity. Holobiosys is obtained through fermentation, an age-old green chemistry process that harnesses the power and benefits of yellow gentian roots, using a rare, cold-resistant bacteria found in the aerobiota. Holobiosys is a COSMOS-certified organic ingredient, sourced in a traceable, sustainable and local manner, within 30 km of the production site.

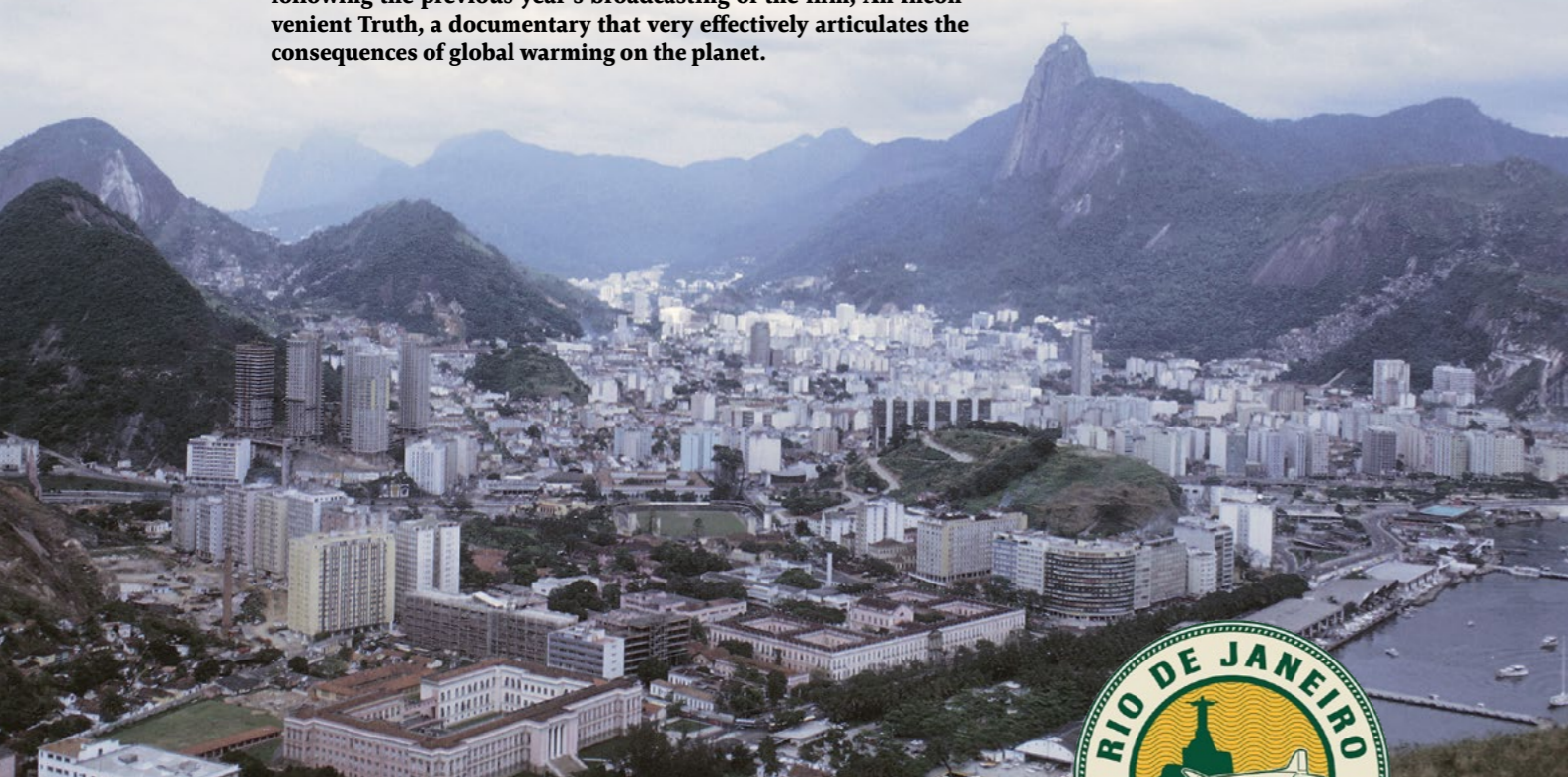


The importance of the holobiont in cosmetics

At the latest InCosmetics Global conference, held in Barcelona in March 2023, a large body of research was presented on the topic of how health, both physical and mental, affects beauty. This is not a new concept; several years ago, we discussed the microbiome: skin is the largest organ in the human body, with research revealing that complex interactions between bacteria, soil and microorganisms caused skin breakdown, leading to skin damage and disorders. For example, skin that is sensitive, reactive or prone to psoriasis or any other condition has been found to have an unbalanced microbiome with an overpopulation of certain bacteria. Feeding the skin with good bacteria has beneficial effects on skin health.



In November 1988, the World Meteorological Organisation (WMO), under the patronage of the United Nations Environment Programme (UNEP), established the Intergovernmental Panel on Climate Change (IPCC) at the request of the G7 (a group made up of Canada, France, Germany, Japan, Italy, the United Kingdom and the United States). Open to all member countries of the United Nations, it comprises 195 States. In 2007, the Nobel Peace Prize was awarded jointly to the IPCC and former US Vice-President Al Gore, following the previous year's broadcasting of the film, *An Inconvenient Truth*, a documentary that very effectively articulates the consequences of global warming on the planet.



1992-2022 FROM RIO TO GIEC

Is our brain in denial?

In 1992, the Rio Earth Summit – still the largest gathering of world leaders to date – laid the foundations for better management of the Earth's natural resources, advocating the notion of the rights and responsibilities of countries in addressing global environmental issues. It was here, in Rio, that the term «sustainable development» was first introduced. 170 heads of state and government signed an environmental action plan for the 21st century, Agenda 21, which set out the following objectives in particular: the conservation of biodiversity, the sustainable use of its components, the fair and equitable sharing of the benefits arising from the exploitation of resources.

“Two weeks to save the planet.» That's how, thirty years ago, on 3rd June 1992, the daily newspaper *Journal de Genève* and *Gazette de Lausanne* headlined its first article covering the United Nations Conference on Environment and Development held in Rio de Janeiro, better known as the Rio Earth Summit. Bringing together political leaders and non-governmental organisations from 179 countries, the main aim of this major UN gathering was to «set rich and poor countries alike on the path to sustainable development», fostering respect for the environment and guaranteeing decent living conditions for all. The strategies that will supposedly lead humanity towards this bright future, wrote special envoy Suren Erkmann, «can be found in four laboriously negotiated documents: the United Nations Framework Convention on Climate Change, the Convention on Biological Diversity, the Rio Declaration and Agenda 21, a daring new action plan for the 21st century.»

Among the issues addressed by this plan were the conservation of biodiversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising from the exploitation of resources. Three decades on, what conclusions can be drawn from this conference, which was supposed to establish the key principles of a new relationship between humankind and the planet? «In terms of its primary objectives, this summit has been a total failure,» comments Dominique Bourg, a philosopher and specialist in environmental issues. Concrete achievements of the Earth Summit appear mainly on an institutional level. The United Nations Framework Convention on Climate Change was signed a few months after Rio, just as the first COP [the annual mee-

ting of States to set global climate objectives] was organised in 1995, as a direct follow-up to the Rio Summit, not forgetting the 1997 Kyoto Protocol. It must nonetheless be acknowledged that the global environment has deteriorated dramatically over the last thirty years. This can be seen in the loss of biodiversity, which is reflected both in the collapse of insect populations and in the total biomass of vertebrate animals. Wild animals now account for only 3%, compared with 30% for humans and 67% for domestic animals, mainly farmed. As for greenhouse gases, emissions have literally doubled between 1992 and today. As Dominique Bourg puts it: «In other words, since we started talking about sustainable development, a key concept of the Rio Summit, we've never destroyed so much of the planet.»

Even if environmental damage was perceived to be very slight at the time, by the end of the last century we were already aware of the dangerous path our planet was on. Deforestation was proceeding apace, and people were beginning to take stock of the very rapid buildup of carbon dioxide in the atmosphere. As the 1980s progressed, the consensus on this issue grew stronger, culminating in the creation of the IPCC [Intergovernmental Panel on Climate Change] in 1988. People were also already discussing issues surrounding soil, desertification and plastic pollution. «By the late 1980s, the only aspect being questioned was the exact role of human activity in climate change, a point on which scientists now all agree,» adds Dominique Bourg.

On 28th February 2022, 4 days after the start of the war in Ukraine, the IPCC released Part 2 of its sixth report. Antonio Guterres, Secretary General of the United Nations, described the document as an «atlas of human suffering», «a damning indictment of failed climate leadership», and an «abdication of leadership that is criminal». So why is there no clarion call for immediate action? This is the paradox of climate change: it is unfolding before our very eyes, and yet we still postpone action, as if the IPCC report simply made us consider the idea of a danger to come, rather than feeling the peril now staring us in the face. Philosopher Timothy Norton, in his book *Etre écologique* (2021), writes on this subject: «We represent the ecological crisis as something lying ahead of us, interposing an infinite quantity of data between us and it. We live in an information dump.»

“In other words, since we started talking about sustainable development, a key concept of the Rio Summit, we've never destroyed so much of the planet.”

The IPCC method

The IPCC's mission is to assess and summarise the current state of scientific, technical and socio-economic knowledge, in a neutral and objective manner, in relation to the issue of global warming. It takes account of all the various points of view and uncertainties, while highlighting the elements on which the scientific community has reached a consensus. The IPCC's mission is therefore to “provide regular assessments of the scientific basis of climate change.” Valérie Masson-Delmotte, co-chair of Working Group I of the IPCC's sixth assessment cycle explains further, “The IPCC does not conduct its own research; it assesses research papers published by the scientific community.”

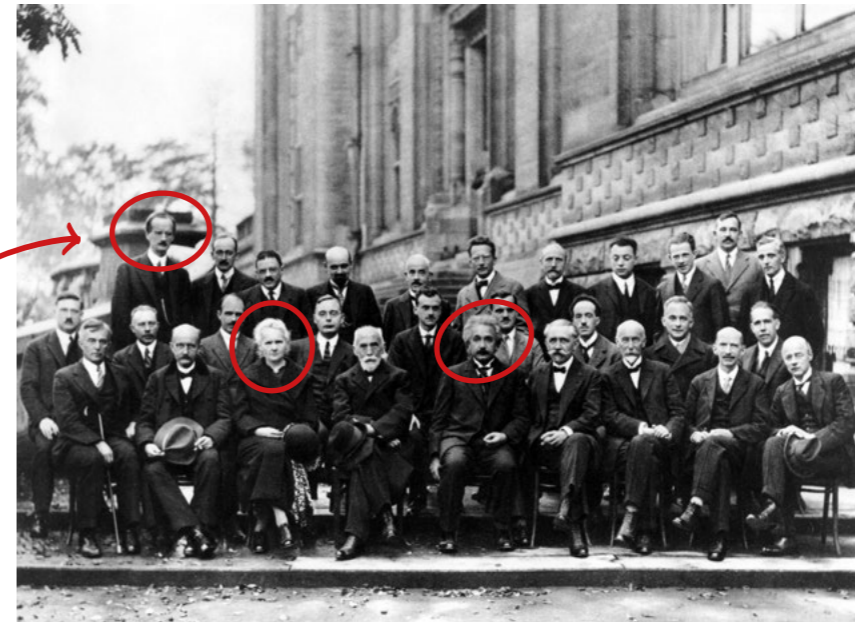




“It is also interesting to read Article 3.5 of the UN Framework Convention on Climate Change signed in 1992, which states that the climate must not be used as a pretext to restrict international trade, even though this is precisely the crux of the problem. You can see the ambiguity of the policy-makers at that time, which hasn’t changed much today.”

Dominique Bourg

THE PICCARD FAMILY: THREE GENERATIONS DEDICATED TO SCIENCE AND EXPLORATION



5th International Congress of Physics in Solvay, Brussels, 1927. 17 of the 29 people present are or will be Nobel Prize winners. Auguste Piccard, standing on the left, is recognisable by his tall stature.

The other two faces circled are Marie Curie and Albert Einstein.

AUGUSTE PICCARD: HIGH-FLYING PIONNEER

“When the environment to be studied is too vast to fit into my laboratory, I take my laboratory to the environment to be studied.”

Auguste Piccard was the first man to see the curvature of the Earth with his own eyes. On 27th May 1931, the patriarch of the Piccard family of explorers climbed to an altitude of 15,781 metres, in Augsburg, accompanied by his assistant, the engineer Paul Kipfer.

Swiss physicist Auguste Piccard (1884-1962) served as the model for Professor Tryphon Tournesol by Hergé, the creator of Tintin. The scientist – who unlike his cartoon character was not hard of hearing – paved the way for modern aviation and the conquest of space by inventing the pressurised capsule and the stratospheric balloon. By the time of the ascent, on 27th May 1931, trouble was already brewing due to the balloon having taken off earlier than planned due to error. First, they had to repair the oxygen apparatus, damaged when the wind had picked up during the night, and they were also having difficulty closing an orifice that had been distorted as the wind buffeted the capsule... At 4.25 am, within half an hour of take-off, they had reached an altitude of 15,500 metres, climbing at 555 metres per minute, 33 kilometres per hour. At this altitude, it's calm, the air is clear and the sky is dark blue, tending towards violet. They released a little more ballast and approached 16,000 metres (the record was set at 15,781 metres). At 6.35am, they realised that the valve designed to allow

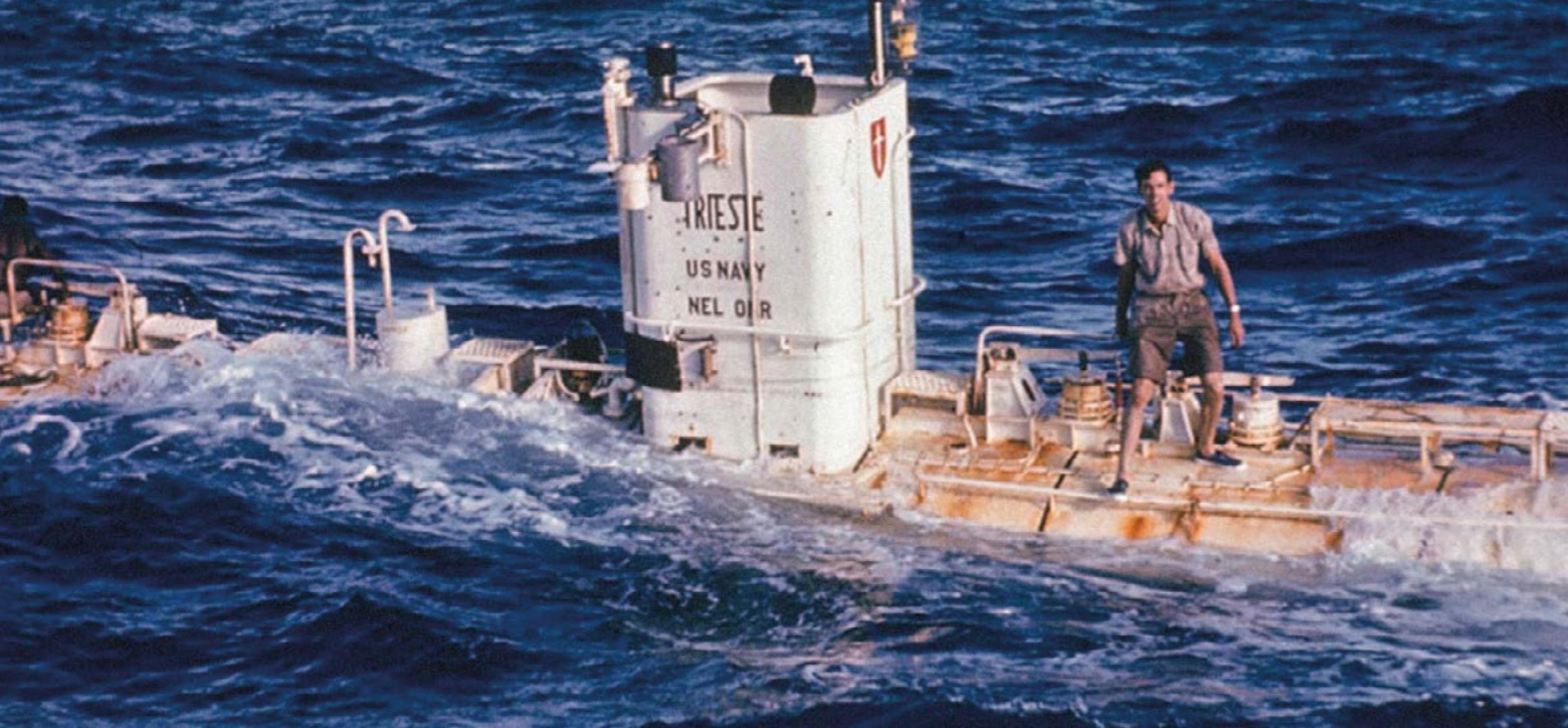
them to descend by releasing hydrogen had been jammed by a rope that should have been released on take-off, meaning that they would have to wait for the night's drop in temperature before descending. Following a serious risk of dehydration due to the failure of the system that was supposed to regulate the temperature inside the cockpit, at 9 p.m., after a 17-hour flight, they finally landed safely at an altitude of 1,950 metres on the Gurgl glacier, near Sölden in the Tyrol, where a triumphant welcome awaited them.

Holder of the Chair of Physics at the Free University of Brussels (Belgium), Auguste Piccard also invented the legendary bathyscaphe underwater submersible for deep-sea exploration, a project continued by his son, Jacques. Despite being record-breakers, the Piccard family is not obsessed with them. Auguste Piccard is said to have replied to an audience of journalists who were asking him about his fourth record, in 1960: «Tell me: what's the point of all these world records?» A family that pushes back the frontiers of what is possible, rather than a group of zealous record-holders. A fervent desire to advance scientific knowledge and achievement, soon joined by a consideration of environmental issues, which Bertrand Piccard, the 3rd generation, is addressing with the same desire to combine exploration and technological progress for the benefit of humankind.



In the words of writer Jacques Lacarrière: « These three are the embodiment of humankind's maddest dreams – becoming a fish or a bird.» Auguste, Jacques, Bertrand: a family driven by the values of scientific and technological humanism, very early on aware of the pressing need to safeguard our planet. These savanturiers, as they were nicknamed, are renowned for their efforts to link the major technological challenges of the 20th, and now the 21st, centuries with the environmental issues of our times.

A few historical facts about the heritage of this unique family.



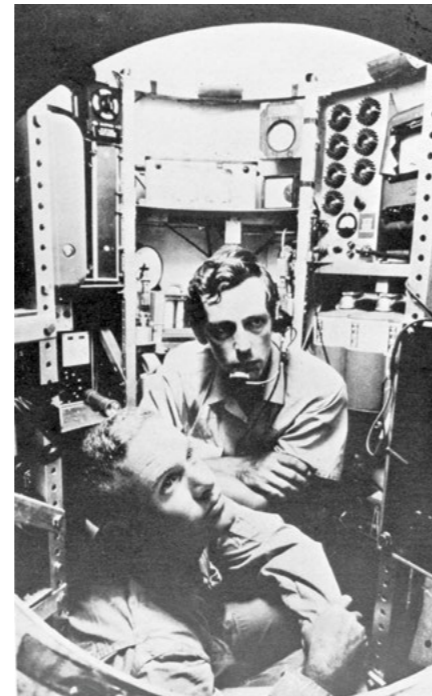
JACQUES PICCARD: THE UNFATHOMABLE DEPTHS

His son Jacques (who died in 2008 at the age of 85), Bertrand's father, continued Auguste's work, in 1960 making a historic dive to a depth of 10,916 metres in the Mariana Trench, east of the Philippines, where he found... life where none was thought possible. Although he had already set a first record with his father aboard the Trieste, in the Tyrrhenian Sea in the summer of 1953, at a depth of 3150 metres, this extraordinary dive to the Challenger Deep, the floor of the trench, went a step further by making an environmental claim. By proving that a unique fauna can also be found where none was expected, Jacques Piccard convinced governments to stop dumping toxic waste in the sea and campaigned for the protection of the Earth and its oceans. Since the First World War in fact, several armies have used seas and lakes to dispose of hazardous waste (unexploded ordnance in particular). This action led the United States to definitively abandon its project to dump nuclear waste in the marine trench.

Today, we have maps of the surface of Mars with a resolution of 5 metres per pixel. In comparison, our mapping of land surfaces on Earth is 30cm per pixel.

And the seabed? 1.5km – 300 times less detail than the Red Planet. The Seabed 2030 programme, launched in 2017 when only 6% had been mapped in high resolution, is leading a global effort to map the Earth's entire ocean floor before the end of the decade. In just six years, more than 90 million square kilometres of bathymetric data have been collected through global partnerships, the mobilisation of data and advances in technological innovation. The project has driven major developments in scientific research. In March 2023, a new catalogue of seamounts was published, including more than 19,000 newly discovered undersea volcanoes. Discoveries such as these are both helping to advance science in the fields of oceans, ecology and plate tectonics, and improving our ability to protect and manage oceans in a sustainable manner. A continuing story, a distant legacy of the adventures of the Piccard family...

Jacques Piccard (facing) and Don Walsh (bottom) on board the Trieste.



BERTRAND PICCARD: THE HERITAGE OF SOLAR ENERGY

Bertrand Piccard and his team beat Jules Verne's Philéas Fogg and his record of 80 days.

Two previous unsuccessful attempts, in January 1997 and January 1998, nearly derailed Bertrand Piccard's plan to make the first non-stop around-the-world balloon flight. In 1999, the crew finally completed the construction of Breitling Orbiter III, an even bigger balloon (18,500 m³ of helium, 55m), capable of holding air for 3 weeks and pressurised to fly at maximum altitudes of around 12,000 m... This final attempt – because there would be no others – successfully circumnavigated the globe after a flight lasting 19 days, 21 hours and 47 minutes (447 h and 47 min) over a distance of 45,755 km; the longest flight in terms of time and distance in the history of aviation.

In 2003, Bertrand Piccard joined forces with the EPFL (École Polytechnique Fédérale de Lausanne) and pilot André Borschberg to develop a solar aircraft project: Solar Impulse, a global circumnavigation

project using a solar-powered glider. The second version of Solar Impulse circumnavigated the globe between March 2015 and July 2016, its crossing of the Pacific Ocean setting a record for a solo flight with no refuelling or stopovers, covering 8,900 km in 5 days and 5 nights. On completing their round-the-world flight, Bertrand Piccard and his team-mate, André Borschberg, launched the Global Clean Technology Alliance and the Solar Impulse Foundation with the aim of federating the key economic actors in the fields of renewable energy technologies and sustainable development. From this moment on, his aim shifted to bridging the gap between economic and environmental concerns. He believes there is nothing to be gained by attempting to protect the environment by threatening human comfort, mobility and economic development. A medical doctor by training, specialising in psychiatry, Bertrand Piccard believes that people don't change their habits easily, and that solutions must take account of their reluctance to make sacrifices.



Bertrand Piccard took this spectacular selfie on board Solar Impulse.

“Adventure in the 21st century consists of using human creativity and the pioneering spirit to develop the quality of life that present and future generations have a right to expect.”

INTERVIEW WITH BERTRAND PICCARD

SOLUTIONS FOR A WORLD SEEKING SALVATION

Bertrand Piccard, your legendary family history embodies scientific progress, technological prowess, adventure, and ecology. Your father and grandfather were environmental pioneers – they were far ahead of their time, perhaps too far ahead?

Absolutely, they were true trailblazers, in that they were highlighting issues that were often considered unsolvable at that time. They taught me that scientific exploration should always strive to improve the quality of life on earth: by discovering new ways of doing and thinking for the benefit of all. On his first stratospheric ascent, my grandfather proved that you can fly at high altitudes, above bad weather, in thin air, thus reducing drag and fuel requirements. My father dived to the deepest point of the ocean, the Mariana Trench, and proved that there was life there, thereby forcing governments to abandon their dangerous plans to dispose of radioactive waste in the ocean depths. While my father and my grandfather would have liked to do more, I don't actually think there is such a thing as being «too early» for environmental protection, but rather a lot of being «too late». I realise, however, that idealism alone is not enough. My father worked on visionary projects that failed for lack of practical solutions. That is why I have always sought realistic means of achieving results, forming alliances and seeking compromise through highly specific unifying solutions.

The Solar Impulse Foundation presents over 1300 efficient solutions addressing climate change. You go beyond the concept of innovation – a word so often used by politicians and the media – is this because you distinguish between innovation and progress, which are often confused?

We have to dispel the myth that human progress depends solely on innovation. This is just too simplistic an idea. Firstly, because we don't have time to wait for future innovations to solve today's urgent problems. We must use the solutions we already have at hand without hoping that future technologies will counteract the mistakes we make now. Secondly, we live in one of the world's most innovative societies, but does this mean that human progress is following the same path? Everywhere we look, we are seeing the insidious erosion of civic engagement, the quality of our democracies, social cohesion and trust. While necessary for progress, innovation alone is not enough. Innovation in and of itself has no higher moral purpose. It can protect the environment or destroy it, depending on how it is used. It all comes down to the nature of the person who uses it. Progress, on the other hand, should always aim at improving life on earth.

The efficient solutions that you present are already operational. The challenge, therefore, lies in deploying these solutions – scaling them up. What are the

obstacles? What drives political inertia? Is it necessary to prove the short-term economic viability of the environmental approach?

Yes, political and legislative inertia is delaying faster deployment of these solutions. So long as the legal framework continues to allow the use of polluting and inefficient systems, there will be fewer incentives to switch to cleaner solutions and we will legally continue to pollute and waste natural resources. This stalls companies – no one wants to take the first step for fear of being at a competitive disadvantage. But if no one moves, we are all letting precious time pass until it is too late. We need pioneers who are not afraid to boldly embark on

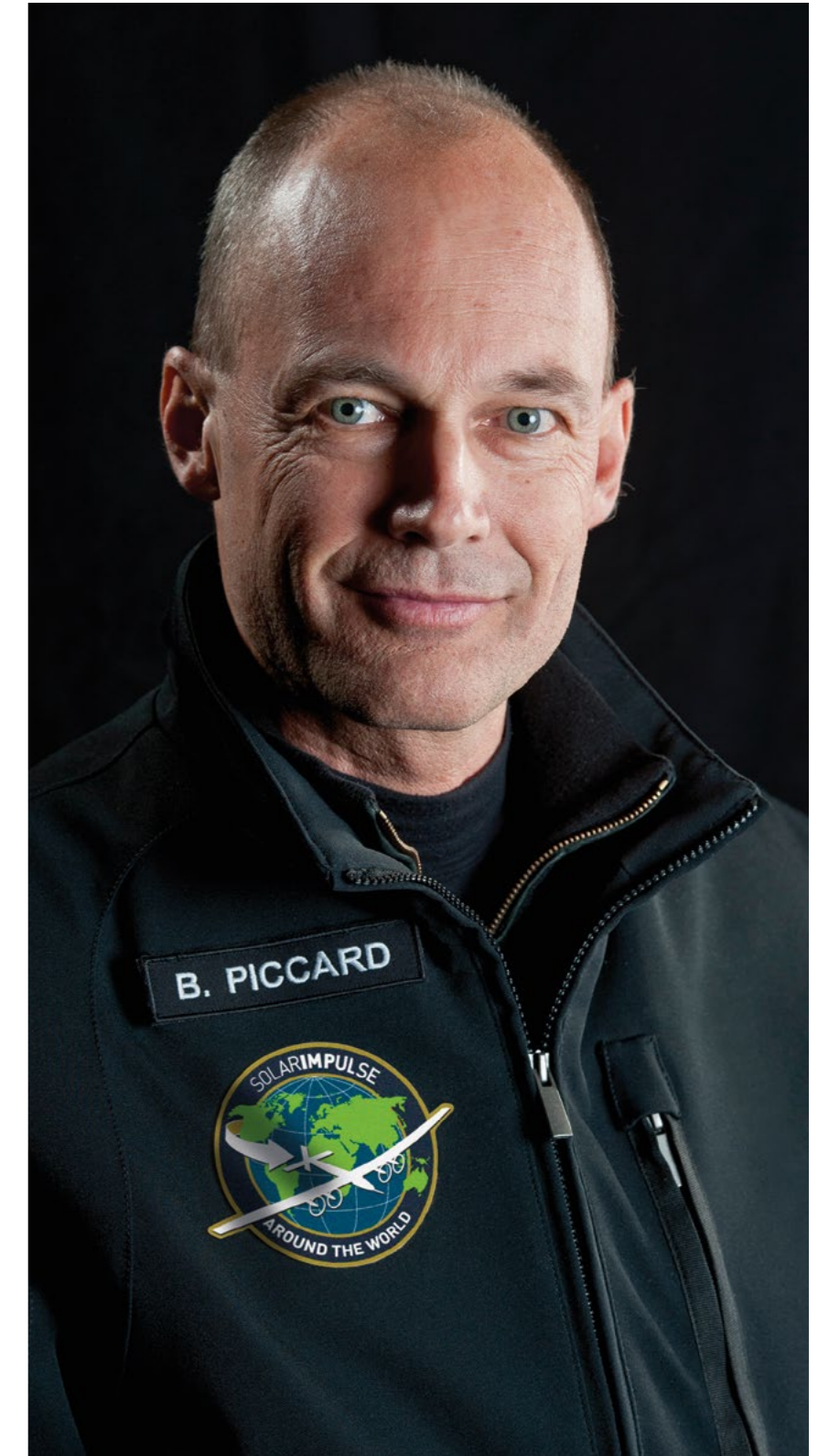
“We have to dispel the myth that human progress depends solely on innovation.”

“Idealism is attractive, but it just doesn't work in the real world.”

more ambitious environmental legislation. I realise that this is a challenging political process that requires public endorsement. We want to use the Solar Impulse Foundation to show people that the ecological transition will benefit us all and that there is nothing to be afraid of. We must wholeheartedly embrace it, not due to a desire to make sacrifices, but because doing so will improve our purchasing power, which is far more motivating.

In your book «Realist», you included this very harsh sentence: «human nature itself works against idealism.» Is it because you are a psychiatrist that you doubt our civilisation's capacity for environmental commitment?

Idealism is attractive, but it just doesn't work in the real world. Political leaders need to create jobs to get re-elected; business leaders need to make profits and satisfy their shareholders, often pension funds and life insurance companies, or they are fired. To achieve ecological progress in this world, we have to speak the language of those in power and persuade them using their own arguments. We have to prove to them that environmental protection, efficiency and novel industrial opportunities in ecology will generate greater profit and jobs than the polluting status quo. Idealism that calls for economic degrowth would spark social chaos due to a lack of means to fund social security, pensions, education, health care etc., and would ultimately harm the cause. We need majority support if we are to take tangible steps in the right direction. This is what I call the transition from idealism to realism, to achieve a result regardless of ideology. I consider this the only way to push our society into a new growth model that I like to call qualitative, efficient and profitable, rather than quantitative, polluting and expensive.



The IPCC report confirms that decarbonisation and growth are conflicting concepts. The 2020 confinements led to forced degrowth, which has demonstrated measurable results. Between the continuous growth of our consumer society – this veneration of GDP – and the radical degrowth called for by certain environmental movements, you are suggesting a third way, qualitative growth. What does this mean?

I reject this dilemma between degrowth, that leads to social chaos, and the myth of so-called unlimited growth, that leads to ecological disaster. I advocate 'qualitative growth', where we create jobs and generate profit by replacing what pollutes with what protects the environment. This means modernising infrastructure, buildings, energy systems, industrial systems, heating, lighting and air conditioning. This is the industrial market of the century. If it were too expensive to modernise all this, I couldn't make this speech. But the Solar Impulse Foundation, through all its labelled solutions, shows us that this can be profitable. This is what will revive the world's post-Covid economy. We cannot revive the economy by continuing to invest in inefficient combustion engines that barely reach 27% efficiency, when we have electric motors that are 97% efficient. Qualitative growth will benefit the environment and industry alike. Social protection will be improved. Quality of life, purchasing power... This is what's important.

Politics is bound by certain constraints in environmental terms; it's a question of compromise. For instance, governments can't just disband polluting industries because they also have to protect jobs. As such, it's up to the business world to set an example. Once part of the problem, companies are now potentially part of the solution; we now see mission companies being set up – does this indicate that financial profit is no longer the sole raison d'être? The younger generation wants to work with companies that have a positive impact. It's about producing better, consuming fairly, and protecting sources. Is this analogous to your proposal for qualitative growth?

Absolutely. You've summed it up perfectly. We need to decouple economic growth

from quantity in terms of production and consumption, and couple it with quality in terms of efficiency. That's why we support companies that, historically, have been part of the problem, but are now seeking to embrace new, cleaner production methods. Our job is to provide them with the solutions they need to do this.

You say that «ecology isn't delivering its messages effectively». For instance, not enough people today are concerned by the notion of future generations. Bruno Latour, the sociologist, ethnologist and philosopher of science, agrees with you: «All it does is frighten people or make them yawn with boredom.» Does ecology need new a marketing approach?

We definitely need a new marketing approach and a new narrative, one that inspires enthusiasm rather than rejection. We must abandon the idea of a sacrificial and burdensome environmental transition, and instead spotlight the meaningful benefits and opportunities that the ecological transition will bring to us all. We associate climate change with starving polar bears and melting ice caps, forest fires and droughts. While these images are necessary, we also need images that offer solutions that can trigger a «can do» attitude, rather than a «we're all doomed» fatalism. That's why I expect activists to shout «Solutions, solutions» instead of «Problems, problems».

The recent Netflix hit «Don't Look Up» tells the story of scientists who discover that an asteroid is going to hit the Earth in a few months' time. But... nobody cares: the media, the politicians, society. Then, a tech company discovers that there are rare metals on this asteroid, with billions to be made. A superb parable of the current environmental crisis... The film got more coverage, and better media treatment than the publication of the IPCC report. Maybe this tells us something important: that ecology sends messages that make people uncomfortable, leading to a form of denial...

I really enjoyed this satire, which contains a lot of truth. All those who tend to deny problems are ridiculed. This applies not just to Covid, but also to climate change and pollution. Human nature is not always driven by curiosity, an unquen-

chable thirst for the unknown, respect and compassion. This is why we have to find other ways to motivate people, to encourage them to think and act differently.

You say we should be neither optimistic nor pessimistic, but realistic; we're told that there is only one generation left before the Earth reaches the point of no return. What do you hope to see in the coming years?

I would like to see a legislative framework that really encourages a shift from waste to efficiency, from quantity to quality. A way of federating the forces involved by proving that everyone can achieve their ambitions through fruitful consultation rather than ideological confrontation. I also hope to see less political division. Currently, it takes four competing parties to promote the four fundamental values we so desperately need: ecology, solidarity, personal accountability and security. How do you expect voters to choose between these parties when they are looking for all these things at once? That's why there is so much abstention and apathy. We must federate the core values championed by both left and right, ecology and economics. The very survival of our society and our quality of life depends on it.

“We need to decouple economic growth from quantity in terms of production and consumption, and couple it with quality in terms of efficiency.”





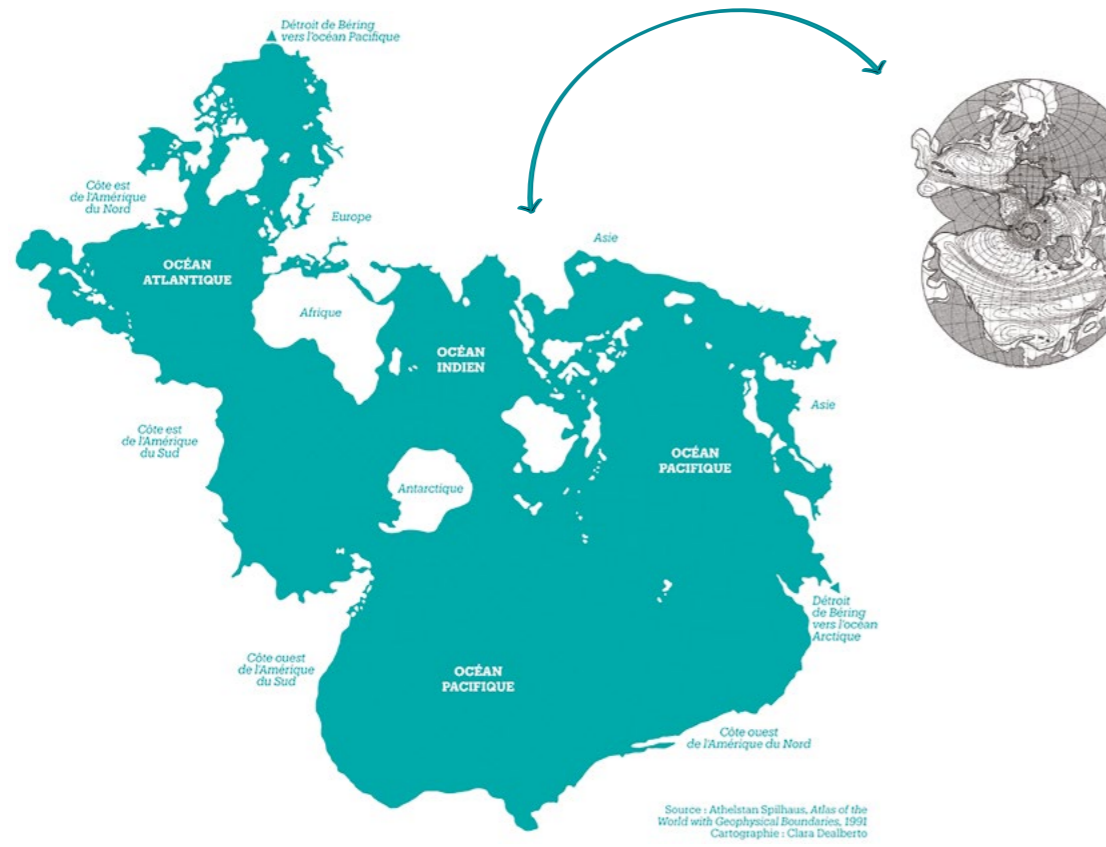
The Southern Ocean

In 2018, the (re)discovery of a map known as the 'Spilhaus projection' went viral. It shows the globe viewed from the South Pole, presenting the ocean basins as one connecting body of water.

In 1942, the oceanographer and geophysicist Athelstan Frederick Spilhaus produced a fascinating map that placed the marine regions at the centre of the globe, thereby revealing a huge inland sea (covering just over 70% of the Earth's surface). The world ocean generates over 60% of the ecosystem services that enable us to live, starting with most of the oxygen that we breathe. This map therefore symbolises the importance of the oceans.

The result is an interrupted projection which displays the oceans as a single unit. It is both brilliant and baffling!

Viewed on a "Spilhaus Projection"



Source : Arhelstan Spilhaus, Atlas of the World with Geophysical Boundaries, 1991
Cartographie : Clara Dealberto

AN EXCEPTIONAL ECOLOGICAL RICHNESS AND A KEY ROLE IN CLIMATE REGULATION

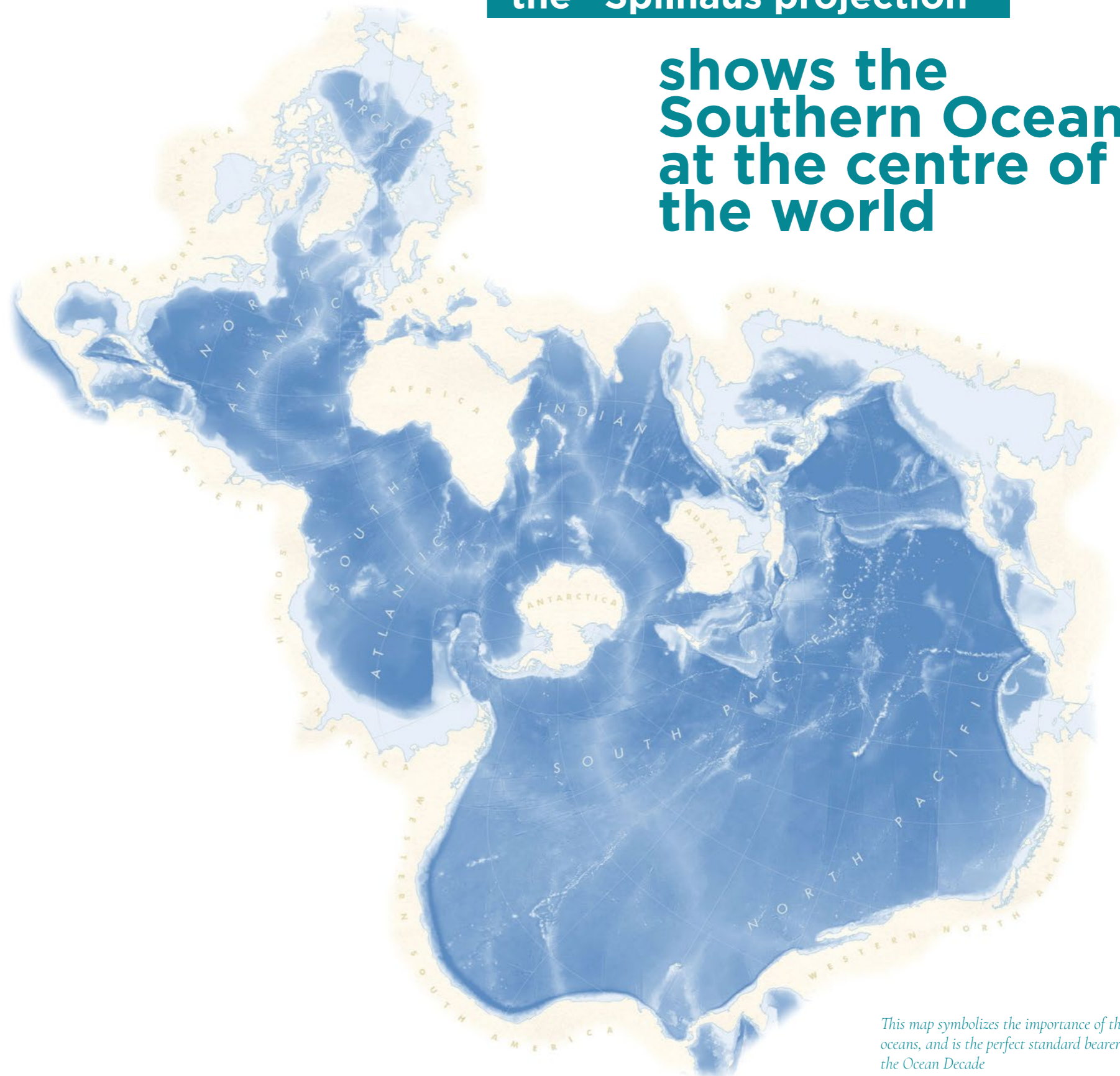
The «Spilhaus projection» provides a unique, unconventional, yet highly relevant viewpoint, which perfectly illustrates the importance of the oceans at the heart of the planetary system, starting from the Southern Ocean, also known as the Antarctic Ocean or the South Polar Ocean. It is the world's fourth largest ocean, and the last one to be defined by the International Hydrographic Organisation. On 8th June 2021, World Ocean Day, the National Geographic Society also declared it as the fifth ocean. The Southern Ocean is a truly exceptional body of water, unlike any other. Lying beyond the 30th parallel south, it acts as the planet's primary heat and carbon sink, thought to absorb nearly 75% of global excess heat and to sequester around 35% of excess CO2 in the atmosphere. With the exception of the Arctic Ocean, the Southern Ocean is connected to all the major ocean basins via the Antarctic

Circumpolar Current, the strongest ocean current on the planet. The annual sea ice freeze-thaw cycle around Antarctica is one of the world's defining phenomena and another key aspect of the Southern Ocean's role. As such, the two polar regions differ markedly. While the Arctic is a small, deep ocean surrounded by land, with narrow access routes, the Antarctic is a vast expanse of land, consisting of a continental shelf bordered by the ocean, that hosts the formation and melting of some 15 million square kilometres of pack ice every year. Beneath the surface of this ocean lies a world teeming with life and complex ecosystems, ranging from single-celled algae and tiny invertebrates to large predators such as penguins, seals and whales. The Southern Ocean is home to over 9,000 marine species, not counting those that are constantly being identified through expeditions and laboratory research.

Its incomparable diversity a regulation masterpiece: a reservoir of sea gas transferred to the atmosphere, estimated to absorb carbon dioxide in equilibrium, in its role as a carbon

the «Spilhaus projection»

shows the Southern Ocean at the centre of the world



This map symbolizes the importance of the oceans, and is the perfect standard bearer for the Ocean Decade

EUROPE'S LAST PRIMEVAL FOREST

BIALOWIEZA

Almost 70% of existing primeval forests disappeared during the second half of the 20th century. Białowieża in Poland is therefore highly symbolic: it is Europe's last remaining primeval forest, and a listed Unesco World Heritage Site. «It is a vast natural laboratory, allowing us to study ecosystems that evolve without human interference,» explains Bogdan Jaroszewicz, Director of the Warsaw University scientific unit in Białowieża. «A fascinating window into the past that shows us how today's forests differ from ancient natural forests – a natural genetic reservoir of inestimable value for the future,» he continues, stressing that Białowieża has «documented continuity of existence going back almost 12,000 years.» Today, though, the forest is under threat.

BIALOWIEZA

Białowieża could be described as our European Amazon, unchanged since the end of the Ice Age over 11,000 years ago. A magical forest, in Poland's far east, along the Belarusian border. Historically, a hunting reserve of kings and czars made a national park just 100 years ago, it is home to wolves, lynxes and even the last remaining European bison, survivors from prehistoric times. To enter Białowieża is to travel back into the mists of time. After the wonders of time travel, however, come more pressing present-day concerns. For some years now, on the pretext of combating a predatory insect, the Polish government has made persistent efforts to cut down part of the forest surrounding the area that is a labelled Natura 2000 and a Unesco World Heritage Site. In 2017, environmentalists won the first round after residents banded together in «Locals for forest», and succeeded in having Poland condemned by the European Court of Justice. On 9th March 2021, however, the Polish Minister of the Environment reopened hostilities with a new logging programme, immediately attacked on all sides. The forest, which covers 1,500 km², is home to 12,000 species of animal. This treasure of biodiversity has become a battleground between conservationists and local and national authorities.

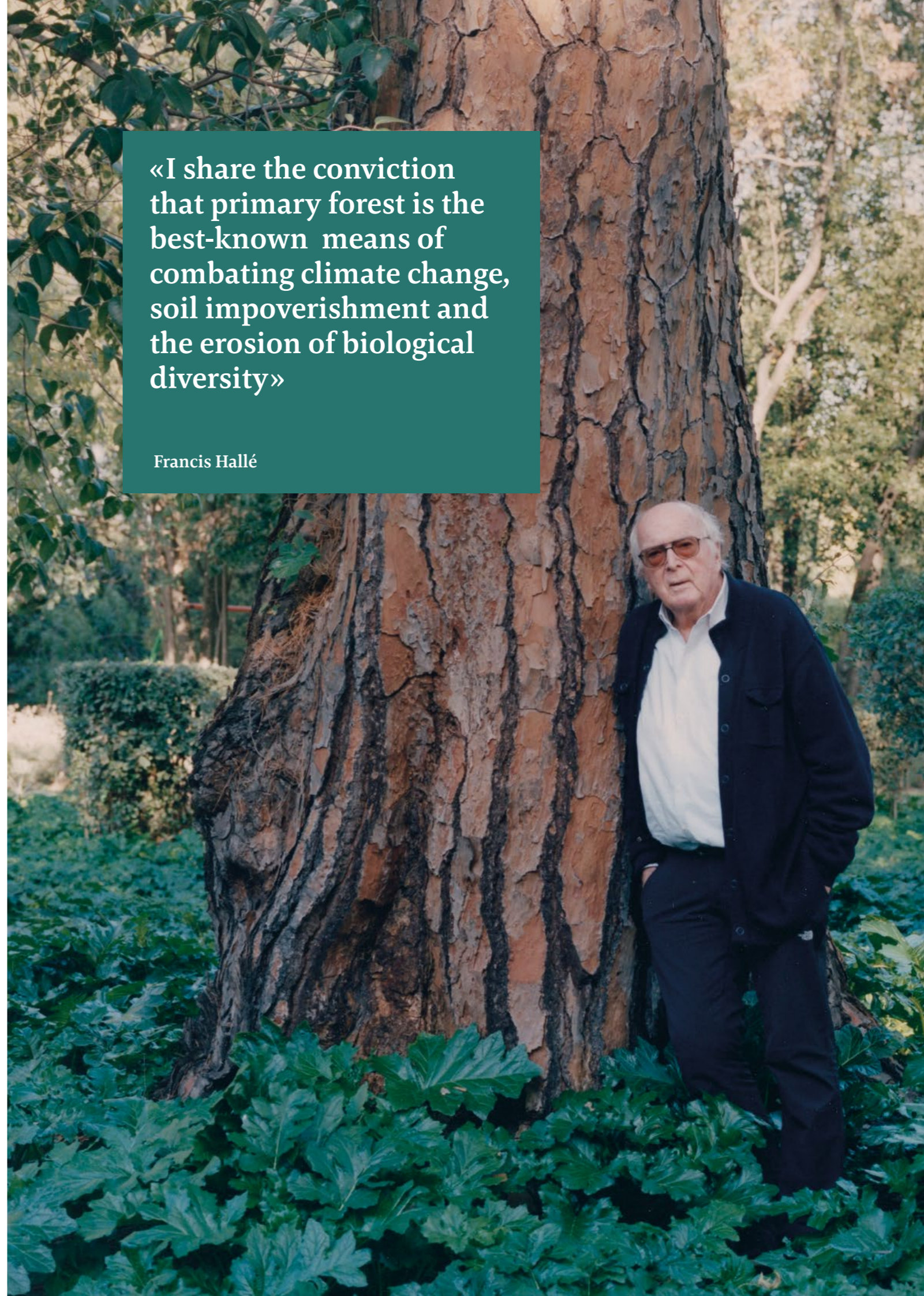
The famous biologist and botanist Francis Hallé has been moved to say: "I preside over an Association under French law that promotes the restoration of a vast area of primary lowland forest in Western Europe; together with all the members of this Association, I share the conviction that primary forest is the best-known means of combating climate change, soil impoverishment and the erosion of biological diversity. What will be the purpose of the project I am carrying out, or of the climate plans, the forest plans or even of the European Union's Green New Deal if, by allowing obscurantism to prosper, we are unable to protect the last primary lowland forest on our continent?"

An ambitious project, spanning several centuries. Could a primary forest rise again in Western Europe? On the initiative of its founder, the Association Francis Hallé Pour la Forêt Primaire is seeking to create a vast natural area on a European scale – around 70,000 hectares – in which an undisturbed forest will evolve autonomously, renewing and developing its fauna and flora over a period of several centuries, totally free of human intervention. This area, which has yet to be identified, will be cross-border, with a French base. «A primary forest is a forest that has not been cleared, exploited or modified in any way by human intervention. It is a jewel of nature, a true pinnacle of biodiversity and aesthetics. Its action as a carbon sink, climate regulator, biodiversity reserve, means of water replenishment, etc. gives it inestimable value. A primary forest is far more beautiful and richer in life forms than a secondary, degraded, impoverished forest. In Western Europe, these "managed" forests have gradually replaced primary forests. It is estimated that it takes 1,000 years to create a primary forest from bare soil, and about 800 years from a secondary forest. The last primary equatorial forests are found in the Amazon, the Congo Basin and Indonesia. All are in alarming decline. In Europe, since 1850, they have all but disappeared, the remarkable Białowieża primary forest in Poland being the only one remaining. Unfortunately it too, now, is in great danger. From the outset, the project has attracted widespread support and approval, with several foundations and associations now backing us. It's not a question of money, though, as the whole idea is to do nothing! 70,000 hectares is a square measuring 26 kilometres on a side, it's not huge. It's the size of the Mediterranean island of Menorca. One aspect I want to talk about is time. It takes a thousand years for a primary forest to fully develop. So everything will depend on the age of the forest that we find on our site. If, as I hope, it is 300 or 400 years old, then it will be six centuries short of becoming truly primary. That's not a very long time and it depends entirely on the trees. The oldest tree in the world is 43,000 years old."

Recreate a primary forest in Europe: The ambitious project of the famous botanist and biologist Francis Hallé looks centuries into the future!

«I share the conviction that primary forest is the best-known means of combating climate change, soil impoverishment and the erosion of biological diversity»

Francis Hallé



“[...] I would say that what matters in saving the rainforests is not so much that we need them right now, but that we need the human qualities necessary to save them; for it is precisely these qualities that we need to save ourselves.”

Francis Hallé (Le radeau des cimes)

HOPE ACCORDING TO FRANÇOIS HALLÉ

“The revival of a large primary forest in Western Europe is both necessary and possible. It is purely a question of will. Forests provide a key solution to global warming through their ability to remove and store carbon, via both their life cycle and storage in soil. Forests help to rebuild and protect a valuable reservoir of biodiversity, home not only to small and large mammals, but also to insects, fungi, cavity nesters and an immense variety of plant species. Firstly, we have to let the pioneer trees grow – these are seeds that can only germinate in full sunlight. They will be left to die and will be replaced by post-pioneer trees that will live for 3 to 4 centuries before the trees of the primary forest develop, forming the closed canopy. Although we think of oaks or beeches in our forests, climate change may mean that the forest develops with trees not found in Europe at present. In all, from bare soil, the whole process should take about 10 centuries, a little less if you start from an old forest. As for biodiversity, everyone remembers the explosion in biodiversity that occurred during the confinement... We will be surprised by the speed with which it returns to its state of abundance.”



Born in 1938, Francis Hallé simply – and modestly – announces on his website that he “has two scientific specializations: the ecology of tropical forests and the architecture of their trees.” You have to check Wikipedia to discover the scope of his work (some twenty books published):

“PhD in Biology from the Sorbonne, and a second PhD in Botany from the University of Abidjan. A former professor of botany at the University of Montpellier, he specialised in the ecology of tropical rainforests, moving to tropical regions to study primary forests. After a first period, from 1960 to 1968, in the Ivory Coast, where his children were born, he went on to the Congo, Zaire and Indonesia. From 1964 onwards, he specialised in studying the architecture of vascular plants. Driven by a constant desire to protect plants against damage, he was the originator of the Radeau des Cimes, a novel system designed to study the canopy of tropical forests, for which he directed scientific missions from 1986 to 2003. Numerous researchers from all disciplines and all corners of the world have stayed on the Radeau des Cimes; among other things, research into this biotope has increased assessments of biological diversity (the number of species living on Earth) tenfold. He notes that our knowledge of plants is far from complete, as the training of biologists still takes a zoocentric approach that focuses on humans and animals. He is a fervent defender of primary forests, i.e. forests that have never known human intervention. He stresses that, today, while primary forests only represent 5 to 10% of terrestrial forests, they constitute over three quarters of the planet’s biodiversity reserves.

Read Francis Hallé’s manifesto “Pour une forêt primaire en Europe de l’Ouest” (Recreating a primary forest in Western Europe) published by Actes Sud

INTERVIEW WITH FRANCIS HALLÉ

2022 will mark the 30th anniversary of the Rio Earth Summit, and the latest IPCC report can do no more than to describe climate change as a simple “emergency”. With the benefit of hindsight, how do you explain the fact that despite all the increasing awareness of and multiplicity of discussions on environmental issues, worrying signals are continuing to accelerate apace?

“We need to distinguish between people. There are those who really want to help protect the environment, and those who see the environment solely as a resource. Unfortunately, the latter are far more powerful than the former.”

“[...] There are those who really want to help protect the environment, and those who see the environment solely as a resource.”

In the words of Antarctic explorer Robert Swan: «The greatest threat to our planet is believing that someone else is going to save it.»

“Absolutely. The greatest danger is indifference. In my particular field, forestry, I don’t understand the attitude of the timber industry; this excessive exploitation guided solely by economic interest. I don’t believe in labels either, especially in the tropics: you cut down a primary forest to replace it with pine trees, and you get the FSC label. I’ve long been convinced that this is purely a mask for dubious commercial practices.”

Was it you who said that if aliens arrived on Earth, they would be more attracted to the intelligence of plants and trees than to that of humans?

“I didn’t say that, but I recognise my ideas. The reality is that plants improve their aerial and subsurface environments, and they regulate their demography very effectively. One touching example is that of a certain ‘shyness’ in trees. Discussed since the 1920s, Australian researchers in the 1960s nicknamed this phenomenon «crown shyness». There are around a hundred types of tree, including pines and fagaceae (beech, oak,

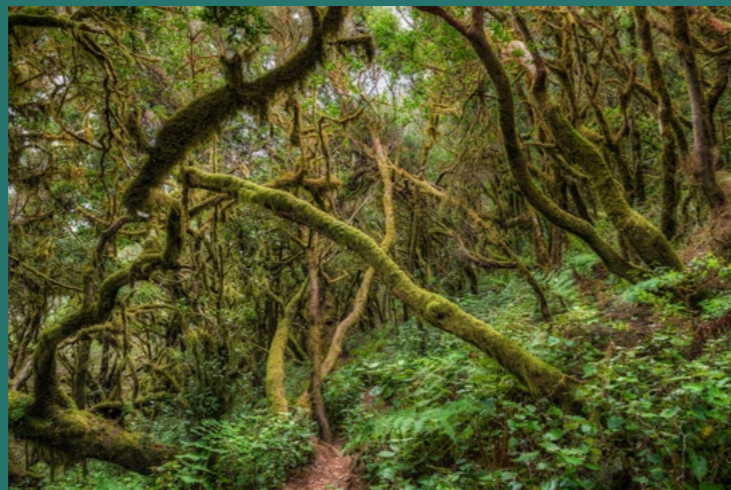
chestnut, etc.), which behave in this way and carefully avoid intertwining their branches. Certain species of tree also demonstrate root shyness, and likewise carefully avoid them meeting. To do this, trees need to communicate with each other... and therefore share information. Trees know if they have a neighbour, and if they are of the same species. If they have no neighbours, they tend to grow indefinitely. Plants are not only intelligent, they are also capable of solving the problems they face, particularly in the struggle for their survival and well-being... We still maintain a form of prejudice towards the plant world that was shaped by Aristotle, who distinguished between three kinds of soul: intellectual for humans, sentient for animals and vegetative for plants. Our vocabulary reflects how dismissive we are of plant life, compared with that of the animal kingdom, as seen in the terms ‘vegetable’, ‘vegetative state’ or ‘plant’, often used in a pejorative sense...”

“We still maintain a form of prejudice towards the plant world that was shaped by Aristotle [...]”

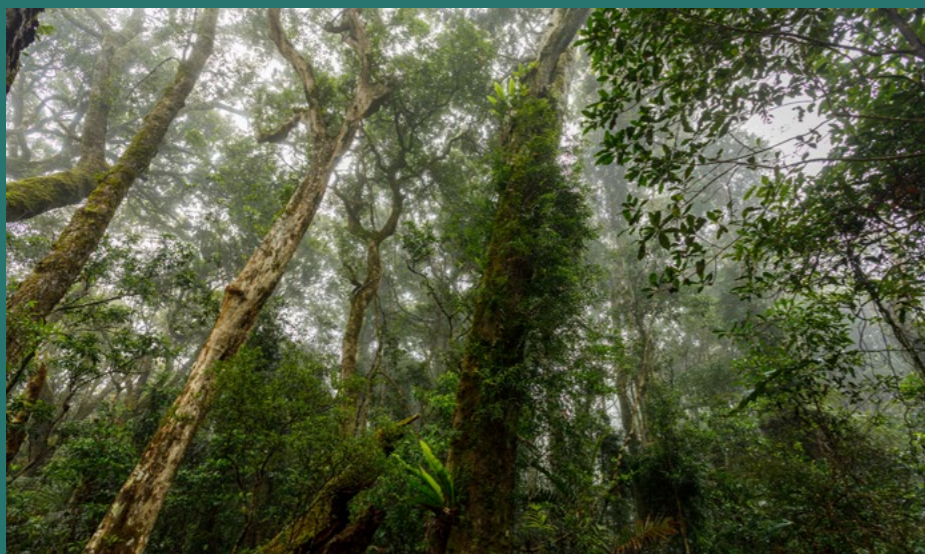




Amazon rainforest, Yasuni National Park, Ecuador



Lauriferous forest, Garajonay National Park, La Gomera, Spain



Antarctic beech trees, Tullawallah, Australia

People say that we have around 30 years left in which to turn things around. Your primary forest project looks ahead to a thousand years from now. Rather like a visionary forest cathedral builder, you're banking on the long term; is that because you're an optimist?

"I am an optimist, yes. What I'm proposing doesn't involve high costs. Despite the political world's lack of understanding of environmental issues, especially concerning primary forests, our project has been welcomed by the European Commission. It's an international project that involves a collaborative effort as I didn't want it to be led by a single State. We are studying 5 areas in France, Germany, Belgium, Italy and Switzerland... The forest – a primary lowland forest – will straddle at least two countries. We also have private partners..."

Your project highlights the importance of biodiversity.

"Not just biodiversity. Resilience is important too: a primary forest doesn't burn down, and parasites can't get a hold there either. And it's also extremely beautiful! I find it sad that neither biology nor ecology take aesthetics into account. They ignore the concept of beauty because it can't be quantified. And yet, we can't quantify scientific intellect either... I'm convinced that all those who have chosen the field of biology were initially inspired by beauty; but they don't talk about it any more, as if they'd forgotten. I would like the notion of beauty to be an integral part of biology and ecology! Unfortunately, though, this is an opinion not shared by academia. During our studies, we were always discouraged from taking an interest in beauty, with our professors at the Sorbonne telling us to beware of «subjective feelings» that could «distort our reasoning». In their opinion, the consideration of beauty was OK for children, artists and poets, but certainly not for scientists. We need to free ourselves from the shackles of strict measurement and rediscover sensitivity!"

Your project also makes sense because primary forests are disappearing.

"There are hardly any left. In strictly economic terms, it's the most precious thing there is, which explains their disappearance... We don't plant precious wood, we find it in primary forests."

What do you think of the trend for planting trees, i.e. if you buy a new phone, we'll plant two trees, and save the planet...

"It's better than felling them, but it's not really the best approach; you can't compare a forest with a plantation. Planting fast-growing trees for good wood is one thing. But it's not a forest, it's a plantation of identical trees of the same age. Yet people are led to believe that this is a forest. When people talk about the pine forests in southwestern France, they are seriously mistaken: one million hectares of maritime pine in the Landes region do not constitute a forest. It is my firm opinion that forests should not be managed by the Ministry of Agriculture. There's nothing wrong with «plantations» staying within its remit, but natural forests should come under the banner of ecology."

You're the only person really speaking out on the issue of primary forests...

"That's because our contemporaries have never seen one, especially in Europe. I've spent my life in the primary forests of the tropics. The last remaining primary forest in Europe, Bieloweza, is in grave danger because, here too, its spectacular oaks attract economic exploitation... Our project covers an area equivalent to Bieloweza, 70,000 hectares. A word here on the 1,000-year timeline you mention; yes, it would take 1,000 years if we were to start from bare soil, but we're starting from forest soil, meaning that it will take several hundred years less."

Would you describe your project as a sort of sanctuary?

"Absolutely not! It's going to be open to everyone, a living museum for people and scientists. This is an essential point – we're not putting it under a bell jar; we want people to visit it as they would a national park..."

Beyond nation states and their governments, do businesses have a role to play in repairing the planet?

Possibly, yes. But I always ask for proof. We've had to part ways with financial partners because they were using us for greenwashing purposes, thus making us more suspicious of others... When it comes to climate change and humankind's ability to reverse the trend, I have my doubts, yes. But to hide behind one's doubts and do nothing is the worst possible approach: it means letting the other side win. Every action counts, no matter how small!"

“I've spent my life in the primary forests of the tropics.”



The Soil, a Treasure for All Humankind

Industrial farming's impact on the environment, and the massive scale of its development faced with the need to feed a growing global population, will be the major challenge in the years ahead: this observation is creating a new agronomy, committed to innovating for a sustainable agriculture that respects the planet and its resources.

“Our use of chemicals and machinery has led us to believe that the soil will keep on giving....”

THE SOIL, A TREASURE FOR ALL HUMANKIND

With its slogan «healthy soils for healthy lives», used in its campaign in 2015, declared by the United Nations as the «International Year of Soils», the FAO (Food and Agriculture Organisation) sought to raise global awareness of the fact that soils, probably one of humanity's most precious assets, are at the crossroads of the major issues of our time: food security, food quality, water, air, the environment and the climate. In short, life itself! While that was nearly 10 years ago, it's now more relevant than ever, especially in terms of reducing our reliance on chemicals and crop protection products in farming. The government has since implemented a series of measures, the Eco-Phyto plans, recently somewhat undermined by the 10-year extension for EU glyphosate use. It is therefore vital to identify alternative solutions. The massive efforts needed to clean up our soil and water are a crucial challenge to our existence as a whole.

Soils are also teeming with beneficial biodiversity. Even more so than on land.

More than a quarter of all living species on Earth are thought to live in the soil. Soil organisms are of inestimable value: they break down organic matter, form soil, are vital components of the cycle that supplies plants with all the nutrients they need, and so on. They also contribute to the composition of the atmosphere, to water quality, to the control of plant parasites and diseases, and even human illnesses: take penicillin for instance, a critically important antibiotic for human health, originally synthesised by a fungus of the genus *Penicillium* that grows extensively in the soil? Here too, we increasingly use terms found in microbiome research.

From microbiota to soil microbiota

Pathogenic bacteria represent only a small portion of the bacterial population with which we interact, most of which are beneficial to our health. This has made the microbiota a hot topic in the mainstream press in recent years, especially regarding its gut and skin versions. Humans have several different microbiota: pulmonary, vaginal, skin and gut. The gut microbiota, containing 100,000 billion microorganisms, is the most important and plays a fundamental role

in our digestive, metabolic, immune and neurological functions. Current research is revealing that its balance is central to our health, with the efforts to understand it revolutionising the medical world and ushering in a new era of prevention and treatment.

The major role played by soil microbiota

The soil microbiota consists of all the microorganisms (bacteria, fungi, etc.) living in the soil. Two types of soil compartment can be distinguished: bulk soil free of any direct influence from plant roots, and the rhizosphere, i.e. the area of soil close to the roots, closely linked to the root system and affected by plant metabolisms. Microorganisms in the rhizosphere maintain close relationships with plants. The soil microbiota therefore plays a major role in maintaining soil health through a range of activities and complex interactions with plants. It helps to structure the soil by producing organic molecules, or by bacteria that help to form aggregates that aerate the soil and allow water to pass through, making the soil more favourable to plant development.

The fermentation process opens up a vast field of applications

Louis Pasteur's discovery of microbes in the 1870s is one of the most famous pages in the history of science. By proving the theory of the microbial origin of diseases, he transformed the way we think about human health, and literally revolutionised 19th century scientific endeavour in the fields of biology, medicine, health and agriculture. Pasteur also proved that microorganisms were responsible for the fermentation process, opening up a vast field of applications that still resonates today in biotechnologies, right up to their environmental innovations. Nowadays, microbial ecology is a discipline that links ecology and microbiology. It involves characterising the microbial biodiversity of an environment, gaining insight into these microorganisms and how their activities affect other organisms and the environment in terms of general plant development.

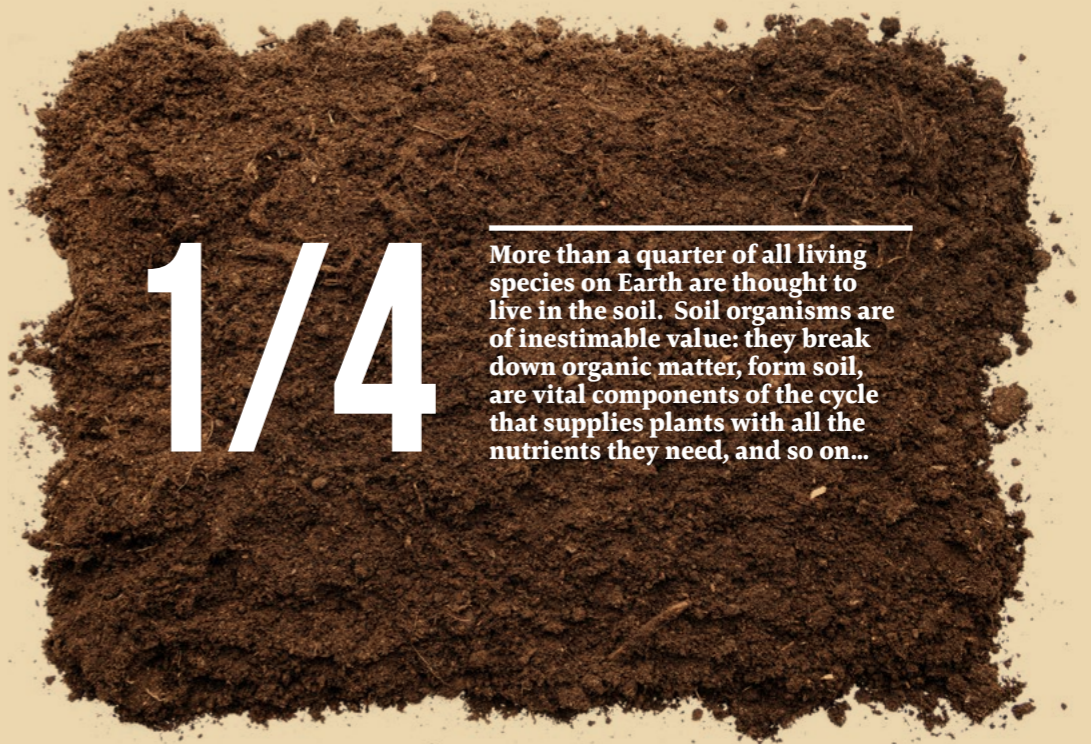
Microbial ecology, the inspiration behind Greencell

Industrial farming's impact on the environment, and the massive scale of its development faced with the need to feed a growing global population, will be the major challenge in the years ahead: this observation is creating a new agronomy, committed to innovating for a sustainable agriculture that respects the planet and its resources. In the search for natural alternatives to chemical fertilisers and pesticides, two particular solutions are coming to the fore: biofertilisation and biocontrol, officially defined as all plant protection methods that use natural mechanisms. Greencell, part of the Greentech group, is a French company championing this microbial ecology, harnessing the power of microorganisms in applications for agronomy, agri-food, health and the environment. Greencell also supports the pharmaceutical industry, cosmetics brands and players in the field of water and soil decontamination, offering in particular specific microbial cocktails that improve the performance of wastewater treatment plants (reduction in foul odours, higher purification yields, lower operating costs, etc.).

“We treat effluent using yeasts, bacteria and fungi, thus reducing sludge production by 30%... In addition to soil microbiota, we are working with gut microbiota in the field of healthcare which, in collaboration with pharmaceutical laboratories, will enable us to offer solutions for Crohn's disease. Our research also focuses on neurodegenerative diseases such as autism, Parkinson's and Alzheimer's, and their relation to the microbiota.”

“Today's soil resources are literally being depleted through the use of intense farming methods. Constant bombardment with fertilisers and chemical crop protection products has an adverse effect on microbial life, which is crucial to soil fertility and crop health. Our biostimulants impact on soil biodiversity, encouraging the growth of microorganisms and helping them repopulate the soil. This goes beyond the fight against pathogens; our approach here is genuinely holistic! We use non-GMO strains, all isolated in the wild. We have over 500 wild strains, natural organisms that have not been modified in any way. Our products are certified organic, and our processes are green, with very little waste or depletion of natural resources. In terms of microbial ecology, our products promote microbial life and soil balance.”

JEAN-YVES BERTHON



More than a quarter of all living species on Earth are thought to live in the soil. Soil organisms are of inestimable value: they break down organic matter, form soil, are vital components of the cycle that supplies plants with all the nutrients they need, and so on...

“SOIL HAS NO RIGHTS, IT DOES NOT EXIST IN LEGAL TERMS”

Interview with Frédéric Denhez

I read this terrible sentence: soil is naturally despised, because we walk on it...

FD : “Yes, our soil has always provided food, our homes are built on it, but we no longer actually see it as such; this is all the more illogical given that it forms the very basis of our collective memory. Soil, as described in ancient Hebrew, is quoted in the writings of the great religions; soil is both life and death, fertility and punishment: man – Adam – having sinned, was punished with having to plough, sow and harvest to find his sustenance. Soil is a gift, but one that has to be earned, and suffered for. In our very French culture – which often refers to the *droit du sol* in immigration matters – soil itself has no rights, it doesn’t exist in legal terms. It isn’t covered by the environmental code either: the right of use has always provided a basis for the right of ownership, a legacy of the French Revolution, itself based on an aristocratic heritage that states what can or cannot be done with soil. In view of all this, soil as an ecosystem has been relegated to the dustbin of history. Since the end of the Second World War, soil has been transformed into a flat surface designed to produce again and again, whatever is asked of it. Our use of chemicals and machinery has led us to believe that the soil will keep on giving...”

Even people on the front line, such as the farming community, demonstrate a lack of awareness of this, especially in terms of the need to protect living organisms in soil.

FD : “Farmers do what society tells them, with the training they’ve had: soil is a

medium for growing crops, designed to produce; and we’re going to help you with fertilisers, pesticides and tractors. Soil has become anodyne, just as for many years trees were considered an enemy that had to be felled. Naturally, after the war, the country had to be rebuilt and fed, but the intuitive existence that still survived in the 1920s and 1930s is now long gone. At that time, people knew that working the soil too hard with a plough had consequences; soil science – pedology – was born in the late 19th and early 20th centuries in Ukraine, around chernozem, its distinctive black soil, one of the most fertile in the world. This soil had its own intrinsic existence, and was considered best left to itself. In the Russian subconscious, soil is a barricade, an effective defence system that bogged down both Napoleon and Hitler. More recently, the Russian offensive in Ukraine began once the soil could support tanks... Soil science was revived in the 1990s by a new generation of researchers, notably from INRA, since renamed INRAE.”

Biotechnologies applied to agronomy are seizing on this, in particular with the idea of using microorganisms to restore soil health.

FD : “Yes, we’re finally seeing things differently. The day-by-day accumulation of new knowledge is at last enabling us to see soil as it has always been: an ecosystem. In the United States of the 1930s, for example, soil was seen as a calamity: Steinbeck, in his *Dustbowl* trilogy, wrote about soil that should never have been ploughed so drastically, and which, no longer held together by prairie roots, was totally degraded by

drought, leading to the terrible exodus during the Great Depression. This history has had such an impact on American culture that even today, in some states, sheriffs can prohibit certain soil uses. The Indians never ploughed the prairie, they hoed and sowed the seeds. You see these gigantic combine harvesters in the Midwest plains followed by sowers. So you sow without ploughing. That’s what they do in Brazil too...”

Pesticides were introduced in France in the post-war years. In 2023, Europe has just reapproved the use of glyphosate for the next 10 years...

FD : “We know that glyphosate is toxic, mainly for farmers. While the scientific literature has not yet proved its toxicity in relation to the end consumer, there is ample documented proof that it is toxic for microbial life in the soil. The real problem is that we haven’t provided farmers with any meaningful alternative. However, we mustn’t talk about soil death as we sometimes see in the press. Even soil that has been bludgeoned by years of pesticides and ploughing, as in the Beauce region, will resume its natural ecological functioning, based on its stock of microorganisms. This obviously takes time, but we cannot scientifically speak of dead soil. By stopping the mechanical and chemical bludgeoning, by possibly reviving the soil using spores and microbial cocktails, we can get the soil working again. There is no such thing as dead soil.”



What about cities, given all these major regeneration projects?

FD : “Cities have compacted, over-polluted, microorganism-poor soils, which thus restricts a tree’s lifetime; trees need a lot of watering, which is complicated in view of climate change. It takes 15 years to grow a tree that is capable of cooling its surroundings, like a natural climate control system. Today, now that our backs are against the wall, it seems that every city is rediscovering warm water; and every nursery in France is flooded with hundreds of thousands of orders for trees. While the heatwaves have spotlighted the issue, awareness has come late. How can you grow trees in Paris when there’s no soil for it? There are too many buried networks; to grow a tree you need between 10 and 20m³ of soil, and in terms of free surface area you need the equivalent of the surface area occupied by its branches and leaves. A tree in Paris gets just 1m³. We prune it to make it easier to collect the leaves. After 15 years, it will be suffering...”

Here, trees are in boxes; we need to open up pavements and roadways. Trees need their soil to be in symbiosis with the fungi and microorganisms that feed them. A hundred-year-old tree no longer needs to be watered; its connections run deep enough in the soil, with fungi that will find water deep down, in the slightest crevice. It doesn’t even need rain...”

What about soil-water connections.

FD : “60% of surface water is in the ground. 40% is in rivers and lakes and streams, can you imagine? Water-rich soil means porous soil, and porous soil means rich in life, and only lightly compacted. Like prairie soil. And this then makes it an excellent carbon sink. But in cities; Paris, Lyon, Bordeaux, Lille... In France, we’re in the Top 10 countries with the most concrete urban covering. Cities have been designed not around plants, but around minerals, buildings and our cultural heritage.”

In your opinion, as long as cities and urban development are not designed around plants, all these major revegetation projects, islands of coolness, shaded areas... are just short-term solutions.

FD : “If that’s the aim, then yes, plants should be at the heart of the urban project. Even letting grass grow in an urban park would lower ground temperatures. And then there’s the question of reusing water; rather than letting all the water from treatment plants go into the river, why not reuse some of it for watering... Let’s not forget that in France rainwater is considered as a waste product and every effort is made to dispose of it as quickly as possible. We could channel it directly into the ground, after opening up the roadway of course, so that it infiltrates the soil and reaches the water table...”

So what are the obstacles?

FD : “Cultural obstacles, routine

obstacles linked to a given engineering or administrative culture. I did my Masters thesis at the Artois-Picardie water agency. At the time, water was seen as both inexhaustible and hazardous. The first serial killer in history was water, wasn’t it? Whether it’s lacking or polluted, water is a threat. In the Western world, especially in France since Pasteur, stagnant water represents a hazard and must be removed. We’re now beginning to realise that water that has time to soak in isn’t necessarily a problem. We can’t have a sustainable greening policy without rainwater harvesting, which will be complicated in Paris because of the underground networks...”

What remains of the UN International Year of Soil 2015?

FD : “The relationship with soil has evolved in the right direction, towards the common good. I’m seeing more events bringing together stakeholders – scientists, politicians, industrialists, local authorities – around the issue. And I have high hopes for the Soil Directive, which will be voted on in July 2023. Basically, Europe is making it a priority to have healthy soils; what’s going to be interesting is seeing how they deal with the constraints. Think of the establishment of biological soil quality criteria, on which land prices and subsidies would be based! That would be a major step forward, despite being a constraint.”

So, there is hope then...

FD : “Yes, the main issue lies in explaining our fundamental dependence on an element that is under our feet, that we don’t really see, but that is a living entity, with limited quantities, and that is less renewable than water. For instance, excavated soil is dumped in landfill sites; it’s just lost – it’s an appalling waste. The massive transition to agro-ecology is going to cost a lot of money, and the farming world needs to be helped accordingly...”

“The massive transition to agro-ecology is going to cost a lot of money and the farming world needs to be helped accordingly...”



Frédéric Denhez trained as an environmental engineer and is the author or co-author of around fifty books on environmental issues. A freelance journalist, he has long worked for Géo, National Geographic France and Ça M’intéresse magazines, and now writes for Marianne. For a dozen years Frédéric was a columnist for CO₂, mon Amour (France Inter), Ushuaia TV Le Mag and Le Magazine de la Santé (France 5). He is a regular guest on France 5, France Info, Public Sénat and BFM. For several years now he has been writing television programmes, including the series L’écologie près de chez nous for Ushuaia TV, which he also presents, and the short programme À la source for France Télévisions. Marianne broadcasts his L’idée à la con mood piece three times a month on the MarianneTV channel. His books on soil (Cessons de ruiner notre sol, and Le sol, enquête sur un bien en péril, both published by Flammarion) have had a major impact. Frédéric hosts the successful monthly webinar C dans l’sol and presents Portraits de Sols.

“The tree needs its soil to be in symbiosis with the fungi and micro-organisms that feed it. A hundred-year-old tree, for example, no longer needs to be watered.”

To achieve sustainable tree growth in cities, trees need to be at the very heart of urban development, not on the outskirts.

SOIL GIVES A TASTE FOR LIFE

pesticide transition,
let's start with the soil!

Soils have been abused by 70 years of intensive agriculture and massive pesticide use. However, operational alternatives now exist. To better understand what's at stake, and to get you started on your transition to phytosanitary farming, we're offering you an exclusive, practical training course to follow online, at your own pace, starting today!

Reducing the use of pesticides is a strong social expectation. Above all, it is a necessity if we are to preserve health and biodiversity, and provide healthy food in the long term. Between increasingly vague regulatory constraints and sometimes contradictory information, it's not easy to find your way around.

So how do you get started? By understanding soil. As the primary resource for food production, soil is a fundamental element for mankind, essential for life. And yet, astonishingly little is known about soil, even by those who use it directly on a daily basis, the farming professionals.

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