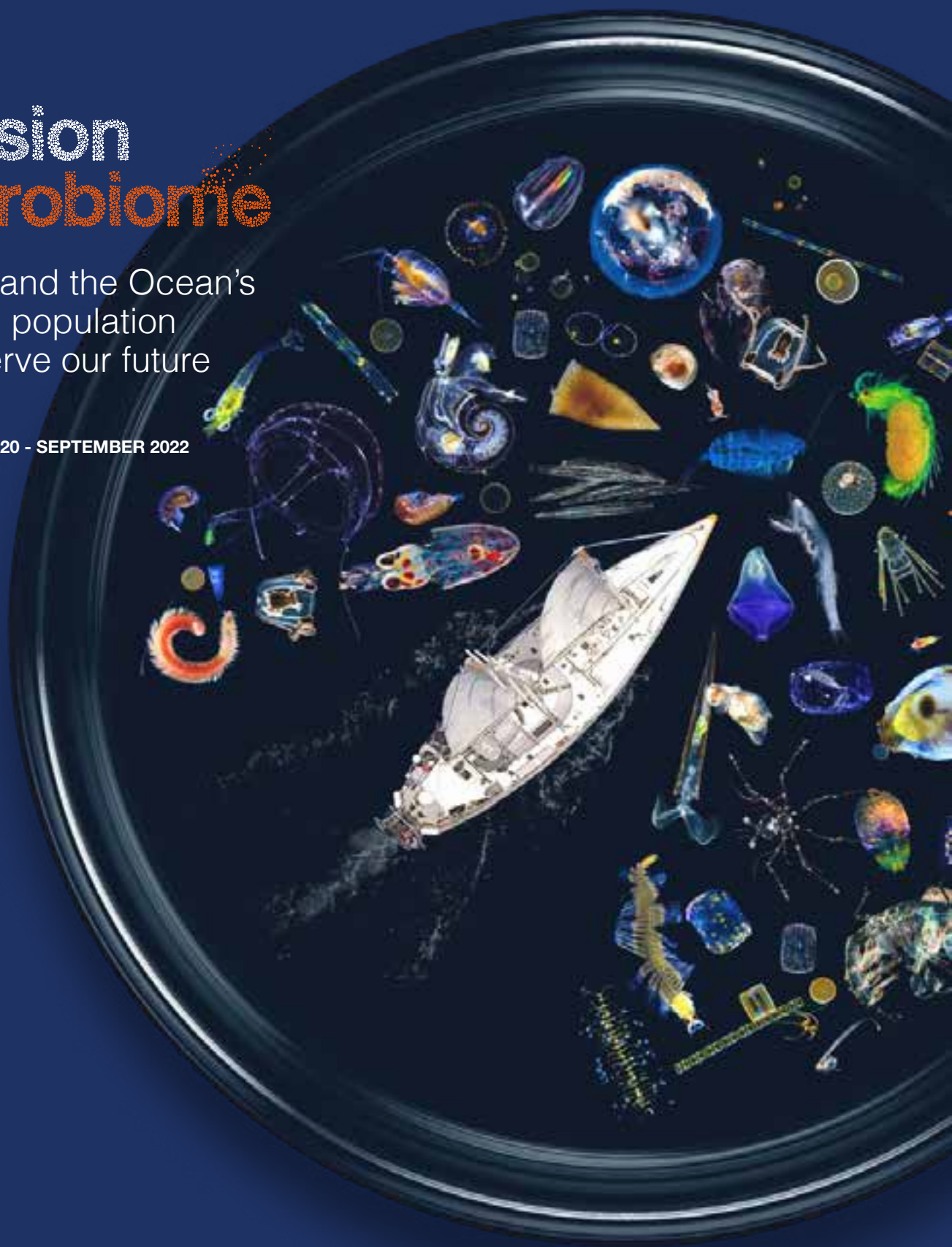


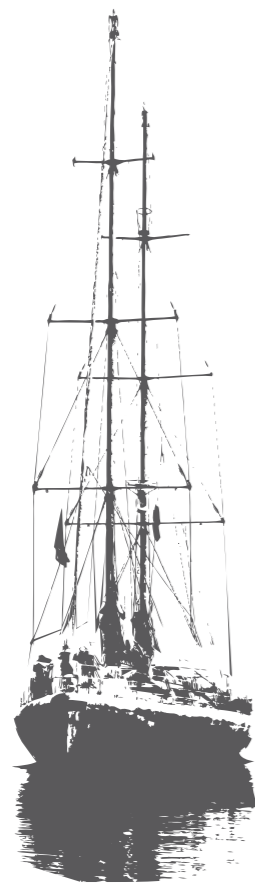
Mission Microbiome

Understand the Ocean's
invisible population
to preserve our future

PRESS KIT
DECEMBER 2020 - SEPTEMBER 2022



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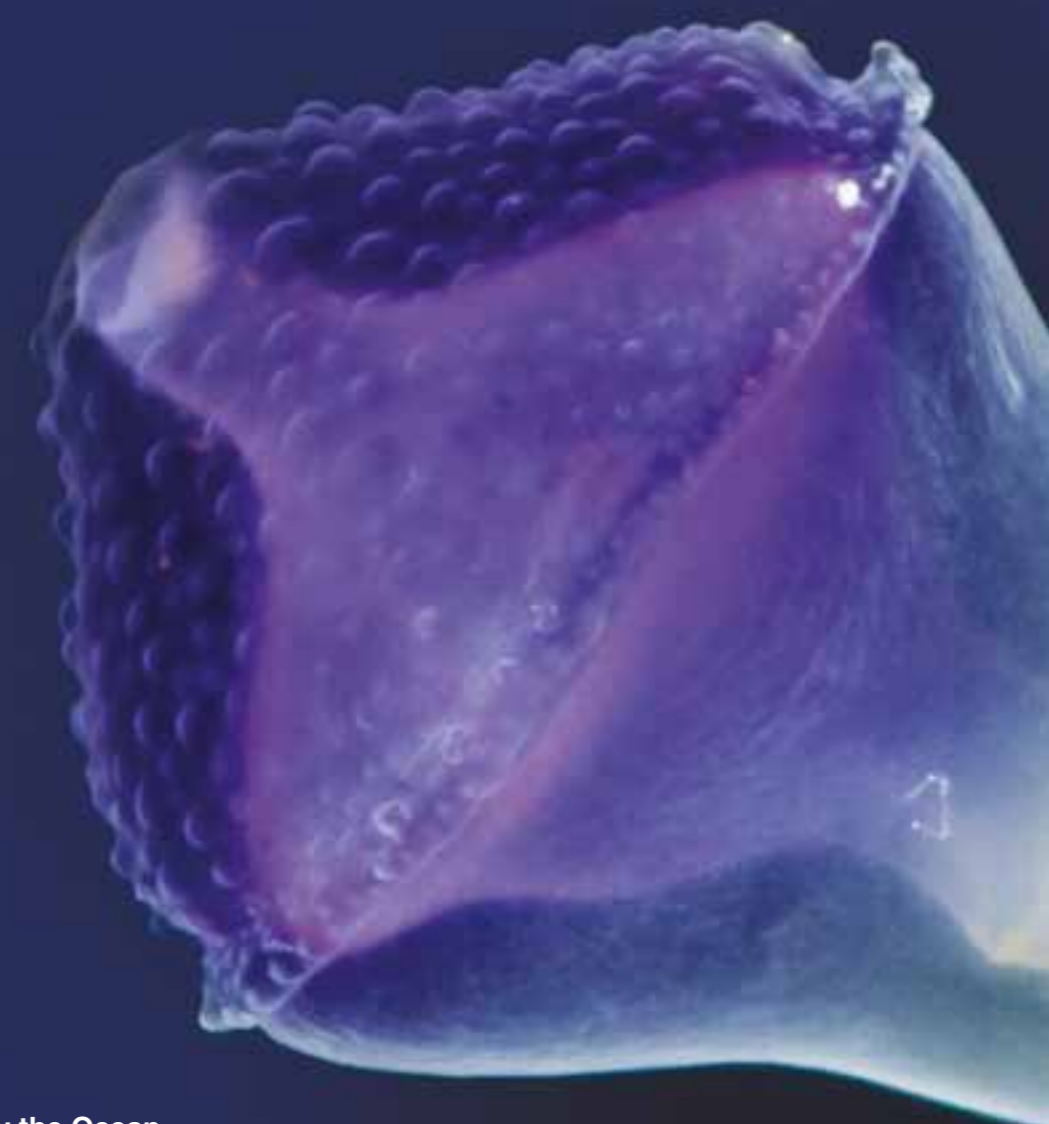
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ROMAIN TROUBLÉ, EXECUTIVE DIRECTOR OF TARA OCEAN FOUNDATION

Over the past fifteen years, the Tara Ocean Foundation has continued, mission after mission, to push the boundaries of our knowledge on the largest and most important ecosystem of our planet: the Ocean. Tara Oceans has revealed over 150 million planktonic genes and 95% of known marine viruses. Tara Mediterranean and Tara Microplastics shed light on the dramatic consequences of plastic pollution at sea and its origin. The 50,000 samples collected during Tara Pacific are allowing us to decipher the impact of climate change on coral reefs.

It is now clear that all these issues are intimately linked, like so many cogs in a single machine. After having identified, studied and deciphered each of these cogs, this new mission will have a global approach and treat the oceanic ecosystem as a whole. To do this, we need to get back to basics, to the primary actor present in all facets of this ecosystem, its most fundamental basis: the microbiome. A world that is both microscopic, immense and unknown, the first link in a long food chain, but also a crucial player in climate regulation, which is all subject to numerous external pressures such as plastic pollution and rising temperatures. Studying how all of these questions fit together is very exciting and becomes essential to understanding how the whole system behaves and will react to the changes we inflict on it.

This two-year expedition deep into the microbial world obviously takes on a special dimension in the midst of a global pandemic.

The health crisis we are experiencing forces us to face our ignorance of this world, as we find ourselves so helpless in the face of an unknown virus. Historically, humans have only really studied the microbes that attacked them, *a posteriori*. Now is the time to take control: the more we know what the microorganisms of our planet look like and what their roles are, the more rapid responses we will have for likely future crises.

This mission also reminds us that beyond certain viruses and bacteria which sometimes strike us hard, a multitude of microorganisms - especially oceanic ones - are in fact essential to our well-being. Just as we couldn't live without the billions of "friendly" microbes inhabiting our bodies, our planet would not be viable without the presence of the marine microbiome which regulates its balances. However, the microbiome is now subject to worrisome threats - global warming, various pollutions - with unknown consequences. It's up to us to dive into this little-known world before it's too late.

ÉTIENNE BOURGOIS, DIRECTOR OF TARA OCEAN FOUNDATION

Since acquiring the schooner in 2003, I've wanted to give Tara her initial role back: to sail the icy polar seas and Ocean for scientific purposes.

This family project, supported from the start by agnès b., was conceived by a group of faithful friends who, over the years, have remained very involved. Since then, many loyal partners and donors joined the adventure, and Tara grew to become in 2016 the Tara Ocean Foundation, the first French group dedicated to the Ocean, recognized for its benefit to the public..

This is the passion of my life, along with the sea and the boat. The Foundation is the culmination of all the extraordinary adventures shared with sailors, scientists, the general public and with future generations.

I wanted long missions because fundamental research takes time. Tara Arctic, Tara Oceans and Tara Pacific, major expeditions have followed one another, and the schooner has sailed the seas of world. Scientists embrace the Foundation's projects and vice versa: from the start, everything has gone as if Tara's story were completely natural.

Today, the Tara Foundation is mobilized more than ever. We will continue carrying out these long missions and collaborating with artists, because I like to see people from different backgrounds mix together. And above all, I believe in sharing. It would be wonderful if in the future there were other Taras. This may be utopian, but it's important to have a much larger project, bringing together private and public enterprises - a project that is not limited to one boat, because urgencies are immense and time is pressing.



*Stéphanie Thiébault,
Director of the Institute of Ecology
and Environment, CNRS*

© CNRS / Délégation PMA

WHAT DOES THE OCEAN PROVIDE FOR THE PLANET ?

Many things. The most obvious is Life itself. Even today part of the world population feeds almost exclusively on seafood. Likewise, fish, crustaceans, marine mammals - all feed on marine microorganisms which provide their basic nourishment. Beyond food, the role of the Ocean is vital: it allows humans to live on planet Earth. The Ocean captures carbon dioxide and produces half of the oxygen we breathe, thus making the planet livable.

ARE WE AWARE OF THE OCEAN'S IMPORTANCE ?

Overall, no. We are starting to see the emergence of a new awareness, but it's still modest, even at the highest level. In 2015, when the United Nations adopted the 2030 Agenda with specific Sustainable Development Goals, the Ocean did not receive sufficient attention. It was only in 2017 that the United Nations gave the Ocean the place it truly deserves.

WHY IS RAISING AWARENESS TAKING SO LONG ?

We know that the Ocean is intimately linked to climate. It is one of the keys to understanding the impacts of climate change, but there are still too many unknowns regarding the mechanisms involved. Research is surprisingly lacking in long-term observational and experimental data, which is why the Tara missions are so crucial. They provide fundamental knowledge for understanding and anticipating changes to come. They also contribute to developing tools necessary for raising society's awareness of the Ocean's capital importance, and the need to preserve it.

The Ocean provides for planet Earth

Microbiome : the invisible world



Chris Bowler,
Scientific director of the Tara Oceans Consortium, director of the Tara Ocean Foundation's scientific committee, CNRS research director and co-director of the Tara Microbiome mission

© Tara Ocean Foundation: Chris Bowler

Until recently, some researchers referred to microbiome as the living environment of microorganisms; others, as their genome. Then, last June, dozens of specialists worldwide finally published¹ a clear definition : a microbiome is a microbial community evolving within a well-defined habitat - the term therefore refers to both the microorganisms and their habitat. That is why the new Tara Microbiome mission is about much more than just fishing "microbes". In addition to marine microorganisms, the physical and chemical parameters of seawater (temperature, salinity, acidity, oxygen levels, etc.), as well as the concentration of pollutants, nutrients and plastic waste will also be studied.

Precisely, what are these ocean microbes ? « *They combine a significant portion of plankton, i.e., all organisms drifting with marine currents, except small animals composed of several cells* », explains Chris Bowler, co-director of the Tara Microbiome mission, scientific director of Tara Oceans Consortium and director of the Tara Ocean Foundation's scientific committee. « *In summary, the ocean microbiome represents all unicellular life in the oceans, including viruses, even though strictly speaking, they are not part of the living world.* » In addition to the millions of viruses inhabiting the oceans, the Tara Microbiome mission will also study bacteria, microalgae and protists - unicellular organisms that are neither animals nor plants.

Although invisible to the naked eye, all these organisms play a key role in the ocean ecosystem, since this microbiome represents over two thirds of the ocean biomass.

Four times the cumulative biomass of all insects on Earth!

The task proves both daunting and essential, Chris Bowler emphasizes. « *We now have a clear understanding of the composition of the ocean microbiome. In contrast, we know very little about its functions. In other words, the question is not so much about "what's there ?" but rather "which microorganism does what ?". As long as we don't know how the microbial community works as a whole, it's difficult to predict how the ocean will react to changes, such as rising temperatures.* »

One thing is certain though: this microbiome plays a key role in the functioning of the entire ocean ecosystem. As a first link in the food chain feeding a good part of humanity daily, the ocean microbiome is also an essential component of the climate machine. Through photosynthesis, like forests on Earth, microalgae and cyanobacteria capture the carbon dioxide dissolved in seawater to produce oxygen, then release it into the atmosphere.

The microbiome's health status, distribution across the world oceans and composition affect the entire ocean ecosystem, and therefore our planet's climate. « *We can make the connection with the human microbiome, the billions of microorganisms living in our gut* », Chris Bowler says. « *This microbiome is essential to our health, affecting our digestion, resistance to pathogens, and even our psychological well-being! Without it, we would simply not survive. It's the same for the ocean: its microbiome is absolutely crucial.* »

Yet, while the human microbiome is now well studied, its ocean counterpart remains largely unknown: the functions of over 60% of the microbial genes present in the ocean are yet to be discovered. The goal for nearly 200 of scientists involved in the Tara Microbiome mission is to unveil many secrets of the invisible world in the years to come.

¹ Berg et al., Microbiome definition revisited: old concepts and new challenges. Microbiome (2020)

The science behind the Tara Microbiome mission

Through studying the ocean microbiome as a whole – microorganisms, viruses, physical and chemical parameters, nutrients, pollutants, etc. – **the Tara Microbiome mission will explore the complex mechanisms behind each of the major functions that make this ecosystem essential to our planet: oxygen production generated through photosynthesis by microalgae and cyanobacteria, carbon sequestration by these organisms, interactions with the major ocean biogeochemical cycles (iron, nitrogen, etc.) and finally production of organic matter at the base of the entire marine food chain.**

The mission scientists will multiply sampling stations in various environments and along localized phenomena (oxygen-depleted zones, upwellings rich in nutrients, temperature gradients, etc.) to observe how the ocean microbiome behaves in a changing environment. "The ocean microbiome is very sensitive to changes in its living environment, whether they result from the introduction of pollutants or variations in water temperature" says Daniele Ludicone, a researcher at the Stazione Zoologica Anton Dohrn (Naples, Italy) and scientific co-director of the mission. **« Most of our scientific questions are linked to climate change, and how the ocean microbiome will respond to environmental disruptions. The answers provided by the Tara Microbiome mission will help improve prediction models that attempt to assess climate change in the medium- to long-term. »**

To gather as much data on microorganisms and their living environment as possible, each sampling station will mobilize a wide variety of tools and equipment, relying on the expertise and protocols developed by scientists in the Tara Oceans Research Federation - GO-SEE² for over a decade. Organisms will be collected through nets of different mesh sizes, submerged down to 1,000 meters deep and using Niskin bottles on a rosette. Immersed from Tara's rear deck, this 250 kg aluminum structure sinks vertically in the water column and collects up to 10 samples per dive. Each of the 10 sampling bottles can be closed at a given depth. The rosette also continuously measures many physical and chemical parameters, such as pressure, temperature, water conductivity and oxygen content. Additional data can also be collected from the surface, such as the amount of light, characteristics of currents and the presence of "trace elements". « For example, iron and cobalt are rare nutrients present in small amounts in the environment, but particularly important for marine life », Daniele Ludicone says. Finally, microplastics and microorganisms living on them will be collected on the surface using a specific net, called Manta, and in the air by sensors set up several tens of meters high.

« In contrast to previous expeditions where Tara's scientists intended to identify marine biodiversity wherever the schooner was, this time we will adapt protocols to target key issues and characterize specific phenomena », the scientific co-director of the expedition points out. « In some areas, sampling stations will be very intense and last 1-2 days, for instance, to monitor a local phenomenon which varies rapidly in time, whereas in other zones, protocols can be simplified to carry out a large number of consecutive analyzes ». This adaptive protocol allows us to explore in detail, and for the first time with such a multidisciplinary approach, the impact of several ocean phenomena on the microbiome. Different challenges, but all leading to the same question : how do current changes, including onshore activities, impact the ocean microbiome, and at the same time, the oceans worldwide and the Earth's climate ?



Daniele Ludicone,
Researcher at the Stazione Zoologica Anton Dohrn (Naples, Italy) and co-director of the Tara Microbiome mission

© Tara Ocean Foundation: Daniele Ludicone



Colombar de Vargas,
CNRS research director, director of the Tara Oceans Research Federation - GO-SEE, and co-director of the Tara Microbiome mission

© Tara Ocean Foundation: Colombar de Vargas



Chris Bowler,
Scientific director of the Tara Oceans Consortium, director of the Tara Ocean Foundation's scientific committee, CNRS research director and co-director of the Tara Microbiome mission

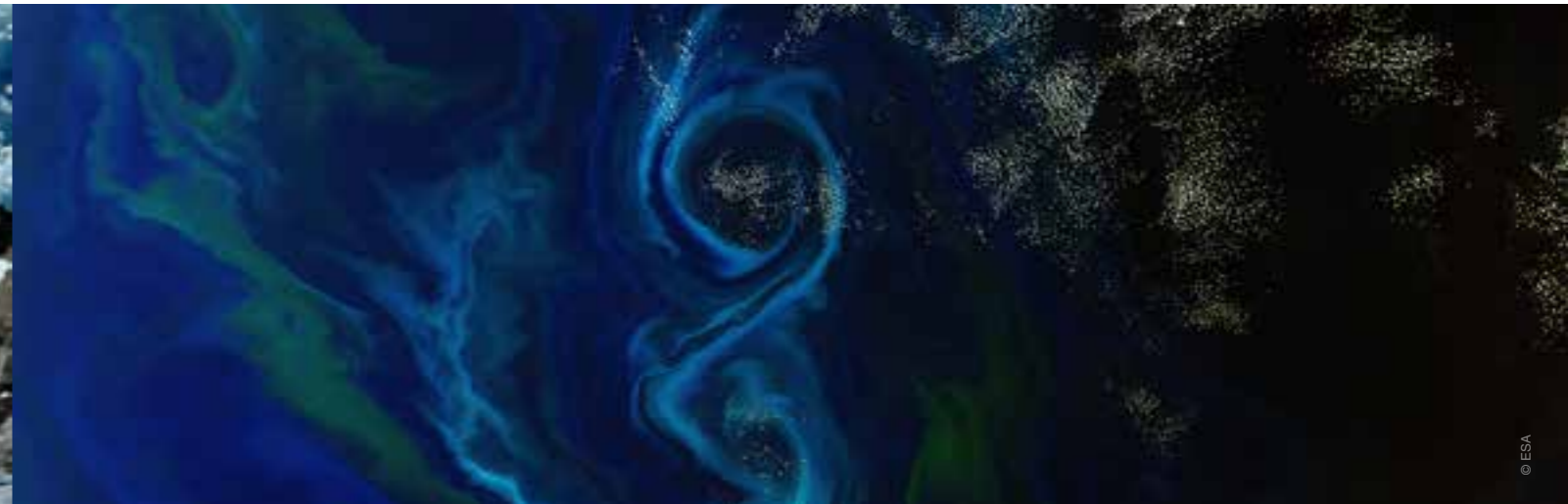
© Tara Ocean Foundation: Chris Bowler



Stéphane Pesant,
Senior marine biocurator at the European Molecular Biology Laboratory - European Bioinformatics Institute (EMBL-EBI) and scientific operations manager of the Tara Microbiome mission

© Tara Ocean Foundation: Stéphane Pesant

² The Tara Oceans Research Federation - GO-SEE involves in particular the CNRS, the CEA, the Tara Ocean Foundation, Sorbonne University, PSL University, INSERM, ENS Paris, IRD, EPHE, the Université d'Évry-Val-d'Essonne, Paris-Saclay University, UPVD, AMU, the University of Toulon, Ecole centrale de Nantes, the University of Nantes, UGA, EMBL and the Faculty of Physics and Mathematics at the University of Chile.



HOW DOES THE LAND FERTILIZE THE OCEANS ?

The ocean microbiome, and more broadly marine life, is dependent on the presence of basic nutrients. « *This is particularly true for iron, a rather rare element in the ocean that limits the expansion of local marine life* », Daniele Iudicone says. « *In some regions, the intake of such nutrients from rivers, especially large ones like the Amazon River or the Congo River, is crucial* ». Besides these 2 great rivers, 4 other rivers will be studied in Africa. For each of them, samples will be collected in the river, its estuary, and along its plume that sometimes extends hundreds of kilometers into the ocean. On the Chilean west coast, Tara will also sail up the many fjords of Patagonia to

study the intake of fresh water from glaciers. In the Weddell Sea, a key zone for climate bordering Antarctica, nutrients supplied by icebergs will be investigated, as well as the powerful carbon pump linked to currents and the rich biomass of this sea. Finally, the mission's route will cross 3 of the largest *upwellings* of our planet - waters rising from the deep, loaded with nutrients - that are essential for ocean fertilization.

HOW DOES CLIMATE CHANGE DISRUPT OCEAN CURRENTS AND MICROBIOME DISTRIBUTION ?

In recent years, several scientific studies have shown the impact of climate change on the strength and pathways of major ocean currents. Ocean currents are essential to marine life, including the ocean microbiome, as Daniele Iudicone points out. « *They are like highways for plankton and microplastics, allowing them to travel immense distances. Currents also affect the distribution of oxygen in the ocean, including that of anoxic zones - oxygen-depleted areas* ». The Tara Microbiome mission will investigate one of these anoxic zones (also called « Oxygen Minimum Zones » OMZs) located north of the coast of

Chile to study its impact on the ocean microbiome. « *We know that oxygen concentration completely changes microbiome characteristics, and therefore all life depending on it: fish, marine mammals, seabirds, etc.* » For the Italian researcher, climate change has therefore a direct impact on animals, but also an indirect and less known effect, by disrupting ocean currents and oxygen distribution.



WHAT ARE THE IMPACTS OF MICROPLASTIC POLLUTION ?

Following the *Tara Microplastics* mission in 2019 which studied plastic waste of a few millimeters in diameter in 9 great European rivers, similar protocols will be implemented in 6 large rivers (including the Amazon and the Congo Rivers) where this issue has hardly been addressed. For the first time on this scale, the study of microplastics will also be extended to the high seas, with sampling carried out along Tara's entire route. « *Just as the Tara Ocean expedition generated massive datasets on plankton, we want to develop a large database on the plastisphere - microorganisms that live on*

microplastics - identifying species, functions, and which genes are present », says Jean-François Ghiglione, CNRS research director. « *We'll also investigate if there's a link between the key species that live systematically on plastics and the rest of the ocean microbiome, especially in areas with high concentrations of plastic waste, since the plastisphere can disrupt major biogeochemical cycles in the ocean, such as oxygen production or carbon sequestration.* »

WHAT IS THE ROLE OF OCEAN CURRENTS ON A SMALL SCALE ?

Medium to long-term impact of climate change is assessed using computer models that simulate atmospheric and oceanic systems and their future development. Unfortunately, these climate models still poorly integrate small oceanic phenomena, Daniele Iudicone says. « *Far from being uniform, the ocean contains a multitude of small-scale phenomena, eddies or small currents for instance, that only last for a few hours or days. Despite their size, these phenomena are particularly important and must be taken into account when modeling climate systems.* » Among other phenomena, the mission will track an eddy in the Atlantic Ocean, between South America and Africa. Once located using satellite imaging, the schooner will follow this eddy, multiplying sampling stations to answer 3 questions: how is such a phenomenon only structured over so few kilometers ? What impact does the eddy have on the concentration of microplastics ? How does it influence the composition of the ocean microbiome ?

Large-scale sequencing



Patrick Wincker,
Director of the Genoscope / CEA.

© Tara Ocean Foundation: Patrick Winckler

Tens of thousands of samples, hundreds of millions of genes, billions of organisms collected. How do you get the most out of this looming mountain of raw data? For this *Tara Microbiome mission* as for the Tara Ocean Foundation's previous major expeditions, this heavy task will fall to the Genoscope, a national sequencing center located a few kilometers from Paris. « We take care of the processing, sequencing and first bio-informatic analyses, using protocols well-established for more than ten years, since we started working on data from *Tara missions* », explains Patrick Wincker, director of the Genoscope / CEA.

Of course, it's impossible to study separately each organism collected in every sample - from a rosette bottle, plankton net or "microplastic trawl". Sequencing is done on an entire sample, providing information about the microbial community as a whole: what organisms are present, what genes they have, what proteins they produce, etc. « Compared to the *Tara Oceans mission*, where plankton was collected from all the oceans of the globe, we will be working in smaller maritime areas, but with more samples », continues the director of Genoscope. « This will let us do deeper analyses, to understand on a much finer scale what these microorganisms do in specific situations. »

Another difference with the *Tara Oceans* mission carried out between 2009 and 2013 : the sequencing speed, which continues to increase over the years, with very high-speed devices and ever lower costs. « In ten years or so, the throughput has been multiplied by at least 100, and this should accelerate further by the end of the mission », explains Patrick Wincker. « We will be able to sequence the totality of samples collected during the mission, which was unimaginable a few years ago. » This will revolutionize our knowledge of the microbiome, as *Tara Oceans* did for plankton: at the time, the mission revealed more than 150 million marine genes, leading to more than 260 scientific publications.

THREE LEVELS OF ANALYSIS

Metabarcoding

Very specific sequences of DNA are targeted. Each genetic barcode is unique to one species. Sequencing a sample in its entirety makes it possible to identify the various species present and draw up a portrait of the entire microbial community.

Metagenomics

Instead of looking at individual microorganisms, metagenomics identifies genes present in the entire sample, as if the microbiome is a single living thing with a single genome. The genes identified thus provide valuable information about the organisms present, as well as their functions.

Metatranscriptomics

Complementing the previous technique, this one examines - via RNA - the genes expressed when the sample was taken. While meta-genomics draws a "genetic potential" of the microbial community, metatranscriptomics looks at how this potential is expressed in a given environment.



FOUR KEY STEPS IN TARA'S JOURNEY (AS EXAMPLES)

CHILE

The first major stage of the mission after a long crossing of the Atlantic, from east to west and north to south, the Chilean coasts will offer the Tara teams 3 subjects of study: fertilization of the Ocean via water from Andean glaciers ; influence of an oxygen-poor zone (OMZ = Oxygen Minimum Zone) on microbiome, and the functioning of the carbon pump in this region which is among the most productive on the planet.

AMAZON

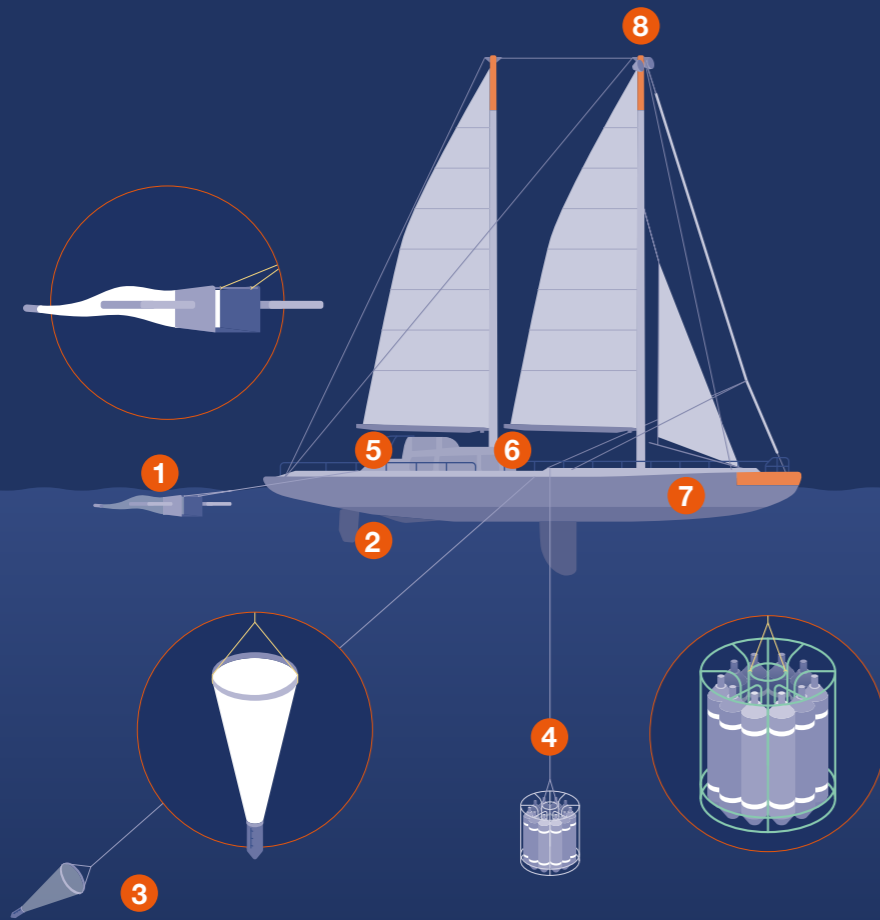
The immense plume of the Amazon brings nutrients and pollutants to the Ocean, at scales that need to be assessed. It also marks the junction between two ocean basins : the North and South Atlantic. This crucial interconnection zone will be sampled at length to understand all its mechanisms, some of which are at the origin of the proliferation of Sargassum in the West Indies.

ANTARCTICA

The oceanic regions surrounding Antarctica are some of the most important for the climate, particularly rich in microorganisms that provide oxygen. There, cold waters plunge down to the ocean floor, drift and eventually form the deep layers of all the world's oceans. The schooner will spend 3 weeks in the Weddell Sea before traversing the Atlantic and heading up the coast of Africa, studying the local carbon pump as well as the effect of icebergs on microbiomes.

WEST COAST OF AFRICA

For the first time, Tara will travel along the western coast of Africa to measure the contributions of 5 major African rivers in terms of nutrients, but also of microplastics, much less studied than in Europe. Researchers aboard the schooner will also look at areas with particular currents in Namibia and Senegal, where upwelling of rich cold water makes them among the most productive marine regions in the world.



EQUIPMENT ABOARD TARA

1 Manta net. Pulled behind the schooner, the Manta net surfs on the water thanks to its two metal wings. By raking the surface in this way, it collects all floating plastic waste, in particular the microplastics on which many microorganisms live.

2 Continuous pump. Water is collected continuously via a pump located under the hull of the schooner, then continuously analyzed on board. Salinity and temperature measurements are used to characterize the different bodies of water traversed.

3 Plankton nets. While the Rosette can only collect a few liters per Niskin bottle, the nets can be submerged to a depth of 1,000 meters, and filter a very large volume of water. Depending on the mesh sizes of the different nets, they collect very specific types of organisms.

4 Rosette. This 250-kilo aluminum structure includes 11 Niskin bottles programmed to collect water at different depths. Attached to the frame, an armada of sensors measure the numerous physico-chemical parameters as the Rosette descends into the depths (pressure, temperature, conductivity, oxygen level, carbon pump, etc.).

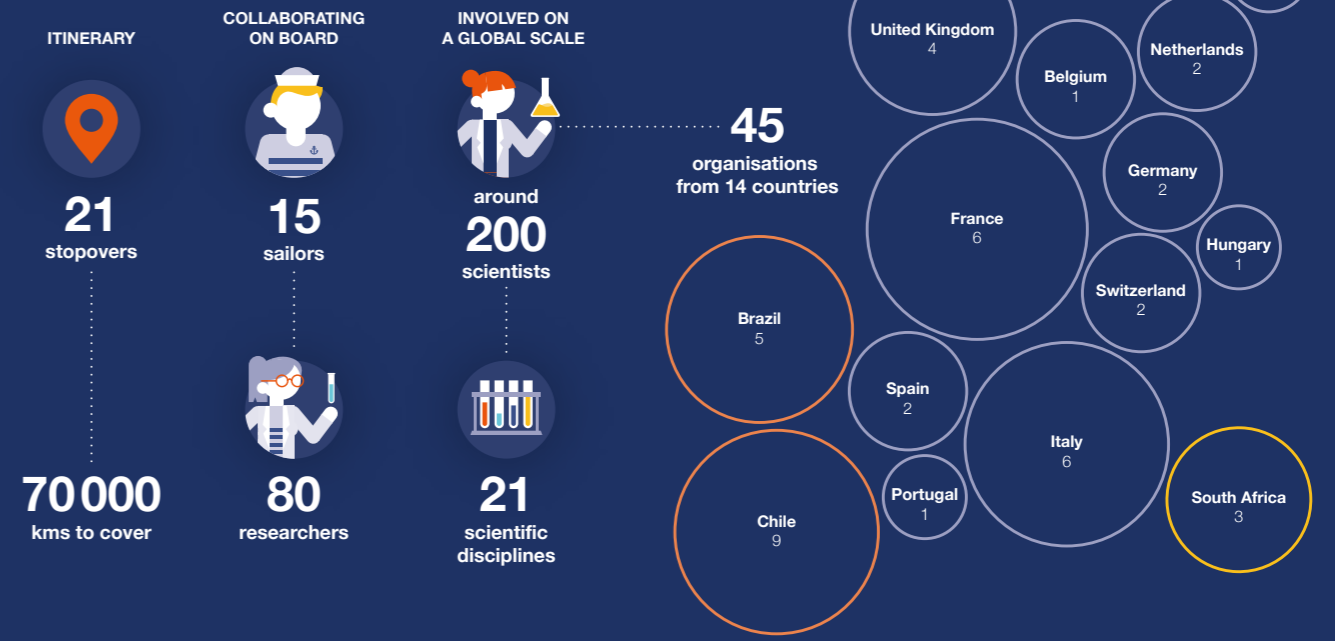
5 Wet lab. Located on Tara's aft deck, it's the place where the samples collected by the nets and Rosette are unloaded, filtered and some are immersed in liquid nitrogen. All the instruments and material needed during sampling stations are stored here.

6 Dry laboratories. Two small laboratories are located inside the boat, between the cabins.

7 Forward hold. Most of the samples collected, once filtered and carefully labeled, end up in large refrigerators in the forward hold, waiting to be sent to partner laboratories during the next stopover.

8 Air measurements. Above the ocean, tiny airborne particles (sometimes microplastics) can carry bacteria and viruses over hundreds of kilometers. These particles are collected automatically at the top of Tara's rear mast.

THE MICROBIOME MISSION IN NUMBERS



The Tara Ocean Foundation



*Martin Hertau,
Captain*

© Sarah Fretwell - Tara Ocean Foundation



*Samuel Audrain,
Captain*

© Noelle Pansiot - Tara Ocean Foundation

Since 2003, the schooner Tara has been circumnavigating the globe to **study and understand the Ocean and the impact of climate change on this ecosystem.**

On land, the Tara Ocean Foundation - **first recognized public interest group in France dedicated to the Ocean** - is leading a **scientific revolution**. We are developing an **open, innovative and unprecedented science of the Ocean**, that will allow us to **predict, anticipate and better manage future climate risks.**

We use high-level scientific expertise to raise awareness and educate the younger generations, mobilize political decision-makers, and exchange with countries of the South Atlantic to co-develop this new knowledge about the Ocean.

A true floating scientific laboratory, the schooner Tara has already traveled more than 450,000 kilometers, making stopovers in more than 60 countries during 5 major missions carried out in collaboration with international research institutes of excellence (CNRS, CEA, PSL, EMBL, MIT, NASA, etc.)

More than 300 publications in prestigious international scientific journals bear witness to the knowledge generated.

130,000 children have participated in Tara's educational programs and 2 million people visited our exhibitions. The Foundation makes it a priority to share knowledge in order to educate the public and change peoples' behavior.

The Tara Ocean Foundation continues to pursue our fundamental missions :

Explore to Understand Share to Change

Advocacy : The Foundation is involved in national discussions and international negotiations

Our advocacy work is crucial so that scientists can be heard and understood by decision-makers at the highest level, in order to take concrete action. This bridge between research and policy, the Foundation is building every day around three main themes: : **plastic pollution, climate and the high seas.**



This mission needs everyone's support

The new mission led by the Foundation could not take place without the commitment of our donors and partners, whom we warmly thank for their active support.

The Tara Ocean Foundation functions on a balanced economic model that brings together public and private funding in one dynamic and gives us the means to plan our actions over the long term. This innovative partnership has proven its effectiveness for over ten years. The Microbiome mission is no exception. Support from individuals and businesses is reinforced by a strong public commitment that makes researchers available through partner scientific institutes or by government support for the research effort.

Thanks to the Foundation and associated scientists, major scientific advances have been made which allow us to better understand the global changes occurring, and build a more resilient society. But our efforts are not enough and it is essential today to strengthen and accelerate our action. Within the framework of the Paris Agreements and the Sustainable Development Goals of the UN's Agenda 2030, we must progress even faster in the advancement of this knowledge to protect ourselves from probable future crises.

Every donation counts and the support of everyone, the general public as well as businesses, is essential. The time is right for engagement ! By making a donation before December 31, 2021, individuals can support the Microbiome mission and benefit from a significant tax deduction (66% of the donation amount) on income tax.

<https://microbiome.fondationtaraocan.org/>

Corporate social responsibility has never been so crucial. Companies choosing to make sustainable development a strong strategic focus can support the Foundation and present these issues to all their stakeholders, especially their employees. Enterprises that accompany Tara are doing the right thing! We are happy to encourage them in their efforts to change.

Today we are facing formidable challenges. Research, innovation and education are the only way forward. Public / private partnerships and the financial support of a great number of people are more than ever necessary to enable us to carry out our action.



Sharing Ocean Culture

WORKING WITH SCHOOLS

Raising young people's awareness about the future of the Ocean is central to our mission. The Tara team has been working closely with the Education nationale for 14 years. We have developed a dynamic educational platform for French-speaking teachers with three main orientations : education for sustainable development (ESD), science education, and media education.

During the Microbiome mission, teachers will have several possibilities for carrying out projects with their students, in accordance with the timetable and specific challenges of the new expedition.

IN TARA'S WAKE : EXCHANGES WITH CREW MEMBERS

Aimed at students of all ages, the operation « In Tara's Wake » offers classes the chance to have regular exchanges with crew members during the Microbiome mission. With answers to their questions in writing (or sometimes even in video), young people's curiosity about everyday life on board, science, or the environment will be satisfied! Live video-conference meetings between classes and crew members are also planned !

<https://oceans.taraexpeditions.org/m/education/operations-educatives/dans-le-sillage-de-tara/>

ECHOS FROM PORTS-OF-CALL : VIRTUAL EXPEDITIONS : STUDYING ISSUES OF SUSTAINABLE DEVELOPMENT

Tara's stopovers are also an opportunity to study issues of sustainable development around the world. The operation « Echos from Ports-of-Call : Virtual Expeditions » offers young people (8 to 15 years old) the chance to go on a "virtual expedition" to discover the local issues in the country where the schooner is docked which echo more global issues..

During the Microbiome mission, new resources will be offered to teachers so that their students can discover the ports where Tara stops over and the challenges these places are confronting.

<https://oceans.taraexpeditions.org/m/education/operations-educatives/echos-descale/>

The vocation of the Tara Ocean Foundation is two-fold - to contribute to the preservation of the environment and the Ocean through high-level research; and to share this knowledge in educating the public.

We use awareness-raising tools to spark interest, to help people understand, and think critically about the constant flow of information confronting us. Understanding is a prerequisite for individual action.

With the new Microbiome mission, the Foundation continues its work of raising public awareness. In 2021, a new edition of *Tara Océan, Le Mag* (200,000 copies) will be distributed free of charge to 8 -15 year olds. The exhibition, *Microbiome Mission : Understanding the Ocean's Invisible Population to Preserve our Future*, will be displayed at each stopover, but also in various cultural places in France. If the health situation does not allow us to organize live events, we will schedule on-line interventions and screenings to reach out to all audiences.

Our ambition is to make Ocean Culture an element of common culture in the face of societal challenges.

ARTISTS-IN-RESIDENCE

The Tara Ocean Foundation not only advances scientific knowledge through our expeditions, we also invite artists for residencies on board. Science has always been a source of inspiration for artists. Aboard the schooner, they observe and interpret, according to their sensitivity and imagination, the richness of the oceans, the research and daily life in this limited space.

The Microbiome mission is once again an opportunity to bring together Art & Science.

Ten artists, selected by a jury from different fields, will embark on the mission to pursue their artistic projects: illustrator, sculptor, photographer, videographer... The objective of their residencies aboard the schooner: cultivate different perspectives and create new experiences.

Many other artistic encounters will punctuate the year 2021. For the Tara Ocean Foundation, both art and science contribute to broadening the field of knowledge

and participate in the same process of observation and exploration of new territories.





ATLANTECO

The Tara Microbiome mission is part of a large-scale project entitled AtlantECO, launched last September and funded by the European Union within the **Horizon 2020 Framework**. For 4 years, working together via AtlantECO, 36 organizations from 13 nations, (including many European countries, Brazil and South Africa) will combine their forces to study the Atlantic Ocean from pole to pole. Our goal is to determine the structure and function of the Atlantic microbiome, taking into account ocean currents and the presence of pollutants to assess the microbiome's role in the dynamics of Atlantic ecosystems at local and regional scales. We will also investigate the microbiome's potential as a sensor of the ecosystem's state of health, as well as the mechanisms by which it drives the provision of ecosystemic services.

AtlantECO addresses three major issues - the microbiome : plastics and the plastisphere; the seascape and connectivity. These are the scientific concepts underpinning our project. Investigating them and their interactions will help us close the gap in current understanding of how they affect ecology, biodiversity, sensitivity to climate change, and the potential for sustainable exploitation of natural resources in the Atlantic Ocean. Building on the knowledge acquired about the status and dynamics of the Atlantic ecosystem, an additional challenge will be to optimize a set of tools and metrics that tightly couple ecosystem functioning and socio-economic activities, integrating them in a unified framework with Eco-Socio-Economic analyses and projections, which is a prerequisite for the sustainable management of the Atlantic Ocean. « *We'll study the Atlantic Ocean's microbiome to see if it contains more fragile regions and design reliable indicators to monitor its condition, using, (inter alia), artificial intelligence tools* », explains Daniele

ludicone. Showing the close links between the Tara Microbiome mission and AtlantECO, the Italian researcher is the scientific co-director of the upcoming expedition and coordinator of the European project. A final challenge to be addressed by AtlantECO is the design of strategy and procedures to guarantee that the new unified framework will be set up in a systemic way so that all the components of the implicated societies in countries bordering the basin will contribute to the implementation and will fully benefit from it.

Ensuring a sustainable impact will not be possible without implementing a set of complementary activities to make the transition between research and real-world application, in partnership with all stakeholders involved in the process. To this end, the project has also developed a program of capacity-building for both researchers and professionals, with summer schools and hands-on training planned. In addition, an ambitious plan to engage with citizens has been devised, it includes « citizen science » activities with the possibility for sailors and science enthusiast to participate in the project's sampling efforts. Also, we've designed an ocean literacy program to target schools in the project countries, so that future generations can acquire an understanding of the Ocean's influence on their lives, and the influence they have on the Ocean.

Ultimately, AtlantECO's ambition is to develop and apply an innovative, unifying framework for providing knowledge-based tools to design policies, support decision-making and engage with citizens to encourage responsible behaviour in order to manage the Atlantic ecosystem, and protect the benefits it provides, in a sustainable manner.



<https://www.atlanteco.eu/>

CEODOS

A team of Chilean scientists will contribute to this initiative through specific work on climate change via the CEODOS Program, promoted by a **consortium of national research centers and the Ministry of Science, Technology, Knowledge and Innovation**. They will carry out integrated, multidisciplinary observations of the Chilean Ocean. The 120,827 km² of territorial sea are considered a true natural laboratory for studying the effects of climate change.

« *In general, this mission will provide a more detailed understanding of the main mechanisms linking the microbiome and climate all along the coast of Chile. The CEODOS program is a long-term initiative that seeks to monitor the Chilean Ocean every five years and thus continue transition towards the new normal that global change brings* », explains Camila Fernández, visiting professor at the Department of Oceanography at the University of Concepción, CNRS researcher, and co-coordinator of the mission in Chile.

<https://www.ceodoschile.cl/>



INTERNATIONAL RESEARCH INSTITUTIONS PARTICIPATING

CHILI ; University of Chile / CMM - Center for modelling and mathematics ;
CIEP - Chilean Center for Studies of Patagonian Ecosystems ;
IDEAL - Center of High Latitude Ecosystem Research ;
COPAS - Center for Oceanographic Research ;
INCAR - Center for Integrative Aquaculture Research ;
CR2 - Center for Resilience and Climate Research.

Consortium AtlantECO ; Stazione Zoologica Anton Dohrn IT ;
Swiss Federal Institute of Technology Zurich CH ; Universidade Federal de São Carlos BR ;
Commissariat à l'Énergie Atomique et aux Énergies Alternatives FR ;
Istituto Nazionale di Oceanografia e di Geofisica Sperimentale IT ; EBI-EMBL DE ;
Fundacao de Apoio a Universidade de Sao Paulo BR ; University of Pretoria SA ;
Universiteit Utrecht NL ; University of Cape Town SA ; Fondation Tara Ocean FR ;
Universidade Federal de Santa Catarina BR ; SINTEF AS NO ;
Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung DE ;
Fondazione CMCC IT ; Consiglio Nazionale delle Ricerche IT ;
Centre National de la Recherche Scientifique FR ;
Council for Scientific and Industrial Research SA ;
The Marine Biological Association of the UK ;
Plymouth Marine Laboratory UK ; Sorbonne Université FR ;
University of Bern CH ; Natural Environment Research Council UK ;
The University of Liverpool UK.

Sapienza University of Rome IT ; Universidad de Santiago de Compostela ES ;
United Nations Educational, Scientific and Cultural Organization UNESCO ;
Seascope Belgium BE ; EMBRC-ERIC FR ;
European Multidisciplinary Seafloor and water column Observatory IT ;
Sociedade Portuguesa de Inovação PT ; MTA Centre for Ecological Research HU ;
Royal Netherlands Institute for Sea Research NL ; Universidade Federal da Bahia BR ;
Univesidade Federal do Rio Grande BR ;
Consejo Superior de Investigaciones Científicas ES.

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Photos & illustration are available for the media here :

<http://quickconnect.to/TaraNas1>

Use the id : *presse tara*

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