

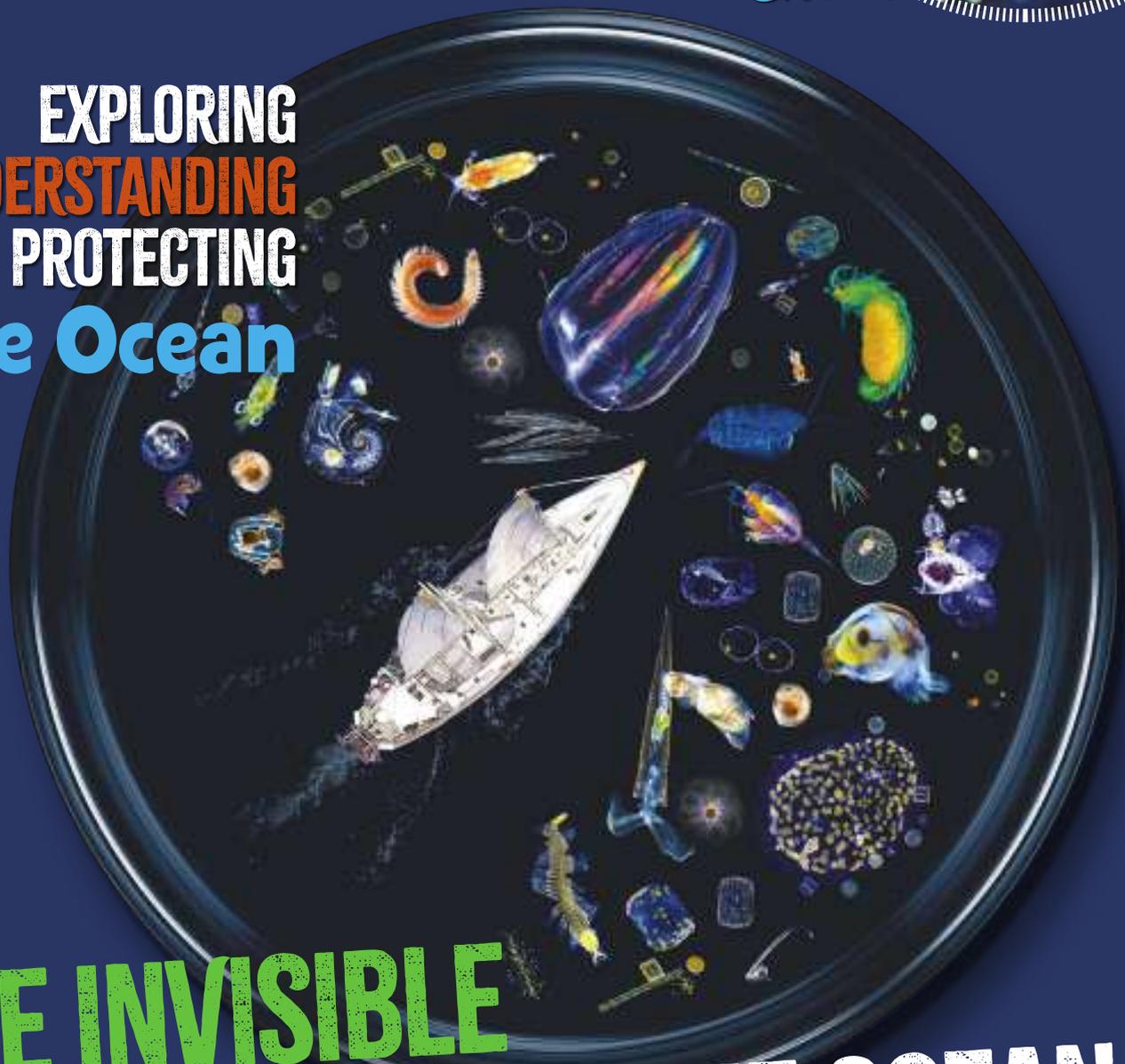
# le Mag **tara** océan<sup>n°2</sup>

FOR CHILDREN BETWEEN  
8 AND 14 YEARS OLD!



**SEARCH  
& FIND SAILOR**

**EXPLORING  
UNDERSTANDING  
PROTECTING  
the Ocean**



**THE INVISIBLE  
INHABITANTS OF THE OCEAN**  
DISCOVERING THE MARINE MICROBIOME

Fondation  
**taraocéan**  
explore and share

# Life on board



The research schooner *Tara* is one of a kind. The vessel sails across the world's oceans with a crew of sailors and scientists. Her mission: studying the Ocean to better understand and protect it.

# TARA, THE EXPLORER

## A sailboat for the Ocean planet

Over the past 20 years, *Tara* has conducted 12 scientific expeditions and traveled 450,000 km across the oceans to study and preserve the Earth's largest ecosystem. *Tara Arctic*, *Tara Oceans*, *Tara Mediterranean*, *Tara Pacific*, *Tara Microplastics* and *Tara Microbiomes*, expedition after expedition, the schooner brings together pieces of this giant puzzle. "The more we learn about the Ocean, the better we protect it" is her motto.

## A committed crew

There are 14 cabins aboard *Tara*. Every spot count and the distribution changes at each departure. Throughout the mission, sailors, scientists, journalists and artists-in-residence take turns on board without distinction, everyone participates in the sailing maneuvers, the vessel's maintenance and scientific operations. "On our own, we go faster. Together, we go further." A sentence *Tara's* team members often repeat. Both on board and ashore.

## The captain

He's the vessel's conductor. From the wheelhouse, he determines the best route, manages navigation, checks weather reports and organizes sampling with *Tara's* scientists. Above all, he's responsible for order and safety of the crew. Day and night, everyone must obey the captain.

## The first mate

The first mate ensures the proper functioning of the sailboat, communication and navigation devices. He manages safety on board and, if necessary, he has the required training and skills to command the vessel.

## The chief engineer

Responsible for maintaining the schooner, the chief engineer is *Tara's* key man. He always has a headlamp and a Leatherman multitool marine knife in his pocket since he has to deal with any kind of repair to solve breakdowns. Sails, engines, desalinator, etc., he always gets his hands dirty!

## The deck officer

His role is to maintain the deck equipment. He maneuvers the sails and is responsible for the smooth running of the ship at sea.

## The scientific lead

He/she coordinates all research on board, from analysis protocols to sampling stations.

## The cook

He/she has the heavy responsibility to supply the kitchen and fill the bellies of the entire crew. The good health and morale of all are at stake. The cook also benefits from the crew members' talent for fishing to vary meals. This way, *Tara's* team enjoyed delicious yellowfin tuna sushi off the Patagonian coasts.





Sails  
**400**  
square meters

Masts  
**27**  
meters

Length  
**36**  
meters

Width  
**10**  
meters

Weight  
**120**  
tons



If you photograph this QR code, you can discover *Tara* as if you were really there! A virtual tour awaits you. Let's meet on deck for presentations. So, do you feel like embarking?

## Fishing for microbes

For this 5<sup>th</sup> major mission, *Tara*'s goal is to study the invisible inhabitants of the Ocean: marine microorganisms. The purpose is to reveal their organization by understanding their individual role and interactions.

## A true floating laboratory

*Tara* has all the required equipment to perform research: a manta net, plankton nets (bongo), a sampling rosette, air-measuring instruments, microscopes, two dry laboratories for real-time analysis, a wet laboratory on the rear deck dedicated to water filtration and used to separate viruses and bacteria, and even a large freezer in the forward hold to store samples at very low temperatures.

**SUPER #1**  
**POWER**  
Turning  
on the light



Discover in the following pages the superpowers of the invisible inhabitants of the Ocean.

*Noctiluca scintillans*,  
the dinoflagellate species that  
enlightens us

This unicellular alga, measuring 1 mm in diameter, is capable of sparkling at night like a firefly. It produces its own light by transforming chemical energy into light energy during mechanical stress. This superpower is called bioluminescence.

An entire world  
to be explored



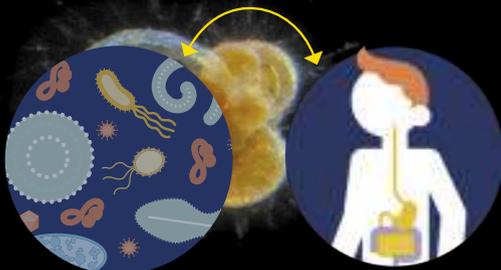
# INVISIBLE BIODIVERSITY OF THE OCEAN

## Multiple and invisible

From the Greek "micro" and "bios" respectively meaning small and life, the ocean microbiome is a microscopic world of incredible diversity: hairy, small, round and tubular organisms interact. An extremely rich, organized, moving, wide world. Compared to them, we're tiny! This microscopic marine world is a key element of life on Earth. It provides enormous services to our planet, but also to human beings.

## Zoom on the microbiome

Your body is made up of a multitude of microscopic cells. But do you know that it also hosts billions of bacteria, microbes and viruses? All this invisible life allows you to digest properly, feel good and fight diseases. It's the same for the Ocean. It is populated by a multitude of life forms less than 1 millimeter wide: marine micro-organisms. They are mainly unicellular beings that ensure the proper functioning of the Ocean and keep it healthy through oxygen production, climate and food chain regulation.



Marine microbiome

Human microbiome

Below the ocean surface live invisible  
but fascinating organisms:  
the marine microbiome

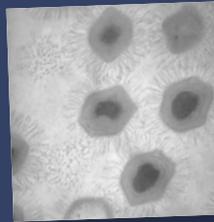
# 4 MAJOR GROUPS

Every liter of seawater contains  
between 10 and 100 billion micro-  
organisms. Their size varies  
from 0.01 micrometer to 1 centimeter.  
It's the same difference in scale as  
between an ant and a brontosaurus!

## Viruses

(Size: 0.01 to 1 micrometer)

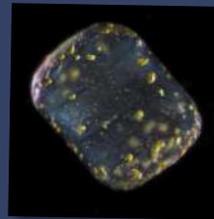
These are the most numerous and varied. They need an organism's cell to reproduce. In most cases, they penetrate their hosts without killing them, bring them new genes and participate in the proper balance of the microbiome.



## Phytoplankton

(Size: 0.1 to 10 micrometers)

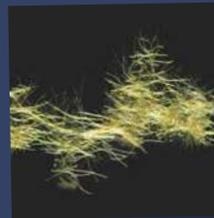
Whether bacterium or protist, phytoplankton is a group of micro-organisms capable of photosynthesis. These micro-organisms, through chlorophyll pigments, use dissolved carbon dioxide (CO<sub>2</sub>) to make organic matter and generate oxygen. They are the equivalent of plants on land.



## Bacteria

(Size: 0.1 to 2 micrometers)

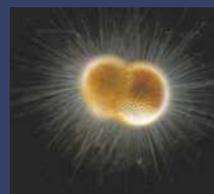
These are simple organisms without a nucleus. Some recycle dead plankton into nutrients, and thus participate in the Ocean breathing mechanism.



## Protists

(Size: 0.8 to 10 millimeters)

They are complex organisms, even though they are always composed of a single cell with a nucleus. Sometimes, they have a skeleton made of glass, stone or organic matter.



\* These figures may vary depending on our location: along the coast or offshore.

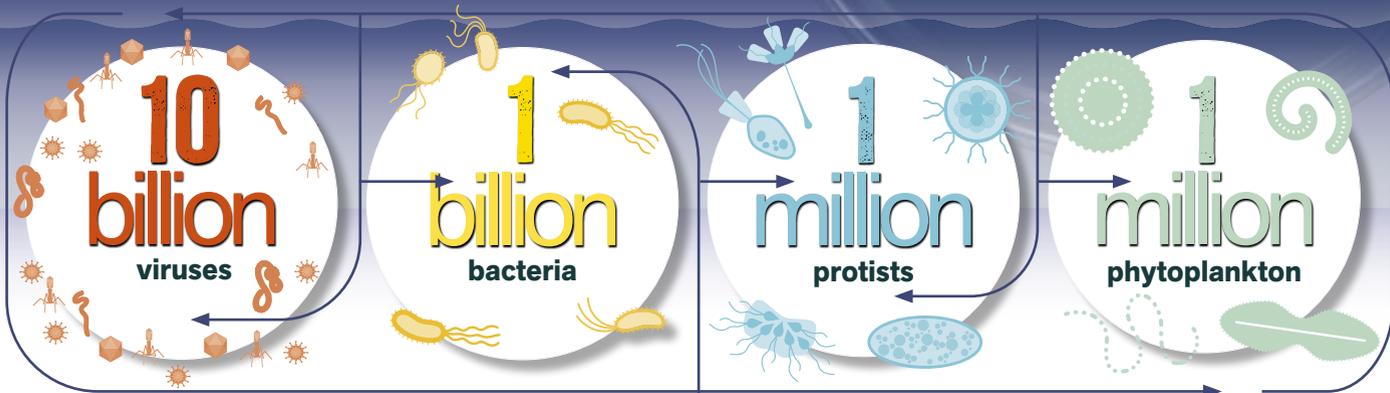
## SUPER POWER #2

Producing oxygen

*Bacillariophyta, the diatoms specialized in photosynthesis*

*Bacillariophyta* is a unicellular alga belonging to the diatom family. Thanks to photosynthesis, it absorbs carbon dioxide and releases oxygen in its environment. The 100,000 species of marine diatoms generate as much oxygen on Earth as forests!

1 liter of seawater contains\* :

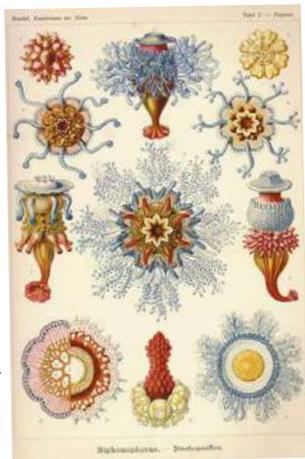


## Our friends the microbes

Microbes often have a bad reputation. Wrongfully, because they help keep us healthy. In our body, they are more numerous than our cells and weigh more than our brain (up to 2.5 kilos). As an order of magnitude, in the Ocean, they represent 4 times the biomass of insects on land.

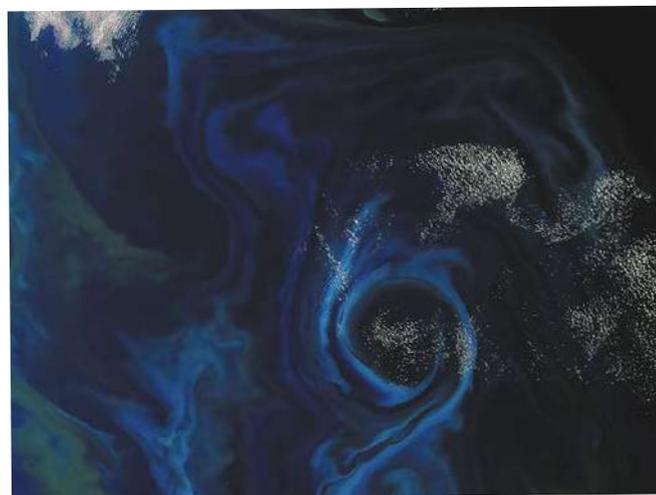
## All connected

Of course, it's not enough to name and classify these microbes to understand them! We must also decipher the immense social network that connects them to each other to know who is doing what and how in a constantly changing environment as a result of increasing climate change and pollution.



## Ernst Haeckel

These colorful drawing boards that one would think were born of the imagination of an artist derived from a careful observation of nature by the German biologist Ernst Haeckel... in the 19<sup>th</sup> century! Fascinated by their variety and symmetry, he drew micro-organisms with incredible precision thanks to the microscope that had just been invented!



## When blooms can be seen from the sky

The climate phenomenon called "phytoplankton bloom" is so wide it can be observed from space. As we approach this large underwater cloud, we discover a huge forest of phytoplankton generating oxygen, like plants on land. These blooms appear all over the planet when conditions are favorable: light, adequate temperature and high concentrations of nutrients in the water.

To discover the incredible marine microbiome in video, scan this QR code:



# Zoom on the ocean



Marine microbes are the hidden face of the Ocean. Silent, moving and invisible, they provide us with immense services. Focus on these little-known and very useful microscopic organisms.

## IN THE KINGDOM OF THE MARINE MICROBIOME

### Micro-organisms are mysterious

Scientists have found bacterial fossils dating back 3.5 billion years. Evidence that micro-organisms have been and are still involved in shaping the face of the Earth. It has also long been known that they are capable of changing the climate. Cyanobacteria, 2.8 billion years ago, were the first organisms capable of photosynthesis and producing energy. Even though they have evolved with us and *vice versa*, their movements and interactions remain very mysterious.

### Micro-organisms are everywhere

Whether it's along the coasts or in the high seas, micro-organisms are everywhere. They can be found in coral reefs, polar ice, whales' bellies, fish scales, mussel flesh,, etc. They inhabit every drop of water, crack and crevice in the Ocean. They're always moving, coming and going with seasons, currents, nutrients, salinity, temperature, depth, etc.

### Micro-organisms are essential

They provide a significant part of the oxygen available on Earth, the remaining being produced by forests. They are also at the base of the food web. They feed fish and therefore, billions of human beings. They shape landscapes, regulate ecosystems and participate in major biological processes such as currents, the climate and species migration. They are the heart and lung of the Ocean.

## Micro-organisms are complex

They are characterized by their very complex genes and highly developed skills. Some settle in other living organisms and live in symbiosis with their hosts. They nourish, protect and connect live species with each other. Others, like viruses, have a very bad reputation. Yet, most of them have a beneficial effect. Passing from one cell to another, they take away pieces of DNA that they redeposit elsewhere. In doing so, they forage and shape the living world!

## Micro-organisms are life-builders

In 1977, scientists discovered at the base of hydrothermal vents, in abyssal depths, a multitude of micro-organisms flourishing and allowing for an incredible biodiversity. 2,400 meters under the surface, in complete darkness, clams, mussels and giant worms live thanks to microbes that transform the sulfides generated in the chimneys into energy. Micro-organisms are therefore an incredible source of life!

**SUPER #3**  
POWER

Consuming CO<sub>2</sub>

## Micro-organisms are our future

They constitute the vast majority of living organisms. Imagine: there are more species of micro-organisms on Earth than stars in our galaxy. By studying them, scientists have developed vaccines and antibiotics that have greatly improved human life. And it's just the beginning! There are still thousands of secrets hidden in the vast ocean and the microbiome.

### *Prochlorococcus, an atmospheric chemist*

About 2.8 billion years ago, a phylum of bacteria called cyanobacteria enabled the development of all the life forms we know on Earth today! These superbacteria contain chlorophyll, draw energy from sunlight, and are capable of absorbing carbon dioxide (CO<sub>2</sub>). They are the oldest living beings known on Earth and the most abundant photosynthetic organisms on the planet!



A mission aiming at shining a light on poorly known organisms essential to our life: the marine microbiome.

# 24 H WITH THE SCIENTISTS ON BOARD

## Conquering the hidden face of the Ocean

"The goal of this expedition isn't to determine who is who, but who does what," explains Chris Bowler, co-director of the scientific mission.  
"To this end, we study micro-organisms to observe and understand how they interact with each other and their environment, and react to global warming and pollution."

### A DAY ABOARD TARA



Scientists prepare the rosette, which will go down to a depth of 300 meters to sample elements of marine chemistry (inorganic and organic carbon, nutrients, trace elements, etc.).



The seawater collected is bottled according to the depth at which the sample was taken.



In the wet laboratory, scientists filter the content of the vials to concentrate micro-organisms.



After filtration, each sample is placed in liquid nitrogen at  $-196\text{ }^{\circ}\text{C}$  or refrigerated at  $4\text{-}5\text{ }^{\circ}\text{C}$ .

1<sup>st</sup> rosette



7 am

7:30 am

2<sup>nd</sup> rosette



8 am

1<sup>st</sup> bongo nets



8:30 am

9:30 am

3<sup>rd</sup> rosette



11 am

11 countries visited

80 researchers

14 sailors take turns on board

# SUPER POWER #4

Living at 85 °C



*Thermus aquaticus*, the bacterium that is not afraid of the heat

Discovered amidst the boiling springs of Yellowstone (USA) in the 1960s, this bacterium is able to survive at temperatures where little else can. Its "Taq polymerase" enzyme has enabled the development of PCR tests to detect the COVID-19 virus.

70.000 kilometers of navigation

START - END  
Lorient, Brittany  
december 2020  
october 2022

Lisbon  
october 2022

Dakar  
september 2022

Banjul  
august 2022

Pointe à Pitre  
july 2021

Belém  
september 2021

Salvador de Bahia  
october 2021

Rio de Janeiro  
november 2021

Iquique  
may 2021

Valparaiso

Concepcion  
april 2021

Puerto Montt  
march 2021

Punta Arenas  
february 2021

Buenos Aires

Itajai

Weddell Sea

1 MISSION, 2 PHASES  
CHILE, WITH THE CEODOS PROGRAM  
SOUTH ATLANTIC, WITH THE  
ATLANTECO PROGRAM

AtlantECO  
Atlantic Ecosystems Assessment, Forecasting & Sustainability

More than 200 scientists involved onshore

45 international scientific institutions

19 stopovers



Late morning, immersion of the manta net to collect microplastics on which many micro-organisms live.



Then they prepare the bongo nets to collect tiny plankton. They filter up to 40,000 liters of seawater in 10 minutes.



Scientists fill an information sheet and assign a bar code to each sample.



In the dry laboratory, a microscope is used to take black-and-white photos and determine the amount of plankton in each sample.



The 150 samples of the day are safely stored. They will be sent to the various partner laboratories in 6 weeks.

Manta net



11:30 am

4<sup>th</sup> rosette



1 pm

2<sup>nd</sup> bongo



2:30 pm

4 pm

3<sup>rd</sup> bongo



4:30 pm

5 pm

5<sup>th</sup> rosette



5:30 pm

7 pm

# A marine game



# LOOK FOR THE INVISIBLE

Open your eyes wide and find the 20 following elements in the image.

Be careful, they must be strictly identical in shape and colors.

## Fauna and flora



## Phytoplankton

from 0.1 to 10  $\mu\text{m}$



## Protists

from 0.8 to 10 mm



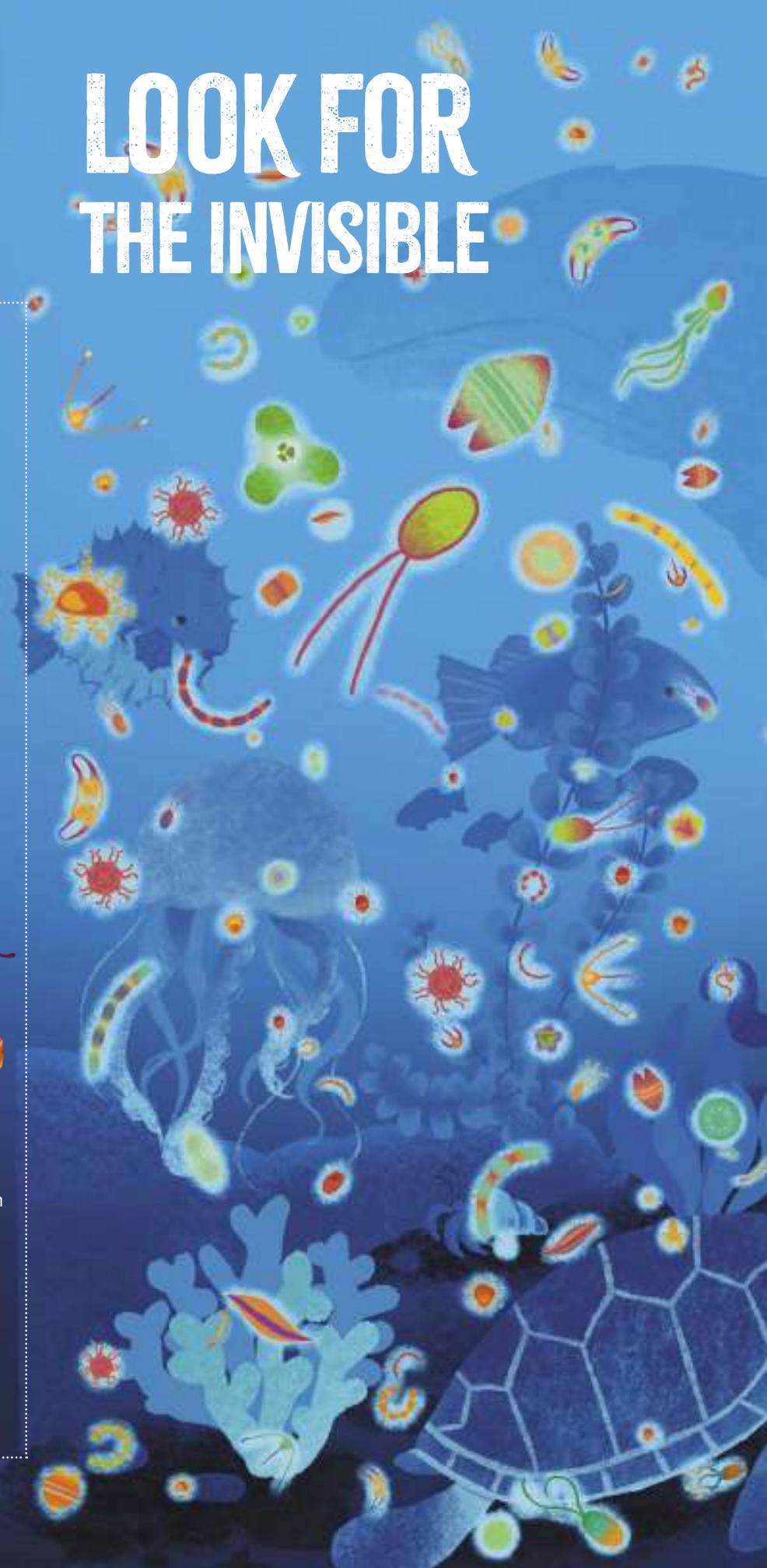
## Bacteria

from 0.1 to 2  $\mu\text{m}$



## Viruses

from 0.01 to 1  $\mu\text{m}$



To find the solution,  
go to our website.  
You can even  
download the coloring!



**SUPER #5**  
**POWER**  
**United for life**



*Symbiodinium,  
never without my microalga*

In exchange for a robust and bright shelter with an ocean view, this microalga, more commonly known as zooxanthellae, nourishes, protects and strengthens the coral with which it lives in symbiosis. One cannot do without the other!

# ATLANTECO PROGRAM STUDYING THE OCEAN CRUCIAL FOR FACING TOMORROW

AtlantECO is a European program bringing together international scientific laboratories. During this second phase of the Microbiome mission, several areas of the Atlantic Ocean will be studied because they play a key role for the planet and are concrete examples of the strong links between biodiversity and climate change.



**6** vessels with different itineraries and fields of research

The Atlantic Ocean is the second largest ocean basin in the world. Surprisingly, it is still largely unexplored, even though important oceanographic phenomena take place there. These mechanisms must be studied to understand the role played by the Atlantic and the services it provides.



## 3 RESEARCH ORIENTATIONS



**discover**  
new bio-resources

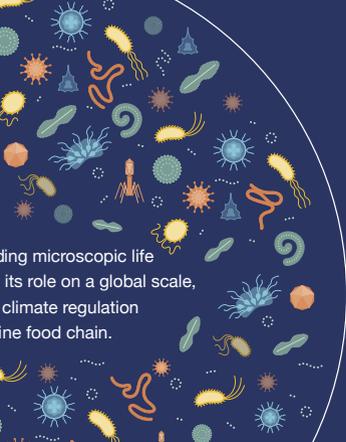
**study**  
the impact of oil and gas extraction platforms

**detect**  
risks of pollution for aquaculture

# THE ATLANTIC OCEAN, ITS CHALLENGES

specifically  
diversity, health and the economy.

## MICROBIOME



Understanding microscopic life  
and its role on a global scale,  
climate regulation  
and the marine food chain.

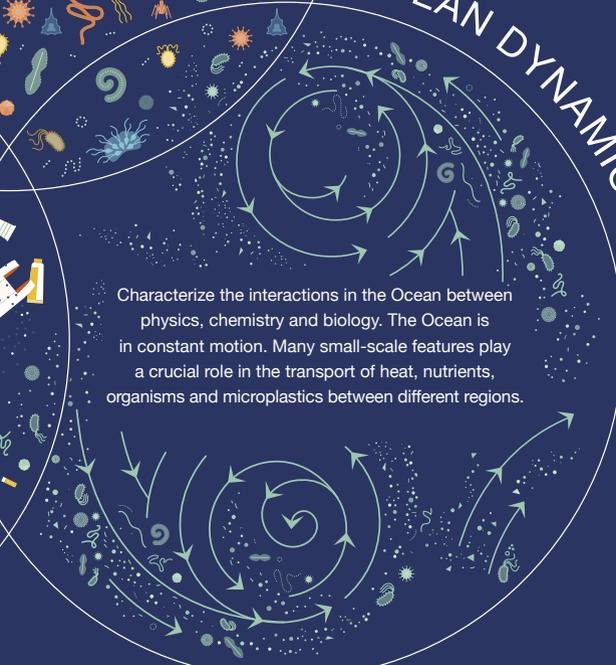


**36** scientific  
partners



**13** different  
countries

## OCEAN DYNAMICS

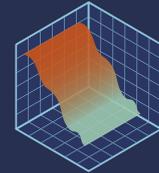


Characterize the interactions in the Ocean between  
physics, chemistry and biology. The Ocean is  
in constant motion. Many small-scale features play  
a crucial role in the transport of heat, nutrients,  
organisms and microplastics between different regions.

## GOALS



Work hand in hand to provide new data with partners  
in various fields -- biology, physics, bio-geochemistry,  
social sciences, economics, politics.



Develop innovative tools based on new data to refine  
forecasting models and better anticipate climate change  
and the effects of pollution.



Move towards a more rational management of resources  
in the Atlantic Ocean basin, while preserving its key role  
for climate equilibrium.



Promote sharing of knowledge world-wide with scientists,  
citizens and decision-makers via free-access data bases  
("open-data")



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and the European Union cannot be held responsible for any use that may be  
made of the information contained therein.



**understand**  
the impact of raw  
material extraction



**adapt**  
food production to the effects of  
climate change



**evaluate**  
the distribution  
of the microbiome  
in ocean currents

Reacting  
is acting



This young South African woman is actively campaigning in South Africa to fight climate change and its impacts on the Ocean. Scientist, involved in NGOs, and also Ocean ambassador for the European Union, she dedicates her life to the Ocean.

# THANDO MAZOMBA, A YOUNG OCEAN AMBASSADOR

“I would like to remind young people of the power of their voice and actions. Globally, the youth is not only passionate and more vocal than past generations, but they are capable and highly qualified.”



## How long have you been involved with the Ocean?

I've been studying and working in the marine space for the past 9 years. My tertiary studies were at the University of Cape Town and my workspaces vary between corporate, NGOs and government sectors. This currently includes being a marine manager at marine company, co-directing an NGO called The Beach Co-op and I am an All-Atlantic Ocean Youth Ambassador for AANChOR. I also partake in various field work – my most exciting being my voyage to our South African Base SANAE IV, in Antarctica.

## What fascinates you most about the Ocean?

I love the ocean because it is ever-changing and forever the same – a great life lesson to hold close! The ocean has taught me a few things about nurture, compassion, resilience, authenticity and community. Also, because of its vastness, very little of our ocean has been documented and even less understood. I like this as it reminds me that somethings can be felt rather than picked apart to the last “T”.

## In concrete terms, what does your role as an ambassador for the Ocean involve?

I, along with 25 of my fellow AAOYA, work towards engaging the Atlantic Ocean community - whether it be governmental officials, various scientists, storytellers, civil society, NGOs, first nations, academic institutes, filmmakers, artists, anyone! Our oceans are in trouble because of our human activities, so we are working to not only create awareness but activate global and local initiatives that work towards finding and implementing solutions for a healthy, resilient and inclusive ocean.



## “Ocean Decade”: the United Nations Decade of Ocean Science for Sustainable Development (2021-2030)

Organized by the United Nations, the Ocean Decade began on January 1, 2021.

This global initiative aims at deepening scientific knowledge about the Ocean and protecting its health. The Tara Ocean Foundation participates in the Ocean Decade through its present and future scientific missions and by sharing its knowledge with the largest audience possible.



2021 United Nations Decade of Ocean Science for Sustainable Development 2030



## What do you think needs to be done urgently to protect the Ocean?

We need our global leaders, both in the public and private sector, to clamp down on the overexploitation of our marine resources. This largely needs to be directed towards those who have had the resources to exploit the ocean in a very inequitable world. Of course, everyone has a role to play in working towards healthier oceans, but the few who have the platform, agency and resources need to be called to action the more than those who have so little but suffer the consequences the most.

## What advice would you give other children?

I would like to remind young people of the power of their voice and actions. Globally, the current youth is not only passionate and more vocal, but they are capable and highly qualified. We need youth to continue to step into their power! The second thing I want to speak to is that it is important to start building strong community from a young age so as to grow and learn together. Community holds you in difficult spaces and is always there to remind you of your capabilities. The practice of community has always kept us sustainable, and we need to lean into that practice again. As young as you are. You are never too young to start.



# Daniele Iudicone

## Scientist and coordinator of AtlantECO

The Atlantic Ocean is the second largest ocean basin in the world. It hosts a huge amount of marine life, rich coral reefs and organisms living in deep, dark and icy waters.



The ocean is important to us because it produces oxygen and absorbs CO<sub>2</sub>, provides delicious food, regulates the climate and is a source of employment for many people, such as fishermen and fisherwomen or ship captains.

So far, we do not know much about the Atlantic, especially the southern region. This is why we created the AtlantECO programme, to investigate the diversity of life in the Ocean, in order to better understand it, learn more about its health and how to protect it.

# Brazil

## Andrea Green, AtlantECO scientist



We do not know the level of microplastic pollution on the Brazilian coast, nor the effects of these pollutants on the local microbiome. AtlantECO's research will bring unique information on these issues so that we can take the necessary measures to protect our marine environment.

## Amazon

The Amazon is the largest river in the world. It discharges on average 200,000 m<sup>3</sup> of fresh water per second into the Atlantic Ocean. This Amazonian water changes the salinity, temperature and composition of the Atlantic Ocean, dispersing nutrients, sediments and a considerable amount of organic matter over hundreds of kilometres into the sea. The study of its composition and diffusion will reveal the impact that the river has on the entire region.

# Antarctic

The Southern Ocean and the Weddell Sea are the two southernmost stages of the AtlantECO programme.



The crew will head south, crossing the 40th parallel called the "snorers" and the 50th parallel, the "howlers", winds with suggestive names. The passage through the southern latitudes aims to study two mysterious mechanisms of the climate machine: the drift of icebergs and the oceanic circulation of the microbiome in the Weddell Sea.

# Africa

## Benguela current

The Benguela Current flows up from South Africa towards the coasts of Namibia and Angola. In the south, the Atlantic waters mix with those of the Indian Ocean, causing multiple eddies that reach as far as Brazil. Along these coasts, cold waters rising from the depths, also known as upwellings, bring nutrients to the surface. The Benguela Current is very productive in fish because it is rich in nutrients and has a rich and varied ecosystem. It has a considerable influence on the South Atlantic Ocean.

Maéva Baroty

**SUPER #6**  
**POWER**  
 Building cliffs



*Coccolithophore, an architect for centuries*

The giant cliffs of Normandy owe their origin to an organism called Coccolithophore, invisible to the naked eye. Tiny disk-shaped calcareous plates (coccoliths) secreted by these microalgae join together to form a protective armor called "coccosphere". The accumulation of these fossilized exoskeletons over centuries resulted in these immense chalk cliffs!

# BY STUDYING AND PROTECTING THE OCEAN WE TAKE CARE OF OUR PLANET.



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*agnès b.*

Join us quickly on the social networks!

[www.fondationtaraocean.org](http://www.fondationtaraocean.org)

