



*Seánicas*  
FEMALE PIONEERS  
IN OCEAN SCIENCE

ANTÒNIA CALAFAT & PABLO LOZANO



*For Ana, creator, promoter and lighthouse of "Oceánicas".*





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# Prologue

In *Oceánicas: women pioneers in oceanography* we tell the life and work of 20 illustrious female marine scientists, some of them forgotten by history. From the first and only woman to sail around the world during the time of the great explorations, to women who today lead the fight for ocean conservation.

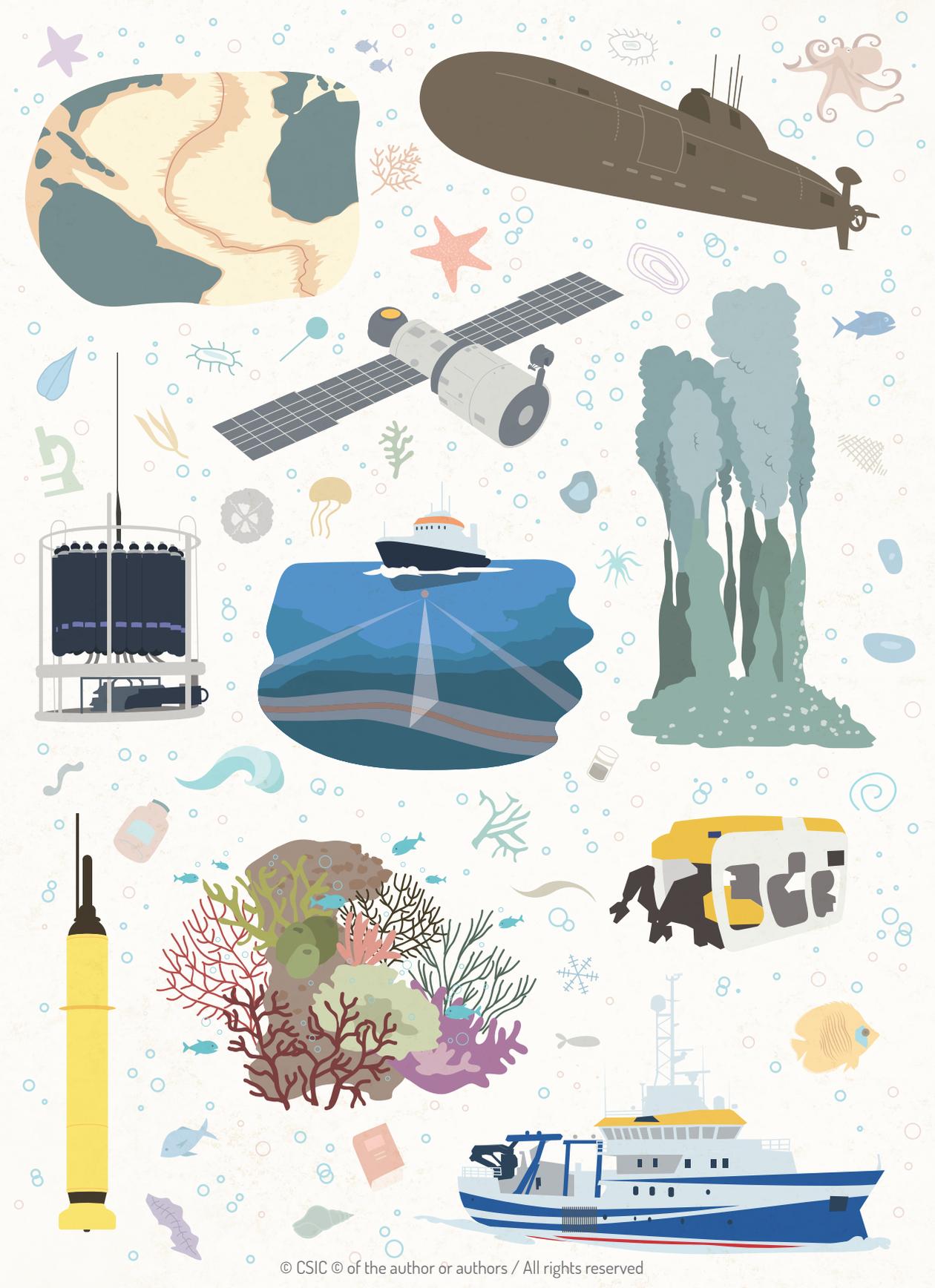
Their stories tell us about the development of marine sciences over the last centuries, but also of the difficulties they have faced for being women—in oceanography, in science, and in life—and of the fight for equality of many generations.

Climate change, overfishing and pollution threaten to transform our oceans forever. The challenges are enormous and to meet them we need to count on all the talent available. Therefore, equal access of women and men to marine science, including positions of responsibility, is more necessary than ever.

We hope these twenty stories, which are only a few examples of the many illustrious female scientists of the past and present, will provide a source of inspiration for anyone dreaming to engage in marine research.

This book is part of the dissemination project «Oceánicas: women pioneers in oceanography» ([www.oceanicas.ieo.es](http://www.oceanicas.ieo.es)), developed by the Spanish Institute of Oceanography (IEO-CSIC) with the collaboration of the Spanish Foundation for Science and Technology – Ministry of Science and Innovation (FECYT-Ministerio de Ciencia e Innovación).





# A science for gaining knowledge of and protecting the seas and oceans

Oceanography is the science that studies the ocean: from the geology of the sea floor to the composition and movement of its waters, as well as the fauna and flora inhabiting them. In short, oceanography includes all natural sciences (biology, geology, physics, chemistry...), applied to exploring and gaining knowledge of the ocean; that is why it is also called marine science.

Various disciplines with a common object of study: oceans and seas, which occupy three-quarters of the planet, are key in climate regulation and are home to valuable resources that are essential for our survival. However, we are a terrestrial species and the ocean is a medium incompatible with our physiology. This has meant that, throughout history, humanity has concentrated all its ingenuity on building instruments that reveal its mysteries to us: from the boats built by the first humans, to the most sophisticated ships, diving systems, submarines or sensors we use today.

Although currents had already been observed for centuries, tides or waves and resources from the sea were used as food, oceano-



graphy as a science is relatively modern. Its foundation was laid in 1872, when The Challenger made the first expedition in oceanographic history. This British Navy corvette was converted into the first research vessel and spent four years collecting data in oceans all around the world, including measurements of temperature, marine chemistry, currents, ocean life and seafloor geology.

Since then, other instruments have been added to these oceanographic vessels, key elements of this young science: satellites, buoys, submarines, sonars, unmanned vehicles... In just 150 years, thanks to this technological deployment, many mysteries hidden at the bottom of the ocean have been disclosed. However, there are still many places to explore and things to discover. In fact, many scientists say that today we know more about the moon than about the ocean depths. But the great challenge faced by oceanography at present is to protect the seas from ourselves. Climate change, pollution or overfishing threaten the world's largest ecosystem and we need to study, denounce and seek solutions to these problems.

Do you accept the challenge?



# Women and oceanography



For a long time, women were excluded from the world of science. However, their contribution has been fundamental since its inception, despite the obstacles and the fact that on many occasions their achievements remained hidden in history.

But if the participation of women in science has generally been full of obstacles, in oceanography it has been especially difficult. Work at sea has been considered a man's job until very recently, women even being banned from going on ships. Therefore, their contribution to marine sciences is initially limited to sampling in coastal areas and, above all, laboratory work.

Only one woman participated in the golden age of the great European expeditions that explored the world, and she did so disguised as a man. Nearly an exception, since it took more than 150 years for another woman to take part in an oceanographic campaign.

Not only did they have limited access to ships, but also to university. That is why the first women interested in marine science were mostly self-taught. They were usually girls of the upper classes, who had scientific books available to them and an amazing interest in the natural world, as is the case of Maude Delap, Jeanne Villepreux or Anita Conti.

Women were gradually able to pursue higher education, embark on oceanographic expeditions and develop their career. However, for the most part, the first women oceanographers were overshadowed by men: they worked and published with their chief scientists and, sometimes, their contributions were not even recognized and remained anonymous.



In the US until the sixties women could not go aboard a ship unless accompanied by their husbands. Pioneers such as Marie Tharp or Mary Sears worked for years in their respective disciplines without setting foot on a ship. However, there were some exceptions such as the Spanish women Jimena Quirós and Emma Bardán, who boarded domestic vessels for the first in the twenties, or Maria Klenova, who led expeditions to the Arctic in the thirties.

These women charted the course towards gender equality, but it wasn't until the 1990s when they started to hold posts of responsibility. In 1990, Cyndy Lee Van Dover was the first, and so far the only, woman pilot of Alvin, the most important submarine in the history of ocean exploration.

Until 1999, with Sylvia Earle, no woman had ever been the chief scientist of the main institution dedicated to ocean study: the U.S. National Oceanic and Atmospheric Administration (NOAA). In Spain we had to wait five more years for Concepción Soto to become the first director of the Spanish Institute of Oceanography (IEO).



The number of women oceanographers has continued to grow and, today, they are even more numerous than their male colleagues in some specialties. Many of them head cutting-edge research that deals with the study and remedy of some of the major challenges faced by society.

However, despite great progress, equality between women and men is still not a reality and until this occurs, we will be wasting half of the talent on the planet. A talent that, without any doubt, we need for the challenge of preserving and protecting our oceans.







*Stories of  
female pioneers*

1769



18

**Jeanne Baret**  
becomes the first woman  
to sail around the world...  
although disguised as a man

1834



20

**Jeanne Villepreux**  
invents the aquarium

1886



22

**Luisa de la Vega**  
becomes the illustrator  
of the first marine  
biological station in Spain

1872

Oceanography is born  
with the Challenger  
expedition



1949



26

**Emma Bardán**  
is one of the first Spanish  
women in the International  
Council for the Exploration  
of the Sea (ICES)

1953



36

**Ángeles Alvariño**  
is the first woman  
scientist aboard an English  
exploration vessel

1955



40

**Katsuko Saruhashi**  
demonstrates how the wind  
and currents transport  
radioactive pollution

1962



34

**Rachel Carson**  
publishes a pioneering book  
denouncing pollution

1988



46

**Josefina Castellví**  
becomes the first female  
director of an Antarctic  
base in the world

1990



52

**Cindy Lee Van Dover**  
is the first woman to pilot  
the submarine Alvin

1998



44

**Sylvia Earle**  
becomes a National  
Geographic explorer

2004

Concepción Soto  
first female director  
of the IEO

1901



24

**Maude Delap**  
breeds jellyfish in captivity  
for the first time

1914

Odón de Buen  
founds the IEO



1920



28

**Jimena Quirós**  
becomes the first Spanish  
woman to participate in an  
oceanographic campaign

1943



32

**Mary Sears**  
is appointed as the first  
director of the U.S.  
Navy's first oceanographic  
unit during World War II

1971



30

**Anita Conti**  
denounces the impacts  
of industrial fisheries

1977



38

**Marie Tharp**  
publishes the first map  
of the planet's sea floors

1979



42

**Eugenie Clark**  
discovers a natural  
shark repellent

1986



50

**Ana Ramos**  
participates in the  
first scientific Spanish  
expedition to Antarctic  
waters

2006



48

**Aida Fernández**  
becomes the first woman  
director of the CSIC  
Institute of Marine  
Research

2008



54

**Asha de Vos**  
discovers that Sri Lankan  
blue whales do not make  
large migrations

2020



56

**Cristina Romera**  
is recognized as one  
of the world's 15 most  
promising young women

2050

And you,  
what are  
you going  
to do?



# Jeanne Baret

(1740-1807)

## THE FIRST WOMAN TO SAIL AROUND THE WORLD

Jeanne Baret was a French botanist and the first woman to circumnavigate the oceans, long before oceanography existed as a science. It took her ten years to complete the journey, from 1766 to 1776, and she had to do it disguised as a man.

Jeanne was born in La Comelle, a small French town, where she grew up and lived helping her parents on the family farm until she was orphaned at the age of fifteen. Some time later, it is unknown how, Jeanne ended up working as a housekeeper for a scientist, Philibert Commerson, who would later be appointed King Louis XVI's botanist. With him she began to study, became his assistant and they fell in love.

In 1765, Commerson was called to participate in the first French expedition that would circumnavigate the world. At first he had doubts about whether to accept or not because of his poor health. He knew he needed Jeanne for this adventure, but women were totally forbidden to board French navy ships. Commerson demanded as a condition that he be accompanied by a servant, and Jeanne, who pretended not to know him at all, got the job disguised as a sailor.

During the sea crossing the botanists did not have much work, but once they reached the coast, Jeanne participated in all the land trips. Some were very dangerous, like in Rio de Janeiro, where natives murdered several crew members, and others were very demanding, in inhospitable lands such as Patagonia, carrying plant specimens for kilometres. Commerson even referred to Jeanne as a "beast of burden." But in addition to the physical work, once back on the ship, she was in charge of organizing and cataloguing the specimens.

Although for a long time there were rumours on the ship regarding her gender, it was when they arrived in Tahiti that the hoax was discovered. They continued the journey to Mauritius, where the expedition stayed a few years. Commerson continued to have health problems and eventually passed away. Alone and without resources, Jeanne worked in a tavern on the island. Here she met a naval officer who she married so she could return to France and complete her trip around the world.

Baret arrived in Paris in 1776 with a collection of over five thousand plant species, including bougainvillea, native to Brazil, which today we find in patios and gardens all over the world and whose name is dedicated to the officer who led the expedition: Louis Antoine de Bougainville. In addition, they observed and described some marine species during their journey, such as Commerson's dolphin (*Cephalorhynchus commersonii*), named after the French botanist. And, at first, tribute was also paid to Jeanne with the shrub *Baretia bonafide*, although a few years later they changed its name.

King Louis XVI publicly congratulated her on her arrival, describing her as an "extraordinary woman" and assigned her a lifelong income.



ANTONIA CALAFAT



# Jeanne Villepreux

(1794-1871)

## INVENTOR OF THE AQUARIUM FOR THE STUDY OF MARINE WILDLIFE

Jeanne Villepreux was born in a small French town in 1794, during the French Revolution. There she taught herself to read and write before leaving for Paris at the age of 18. She worked as a seamstress for a while until, thanks to a dress she made for a princess, she met an Irish merchant, they got married and went to Sicily. It was on this Italian island that she became interested in natural sciences. She explored Sicily on foot for years, collecting shells, butterflies, fossils, minerals and wrote a comprehensive guide on the island's natural and cultural history.

Her special interest and curiosity for marine life led her to invent one of the most basic and fundamental tools in marine sciences: the aquarium. Not only did she invent it, but she discovered some of its major uses: on the one hand, to observe marine species and study their behaviour; on the other, she used it to repopulate fish in rivers where they had almost disappeared. In this way, she bred young specimens in her aquariums and released them in areas where they were no longer to be found.

One of her greatest discoveries was to prove that the nautilus, a mollusc very similar to octopuses but with a shell, did not steal its shell from other animals, as hermit crabs do, but made its own. She also observed common octopuses and showed that they were capable of using tools, something that few animals — marine or terrestrial — can do.

Jeanne became the first female member of the Catania Academy of Sciences and was a correspondent for the Zoological Society of London, where she sent all the work she did from Sicily. However, a huge part of her manuscripts, collections and notes were lost at sea when the ship carrying them capsized.

In 1843 Jeanne and her husband returned to Paris until the Prussian army besieged the city in 1870 and they had to flee to their hometown, where she died at the age of 77.



ANTONIA CALAFAT



# Luisa de la Vega

(1862-1944)

## TEACHER AND ILLUSTRATOR AT THE FIRST SPANISH MARINE BIOLOGICAL STATION

Luisa de la Vega Wetter was born in 1862 in France. Her father was a writer and journalist from Cádiz who emigrated to Paris, where he met Emilia Wetter, a Frenchwoman of German origin. At this time very few girls went to school, but Luisa had the support of her mother, who stimulated her interest in learning and passed on her love of nature to her. There were not many options for women to study natural sciences in those days, so Luisa ended up doing teacher training in Paris.

In 1880, at the age of 19, she met Augusto González de Linares, a young Cantabrian naturalist who was travelling throughout Europe training to carry out the great task he had received: to create the first marine biology laboratory in Spain. They got married in Paris and went to live in Naples where they would both work at the city's marine biological station. Luisa had no scientific training, but here she entered the world of marine wildlife illustration.

After these experiences, full of knowledge, Luisa and Augusto moved definitively to Santander, where they would set up the station in 1899. Luisa played a fundamental role. She was an educated woman, fluent in three languages and with an extraordinary gift for drawing. For more than ten years she was in charge of illustrating the marine fauna and flora that were at the station, an extraordinary and fundamental work for this laboratory's pioneering studies, which she had to combine with domestic chores and looking after three children.

Following Augusto's death, Luisa went with her daughter in 1904 to a small town in León, Villablino, where she would work as a teacher at the village school - at first only for boys. Luisa began a great fight for girls' access to education. First, she achieved a school just for them and, in a few years, she managed to equalize the contents as well as the sharing of classroom by both girls and boys. During the 12 years that Luisa worked in Villablino, her daughter Genara was the first female to pass high school studies in the entire province of León.

So, mother and daughter packed their bags once again and moved to Madrid, where Genara would study Natural Sciences at the university. Luisa returned to her marine drawings and worked at the National Museum of Natural Sciences as an illustrator from 1923 until her retirement. She died in 1944, aged 82, leaving us an extraordinary collection of zoological and botanical illustrations.







## SELF-TAUGHT BIOLOGIST AND PIONEER IN BREEDING JELLYFISH IN CAPTIVITY

Although she was born in a small town in Northern Ireland, in 1866, she soon moved with her family to Valentia Island in southern Ireland, where her father had been appointed governor. Maude was the seventh of ten siblings, of whom only the males would go to school. However, that did not truncate Maude's interest in nature and, together with her sister Constance, she caught marine species along the shores of the island and kept them in home aquariums to observe their behaviour.

Many of the specimens caught by the Delap sisters would end up in the Natural History Museum of Dublin and, as a result of this work, the Royal Irish Academy carried out an expedition to the island. Maude and Constance took part in it and then continued to collect specimens, which they sent to Dublin along with drawings and descriptions.

Thus, Maude became a self-taught marine biologist. Her interest continued to grow and she began to study the biological cycle of various species of jellyfish, becoming the first person to breed them in captivity. She observed their behaviour, studied their diet, for the first time described some phases of their life cycles and published her results in scientific journals.

Due to her contributions, at the age of forty she was offered a job at the Plymouth Marine Biological Station. However, she had to decline it because of her father's reaction, who assured that none of his daughters would leave the house unless it was to get married.

Maude would continue all her life on Valentia Island studying its fauna and flora and sending drawings and specimens to Dublin until her death in 1953.







## A WHOLE LIFE AT THE IEO, BETWEEN CHEMISTRY AND FISHERIES

Emma Bardán Mateu was born in Madrid in 1899. She had three sisters and two brothers, who all studied scientific careers, something uncommon at that time when women's access to university was very limited. Their mother, María Mateu, a pioneer in the fight for women's rights, played a major role in this family feat.

Emma Bardán soon discovered her passion for the sea. While studying Natural Sciences, she took several courses at the Spanish Institute of Oceanography (IEO) on plankton and, once she finished her degree, began working there as an intern.

She began specializing in marine chemistry, studying the most cutting-edge methodologies to determine variables such as temperature, salinity, density or dissolved oxygen in water. Due to this knowledge gained, she was able to embark on her first expedition in 1924 and publish her first scientific article.

She passed the public examinations for research assistant and was assigned to Málaga, along with her husband, Luis Bellón, with whom she would participate in many campaigns and projects. The couple's next destination was the newly created IEO laboratory in the Canary Islands, where they launched several pioneering research programmes on the islands until the closure of the centre in 1935.

The Civil War paralyzed the activity at the IEO and also Emma's. After the war, back in Málaga, Emma changed her scientific career to devote herself to the study of fisheries in the Alboran Sea, especially sardine and anchovy, so important for the Málaga economy. She was one of the first women to take part in the International Council for the Exploration of the Sea working groups, where the decision is taken as to how many fish can be caught so that catches are sustainable and populations are not depleted.

When her husband Luis died, she moved to the IEO headquarters in Madrid and spent the last years of her career organizing databases, editing publications and other research support tasks. She retired after almost 50 years of working at the IEO, a lifetime of dedication to getting to know and protecting the oceans. She died in 1992 at the age of 93.

Since 2006 a ship engaged in working in oceanographic and fisheries research bears her name.



ANTONIA  
CALAFAT



## THE FIRST FEMALE OCEANOGRAPHER IN SPAIN

Jimena Quirós was born in Almería in 1899. Before her 18th birthday she went to Madrid, where she began to study science. There she lived at the Residencia de Señoritas, the least known of the two Madrid institutions that were the centre of cultural activity in Spain in the early twentieth century. The other, much more famous one, was the Residencia de Estudiantes, only for men. Jimena shared her daily life here with future women painters, philosophers, jurists and scientists, who would later become the best in their professions.

In 1920, while finishing her studies, Jimena began working at the Spanish Institute of Oceanography (IEO). She graduated with a special award and, a few months later, became the first woman in Spain to embark on an oceanographic campaign. When she returned from this expedition through the Mediterranean, she took state exams and, at the age of 22, she joined the IEO as the first female scientist in the institution's history.

Jimena never stopped learning and her restlessness led her first to the University of Paris and then to the University of Columbia, where she studied "Physical Geography of the Atmosphere and the Oceans" with some of the best scientists of the time in this area. Although she worked in several fields of marine sciences, Jimena's specialty was physics to which she devoted most of her short career: to the study of ocean water bodies, their temperature, salinity, currents ...

In addition to science, Jimena engaged in politics and the fight for equal rights for women. She chaired the women's committee of the Radical Socialist Republican Party even before women had the right to vote. Jimena began to have problems at work and temporarily left to devote herself to teaching. She worked at several schools until the Civil War broke out. In 1940, the Franco dictatorship dismissed her from her posts as well as from the IEO.

She survived the Civil War, but her career and fight for equal rights were cut short. In 1966 Jimena obtained a pardon from the Franco government and obtained her readmission to the IEO, but now as a retiree.





# Anita Conti



(1899-1997)



## FISHERIES OCEANOGRAPHER AND COMMUNICATOR

On May 17, 1899, on the outskirts of Paris, Anita Caracotchian was born into a wealthy family of Armenian origin. She spent her childhood travelling around the world with her parents and siblings and was educated at home. Anita was a great reader and from a young age would write poems. In 1914, during the First World War, they had to take refuge on the island of Oléron where her passion for the ocean and her fondness of photography began.

After the war she returned to Paris. Here she got married and adopted her husband's surname, by which she is known today: Conti. She began to write articles for different magazines about the sea and fishing, which led her to embark on her first campaigns aboard large fishing boats to report, first hand, their work on the high seas.

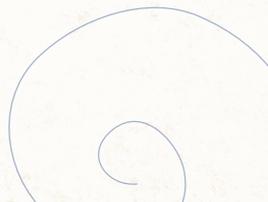
Her articles caught the attention of the institution in charge of fisheries research in France and she was hired, in 1935, as "responsible for propaganda", probably the first person hired by a marine research organization for dissemination purposes. She participated in several research campaigns aboard oceanographic vessels and also on fishing boats where, in addition to reports, she assisted in the development of the first fishing maps of fishing grounds in the Bay of Biscay, Newfoundland and the Irish Sea.

When World War II broke out, the difficulties for fishing in European waters aroused her interest for studying African fisheries. Anita worked there for five years, exploring new fishing grounds, studying their species, training local fishermen and, of course, photographing and documenting everything.

In 1952 she returned to Newfoundland aboard a large industrial fishing vessel. After the campaign she published a book in which she expressed her indignation at the enormous amount of fish being discarded. In each trawl, more than two thousand kilogrammes of species could be caught and thrown back into the sea. Anita denounced that with the discards of the French fleet it was possible to feed entire regions of Africa.

She gradually became more aware of the impact of industrial fishing on ecosystems, which led her to becoming an activist for ocean conservation and a pioneer in showing that the resources of the sea are not inexhaustible.

Anita Conti, who died at the age of 98, left a legacy of 45,000 photographs, 120 hours of recordings of interviews and lectures and thousands of documents such as articles, books and illustrations of fish.





ANTONIA  
CALAFAT



## COMMANDER IN CHARGE OF THE U.S. NAVY'S FIRST OCEANOGRAPHIC UNIT

Mary Sears was born in 1905 in a small town in Massachusetts, in the United States. At the age of 22 she graduated in marine biology, and when she was 29 she received her doctorate in zoology, all from Radcliffe College, which was then the women's section of Harvard University and which would not be integrated under the same name until 1977.

After graduating, she worked at the university studying plankton with Henry Bigelow who would later be the founder and first director of the Woods Hole Oceanographic Institution (WHOI), one of the most prestigious marine research institutions in the world, where Mary would be one of its first employees. There she continued to study plankton for almost ten years: its distribution, its movements... and with it she understood how currents work in the ocean.

In 1943, during World War II, she enlisted as a volunteer in the United States Navy, where she created and directed the first oceanographic unit and reached the rank of commander. Mary headed a team of four hundred people who were in charge of studying the tides, waves and currents, information that would help the American army fight the Nazis in the war. She managed to apply her knowledge to, for example, locate places in the ocean where submarines could not be detected by enemy sonars. Thus, what began as a small unit grew into a division.

After the war, Mary returned to her scientific work at WHOI, until she retired in 1970. During those years she laid the foundations of modern oceanography, founded several international scientific journals where, today, oceanographers from all over the world publish the results of her research.

She died in 1997 at the age of 92. In 2000, a new U.S. military oceanographic vessel was named after her, the first one with a woman's name.





## MARINE BIOLOGIST PIONEER IN RAISING ENVIRONMENTAL AWARENESS

Rachel Carson was born on May 27, 1907 in a small town in the United States: Springdale, Pennsylvania. She lived on a farm in close contact with nature. She was always a great reader and very soon became a writer... at the age of eleven she published her first short story!

Rachel tried very hard to study at the university. She began her studies in English Literature, but soon switched to Biology, her two passions. She graduated and continued to study Zoology and Genetics. However, her family's financial problems prevented her from continuing her studies and she began to work, first as a professor at the University of Maryland and then with a job that would mark her career as a communicator: she got a contract at the U.S. Fisheries and Wildlife Service to write scripts for an educational radio programme called *Romance under the Waters*.

Although she didn't see the sea until she was 22, her passion for marine biology and ocean biodiversity was enormous. Her first publishing success was a trilogy of books on marine life, from the coasts to the ocean depths. One of these books, *The Sea Around Us*, published in 1951, was translated into more than thirty languages and has received several awards. For several years it was one of the best-selling books in the United States.

Rachel continued to combine her scientific work with that of writing, and in 1962 she published her best-known work: *Silent Spring*. A pioneering book in denouncing the consequences of pollution on nature, with which environmental activism was born and without which today's ecological awareness cannot be understood.

The outrage caused by her book was the reason why the U.S. Environmental Protection Agency was created. Many of the demands that Rachel made at it became political measures, such as the prohibition of the use of DDT, an insecticide widely used in the past with a disastrous impact on fauna and human health.

Rachel Carson died prematurely, at the age of 56, just two years after publishing her book.

She has recently received many tributes. An American oceanographic vessel is named after her, as well as a nature reserve, a German research centre and a prestigious award for women working in conservation.





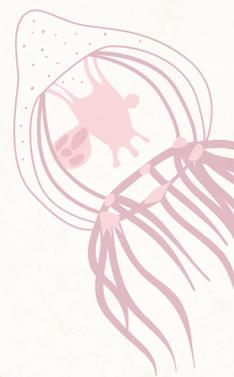
ANTONIA  
CALAFAT



# Ángeles Alvariño

(1916-2005)

## GALICIAN OCEANOGRAPHER EXPERT IN ZOOPLANKTON WHO DISCOVERED 22 NEW SPECIES



María Ángeles Alvariño González was born in Serantes, a small coastal town in Galicia on October 3, 1916. At the age of three she could read and studied music. She loved natural history books and in 1933 she finished the University Baccalaureate in Arts and Sciences at Santiago de Compostela University.

In 1934 Ángeles went to Madrid to study Natural Sciences. However, during the Civil War it would close, so she returned to Galicia. She took advantage of this time to learn French and English, which would be fundamental to her future scientific career abroad. Ángeles was able to continue her studies after the civil war and graduated in 1941.

After a few years as a high school teacher, she returned to Madrid with her husband, a military sailor who had been stationed there, and joined the Spanish Institute of Oceanography (IEO) as an intern at the age of 32. Two years later, by state examination, she obtained a position as a biological oceanographer at the IEO laboratory in Vigo and began to study zooplankton.

In 1953 she received a scholarship for the further study of these small organisms in England, where she became the first woman scientist to work aboard a British research ship. Three years later she received more aid, this time to continue her research in the U.S. under the tutelage of another woman pioneer of whom we have already spoken: Mary Sears. She would be the one who, impressed with her work, would recommend her to take a position at the Scripps Institution of Oceanography, in California, where she remained until 1969 analysing thousands of plankton samples from around the world.

She continued her career at another prestigious American institution, NOAA, where she would study fish larvae in plankton. After her official retirement in 1987, she continued to work as a scientist emeritus as well as writing and disseminating the history of marine sciences in Spain.

Thanks to her meticulous work, Ángeles described 22 new planktonic species for science.

She died in 2005. Since 2012 one of the most advanced oceanographic vessels of the Spanish scientific fleet bears her name.





## THE FIRST PERSON TO MAP THE OCEAN FLOOR

Few people in the world can say that thanks to their work we know what 70% of the entire planet looks like; that's the case of Marie Tharp. She worked as an oceanographic cartographer, that is, making maps of the relief of the ocean floor, the surface of the Earth hidden from our eyes by sea water.

Marie was born in Michigan in 1920. First, she studied English Philology and Music at college, then achieved a Master's Degree in Geology and another in Mathematics.

She began working as a geologist at an oil company and later moved to New York, where she joined Columbia University. There she met marine geologist Bruce Heezen, with whom she collaborated on several projects. First locating ships sunk during the Second World War and then in what would be her greatest contribution to science: the elaboration of maps of the relief of the seafloor. She thus became an oceanographic cartographer and, together with Bruce, made the first complete map of all the oceans.

At that time, in the U.S., women could not work aboard a research vessel, so Bruce was in charge of collecting the data at sea and Marie used that information to draw the maps by hand. In 1957 they published their first cartography of the North Atlantic, demonstrating the existence of the mid-oceanic ridge, a huge underwater mountain range that crosses the ocean from north to south where new seafloor is being continuously created.

It wasn't until 1965, at the age of 45, that Marie could board a ship for the first time. In 1977 Marie and Bruce, with the help of Austrian painter Heinrich Berann, published their map of the entire ocean floor. Marie and Bruce's maps provided clear evidence supporting the plate tectonics theory.

Marie continued to work at Columbia University until 1983, after which she started a map distribution business. She died in 2006, aged 86.







# Katsuko Saruhashi

(1920-2007)

## GEOCHEMIST PIONEER IN THE STUDY OF THE EFFECTS OF RADIATION ON THE OCEAN

Katsuko, which in Japanese means “strong-minded and victorious,” was born in 1920 in Tokyo. This name would gradually forge her character, despite her being shy and introverted as a child.

Katsuko was also a very inquisitive person and, at a very young age, showed a great interest in nature and in seeking answers to everything around her. Some answers that, as could not be otherwise, she would find in science. She especially liked physics and mathematics, for which she proved to have extraordinary qualities at school.

In 1943 Katsuko graduated in Physics, in the middle of World War II. She turned down several offers to work as an army scientist. A convinced pacifist, she argued that the goals of science and technology should be the well-being and happiness of humanity. So, she joined the Japan Meteorological Institute, where she specialized in atmospheric and oceanic geochemistry.

Her first major contribution was to develop an analysis method that bears her name, the Saruhashi table, used by scientists all over the world for years to measure carbon dioxide in seawater, work that helped her become the first Japanese woman to obtain a Doctorate in Science.

In August 1945 the U.S. dropped two atomic bombs on the cities of Hiroshima and Nagasaki that killed more than two hundred thousand people. This atrocity marked Katsuko deeply, as she could not understand how science could be used to cause such brutal harm. After that, she devoted her career to studying the effects of radiation on the sea and to fighting for the abolition of nuclear weapons. She demonstrated how wind and ocean currents carried radioactive contamination from nuclear tests being conducted in the Pacific. Signs of these substances could be detected at a depth of more than eight thousand metres, which completely changed the existing idea about the speed at which the waters of the surface and the seabed mix.

Her studies revealed the enormous environmental and human health impact of these tests and, despite the reluctance of the United States, which at first questioned her results, she succeeded in getting this type of test banned.

Katsuko was also a great fighter for women's rights. She founded the Society of Japanese Women Scientists, and an important award given every year to highlight the contributions of women scientists in Japan bears her name.





# Eugenie Clark

(1922-2015)

## MORE THAN 40 YEARS SWIMMING AMONG SHARKS

Eugenie Clark was born in New York City in 1922. Her father died when she was just two years old and her mother Yumico, of Japanese origin, had to raise Eugenie on her own. To do this, at times she had to be very creative and so, some days, while Yumico was busy working, Eugenie would spend the day at the New York Aquarium. The result was that, at only nine years old, Eugenie became fascinated with marine life, especially fish and, above all, sharks.

Her passion grew and she ended up studying Zoology at the university. She specialized as a fish expert — or ichthyologist, which is what these scientists are called — and, at the age of 27, joined a project that took her diving through many unexplored places in Micronesia, in the Pacific Ocean. After taking her doctorate, she continued to explore new places, this time in the Red Sea, at the Al-Ghardaqaq Marine Biological Station in Egypt. This experience was reflected in the book *Lady with a Spear*, which would be a bestseller.

Since then, Eugenie focused her work on studying sharks. During her career of more than 40 years, she would dive alongside these dreaded fish on hundreds of occasions to investigate their behaviour and ecology. Among her discoveries is a natural shark repellent secreted by a flat fish. She also proved that some sharks don't have to swim continuously to breathe as had been previously believed.

Interestingly, during all this time she did not have a single mishap underwater. She was only injured once by shark teeth and it was by accident, with a dissected jaw that Eugenie was carrying in her car on her way to a conference.

Eugenie always liked to share her adventures and scientific research with all types of public and not only in the academic world. She wrote many books, magazine articles and appeared in several television programmes.

She carried on diving until a year before her death... at the age of 92!





## BIOLOGIST, EXPLORER AND ACTIVIST IN DEFENSE OF THE OCEANS

Sylvia Alice Earle was born in New Jersey in 1935, but when she was just 12 years old she went with her family to Florida, to live in a house by the sea, which would mark her life from then on. The fauna and flora that came to the coast attracted her attention enormously until, at the age of 17, she went diving for the first time and could see the sea from within.

Sylvia graduated in Botany and ended up doing her doctoral thesis on algae in the Gulf of Mexico, where she collected more than 20,000 specimens.

In 1964 she took part in the first expedition to explore the seabed of the Seychelles, the only woman along with seventy men. Two years later she also participated in the exploration of the Galapagos Islands and gradually started to reach places where no one had been before.

She was the first person to walk along the bottom of the sea at a depth of almost four hundred metres. Later, together with the engineer Graham Hawkes, she designed a submarine with which they would descend to a depth of over one thousand metres, the Deep Rover submersible.

Among the milestones of this woman pioneer was being the first female chief scientist of NOAA, one of the most prestigious institutions for ocean study. She held the post for two years until publicly resigning in order to denounce the Government's lack of interest in defending the marine environment. In her own words: "As an ordinary citizen I will be able to do and say things that are not appropriate for a senior U.S. official."

Since then, she has become one of the main voices in highlighting the importance of the ocean, disseminating its wonders and defending its protection. In 2009 she received the TED prize for an inspiring talk that went around the world. With the prize money she founded Mission Blue, an initiative whose goal is to create a global network of protected marine areas and which has become an extraordinary platform of dissemination.

Her tireless work for protecting the oceans contributed to her receiving, in 2018, at the age of 83, the Princess of Asturias Award for Concord.

Sylvia has spent more than a thousand hours under the sea and today she continues to fight and work for an ocean full of life.





# Josefina Castellví

(1935-)

**ANTARTIC PIONEER, MICROBIOLOGIST,  
DIRECTOR AND COMMUNICATOR**

Pepita, as she has always liked to be called, was born in 1935 in Barcelona.

She started to study Medicine, like her father, but soon changed her studies to Biology. Her interest in the ocean and the scarce opportunities available in Spain at that time, led Pepita to study at the prestigious Sorbonne University. Here she spent two years and specialized in the study of ocean microbes, a very novel and unknown line at the time.

In 1960 she began working at the Fisheries Research Institute of Barcelona — later the Institute of Marine Sciences — where she did her doctoral thesis and became an expert in the study of ocean bacteria and microalgae. Her first years were not easy, one of her bosses even said to her, “My dear child, you have made a mistake, this is not for women”. However, she carried on, “playing the absent-minded,” as she recalls. The first time she wanted to participate in a sampling expedition, she wasn’t allowed to do so. She had to insist a lot, saying, “Let me go once, just once, and I won’t ask you again.” Her boss gave her permission and she didn’t ask him again... the next times she simply went.

Luckily, not all her male colleagues were like-minded. Her friend Antoni Ballester passed his passion for Antarctica on to her and, thanks to his support, in 1984 she embarked on her first campaign to the frozen continent. For several years, they were invited by Argentina and Poland, since Spain did not have its own bases.

Since then they have focused their efforts on convincing the authorities of the importance of a Spanish base in Antarctica. They even went camping as a protest on Livingston Island and, finally, their demands became a reality: in the austral summer of 1987-88 the Juan Carlos I base was set up. However, Antoni had a stroke and the Antarctic project was left up in the air. This is when Pepita took over, thus becoming the first woman in the world to run a base in Antarctica.

She became a top-notch scientific manager. In addition to running the base for five years, she was director of the ICM and was in charge of the national Antarctic research programme. She set aside her contribution to science to open doors for other researchers to work. Pepita said that the Antarctic ice contains information on the experiences of the planet and worked so that hundreds of scientists could reveal some of these secrets.

In 2000 she took retirement, but did not retire from research. She focused all her efforts on disseminating her work and raising public awareness on the importance of Antarctica. In 2013, at the age of 77, she returned one last time to shoot a documentary.

Thanks to the administration work started by Pepita, Spain now has two modern bases in Antarctica. And thanks to her efforts to disseminate information, the unit of the old base that she directed can be visited at the CosmoCaixa Museum in Barcelona.



ANTONIA CALAFET



(1947-2015)

## PIONEER IN THE STUDY OF OCEANIC ACIDIFICATION

Aida Fernández Ríos was born in 1947 in Vigo, surrounded by a seafaring environment. When she was a little girl, her uncle, who participated every year in the fishing campaigns in Newfoundland, brought her illustrations that he himself had drawn and told her many stories about his work on the high seas.

Although the ocean fascinated her, Aida never thought of making it her profession. She began to study commercial studies at business school but, due to her father's ill health, she left to work in a printing press to help her family. She signed up for French classes and there she met a scientist from the Fisheries Research Institute who aroused her interest in marine sciences and encouraged her to prepare for the laboratory assistant state exams.

No sooner said than done. At the age of 25, Aida passed the exams and started working from the lowest echelon. Her early years were dedicated to analysing otoliths, calcareous structures that fish have on their heads and that allow to determine their age, something essential to be able to manage fisheries in a sustainable way.

Aida liked her job so much that she enrolled at university to study Biology. She combined her studies with the work of an assistant, finished her degree and did her doctorate on phytoplankton from the Vigo estuary and the environmental conditions that influence its growth. Her scientific interest gradually geared towards understanding the physical and chemical changes in the ocean and how they affect ecosystems and the climate of the entire planet. She participated, together with scientists from around the world, in the first global study to quantify CO<sub>2</sub> from the burning of fuels that accumulate in the oceans, work that exposed one of the main problems facing our seas: acidification. Since then, Aida has specialized in studying this process and warning of its effects on organisms with calcareous structures such as mussels.

Aida started to ascend in her job, first at the technical level, then at the scientific one, until she managed, after much effort, to promote herself to the highest degree in her institution: Research Professor. Furthermore, in 2006 she became the first woman to head the CSIC Marine Research Institute, the same institution where she had started to work thirty years earlier with hardly any training. An extraordinary example of self-improvement.

In 2015 she died in a traffic accident.



ANTONIA CALAFAT



# Ana Ramos

(1950-)

## 30 YEARS STUDYING BENTHOS FROM AFRICA TO ANTARTICA



Ana Ramos was born in 1950 and grew up in what was once a fishing town in Málaga. The courtyard of her house opened directly onto the Mediterranean, which marked her life from a very young age.

She studied Biology at Granada University, being part of the first promotion. She went to Madrid for love where she worked several years as a school teacher.

At the age of 30 she returned to Málaga, with the very clear idea of dedicating herself to marine research. Taking care of two young children and working sporadically on many things, she began to go every day to the Spanish Institute of Oceanography (IEO) as an intern.

In 1985 she obtained a research assistant post by state exam. Just at that time the first scientific expedition in Antarctic waters was being organized and, although assistants were not expected to be allowed to participate, Ana requested it and, as places were available, she was able to go.

The main objective of the campaign was to study the fishery resources of the area. But Ana focused on the animals that live associated with the seabed, which we know as benthos. At that time, these invertebrates that Anne was studying were not a priority. The main thing was to get to know better the commercial species and, of course, these inedible organisms were not important, although later they have proven to be fundamental for the health of the ecosystems ... and also for fishing!

But Ana's insistence allowed her to continue studying Antarctic benthos for twenty years. She led four expeditions in which they discovered more than fifty species new to science. However, in parallel, Ana had to fulfil her main task at the IEO which was the study of the African fisheries where the Spanish fleet operated. This consisted of analysing data, attending meetings and drawing up reports. In 1990 she managed to lead her first on-the-ground campaign in Africa and transferred her pioneering studies on Antarctic benthos also to these waters.

Since then, she has led and participated in more than twenty expeditions. As in Antarctica, her work has served to discover numerous species and advance scientific knowledge, but in the case of Africa, her commitment went beyond science. Ana and her team turned to development aid through the training of scientists. An extraordinary commitment, even on a personal level... to the point that Ana adopted two of her daughters there!

At 72 years old, the idea of fully retiring does not cross her mind. In 2019 she took retirement from her post at the IEO, but currently continues her work as a researcher at Vigo University.





ANTONIA  
CALAFAT

# Cindy Lee Van Dover

(1954-)



## SUBMARINES, HYDROTHERMAL VENTS AND FAUNA FROM ANOTHER WORLD

Cindy Lee Van Dover was born in 1954 in New Jersey. Like other children, she loved animals, but not the most common ones like cats and dogs... She was more attracted to stranger ones, such as horseshoe crabs that have ten eyes and use appendages on their legs to feed themselves. For some time, Cindy wanted to be an astronaut, but as soon as she got hold of a book on the deep ocean and saw some of the creatures that live there, she knew she wanted to be a marine biologist.

As it could not be otherwise, Cindy specialized in deep-sea fauna, especially those inhabiting hydrothermal vents, areas where volcanic activity is very important and there are extraordinary incredibly diverse and productive ecosystems, which, instead of being based on light and photosynthesis, are based on the metal-rich elements discharged by the chimneys that serve as food for bacteria.

In 1985, she had the opportunity to observe one of these ecosystems with her own eyes. It was her first dive in the submarine Alvin, as a passenger, on the Galapagos ridge, where the lithospheric Cocos and Nazca plates meet. There they discovered a landscape like from another planet, with black and white chimneys discharging hot springs, two-metre-long red worms on the sea floor, huge yellow mussels, giant clams...

Following this experience, Cindy decided to train as a pilot of the submarine Alvin. To qualify as such, you need months of training, having to memorize an infinity of systems and protocols and be able to execute them at thousands of metres depth, sometimes in very stressful situations. This is how, in 1990, Cindy became the first woman capable of piloting this famous submarine and, since then, she has commanded 48 dives in which she has discovered dozens of invertebrates in hydrothermal vents.

It is curious to think how Marie Tharp, our pioneering geologist, discovered and mapped the mid-oceanic ridges and Cindy, thirteen years later, descended thousands of metres in a submarine and observed with her own eyes the impressive biodiversity living there at temperatures of up to 400°C. How fast oceanography evolves!

In 2005 Cindy became the first woman director of the Duke University Marine Laboratory, where she continues to work today.

Currently, underwater mining is the main threat to these ecosystems, where there are huge amounts of valuable minerals, and Cindy works for their protection by collaborating with the industry and giving advice to the administrations.





(1979-)

## EXPERT IN WHALES AND A GREAT COMMUNICATOR

Asha de Vos was born in 1979 in Sri Lanka, an island-state bathed by the Indian Ocean. Her first memory of the sea is the feeling of fear she had when she saw that immense and inaccessible place. This is because the inhabitants of Sri Lanka, despite being surrounded by the sea, have never considered it as a place of leisure and only fishermen and sailors came there.

However, Asha's father, who bought her National Geographic magazines, passed his passion for science on to her and, above all, the desire to explore. And so the ocean went from generating fear to enormous curiosity.

Despite the lack of close references, from an early age Asha knew that she wanted to be a marine biologist. Her parents made an enormous effort to help her accomplish her dream, so, after finishing her primary education, she continued her studies abroad.

At that time, just twenty years ago, the study of marine science in Sri Lanka was unthinkable; it was even considered something frivolous, as she explains. But Asha graduated in Marine and Environmental Biology in Scotland, then took a Master's degree at Oxford University and ended up getting her doctorate in Australia. She had achieved a curriculum that would have opened the doors of any of the best marine laboratories in the world, but she knew she wanted to return to Sri Lanka and contribute to the development of marine science in her country.

In 2008 she launched an ambitious project to study Sri Lankan blue whales and discovered that these cetaceans, contrary to what all scientists thought, did not make large migrations, but lived permanently in the waters of the island. This was something that was not easy to demonstrate. Asha meticulously studied their movements and analysed numerous samples of excrement, which showed that they did not eat Antarctic krill, but other crustaceans present in the area. She found the explanation in the monsoons, a wind regime that in Sri Lanka creates the ideal conditions for the feeding and reproduction of whales all year round, so they do not need to spend energy on large migrations.

In addition to being a great scientist, Asha dedicates her efforts to the training of new scientists as well as the dissemination of information. She is a National Geographic explorer and directs the Oceanswell Foundation, Sri Lanka's first organization dedicated to ocean education and conservation.

Asha continues to study the ocean, seeking to show the world its secrets, its importance and the urgency of protecting it.







## YOUNG WOMEN SCIENTISTS WHO LEAD THE NEW CHALLENGES OF OCEANOGRAPHY

Cristina Romera was born in Jaén in 1982. She hesitated between studying Fine Arts or Sciences and, although she finally chose to study Chemistry, she has never stopped writing and drawing. As she herself says, “Art is essential for science and it takes creativity to investigate”.

Looking for topics for her thesis, pure chemistry did not attract her very much and she found in marine sciences a more general vision that allowed her to learn a little more about various disciplines. Thus, Cristina ended up doing her PhD at the Barcelona Institute of Marine Sciences on the transformations suffered by carbon compounds in the marine environment. These studies are key to knowing the role of the ocean in the regulation of the planet’s climate.

After her doctorate, Cristina spent periods in Miami and Vienna and has now returned to Barcelona to lead her own research project, a study with which she intends to contribute to the search for solutions to one of the main problems facing the ocean: plastic pollution.

It is almost impossible to know how much plastic is in the sea. One of the best estimates, published in 2015, points to almost 150 million tons. But, if the situation does not change, the same study calculates that in 2040, 600 million tons could have accumulated. Other studies estimate that by 2050 there will be more plastics than fish in the sea. And this is just what we see as, over the years, plastics fragment and decompose and release substances into the water that can cause adverse effects on marine organisms and human health.

This is precisely what Cristina is currently focusing her efforts on, studying the degradation of plastic in the ocean: what substances they release, how they affect ecosystems or what bacteria could accelerate this process and help combat this gigantic problem.

In 2020 she was recognized as one of the fifteen most promising young scientists in the world through the “International Rising Talents” award granted by the L’Oréal-UNESCO For Women in Science programme, the first Spanish marine scientist to achieve it.







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# Oceánicas

FEMALE PIONEERS  
IN OCEAN SCIENCE

*Oceánicas: women pioneers in ocean science* tells us the life and work of 20 illustrious female marine scientists, from the first and only woman who sailed around the world during the time of the great explorations, to women who today lead the fight for ocean conservation.

Not only do their stories tell us about the development of marine science in the last centuries, but they also reveal the difficulties faced by women – in oceanography, science and life – and the struggle for equality of many generations.

These are just a few examples of the many illustrious female scientists of the past and present who we hope will serve as inspiration for those who dream of dedicating themselves to marine research.



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