



# Can Monaco save the oceans?

Aquarium room © Eric Béraud (CSM)

## Studying coral at the Centre Scientifique de Monaco

Inside an office building in Port Hercule is one of the most important environmental research facilities in the world. But what does Monaco have to with coral? Riviera Insider visits their impressive facility to find out.

By NICOLE RUSKELL

**W**hen you think of coral, Monaco is certainly not one of the first places to come to mind. In fact, there is very little coral in the waters off the coast of the Principality. But for coral habitats across the planet, Monaco is one of the most important places on Earth.

The Centre Scientifique de Monaco (CSM) was the first research centre to devote itself to the study of coral physiology. It was also the first to have a live coral aquarium. Even today, their coral collection is one of the oldest and most varied in the world.

Founded in 1960 by Prince Rainier III, the CSM was established to study man's affect on the environment, specifically the oceans. Long before climate change was a household term and long before plastic was a common sea pollutant, the sovereign had the foresight to know our destructive tendencies would have consequences on our planet.

Professor Denis Allemand, a coral specialist who joined CSM thirty years ago, is the Scientific Director of the centre. At the time he joined, scientists knew nothing about coral physiology. "There were just two of us back then," he says, recounting his arrival in Monaco. Today, CSM has around 60 researchers, 30 in coral studies alone.

Continuing on from his father's dedication to the environment, Prince Albert II is a strong supporter of CSM. After taking over as sovereign, he helped develop the centre's research focus to two additional departments: Polar Biology was started in 2010, a topic very close to the Prince; and in 2013 the Medical Biology department which is studying a wide range of medical topics from paediatric cancer to immunity and sickle cell disease.

"We are very unique in Monaco, with a government and a Prince that supports us very much," says Dir Allemand. He's not kidding—unlike most research laboratories, the CSM doesn't have to propose new projects for funding each year. The Monegasque government provides a set amount of the yearly budget to the centre, guaranteed. This allows the teams to not only continue long-term projects, but also get creative and follow leads they may otherwise be constricted on. Researchers still do apply for grants for particular projects, as the state funding covers about 80% of their budget, but it is a substantial advantage for the centre.

Another ace up their sleeve is a resident economist. Perhaps an unlikely association for most biological research centres, but the idea was brilliant. No matter what the scientists

find, not much can be done at policy level without getting government backing. And at the government level, policy makers usually don't understand the impact of a document saying the oceans have become 0.1 more acidic, or that 1° more could cause the loss of our coral reefs. It's abstract. But getting an economist to crunch numbers and present to the UN that 500 million people survive directly from coral helps puts things into perspective.

### Studying coral

When Director Allemand started in the late 1980s, he studied the native red Mediterranean coral (*Corallium rubrum*) that so often adorned the necks of wealthy women. In fact, at the time, the biggest threat to this precious coral was not environmental, but over-fishing for fine pieces of jewellery.

Their tropical cousins, however, were being threatened by a changing environment, even back in the 80s. "We didn't know anything about coral physiology back then," he admits. "We wanted to better understand the coral so we could better manage the environment." Thanks to CSM, scientists now understand coral physiology - how they are nourished and how they die. What they don't know: how long coral lives. "We can't really say," revels Allemand. "The oldest coral we know of is 4,000 years old. In fact, we don't really know if coral has mortality." Like succulent plants, coral can regenerate itself from broken pieces. To explain this better, he takes two pieces of coral in hand and says, "if you break a piece, you will have two pieces that keep growing. If you

break those pieces, you'll have even more. Plant them back and they will keep regenerating and growing new branches indefinitely. It's the same genome - it's the same coral family." The secret to coral's longevity, however, is a very important relationship with algae.

### Coral and algae: The perfect marriage

Beautiful coral reefs can be described a bit like a love story. Coral skeletons have lots of porous surface area, making an excellent home for algae to attach and build a home. From this sturdy base they can feast off the micro-nutrients flowing by, growing in rich, beautiful colours and nourishing the coral to grow. The happy couple flourishes together, being equally important partners in the relationship (although coral is co-dependent). When they are happy, everyone is happy. Healthy coral reefs create abundant habitats for just about every creature in the ocean which, in turn, creates a healthy planet. Referred to as the 'rainforests' of the ocean, the whole world is healthier when there are happy coral reefs.

But just like any marriage, a stressful atmosphere can be taxing on the relationship. The warming of the ocean is one of the biggest stressors leading to what is known as 'blea-

ching'. The term refers to the whitening phenomena that is happening more and more in some of our most important reefs worldwide. Dir. Allemand explains this phenomena more as a 'divorce' than bleaching because it is actually the result of algae detaching from the coral, taking its vibrant colour with it - and also it's food. Without the algae, coral quickly starves to death. It's a dramatic outcome for a couple that was once so perfect together; and it's leaving large swaths of barren, white coral skeletons across the world.

So it's this 'divorce' that scientists are still trying to understand. The warmer temperature "stresses out the algae" and makes it excrete toxic compounds, explains Dr Francois Seneca, a Molecular Ecologist and senior researcher at CSM. "We don't know whether the coral is expelling the algae [because of this toxin], or if the toxins are killing the attachment cells. We've seen evidence of both."

What scientists do know, is that coral can only last 15 days without their algae: if it comes back, it returns to health - if not, it dies.

### The aquariums

Director Allemand gives us a tour of the coral aquarium - the only one like it in the world - with coral that has been with the CSM for 50 years. The maze of glass cases filled with

## FACT FILE

Coral reefs cover only 0.2% of the seabed but are home to about a third of all known marine life. Here are some fact on these 'undersea rainforests:

- ▶ 40% of coral reefs are located in the Pacific Ocean.
- ▶ More than 500 million people worldwide depend directly on the survival of coral reefs - in the form of tourism and fishing.
- ▶ Studies say that a 2° increase in average global temperature will kill 99 percent of the world's corals.
- ▶ By 2055, scientists say, 90% of coral reefs will experience lethal 'bleaching' and will take 10 to 15 years for the surviving corals to recover.
- ▶ Coral bleaching is also only one reason reefs die. Overfishing, environmental pollution, coastal development, tourism and acidification of the oceans have all led to about 40% of the world's coral reef deaths since 1990.

### Sources:

*Tara's Blue Book for the Pacific; Time Online*

## DR FRANÇOIS SENECA

### Molecular Ecologist



Riviera Insider spoke with Dr Seneca, who is a senior researcher on the Ecosystems and Immunity team. He has studied coral most of his life, in Hawaii, Australia and the California coast. At the CSM, he is currently studying the microbiome and its interaction with immune response. Once the scientists decoded the genome, they discovered that sea anemones are incredibly similar to human

benings. "We discovered genes that we were not expecting to be there," he reveals. "Some genes we thought were only human or only vertebrate genes. And we found them in there!" The digestive system is an excellent model for quickly studying the affects of bacteria and intrusive invaders. "Sea anemones have been evolving in the ocean for 500 million years," he says. "Humans have only been around for about 65 million years - so we're new compared to these little anemones...they have evolved innate immune responses and there are genes in there that we could definitely learn from." Algae plays a big role in the little sea creature's life - both for its nourishment and its immunity. Dr Seneca explained the 'endosymbiosis,' or the amazing ability of algae to be taken in to the anemone's cells and continue to live, producing energy for the anemone. "It's

extraordinary. It's still an algae cell, because if it gets out it still behaves like algae. But they have developed some kind of signal that says, 'hey, don't digest me, I'm your friend.'" They are studying this communication, but he describes it as "tricky" to decipher. We discuss bacteria and how we are now learning the important 'gut-brain connection', or how the different bacteria in the digestive system affect mood and thinking. Anemones are aiding this research because they have a very similar digestive system, including a thin mucosal lining to the protect, filter and assimilate what they eat. Scientists can study the different strains of bacteria present, like the one behind common gastroenteritis. "This research is changing how we think about gene families," and their findings could help with human immunity. ▶

## THE POLAR BIOLOGY DEPARTMENT

The Polar team studies the ecology and evolution of Antarctic populations. The centre has microchipped nearly 20,000 penguins to study their migratory patterns and individual responses to environmental changes in a non-intrusive way.



colourful and, more importantly, living coral, twists around the room. The tanks are filled with numerous cnidarians (from the Red Sea) and reef-forming sun corals, sea anemones and colourful fish of all kinds. They have about 50 coral species (not all in these tanks) but there are about 1,500 known species worldwide.

The tanks are kept at a constant temperature of 26°C and full-spectrum lights are kept on 12-hour cycles of light and dark. This is utopia for the coral, shown particularly by its growth: 30 cm per year. In the wild, coral averages 10 cm per, but these happy cnidarians grow so much the centre has to continually 'prune' them. But don't worry, they go to scientific research.

As you would expect from a scientist who has devoted his life to the research of coral, Dir Allemand is thrilled to show us his coral collection. Being in the room with thriving, vibrant coral, the professor is in his element and excited to show the different species, including the one that creates air bubbles to increase its surface area for photosynthesis. This is the 'happy' room, with happy coral, happy fish and happy scientists. The next rooms are not quite so happy.

### The Labs

Numerous small rooms also have coral tanks. However, these tanks are for research experiments and that's where the reality of our environmental crises comes to the forefront. The first room we peek into is the study on acidification. A series of small tanks have small corals sitting on a pedestal. Each tank is numbered with a pH of 7.8 to 7.2.

The pH of our oceans has lowered 0.1 in the last 100 years. That sounds like a negligible number, so Dr Allemand clarifies: "this



means that the oceans have become 30% more acidic. We're testing whether the coral can adapt to the ongoing process." Other rooms include smaller tanks with lone branches of coral hanging upside-down from strings. Here they are studying coral nourishment. Another room is kept much colder and darker - we pop in quickly to get a peek but don't stay to affect to the environment. These rare pieces are from the deep depths of the ocean, some up to a 1,000m below the surface, brought to them by research submarines.

### Medical research

The newest department for CSM is the medical biology research centre. Several different teams are working on a wide range of Medical applications, from tumor hypoxia and metabolism to neuromuscular diseases. They also work with Monacord for sickle-cell disease observations. Read the insert with Dr Seneca about their microbiome and immunity research.

[www.centrescientifique.mc](http://www.centrescientifique.mc) ▀

## The CSM - UCA Family

### A cross-border collaboration



From left to right: Patrick Rampal, Patrice Cellario, Denis Allemand, Jeanick Brisswalter, H.E. Laurent Stefanini © Director of Communication - Michael Alesi

**O**n Monday 3 February, H.E. Mr Laurent Stefanini, Ambassador of France to the Principality and Patrice Cellario, Government Counsellor-Minister of the Interior, Professor Patrick Rampal, President of the *Centre Scientifique de Monaco (CSM)* and Jeanick Brisswalter, President of *Université Côte d'Azur (UCA)*, signed a partnership agreement in the main hall of the Ministry of State. The two institutions have joined to create the *Associated International Laboratory (LIA)* entitled, "Response of organisms and populations to environmental stress".

This new laboratory, bringing together a number of teams from both establishments, will enable the creation of a strengthened collaboration between the UCA and the CSM in the field of scientific research, innovation and training. It will foster collaboration in research areas attractive to future researchers and will set up collaboration in the field of climate change impact.

Historically, the CSM has developed numerous relationships with the *Université de Nice-Sophia Antipolis*, which recently became the *Université Côte d'Azur*. A number of professor-researchers from this University have been involved in the work of the CSM since the end of the 1960s, including Professor Raymond Vaissière and Professor Jean Jaubert. The Scientific Director of the CSM, Professor Denis Allemand, was himself Professor of Animal Biology at this university.

The scientific objectives of this collaboration will be to create innovative interdisciplinary research in the fields of marine, polar and medical biology, by integrating the approach of human and social sciences.

Recently, several research agreements have been established between these two institutions, in particular for the *Université Côte d'Azur*, with IRCAN (*Institut de Recherche Cancer et Vieillesse de Nice*) or the C3M laboratory (*Centre Méditerranéen de Médecine Moléculaire*). Doctors Gilles Pagès and Jacques Pouysségur, Research Directors at IRCAN, work closely with the Medical Biology teams at the CSM. ▀