EMBL Podcast March 2012: the Tara Oceans expedition

Adam Gristwood: At the end of March, Tara Oceans arrived in Lorient, France, following an epic two and a half year scientific expedition around the world, travelling some 115 000 km through the Arctic, Atlantic, Pacific and Indian Oceans, many seas, and stopping in over 50 ports. The project is the first of its kind to attempt to study marine plankton all over the globe with the goal of understanding better the function, ecology and evolution of marine species, and analysing the effects of climate change on marine biodiversity. EMBL’s Eric Karsenti has been the scientific coordinator of the expedition.

Eric Karsenti: The most interesting part of plankton is actually the photosynthetic organisms – the photosynthetic bacteria and protists – that are at the root of the food chain and also have played a key role in the atmosphere, because they produced the oxygen we breathe, and they’re also actually sequestering carbon dioxide through photosynthesis. So it’s very important to understand how these organisms live together, the ecosystems that are built of these different organisms, because we don’t know how they’ll react to climate change or pollution or to just changes in general circulation of the ocean and it’s very important to be able to monitor this.

Adam: A litre of seawater can contain between one billion and 10 billion single celled organisms called prokaryotes, and between 10 billion and 100 billion viruses, and a vast number more complex microscopic creatures known as zooplankton. But only 1% of life forms in the sea have been properly identified and studied. Equipped with advanced instruments for sampling, sorting, underwater sensing, and imaging, one of the key aims of Tara’s expedition is to change this, by analysing thousands of samples from around the globe, and link biological information to ocean conditions like acidity, temperature, and currents. An international team of scientists from fields as diverse as ecology, oceanography and molecular biology, measures temperatures, salinity, oxygen levels and takes biological samples from depths ranging the surface level to over 1000 meters below in the mesopelagic region – or the ocean’s twilight zone. These range in size from a couple of centimetres down to less than a hundredth the size of the width of a human hair.

Eric: The challenge in this expedition is to sample from viruses to fish larvae. So this is difficult because the size [difference] is huge – you go from a few microns or less than a micron to centimetres. So we use different tools. We sample viruses and bacteria by pumping water and filtering the water through millipore filters of different mesh sizes. For protists and larger zooplankton – the larger ones – we use nets. So we drag nets of different porosities and collect different size fractions by using this.

Adam: the organisms that the team collects are recorded under microscopes and sent for genome sequencing.

Eric: We have a project in common now to develop a tool to establish correlations between ecosystems and evolution, but also between genomes and morphology, because this is very difficult to do. We will have a lot of data on the imaging side, and a lot of data on the genomics side, and then the interesting thing is to put that together, to establish correlations between genomes and organisms.
Adam: The expedition has taken Tara from Lorient to Dubrovnik, to Mumbai, to Mayotte, to Buenos Aires, to the Galapagos Islands, to New York, and countless places in between, connecting with many different cultures and environments, and providing some striking memories for those on board and on land.

Eric: So the best moment was actually when Tara left Lorient. This was advertised, so there were a lot of people – something like 5000 people came, and everybody was waving; there were a lot of boats sailing around Tara... And before we left there was a lot of TV – TV, Radio, lots of journalist activity... I was with Gabi Gorski, the oceanographer from the expedition from Villefranche, and he did not really believe that this would work one day, so he told me, you know, "it's incredible, it happened!". Everybody was crying actually, because it was very emotional... so we left, and suddenly we were out at sea without any noise, without anybody.

Adam: When Tara docks it's a different story, as groups such as school children hurry excitedly on board to learn about the importance of plankton in both evolution and global ecology. As Tara sailed into some of the world’s most dramatic coastal ports, waiting in the harbour was scientific operations manager Steffi Kandels-Lewis, who is based at EMBL Heidelberg. Steffi is responsible for both getting the equipment that the scientists need onto the boat, and getting the samples that they have gathered off the boat.

Steffanie Kandels-Lewis (Steffi): I am always trying to be in the place in the harbour before the boat arrives. For me it is always very exciting when I am the dock and Tara arrives. People are very happy to see me and I am always extremely happy to see them! I think I am one of the lucky few that had the whole picture, because I knew all the details – everything from the sampling to the protocols... I knew all the people involved, and I think I was the person who has visited the boat most of the times.

Adam: Organising a global operation spanning 70 countries and immense distances on board a 36-metre research vessel requires pinpoint planning, communication and negotiation skills and an ability to make the best use of the often-limited resources available.

Steffi: In terms of planning, the worst for us was the South Pacific, which was last summer, because it was impossible to plan a shipping between Ecuador and Tahiti, which was a time span of four months. So for four months in the South Pacific, at average temperatures of 35 degrees, it was a challenge to make sure that you have enough to keep your samples frozen.

Adam: But no matter how well you plan things, sometimes the unpredictable can happen.

Steffi: I remember one and a half years ago we had a meeting in Paris and I got a phone call from Tara – and getting a phone call from Tara is never good. The biology engineer was on the boat and said “Steffi, the freezer is broken.” I said “oh my god– I am in Paris, it is 10 at night,” there is nothing I could do. I had my computer with me, I looked at the samples which were in the freezer and I was wondering which ones could go in the food freezer and which ones could go in the fridge, and what we could do. They were between
Cape Town and Ascension Island, and luckily the freezer was just unplugged, and nobody noticed – I mean the boat is so packed that it’s easy that this can be unplugged… but I know what it’s like when they are living in their microcosmos and they have no-one to turn to, so at least they could call me, and talk to me about it.

Adam: In December, Bianca Silva, a predoc in the Gross group at EMBL Monterotondo boarded Tara in San Diego for a month long stint on the boat as a member of the scientific team. During her time on the boat, the team made some fascinating observations under the microscope.

Bianca Silva: Plankton in general is… it’s really nice. There are really crazy organisms we fished, especially the ones coming from the lower depths. You find things you wouldn’t even imagine that exist. What I found really exciting, maybe because I’m already interested in these neuroscience things, was that once we fished – like, it was the last net of the night, we were all very tired – and we picked up a fish that was completely transparent, completely. So when it was dry with no water you could see it but then when we put it in a tube with seawater you couldn’t see it at all – the only thing you could see was the eye. Then when we put it under the microscope, we could make a contrast where we could see perfectly the brain.

Adam: When the boat was travelling between locations, it enabled time for exercise, relaxation and sometimes even quiet reflection. But even then, the ocean never failed to throw in the odd surprise…

Bianca: The thing is that everything you see in the middle of the ocean – and it’s days and days when you don’t see another living thing [other] than yourself and plankton – it’s always very exciting. So of course seeing whales really amazing, because it’s something so rare, and you really wanted to see them – and you have a little bit the feeling that you are actually visited…

Adam: Scientists working on board Tara typically stayed for one month, and worked closely together with other crew members such as sailors, journalists, and artists.

Bianca: As you can imagine, when you stay one month on 36 meters of boat – either you hate each other or you start to be very close – we were laughing all the time, making jokes all the time, staying together in a real nice way – you feel at home, you feel that you are in the place where you want to be.

Adam: While Tara has come to the end of her incredible voyage, the scientific journey is just beginning. Organisers and crew are sharing their experiences with scientists, the general public, and the many students who have followed the expedition. The reams of data collected will be scrutinised by laboratories around the world, including groups at EMBL, who will be studying aspects such as genetics, evolution and imaging. The information will be made available to the wider scientific community, as scientists look to understand how the microscopic life in the oceans will play its part in the earth’s future.