

A conversation with Eric Karsenti, Heidelberg

“Very Few People Know About Ocean Life”

Since September 2009, Eric Karsenti has been co-directing the three-year project TARA-Oceans expedition. During the ESOF meeting in Dublin he found time to talk to *Lab Times* reporter Giuliana Deflorio about the importance of plankton ecosystems and how their organisation, evolution and dynamics may help explain environmental changes.

L *ab Times:* How did your fascination for science begin?

Eric Karsenti: Since the age of 15, I have wanted to understand the world in which I live. My family was completely atheist and I started asking myself questions about the origin of life and the forms it takes. So I became interested in studying biology, chemistry and physics. I read a lot of books on these subjects that forged my future career.

Before the TARA project your research focused on the principles governing the organisation of cellular components into complex patterns, as well as on the behaviour of cells and their organisation in complex tissues.

Karsenti: Yes, this has been the main line of my research for over twenty years [with more than 100 research publications]. After my PhD in Paris, I went to San Francisco to work on the spindle, a cellular structure organising and separating the chromosomes during cell division. I made observations back then that made me think that the formation of the spindle could emerge from the self-organisation of microtubules into a spindle. When I moved to EMBL, I used biochemistry to identify the molecules involved in spindle assembly and collaborated with statistical physicists and biophysicists to try to understand the physical principles underpinning the self-organisation of the mitotic spindle. I was pretty much determined! Early ideas never left my mind all the way to very detailed and precise analyses and conclusions.

“Without plankton we would not exist. Yet we know only 1-10% of the organisms that compose this ecosystem.”

Why did you decide to embark on such a big project like TARA-Oceans? Weren't you happy with what you were doing?

Karsenti: I decided to work on something completely new for two reasons: First, I thought I needed to change my research topic because I had the feeling I had done most of what I wanted to understand about cell organisation and I felt I could not contribute much more at my age. Second, since I have sailed a lot, I have always had a strong interest in marine biology – actually, I remember reading of Darwin's trip to Galapagos, a mix of adventure and scientific observations, and how this experience contributed to the development of his theory of evolution. I thought it would be nice to redo an expedition, like the voyage of the Beagle to popularise science and explain modern cell biology and evolution using the attraction of a sailing adventure as a teaser to catch the attention of the public.

How did you raise funds for the expedition?

Karsenti: Researchers cannot always obtain competitive funding to start a project. For example, for the TARA-Oceans project we did not fall into one sector of the EU FP7, therefore we could not apply for EU funding, or this would have required so much time to organise that the expedition would never have started! So we had to be creative. We raised funds by presenting the project to private and public institutions. In this manner, we raised the €2,5 millions needed per year. About half of the funds came from private organisations like agnès b., EDF, Veolia, Monaco and the rest from research institutions such as CNRS, EMBL and the CEA.

In the TARA-Oceans expedition you co-direct, why is the focus on plankton?



Karsenti: When I was thinking about changing research topic, I met with Étienne Bourgois, owner of the TARA vessel [and son of Agnès Troublé, agnès b. fashion creator, one of the sponsors of the expedition] and we started discussing what we could do together. I also knew several people working at French marine stations such as Christian Sardet, leader of the BioMarCell group at the CNRS, Centre National de la Recherche Scientifique, in Villefranche-sur-Mer in France, who suggested to work on marine plankton.

Why is it so important to work on plankton? The majority of people is not aware of its importance.

Karsenti: Plankton is a generic name for all organisms drifting in currents. This includes billions of viruses and bacteria, millions of unicellular organisms like protists who are our distant unicellular ancestors and thousands of small crustaceans, copepods, medusas and so on. Among such organisms some use the energy of the sun, such as photosynthetic bacteria and protists, diatoms and coccolithophores. These are like land plants: they are at the bottom of the food chain in the oceans. The whole planktonic ecosystem has shaped our atmosphere, reducing the CO₂ concentration from more than 90% to less than 1% and increasing the oxygen concentration from 0 to the 20% we have today over the past 2-3 billion years. So, without plankton we would not exist. Yet we know

“Scientists tend to want to be the first and the only ones working on their topic. That’s fine but when you want to address a complex issue, you can’t behave like that.”

only 1-10% of the organisms that compose this ecosystem. We neither know how the environment affects the composition of such ecosystems nor how they are distributed across the oceans, how they would react to climate change, and so on. Most planktonic organisms have survived great mass extinction phases during geological times but we still don’t know how and how fast they change, adapt or disappear.

Among the physico-chemical parameters influencing the plankton, there are many factors to consider in the analysis like the effect of latitude, currents, temperature, light etc. The TARA-Oceans expedition has been thought of as a case study to make an inventory of plankton organisms in correlation with such parameters to feed evolutionary and ecological models of plankton in the oceans.

Karsenti: To be honest, we haven’t started the statistical analysis yet. Within our consortium, which consists of over 100 scientists, Peer Bork and Jeroen Raes are going to carry out the statistical correlations to see patterns in the data collected. However, since the sampling was not done randomly, we have to find the best way to analyse the data. It is expected that light, temperature, depth and availability of nutrients will play a major role. It is interesting to note that organisms are moving due to currents, and this in turn might lead to gene transfer, mutations, selection and

adaptation events. Therefore, on a short time scale there may be a huge evolution process in the oceans leading to very interesting and unexpected findings!

One of the key preliminary findings so far is that most of the sampled organisms have not yet been classified.

Karsenti: Yes, several taxonomists from various institutions are already working on classification of these unknown organisms. Digital imaging will help them doing it. Furthermore, we are using information gained from sequencing in two ways: from ribosomal tags we can build phylogenetic trees, and with metagenomics we will be able to analyse gene complexity and match the piece of information

obtained with the other sources. However, if we only had genomics data to work with, we would be lost.

Also, you found a huge diversity among all sorts of plankton (viruses, protists, etc.).

Karsenti: Ribosomal tags indicate that the diversity of eukaryotic species is very large in the oceans. Preliminary results indicate that in over 35 stations from all over the world, there might be more than one million different species. Yet in each of these stations we never find more than 100,000 different species. This indicates indeed that the diversity is important but very varied in different regions of the ocean.

The TARA-Oceans expedition so far sampled over 27,000 biological samples from 153 stations – how did you manage this huge amount of data and such a big number of scientists?

Karsenti: Right from the beginning, Stefanie Kandels-Lewis [scientific operations manager at EMBL] and Stefan Pesant [database expert at Pangaea®] devised the tagging of the samples. Barcodes, labels and log sheets were specifically designed. Furthermore, by means of these codes all samples are now interconnected and can be matched in various guises to be analysed. I must say it’s been an incredible piece of work and a very good work as we almost made no mistakes during sampling! It’s been hard to manage so many research groups under this consortium, there are over 100 researchers in it. At the start of the project I was not very worried about it – having had to coordinate 12 groups at EMBL and 150 people in total I thought I



Photo: Giuliana Defforio

Eric Karsenti

...obtained his PhD in 1979 in the laboratory of Stratis Avrameas at the Institut Pasteur, Paris. Two years later he moved to the US for a postdoc position in the laboratory of Marc Kirschner at the University of California in San Francisco where he focused on cell cycle and mitosis. In 1985, he returned to Europe as a group leader at the EMBL in Heidelberg, continuing his work in cell biology. In 2008/9, he organised the TARA-Oceans expedition that sailed around the world for three years with the goal to deepen the understanding of the evolution of plankton organisms and ecosystems.

was used to it but obviously I was wrong! We set up regular meetings every three months, nonetheless, my task has been very exhausting – not because of the amount of work needed but more because of the tension built by trying to bring things together.

the expedition, were working towards a meeting with Ban Ki-Moon. Last February, I gave a press conference at the UN headquarters in New York and afterwards Agnes, Romain, Étienne and myself met him. He is very concerned about the environment.



Three beautiful reasons to get to know our oceans better.

In your talk you mentioned the importance of bringing people closer to science. How much of your time is invested in science communication?

Karsenti: On average I spend 30-40% of my time communicating in public, at events such as scientific congresses like this one, TV programmes [for example, the Brazilian TV channel Globo dedicated 20 minutes of prime time to the TARA project], radio interviews or seminars held at schools, etc. Overall, it's been a fabulous experience: in France, for example, very few people knew about ocean life and with the media coverage we managed to communicate that pretty well.

There is a dedicated website (tarajunior.org) to promote the educational side of the project to younger generations. What made you decide to involve young people with the overall aims of the project?

Karsenti: This was one of my goals perfectly matching what Étienne Bourgois, the owner of the TARA vessel and co-director of the expedition, and his team wanted to do. I believe it is essential that the public, especially children, is informed about what life is. My project partners are very concerned about the environment and the decision to engage young students within the project was there right from the beginning.

Policy making is another important issue that you find of utmost importance: In your talk you mentioned that Ban Ki-Moon, Secretary-General of the United Nations, visited the TARA boat in New York last June.

Karsenti: Yes, agnès b. and Romain Troublé, two major partners sponsoring

He likes science and the communication of it, he thinks we are successful in both and I think he may want to promote scientific knowledge of the environment and how to protect it through TARA-Oceans and, more generally, in collaboration with TARA expeditions in the future.

In the first paper published by the consortium I found a strong ethical statement whereby you write that “competition between scientists may not be the best model” when complex issues of general interest to mankind are addressed.

“My task has been very exhausting – not because of the amount of work but because of the tension built by trying to bring things together.”

Karsenti: Scientists tend to want to be the first and the only ones working on their topic. Maybe that is due to the fact that research funding is based on the publication record of each scientist and one cannot change that quickly.

That's fine but when you want to address a complex issue, you can't behave like that. Actually, I first learned this philosophy at EMBL. In our consortium we decided to have a first paper, the master paper, with the names of all the researchers involved, and then there are going to be other papers to follow later, each of which will be dealing more specifically with more specific findings of our research project. I feel that a fundamental requirement for working well in big consortia is to build trust between people; now much emphasis is placed on who is the best and, in my opinion, in order to progress, science does not only need this. There are many ways to be the best... Sometimes it's not to be (or look like) the biggest fish in the pond!

INTERVIEW: GIULIANA DEFLORIO