ON EXPEDITION

BUBBLING SENSATION

ZMT pilot project off Costa Rica made astounding discovery

The “bubbling reef” in the Golfo Dulce was the last stop on the expedition. Here, in the southernmost part of Costa Rica, local colleagues had discovered gas bubbles rising from a coral community. Whatever was it? This was a question ZMT biochemist Tim Rixen, modeller Agostino Merico and reef ecologist Christian Wild were determined to answer.

ANCIENT WATER

They had spent ten days travelling along the Pacific coast of Costa Rica monitoring the state of coral reefs and water chemistry at several points along the way. The coastal area is particularly interesting because in the north, during the first few months of every year, deep water is forced to the surface. “This upwelling water is among the oldest water masses in the ocean. It is cold and relatively acidic,” says Tim Rixen. How do surface organisms react to the acidic water? The expedition initiated a three-year joint research project involving scientists from ZMT and Costa Rica. “We were all surprised by the poor state of the coral reefs,” says Christian Wild. And one of the aims of the project is to understand better why this is the case. Under the joint leadership of three ZMT departments – ecology, geosciences and ecological modelling – two doctoral students, one of whom is from Costa Rica, will start long-term observations in summer 2012. “They will use an interdisciplinary approach, regularly taking measurements in the water and on the seafloor, and investigate how the corals are reacting to the acidic water conditions and whether they can recover,” the reef ecologist explains.

COLD METHANE SOURCE

The discovery of the “bubbling reef” in the last days of the expedition amazed everyone: methane bubbles rising up from the seafloor with a calcium plateau developing around them. A sensation for biochemist Tim Rixen: "This is a special type of carbonate development which might have played a bigger role in the early period of Earth history.”

According to Rixen, strictly, this process requires low oxygen, so-called anoxic conditions which are found in the deep sea, “but not usually at a depth of just ten metres!” Corals also settle on the plateau and, wherever they appear nowadays, they use CO2 in the water in the production of calcium carbonate. But do they also incorporate carbonate produced by methane oxidation? How does the anoxic community interact with “modern” corals? Like the source, questions bubble up that will keep ZMT scientists occupied for a long time to come. > READ MORE

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CONTENT

GENUS continues!
See video of research project

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THE DRAGON ISLAND SEA

Matthias Wolff models life cycles in the eastern Pacific

El Niño confuses everything. This climatic phenomenon heats up cold surface water in the eastern Pacific and thus confounds the entire trophic web. Nothing is as it was before, explains fisheries biologist Matthias Wolff. Nutrients no longer reach the sunlit zone, and the food web breaks down. "You could say it starves from malnutrition from below."

Born in Potsdam in 1955, Matthias Wolff focused on marine science even as a young biology student in Kiel. At the same time, he was fascinated by life around the Galapagos Islands which he had read about in the famous books by the animal ethologist Irenäus Eibl-Eibesfeldt. "I could never forget the dragon-like creatures on the rocks," explains Matthias Wolff, and his scientific career finally brought him into contact with them. He spent 12 years in Peru and Chile investigating the ecological consequences of the El Niño phenomenon in the eastern Pacific before transferring to Bremen's ZMT some 20 years ago. Here he fed his findings into theoretical models of trophic flows in the waters off Chile, Peru and Costa Rica. Finally, he created a model of the Galapagos to simulate the impact of El Niño and the 1998 ban on industrial fishing on the large Galapagos Marine Reserve.

> *"The Galapagos could enable us to take a look at the future of large stretches of the ocean."*

GALAPAGOS MODEL

Matthias Wolff was one of the first scientists to start conducting research at the newly-founded Bremen Institute in 1991. A professor at the University of Bremen, he now works at ZMT in the Department of Ecological Modelling. For decades, he has been interested in understanding and simulating the dynamics of marine populations and ecosystems in the tropical eastern Pacific and around the Galapagos Islands.

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PREDICTIONS CONFIRMED

"We thus created a reference model for the period before 1998 – the year in which there was both an intense El Niño situation and in which industrial fishing was banned in the conservation area." Both events severely vexed the ecosystem, according to Wolff. With the help of the model, he and colleagues simulated the long-term impact. "Our model predicted that the stocks of large predatory fish and sharks around the archipelago would recover, with recovery times of several years and differing between species." From 2007 to 2010, Matthias Wolff was able to find out for himself as Director of Marine Research at the Charles Darwin Research Station on the Galapagos. On leave from his position in Bremen, one of his childhood dreams came true: on the islands he not only met the "dragon" but also the over 80 year-old Professor Eibl-Eibesfeld. The final confirmation for his theories and model predictions was provided by data from long-term observations of different species in the conservation area – a triumph for Wolff. "Our calculations at ZMT largely concur with the observations."

In May 2012, ZMT organised an international symposium to bundle the diversity of current research approaches at the institute and amongst its collaborative partners around the archipelago. The conflict between conservation and tourism was one of the issues under discussion as was the view that the Galapagos is a natural laboratory for ocean acidification. The energy flow models of the area are of great value to everyone. "We can also use our reference model to simulate the impact of climate change on species composition and energy flows within the food web," says the marine scientist enthusiastically, referring once again to the valuable conservation area. "The Galapagos with its varying oceanographic provinces in such close proximity could enable us to take a look at the future of large stretches of the ocean."

APPETITE FOR FISH – THE AQUACULTURE CASE

The demand for fish protein is increasing worldwide. Mass fish production is a solution that creates new conflicts. Three questions for marine microbiologist Astrid Gärdes and marine ecologist Andreas Kunzmann.

Seven billion people need fish. What are the advantages of aquaculture?

Gärdes Global fish consumption has reached record heights: in 2009, on average, every adult ate 17.2 kilos of fish. Capture fishery alone cannot meet this growing demand. 70% of our stocks today are overfished. In the long term, aquaculture can give the overfished species in the oceans enough time to reproduce. Fish derived from aquaculture already account for about half of world fishfood demand: more than 60 million tonnes. It is the fastest growing sector of the fishing industry – but not without risks, unfortunately.

Kunzmann I think aquaculture has enormous potential – but "enormous" is also a problem for the half of the world's population that lives in the Tropics. Ultralarge aquaculture sites are being built there, producing millions of tonnes of fish, which then have to be distributed – a laborious, centralised process that leads to a dead end, just like industrial fishing. For centuries, the population in the Tropics has successfully fed itself using de-centrally organised, artisanal fishery and small-scale agri-aquaculture. Before encouraging these countries to adopt large-scale aquaculture as economic policy we have to know all about the organisational structures and needs of the local communities.

What are the environmental issues connected with fish farms?

Gärdes Intensive farming of marine life incurs the same ecological problems as every other kind of intensive farming: over-fertilisation of the water as a result of over-feeding the fish, and their excrement. A high occurrence of organic matter as well as nitrogen and phosphate promote the growth of algae. The number of micro-organisms increases. Bacteria use huge amounts of oxygen to break down the organic matter, which leads to oxygen-deficient zones in the waters. In addition to the enormous areas needed for the fish farms, all of this impacts on the biodiversity of the entire environment.

Kunzmann All the disadvantages of monocultures that we know from agriculture apply to coasts, too. It is also a problem when species are cultivated just because they bring a good price on the world market. Users in the Tropics know which species are particularly suitable for aquaculture but they are not necessarily the ones in demand in industrialised countries.

How can we reduce the damage caused by aquaculture in order to profit more from the benefits?

Kunzmann An integrated approach of the type we use at ZMT does offer solutions. All those involved have to sit down together and deliberate the issues: Are there mangroves, reefs, seagrass beds, and how are they used? What other interests and sources of income are there, such as shipping, fishing or tourism? How can they be operated compatibly with aquaculture?

Gärdes In addition to this, we have to discover more about the impact of aquaculture on ecosystems in order to develop sustainable aquaculture practices. One aim would be mandatory criteria for sustainable fish farming practice.

ZMT research for better solutions

What is the impact of wastewater from fish farms on the ecosystem? From August 2012, marine microbiologist **Astrid Gärdes** will address this issue at ZMT. She heads the junior research group "Tropical Marine Microbiology" investigating the effects of fishfarm effluents on microbial community response relevant in marine aggregate formation. > READ MORE

Aquaculture refers to effective, mass breeding from egg to fish. Fisheries biologist and marine ecologist **Andreas Kunzmann** heads the ZMT's working group on "ecophysiology" which investigates adaptation mechanisms to changing environmental conditions, particularly in the early life stages of marine organisms.
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GENUS II

The next three years

Off the coast of Namibia, cold currents force nutrient-rich deepwater to the surface. “Upwelling areas like this have hardly featured in the global carbon balance so far because we don’t know enough about them,” says biogeochemist Tim Rixen of ZMT. But since 2009, things have started to change: the collaborative project “Geochemistry and Ecology of the Namibian Upwelling System” (GENUS) has produced valuable data. While ZMT biogeochemists investigate how the offshore “biological pump” works, the ecologists are out there recording the species composition and their physiological adaptation. During the second phase of the project, scheduled to last from 2012 to 2015, ZMT wants to take comparative measurements north and south of the Namibian upwelling area. “We want to find out what effects large-scale climate-induced change has on species,” says ecologist Werner Ekau – an important step towards building a model and simulating the potential impact of climate change. **> READ MORE**

YOUMARES

ZMT spearheads 2012 meeting of young marine scientists

“Between Space and Seafloor – aqua vita est!” is the title of the third conference for YOUng MArine RESearchers and engineers taking place in Lübeck from 12 to 14 September. Launched in 2010, the YOUMARES format is unusual: even undergraduates can join the 200 participants from all over the world to discuss topics ranging from deep sea research via aquaculture or socio-economic research to remote sensing and modelling. A working group at the German Society for Marine Research (DGM) runs this international convention in cooperation with the Fraunhofer Research Institution for Marine Biotechnology (EMB). This year, ZMT is responsible for major contributions to the scientific programme at the conference: Marc Einsporn, who has headed the DMG working group for the last five years, is coordinating the network event while the scientific committee is chaired by Sebastian Ferse. **> READ MORE**

WOMEN IN SCIENCE

Top women scientists present their research

Women have proven their potential in science, although the proportion of female scientists could still be improved – in Germany, only about 19 percent of professors are female. Reasons for women to leave science are manifold. ZMT has decided to take up the cause and introduce a bi-annual lecture series, “Women in Science”, to provide inspiring role models – examples of women scientists with successful careers. Starting with Bettina Beer, Professor of Socio-Cultural Anthropology at the University of Lucerne and holder of the Leibniz Chair at ZMT on 26 June 2012, outstanding female scientists will showcase their research. **> READ MORE**

NEW FACES

On 1 May 2012, the ethnologist **Anke Mösinger** joined ZMT´s social science department. She is conducting research for a PhD on local perceptions of environmental change and developments in the context of global warming debates on Taku'u Atoll, Papua New Guinea. Bettina Beer, first holder of the “Leibniz Chair” at ZMT, is supervising her interdisciplinary work. **> READ MORE**

From Barcelona to Bremen: the ecologist **Georgios Tsounis** previously worked at the Instituto de Ciencies del Mar and transferred to the ZMT in 2012. In addition to his research work he also coordinates research diving at ZMT. **> READ MORE**

AT THE TOP

ZMT is delivering no fewer than 15 scientific papers at the 2012 International Coral Reef Symposium in Australia. This means it will be represented more often than any other institute in Europe and will fall within the first five worldwide. **> READ MORE**

PUBLICATIONS

Books

Human-Nature Interactions in the Anthropocene.
Potentials of Social-Ecological Systems Analysis. Ed. by M. Glaser et al., Routledge, March 2012
> DETAILS

Articles

Physical Ecosystem Engineers and the Functioning of Estuaries and Coasts
JL. Gutiérrez et al., March 2012. Treatise on Estuarine and Coastal Science, 7, 53–81. doi: 10.1016/B978-0-12-374711-2.00705-1
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