**Prof. Dr. Bernd Blasius**

Physicist Bernd Blasius is the director of the ICBM and heads the interdisciplinary research group „Mathematical Modelling“ there. Blasius is an expert in global transport routes, bioinvasion and the spread of infectious diseases, and is also one of the ICBM's researchers at the Helmholtz Virtual Institute „Polar Time“. There he is developing mathematical models for developing krill populations and also studying the adaptability of marine invertebrates.

natural sciences. Expertise in the social sciences is what is needed here! Take the ocean, for example: it extracts most of the carbon dioxide from the atmosphere and deposits it in the deep sea, using it as a kind of warehouse. It's like a biological carbon pump. This process requires the production of large

> **”Data and knowledge about all the world's oceans at our disposal“**
> Bernd Blasius

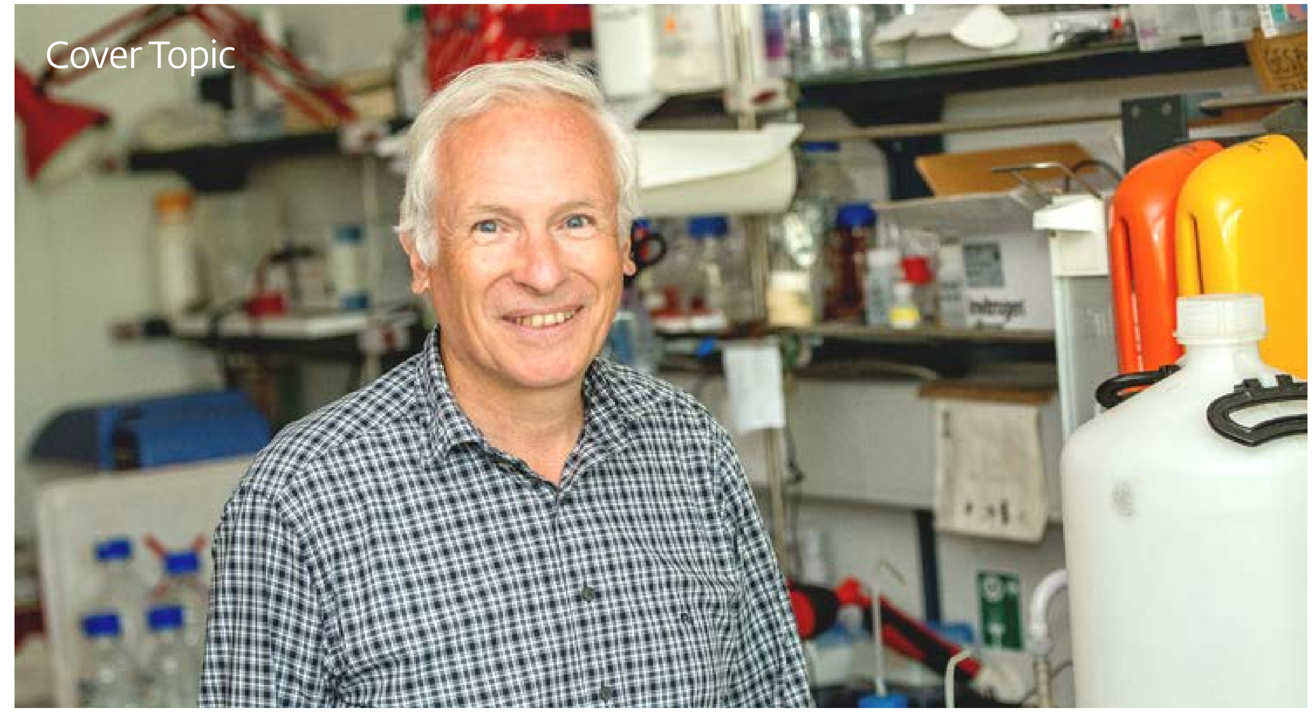
amounts of algae. So one conclusion would be that stopping climate change will require large-scale production of algae. In other words, this green soup may not look very nice but it is incredibly valuable. But try telling that to a tourism manager! So there are ecosystem services that definitely have a divisive impact. This calls for a perspective that takes into account society in all its complexity. This is the second big gap we would like to close in marine biodiversity research.

**Blasius:** And we want to do this together with the Alfred Wegener Institute (AWI). We've just started setting up a research cluster called ”Marine Diversity“, and at the same time we're establishing the Helmholtz Institute for Functional Marine Biodiversity. This means we will have a Helmholtz centre here on the Oldenburg campus. The key elements of this project are two new professorships: one for ”Marine Conservation“ and one for ”Marine Ecosystem Services“. In addition we are planning a theory and computer science professorship to advance modelling in these areas. It's also worth mentioning that Germany's two largest research vessels will be among this new research consortium's ”resources“. The ICBM is the home institute of the ”Sonne“ research ship and the AWI has the ”Polarstern“. If we add the Senckenberg am Meer research centre and the Centre for Tropical Marine Ecology to the equation, both of which we also work closely with, we have data and knowledge at our disposal about all the world's oceans, from the tropics to the polar regions. In combination with the interdisciplinarity we practice in Oldenburg this puts us in a unique and clearly visible position internationally.

*Interview: Volker Sandmann, Deike Stolz*

Further research needed: Realistic predictions about how the North Sea's biodiversity will develop over the next 100 years are not yet possible.






What is the secret of the Roseobacter clade's success? Microbiologist Meinhard Simon is edging closer to unravelling this mystery.

# The Allrounders of the Oceans

Marine Roseobacter reduce the greenhouse effect, supply algae with vital vitamins and help fish to grow. Professor Meinhard Simon is studying these multi-talented and versatile marine bacteria in a Collaborative Research Centre at Oldenburg

A library full of mutants – what sounds like something out of a horror film is actually cutting-edge biological research. The scientists of the ”Roseobacter“ Collaborative Research Centre (CRC) keep 4,000 bacteria with genetic variations, mutants, at the ready. Frozen in little plastic tubes at minus 80 degrees, they are kept on standby to be activated whenever needed. These genetically manipulated tiny living organisms serve as comparison material for various analyses conducted on ”normal“ organisms. All with the sole objective of unravelling the mystery of the Roseobacter clade bacteria and discovering the secret of their success.

Prof. Dr. Meinhard Simon started working towards this vision almost 20 years ago. He is a microbiologist at Oldenburg's Institute for Chemistry and Biology of the Marine Environment (ICBM) and the coordinator of the Collaborative Research Centre ”Ecology, Physiology and Molecular Biology of the Roseobacter Clade: Towards a Systems Biology Understanding of a Globally Important Clade of Marine Bacteria“. Eighty researchers, from PhD students to professors, are investigating the particularities of this group of bacteria at three different locations: Oldenburg, Braunschweig and Göttingen. The team comprises microbiologists, physiologists, ecologists, geneticists, genomics scientists, biotechnologists, organic chemists, and geochemists. ”We have the leading German experts in this field of research all working together here, so we can cover every conceivable question almost perfectly,“ Simon explains.

And there are plenty of questions. ”These bacteria are capable of pretty much anything,“ the scientist says. They are found in almost all oceanic ecosystems – from the surface to the deep sea, and from the tropics to the

The scientists use a rosette system for collecting water samples at different depths (l.). The bacteria are then subjected to detailed analysis in the laboratory (r.).

polar regions. They even colonise oxygen-free sediments and pack ice, earning them a reputation as the "opportunists" among marine bacteria, and they can adapt better than any other group to changing conditions. "They are truly unique in this respect," Simon notes, adding: "We have probably all encountered them somewhere – on seaweed, shells, snails, starfish and also worms." Particularly in open water they play a major role.

The story of the Oldenburg scientist and his "multi-talented bacteria" began in autumn 1997. Simon was just settling in as a newly appointed professor at Oldenburg University when the State of Lower Saxony launched a programme on the biotechnological uses of marine bacteria. He signed up – and with great success: "We were fortunate enough to be able to isolate a bacterium that produces a highly effective antibiotic." It was closely related to a bacterium that had already been discovered but was still relatively unknown, and which the researchers then examined more closely in a comparative study. Both bacteria proved extremely interesting because not only do they synthesise tropodithietic acid, an antibiotic, but they can also produce other natural substances which benefit the various organisms around them. Vitamin B12, for example, which helps algae grow. The researchers named the bacterium "Phaeobacter inhibens T5" – it was the first „Oldenburg" Roseobacter bacterium. The newly discovered organism was rod-shaped and approximately three micrometres in length, a micrometre being one millionth of a metre.

In the years that followed the researchers in Simon's team continued to come across members of this family of bacteria – in mud flats, in the North Sea and during a research trip in the Southern Ocean. "That was when we realised that this clade was incredibly interesting," the microbiologist recalls. The US-based Moore Foundation and the Ministry for Science and Culture for Lower Saxony financed the first genome analyses. "By then we already had nearly everything we needed to apply for a CRC," Simon says. Their application was approved by the German Research Foundation (DFG) in November 2009. "We were delighted. It was like a reward for the enormous amount of work we had put into this subject," he recalls. But that was only the beginning.

## 45.000 litres taken out of the Pacific

Auckland, 1 May 2016: The sun shines brightly as 40 scientists set off to sea in the research vessel "Sonne". Thirty-four days out on the open Pacific lie ahead. The plan is to arrive in Alaska at the beginning of June. The researchers want to gather samples from the ocean's various biogeographical provinces. These provinces each have their own characteristics, just like provinces on land. How do the bacteria of the Roseobacter clade live together with other bacteria in the individual provinces? This is one of the questions the researchers are now hoping to answer, by extracting a total of 45,000 litres of water from the Pacific at 19 different locations. Everything is running smoothly, including the transport of the samples to Oldenburg in huge cool boxes. Next comes the analysis, which will take several years.

Nonetheless already Simon concludes: "The Sonne expedition has been a complete success." The high-tech ship – whose home institution is the ICBM – is an excellent platform for this sort of work. On-board comfort is also excellent, he says, with the mess (the eating area) situated well above the waterline and featuring large panoramic windows. "Just having a view like that makes it special," he adds. Another research expedition with the "Sonne" is planned for January to the end of February 2017, starting from New Zealand and heading for the Subantarctic. "Then we'll have covered practically the whole Pacific, from the Subarctic to the Subantarctic. There has never been anything like it, not even for other marine bacteria," Simon points out.

Living on a ship for weeks on end, collecting and filtering thousands of litres of water, then analysing it in the laboratory – are these tiny living organisms really worth all the trouble? "Absolutely," says the microbiologist. Although the researchers know relatively little at this stage about the role they play in their environment, what they do know sounds very promising. Their rapid metabolism helps the surrounding organisms such as algae, for example, which cannot produce their own vitamin B12. Even humans benefit: eating algae is considered healthy in many cultures. "We believe that what makes algae so healthy are the roseobacters living on them, and humans benefit from their vitamins," says Simon. Roseobacters producing the antibiotic substance mentioned above, tropodithietic acid, are now being used in aquaculture to protect fish larvae from harmful germs.

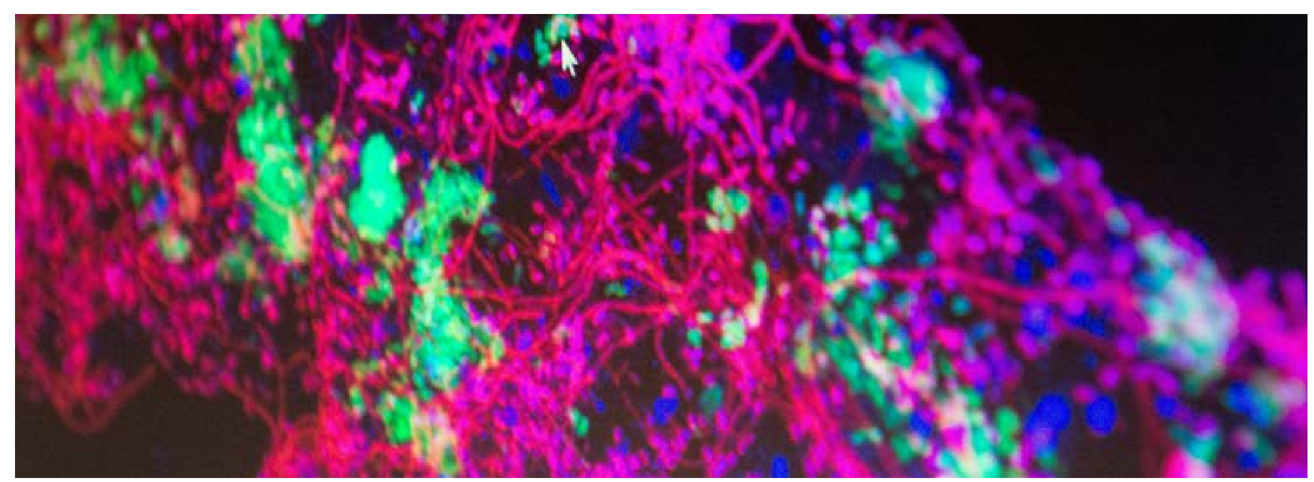
## Clouds for a healthy climate

Roseobacters also help maintain a healthy climate by promoting cloud formation. If algae come under stress, for example due to high temperatures, many of them produce a sulphur compound which roseobacters can convert into dimethyl sulphide. This rises into the air and causes clouds to form. The clouds block the sunlight and the temperature drops. When temperatures drop the algae calm down; they produce less sulphur and the bacteria have less material to convert, and fewer clouds are formed. This natural "air conditioning" would not function without the roseobacters. Some scientists even believe that in certain places algae and bacteria could neutralise the global warming caused by humans. Simon is reluctant to go that far, but he too is convinced that "roseobacters definitely contribute to a healthy climate."

The Roseobacter Collaborative Research Centre is now in its second funding phase. To avoid drowning in the overwhelming diversity of the Roseobacter bacteria the researchers are focussing on just two clade members: "Phaeobacter inhibens", which Simon's team has been studying since the start of the millennium, and "Dinoroseobacter shibae". The latter has a less versatile metabolism but possesses other notable abilities: it can use light as an energy source and can even survive in anaerobic environments. Scientists are continuously discovering bacteria that are genetically related to the Roseobacter clade, new-found relatives, so to speak. So how many branches are there in this family tree? Hundreds – and their number is growing. "This almost automatically raises new questions. That's what makes it so exciting," Simon believes.

In the Collaborative Research Centre's first phase of funding from 2010 to 2013 the focus was on the metabolism of these bacteria – precisely how it works and how the metabolites affect other living organisms, for example the algae that benefit from the vitamins. For the last two years the emphasis has been on genomic analysis, in other words studying the genetic makeup and the role it plays in metabolic processes. This is where the mutant library comes into play, which Simon describes as "a fantastic instrument for finding answers to highly specific questions." In a sub-project, his team, led by marine microbiologist Prof. Dr. Thorsten Brinkhoff, is investigating how algae react when a bacterium suddenly stops producing certain substances. To do this the researchers put together an alga and a mutant that has been genetically manipulated to not produce certain signalling substances. They then compare the result with the interaction between an alga and a normal bacterium. In this way they are piecing together the puzzle of the perfectly coordinated interplay between organisms in the sea.

The researchers of the Collaborative Research Centre are convinced that they will be able to solve some of the mysteries of these vital marine bacteria. Next year they will apply for a third funding phase, and Simon is confident that they will secure it. There is certainly no shortage of open questions. (bb)



A colourful display under the microscope.