Max Planck Institute for Marine Microbiology

MAX-PLANCK-GESELLSCHAFT

Contents

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Editorial

Managing Director
Prof. Dr. Friedrich Widdel

The ocean covers more than two thirds of our planet and is, averaged over its area, almost four kilometers deep. It represents by far the largest habitat on Earth. Compared to the marine animals and the algae with their multitude of shapes, the third group of marine life forms, the bacteria and archaea (archeabacteria) seem utterly unspectacular. With dimensions that barely exceed a few thousandth of millimeters they are only visible under the microscope, where they show the simplest shapes: Cocci, rods, filaments, at best densely packed agglomerates of many single cells. Yet, mere sight and real significance are two different things. The essential characteristic of microorganisms is their impact. The variety of impacts is familiar to us, while the actors themselves oftentimes remain hidden. The pathogenic, infectious bacteria are well known, as well as those bacteria that give flavor to our food or spoil it. A far larger number of microorganisms, somewhat sloppily called “environmental microorganisms” are responsible for nutrient recycling in soils and waters, and provide useful help in sewage plants. Other microorganisms find application in the field of biotechnology, and catalyze industrially relevant chemical reactions.

Microorganisms in the sea have for many decades played an underestimated role in marine research. Only recently, thanks to the progression of detailed chemical and physical methods of analysis, have people become aware of their true significance: They have shaped the chemistry of the ocean since the early history of Earth and play a crucial role in the global cycles of chemical elements like carbon, nitrogen, phosphorus, sulfur and iron. Microorganisms contribute on a large scale to photosynthesis, and thus primary production in the ocean. They produce the climate relevant gas methane and are also able to degrade it. They fix nitrogen from the air and return it again to the atmospheric reservoir. And they are even able to remediate oil spills.

This list shows that we talk about much more than just “pure” microbiology. Marine microbiology has developed into an extremely interdisciplinary field that is closely linked to marine chemistry, marine geology, climate research, molecular biology, biochemistry, and the development of analytical instruments. Since the foundation of the Max Planck Institute for Marine Microbiology in 1992, we are dedicated to multidisciplinary research. To answer our questions we perform seagoing expeditions on research vessels, experiments with model systems in the laboratory, and experiments on single cells. Because a single institute cannot cover the entire field of marine microbiology we cooperate with national and international partner institutions. This brochure hopes to provide you with insights into our areas of research. We would be pleased to have raised your interest in one or the other of our working areas.

Friedrich Widdel

What we know is a drop;
what we don't know is an ocean.
Isaac Newton

And what we know about oceans is a drop.

The Max Planck Institute for Marine Microbiology

They are inconspicuous yet omnipresent, only a few thousandths of a millimeter in size and yet the real rulers of the world, they live underground yet influence the global climate right up to the upper layers of the Earth's atmosphere: 'They' are the microorganisms in the oceans. At the Max Planck Institute for Marine Microbiology in Bremen 'they' are the focus of our research.
Our scientists aim to find out about the potential of these microorganisms and what their impact is. The marine microbes live in close association with the global cycles of the elements carbon, sulfur, nitrogen, and iron. By their sheer number, they influence not only the chemistry of the oceans but ultimately also our climate. In the quest of the missing sources and sinks for nutrients the marine scientists study the influence of important microbial reactions to the nutrient cycles in the ocean, e.g. the anaerobic oxidation of methane (AOM), the anaerobic ammonium oxidation (anammox), and sulfate reduction, among others. Yet, our institute's research encompasses much more than this:
Our scientific staff also searches for new, hitherto unknown metabolic pathways. In addition, they study the marine habitats of these tiny organisms, because there is hardly any place in the ocean where they cannot be found: They occur in all layers of the water column and in the sediment of the oceans, and also as symbionts in sponges, corals and molluscs. The marine scientists also try to find out how the microbial organisms are adapted to their environment and how they react to changes like the ongoing climate change taking place today. Besides the global context our microbiologists endeavor to isolate and cultivate new microbial species, because only one species in a hundred has been identified so far.
The research staff at the MPI in Bremen also study the unique and fascinating characteristics of single species, such as the ability of large sulfur bacteria and diatoms to store nitrate and use it as energy source under oxygen-free conditions. Although microbes are small, surprisingly many tools are needed to draw their secrets out of them. Besides the classical equipment of microbiology, namely the microscope and Petri dish, macro-tools are also needed, including research ships, deep-sea robots, and spectroscopes. The effort to study the mi-

Research vessel HEINCKE (AWI)

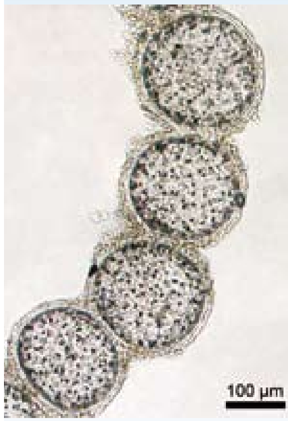
croorganisms is far from minimal: The scientists spend weeks on research cruises, perform minutely planned experiments, evaluate, read and write scientific publications, and attend conferences. Engineers and technicians constantly develop measuring devices and build them. The IT department, the library, and many more departments of the institute provide their services to scientists so that they can do their work properly. The effort is worthwhile: The scientists of the Max Planck Institute for Marine Microbiology frequently publish their results in peer-reviewed journals, and are welcome speakers at international conferences. Much ado about microbial nothings? Only in this way can we all learn to understand the world better – piece by piece. And only in this way can scientists maintain their basic research at the highest possible level.

A variety of microorganisms form differently colored layers in microbial mats.

The Max Planck Institute for Marine Microbiology was officially founded July 1, 1992, almost a year after its counterpart, the Max Planck Institute for Terrestrial Microbiology in Marburg. The institute moved into its present-day premises in the Technology Park at the University of Bremen in 1996; its present neighbors include the Universum Science Center, MARUM – the Center for Marine Environmental Sciences at the University of Bremen, and the Center for Tropical Marine Ecology (ZMT). The MPI for Marine Microbiology, with its three Departments of Biogeochemistry, Microbiology and Molecular Ecology and three Max Planck Research Groups, is one of the world's leading marine research institutes.

The Max Planck Institute – Some Figures

- 1 of 80 institutes of the Max Planck Society
- 3 departments and 8 research groups
- 58 scientific staff
- 74 Ph.D. students, with 68 at the International Max Planck Research School MarMic
- 15 Master's students, with 12 at the International Max Planck Research School MarMic
- 60 employees providing scientific and technical services
- 28 administrative/technical staff
- 34 nations
- ~200 peer-reviewed publications a year (papers in journals, books and specialist literature)
- 13 patents/licenses filed for registration



The cell of the giant sulfur bacteria *Thiomargarita* often occur in chains.

Prof. Dr. Friedrich Widdel, Managing Director and Head of the Department of Microbiology

Department of Microbiology

Microorganisms are the world's natural biodegradation chemists, also in the water. The Department of Microbiology investigates how and under which conditions these biochemical processes take place. It also explores how these reactions sustain the global element cycles of carbon, nitrogen, sulfur and iron. Before researchers can study the metabolic processes in a species of bacterium in detail, they have to isolate this species from others in the sample and grow in a pure culture. To gain insights into the physiological and metabolic function of environmental microorganisms, microbiologists make increasing use of genome analyses, often in collaboration with the Department of Molecular Ecology and the Max Planck Institute for Molecular Genetics in Berlin.

What are your criteria for the choice of study subjects, and which species and metabolic pathways do you study?

Cyanobacteria: *Chromatium*- and *Desulfonema* species under the microscope

We want to learn more about the microorganisms and the enzymatic reactions underlying environmental processes in aquatic habitats such as sediments. This is why we choose research topics or organisms of global or environmental importance. In doing so, we keep our eyes open for new phenomena.

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Fermenters for growing sulphur-oxidizing bacteria

Ecophysiology Group

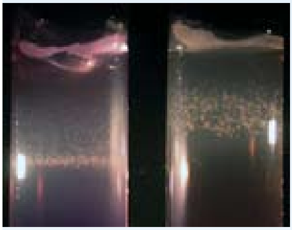
Their motivation is curiosity, their field of research is ecophysiology. Heide Schulz-Vogt and her Ecophysiology Group analyze the influence of sulfur bacteria on different elemental cycles. One important character is *Thiomargarita*, “the sulfur pearl”.

Prof. Dr. Heide Schulz-Vogt, Head of the Ecophysiology Group

It’s been thirteen years since the bacterium with the melodious name was discovered close to the Namibian coast. It is easy to recognize and it looks like a long, white string of pearls. With its size of 100-300 microns in diameter it is 600 times bigger than Streptococci – the bacteria that cause pneumonia. Hence, *Thiomargarita namibiensis* is the biggest known bacterium.

Because *Thiomargarita* bacteria cannot be cultivated in the lab, the research group also works with close relatives: *Beggiatoa*. They make it possible for the team to find out the relationship between bacteria and the nitrogen cycle on the one hand. On the other hand, they can analyze their impact on the sulfur cycle and the phosphorus cycle. These cycles proceed in our environment every day. They play a crucial role in the balance of nature. Our goal is to understand how bacteria influence these processes.

Thiomargarita namibiensis as seen in the light microscope: Many sulfur inclusions can be seen within the cells (Ø 0.3 mm).



Two different tubes (Ø 1.6 cm) with a culture of *Beggiatoa* filaments: The filaments choose to live at different depths in response to different conditions in the medium.

What does it take to be a good biologist?

Most important, a good biologist is creative, imaginative and has the ability to think logically. A combination of these skills allows the scientist to be successful in this profession that is at the same time highly fascinating and important. Certain concepts of nature are agreed upon in the scientific community, but only scientific investigation can unveil the truth. Ultimately, it is important to fit your novel observations into a new concept. So the biologist becomes a sort of “private investigator”.

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Prof. Dr. Marcel Kuypers, Director and Head of the Department of Biogeochemistry

Department of Biogeochemistry

Research in the Department of Biogeochemistry addresses the microbial cycling of biolimiting elements in the ocean. Understanding the pathways, interactions and environmental regulation of microbial processes that control the availability of biolimiting nutrients such as nitrogen, phosphorus and iron in the ocean is imperative to predict the impact that human activities will have on the chemistry of our ocean and climate. We use an array of biogeochemical, microbiological, molecular and mathematical modeling techniques. The Secondary Ion Mass Spectrometry technology (NanoSIMS) that we use in our department combines experiments with stable isotope labeled substrates and molecular *in situ* techniques on microscope preparations of environmental samples. With this "single-cell" research we can link the identity of microbial cells in a complex microbial community to their *in situ* nutrient incorporation, calculate cellular uptake rates and determine nutrient fluxes.

You and your team are investigating how bacteria and archaea interact with key processes in the nutrient cycle. What is your strategy?

Expeditions to ocean environments of interest are essential in order to obtain high resolution environmental data. A key experimental approach is to use isotopically labeled compounds to identify and track processes down to single cells. With a multiple-method approach we greatly improve our ability to identify and quantify the impact of newly discovered microbial processes on the chemistry of the Earth's ocean and atmosphere.

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Scientists set up the water sampling device onboard a research vessel.

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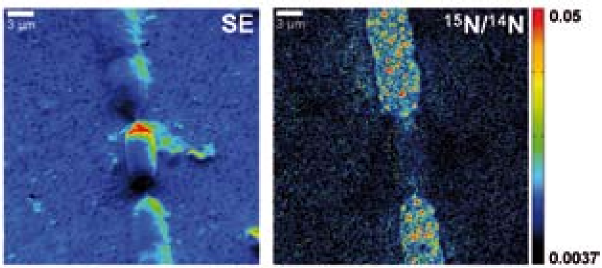

NanoSIMS images of the cyano-bacterium *Aphanizomenon* sp. and its bacterial associates (left). The nitrogen fixing cell in the centre effectively passes the nitrogen to the adjacent cells so that a much lower nitrogen content is measurable in it (right).

Microsensor Group

A laboratory workshop: here, technicians and engineers build sensors in minute detail. The sensors are just five microns thick – a mere tenth the thickness of a human hair. These electrochemical sensors measure the concentrations of oxygen, hydrogen sulfide, nitrogen compounds or other substances. They operate in the Wadden Sea and in deep sea sediments up to 6,000 meters below the water surface, in biofilms and in microbial mats – every 0.01 to 0.1 millimeters and *in situ*. Such detailed *in situ* readings provide microbiologists with data that could not be obtained from samples removed for later analysis in the laboratory. With the help of microsensors, the scientists precisely investigate which substances the microbes convert in which ultra-thin layer, how the microbes regulate different element cycles, and thus how they affect the geochemistry. Molecular techniques help to identify the most active bacteria. Dirk de Beer, head of the research group, and his team often cooperate with the other groups and departments.

You could buy microsensors from commercial suppliers. Why does your research group design and build its own measuring probes?

Commercially available microsensors cost about 500 Euros and are not always ideal for our purposes. Our technical staff builds the perfect sensors. Moreover, we often need complex equipment like optical sensors, so-called optodes, that are able to measure oxygen distribution in two dimensions simultaneously. In such cases, we work together to develop completely new sensors. The microbiologists in our group say what they want to measure, the physicists and chemists explore the boundaries of what is feasible and then our engineers build the sensor and optimize it. This kind of applied development is the logical way for us to work. It has also resulted in a patent, license agreements and know-how transfer.

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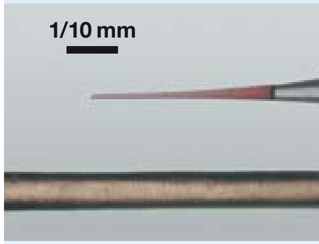
Dr. Dirk de Beer,
Head of the Microsensor Group



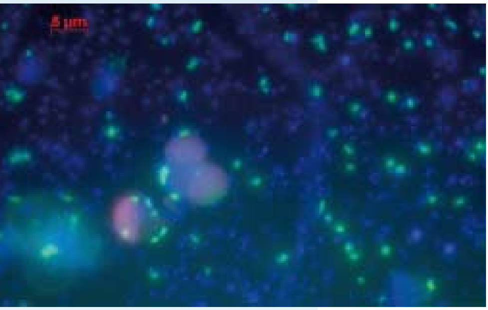
A microsensor compared to a human hair

Production and inspection of microsensors under the microscope

Prof. Dr. Rudolf Amann, Director and Head of the Department of Molecular Ecology

Department of Molecular Ecology

To protect something, one has to understand it. Scientists estimate that only one in a hundred species is known, especially because most microbes cannot be cultivated and therefore cannot be studied. The Department of Molecular Ecology identifies marine microorganisms on the basis of their nucleic acids with the help of nucleic acid probes. Using additional molecular biological methods, scientists detect specific genes in environmental samples and analyze when, why and in what way bacterial populations behave at a particular location, and for which biogeochemical processes the microbes are responsible. In this way, the staff in the department headed by Rudolf Amann try to unveil which enzymes and microorganisms play a role in the anaerobic oxidation of methane or the aerobic degradation of algal polymers. Moreover, locations with a high level of biodiversity are of special interest, for example the Wadden Sea, where many thousands of different microbe species can be found in a single cubic centimeter.



FISH analysis of a water sample from the North Atlantic near Iceland. Only the part of the organic carbon not mineralized by bacteria is buried in the sediments. Flavobacteria shown here in green prefer the algae *Phaeocystis*.

Your department discovers, describes and enumerates biodiversity. Do you also develop your own methods for this?

In most cases, yes. We are always developing innovative techniques, even though one or the other may prove in retrospect to be of no use. ‘Bread and butter technologies’, meaning standard methods such as comparative sequence analysis and fluorescence *in situ* hybridization, or FISH for short, suffice for initial characterization of species. We then adapt and refine these methods to the specific issues we are examining. Our CARD-FISH method, for example, is much more sensitive – the fluorescent color signal is about ten to a hundred times stronger than in a conventional FISH experiment, and GeneFISH is a real cool method.

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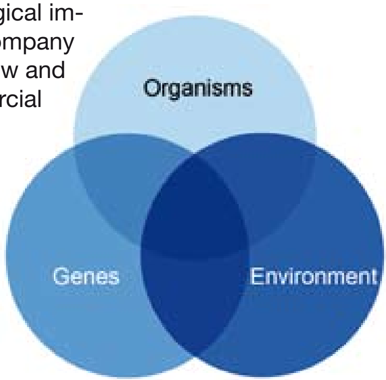
Microbial Genomics & Bioinformatics Research Group

Over the last decade, great technological and scientific advances have allowed researchers to routinely examine the genome within days. Analyzing the sequence of a genome reveals much of the surprising biological capacities of bacteria. Frank Oliver Glöckner's group investigates how bacteria respond to environmental change. They first analyze genomic sequences with a range of computational techniques in an attempt to understand the 'lifestyle' and ecology of the bacteria under scrutiny. They determine which components of the genome are active or repressed under specific conditions and try to identify their function. Further, the group is developing technologies and standards that integrate analyses of genomic and environmental data to predict how microbes have adapted and will respond to changing environmental conditions. The sheer variety of bacterial lifestyles and capacities is a goldmine for biotechnology. Understanding the consequences and implications of bacterial adaptation and responsiveness to environmental cues allows scientists to better advise politicians and industry leaders in the planning of environmental policy and evaluation of ecological impact. Members of this group also founded the spin-off company Ribocon GmbH in 2005. The company provides know-how and products for biodiversity and genome analysis to commercial enterprises.

Prof. Dr. Frank Oliver Glöckner, Head of the Microbial Genomics & Bioinformatics Research Group

For many decades, biologists have been studying environmentally important bacteria without access to their genetic code. What new insights may be derived from the novel discipline of Ecological Genomics?

Modern techniques in genomic analysis render a comprehensive understanding of the biological capabilities encoded in bacterial genomes. An analysis of this genetic information integrated with environmental data will provide unprecedented insights into how both organisms and eco-systems function.



Integration of different parameters – the key to ecosystems biology

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Prof. Dr. Nicole Dubilier,
Head of the Symbiosis Group

Symbiosis Group

Deep down at the bottom of the ocean, far away from the sun's light, unique communities flourish and thrive at hot springs. Like oases in the desert of the deep sea, these hydrothermal vents are densely colonized by animals that live in symbiosis with special bacteria. These symbiotic bacteria do not use the sun to gain energy – instead they produce food for their hosts using geothermal energy from the Earth's interior. Nicole Dubilier and her Symbiosis Group study the diversity and evolution of these symbiotic associations. They certainly have enough samples. Over 200 hydrothermal vents have already been found, with many more yet to be discovered. These vents are found world wide where the Earth's plates are spreading apart, causing extremely hot fluids to rise to the seafloor and mix with the surrounding cold deep-sea waters. This is exactly the environment the symbionts need to gain energy for themselves and their hosts.

The deep-sea mussel *Bathymodiolus* dominates the biomass at hydrothermal vents on the Mid-Atlantic Ridge. It has two types of bacterial symbionts that co-occur in the mussel's gills, one that uses sulfide and the other methane as an energy source.

Are these symbioses also found in other environments?

The discovery of these symbioses in the deep sea lead scientists to look for them in other environments where reducing chemicals mix with oxidized seawater. We now know that these symbioses occur worldwide in a wide range of animal species in environments as diverse as coral reef sands and sea grass beds, and we are continuously discovering new symbiotic associations. In some symbioses, the bacteria are such efficient food providers that their hosts could afford to reduce their digestive system and no longer have a mouth or gut.

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Max Planck Research Group for Microbial Fitness

Microorganisms are our planet's greatest chemists. Almost every chemical reaction that is thermodynamically feasible is exploited by these organisms to sustain survival. Together, the actions of microbes comprise the biogeochemical element cycles, a vastly complicated metabolic network that is the basis of all life. It is currently estimated that there are approximately 1030 of these "great chemists" on planet Earth. The number of stars in our universe appears rather low in comparison, at 10^{23}.
But what are the selection criteria for microorganisms? Which environmental conditions determine whether microorganisms succeed in evolution or not? These are the research questions of the Microbial Fitness Group headed by Marc Strous.

The experimental design to address these questions starts with the sampling of microbial communities in the natural environment. The obtained samples are incubated in laboratory bioreactors under different environmental conditions to stimulate natural selection, as Charles Darwin would say. Using highly sensitive temperature measurements the scientists can track the thermodynamic efficiencies of the competing microorganisms. Metagenomic analyses reflect the total genetic information of the microorganisms. With bioinformatic methods like metagenome analyses it is now possible to reconstruct parts of genomes or even complete genomes of single microorganisms.

What was your initial idea to combine metagenomics with highly sensitive temperature measurements?

Metagenomics is a most successful, modern technique, and combining it with highly sensitive temperature measurements is a pioneering effort. Recent technical progress creates the possibility of high-resolution temperature measurements. The lower the heat production of a microbial community, the higher its productivity. "Imagine you ignite 1,000,000 candles", says Marc Strous, "you'll notice the change in temperature when one of the candles goes out."

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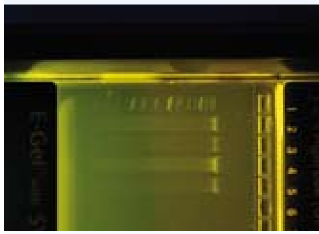
Prof. Dr. Marc Strous, Head of the Max Planck Research Group for Microbial Fitness

In the bioreactors bacterial cultures from the Wadden Sea are exposed to different cultivation condititons.



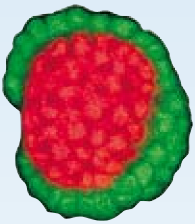
Controlling a microbial DNA extract from the Wadden Sea sediment

HGF MPG Deep-Sea Ecology and Technology Group

Prof. Dr. Antje Boetius, Head of the HGF MPG Deep-Sea Ecology and Technology Group

Since 2009, the joint group of the Helmholtz Association and the Max Planck Society comprises the former working group 'Microbial Habitats' of the Max Planck Institute for Marine Microbiology and the Deep Sea Research Group of the Alfred Wegener Institute for Polar and Marine Research (AWI). The scientists study the biodiversity and function of microbial communities inhabiting coral reefs, hydrothermal vents, mud volcanoes, anoxic basins, deep-sea trenches, gas hydrates, and oil seeps.

The biological, geological, and physical conditions in these habitats differ strongly and show substantial temporal and spatial variations. Other foci of the research group are the monitoring of oxygen depletion and its implications for aquatic systems (http://www.hypox.net). Moreover, our group investigates the ocean acidification caused by the increasing carbon dioxide concentration in the atmosphere and its environmental consequences. Time series measurements of global change effects are enabled by AWI's long-term observatory 'Hausgaten' in the Fram-Strait. It is important to trace the consequences of the Arctic warming for the biogeochemical processes and life in the ocean because especially the Arctic ocean is presently subject to strong climatic changes (http://www.awi.de/en/research/deep_sea/).



A symbiosis of methane-consuming archaea (red) and sulfate-reducing bacteria (green)

An autonomous instrument for *in situ* measurements in the Arctic deep sea

Sampling of bacterial mats at an arctic mud volcano

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Max Planck Research Group for Marine Isotope Geochemistry

The ocean plays an important role in the Earth's climate system. The formation and transport of water by deep ocean currents, the downwelling and upwelling of water masses and the nutrients therein influence our climate and thus the habitats of all organisms on our planet. Yet, many of the physical and chemical processes in the ocean and their impact on climate are poorly understood. The Research Group for Marine Isotope Geochemistry studies the circulation of water masses and the transport of sediments within the ocean. For that purpose they take part in research cruises across the world's oceans in pursuit of the chemical fingerprints that allow them to trace currents and sediments back to their origin. Katharina Pahnke and her colleagues also find these chemical fingerprints, so-called "tracers" in fossil marine sediments. Probing sediments from the early history of Earth provides insight into changes in ocean circulation and sediment transport in the past, and shows how the oceans were involved in past climate fluctuations.

Dr. Katharina Pahnke, Head of the Max Planck Research Group for Marine Isotope Geochemistry

How we read the past from deep sea sediments

The scientists of the Marine Isotope Geochemistry working group use the radiogenic isotopes of naturally occurring elements as tracers, in particular neodymium (Nd). The isotopic composition of neodymium is not altered by biological or geochemical reactions in the oceans as is the case for isotopes of most other elements. Hence, the isotope composition of neodymium is an ideal indicator in the investigation and reconstruction of present-day and past ocean circulation. Dissolved neodymium is bound in iron-manganese oxides that precipitate from seawater at the seafloor. These oxides therefore preserve the isotopic "fingerprint" of the deep waters. In the laboratory, we separate the iron-manganese oxides from the sediment and along with them the neodymium isotopes. Then we analyze the isotope ratio with a special mass spectrometer.

Sampling off the coast of Oahu, Hawaii

Sediment cores from the South Pacific

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Dr. Thorsten Dittmar,
Head of the Max Planck Research Group for Marine Geochemistry

Max Planck Research Group for Marine Geochemistry

The Max Planck Research Group for Marine Geochemistry at the Institute for Chemistry and Biology of the Marine Environment (ICBM, University of Oldenburg) studies dissolved organic matter (DOM) in the ocean. The ocean is one of the largest carbon reservoirs on Earth. Dissolved organic matter alone contains a similar amount of carbon as all living biomass in the ocean and on land combined. Even though marine dissolved organic matter is mainly of microbial origin, its turnover in the ocean is remarkably slow. Dissolved organic matter has accumulated in the ocean over thousands of years, and the controlling mechanisms behind its turnover and cycling are largely unknown. Advanced molecular techniques, in particular ultrahigh-resolution mass spectrometry, are used in the research group to obtain answers to the fundamental questions regarding the cycling of organic matter in the oceans.

Modern mass spectrometer for the precise determination of individual molecules in seawater

Why do you need ultrahigh-resolution mass spectrometry for your research?

It is the most powerful technique to molecularly characterize complex organic mixtures, such as DOM, petroleum or humic substances, whose composition is still largely unknown. We can determine the mass of an individual molecule with a precision of one ten-thousandth of a Dalton, which is less than the mass of an electron. This level of precision is required to identify individual molecules in seawater. There are only five of these powerful mass spectrometers in the entire world.

Sea ice in the Arctic Weddell Sea. More than 1,000 meters of water lies below the scientists and the emperor penguins. At this station dissolved organic material was sampled in and under the ice.

Your research group is located in Oldenburg. How is the cooperation with the ICBM?

This location is ideal for us, mainly because of the geochemical expertise at the ICBM. We have established excellent cooperation with the geochemistry and microbiology groups of the ICBM. Via the intranet, we are in a permanent contact with the Max Planck Institute and it is just an hour's drive away.

tdittmar@mpi-bremen.de
http://www.mpi-bremen.de/en/Marine_Geochemistry_Group.html

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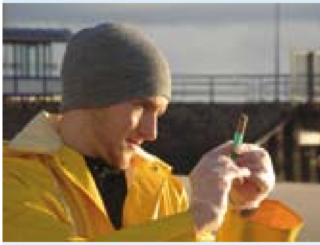
Teaching and Studying

The Max Planck Institute for Marine Microbiology is not only a center for research, but also for teaching and studying. Today's marine scientists educate tomorrow's in many different fields. For example, some of the scientists at the Max Planck Institute are lecturers at the University of Bremen in the Departments of Biology and Geosciences, and at the Jacobs University in Bremen (Department of Bioinformatics & Computational Biology). They also join in the Master's program International Studies in Aquatic Tropical Ecology (ISATEC) that the University of Bremen offers in cooperation with the Leibniz Center for Tropical Marine Ecology.

MarMic students take sediment samples within an algae patch in the Wadden Sea.

International Max Planck Research School of Marine Microbiology – MarMic

The joint M.Sc. and Ph.D. program of the International Max Planck Research School of Marine Microbiology, MarMic, founded in 2002, is synonymous with excellence in graduate advancement: young, highly talented students study with scientists of international repute at the Max Planck Institute for Marine Microbiology, the Alfred Wegener Institute for Polar and Marine Research, the University of Bremen, and the Jacobs University. Each year, as many as twelve selected students embark on a twelve-month training course comprised of lectures, tutorials and internships. They then write their Master's thesis and enter the three-year doctorate phase. Once they have completed their Ph.D., MarMic graduates become a new generation of marine scientists. Having received interdisciplinary training, they go on to conduct research into microbial life and its impacts on the biosphere. www.marmic.mpg.de



Starting microbial cultures, taking samples and performing analyses are just some of the many daily tasks for prospective marine biologists.

The MPI as a Training Center for Chemical Laboratory Technicians

For several years now, the Max Planck Institute in Bremen has been training high school graduates as chemical laboratory technicians. After basic practical training lasting two to three months, held at the facilities of the University of Bremen, the traiees pass through various different research groups within the institute. Like the chemical laboratory technicians, they mainly work in the lab, where their tasks include weighing out samples, cleaning substances, conducting routine experiments, and organizing workflows.

Throughout their training, which lasts three and a half years in total, the prospective laboratory technicians spend two days a week at the SII Utbremen Education Center, where they are taught chemistry, equipment technology, laboratory safety and other subjects. The MPI recruits one trainee a year.
www.chemie.uni-bremen.de/azubis/Laborantenseite.htm

Spin-off: Ribocon GmbH

Cutting-Edge Bioinformatics for Industry and Science

Max Planck Institutes encounter unexplored fields and generate a number of innovative methods and solutions during their research. This know-how is of major interest and leads to successful cooperation between science and industry. Scientists from the Microbial Genomics Group founded the company "Ribocon" together with the group leader, Prof. Dr. Frank Oliver Glöckner, and an external expert for finances in 2005.

Ribocon focuses on the analysis of genetic information (DNA sequences) in microbiology. This field, designated as bioinformatics, ranges from the utilization of selected marker genes to the investigation of complete genomes (the full genetic information of an organism) and is gaining importance at tremendous speed. While just a few years ago, the Human Genome Project was started as a long-term venture, today an immense amount of genetic data can be produced highly cost efficiently in a very short time. However, the raw data provided by the DNA sequencing facilities represent merely the starting point on the path to biological knowledge.

The flood of DNA data that comes with modern technologies represents a tremendous challenge for the users of this young but highly relevant field. To analyze the data, expert knowledge and powerful computer systems are required. At this point, Ribocon offers professional services and support into which the Ribocon team members bring experience from their previous work at the MPI: in 2002 they were the first to analyze the genome of a bacterium isolated from an environmental sample.

Training and education by Ribocon staff

Ribocon GmbH is continuously developing solutions for DNA sequence analysis and offers corresponding services and products. The customers originate in equal parts from basic research, (routine) diagnostics, and the wide discipline of biotechnology. In addition, the Ribocon team is involved in scientific projects relating to applied research or requiring extensive knowledge transfer.

Contact: Dr. Jörg Peplies · jpeplies@ribocon.com · www.ribocon.com

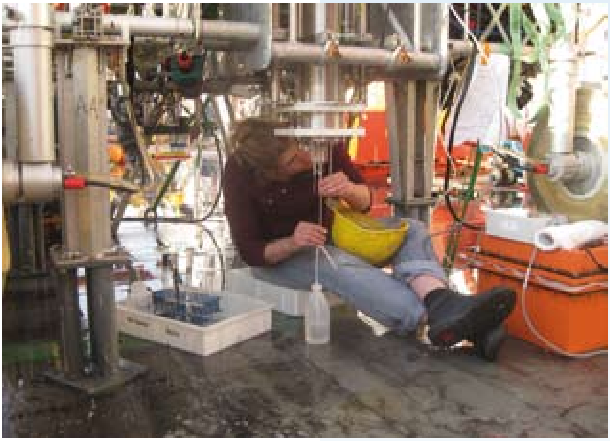
Fascinated Scientists

What is fascinating about your science?

Sampling in the Wadden Sea

In sediments and soils a vast array of chemical processes are taking place, many of which are catalysed by microorganisms. The diversity of these microbes and their affinity for the different substrates often is amazing. I am particularly interested in the role of iron in sediments. Iron interacts with other major global biogeochemical cycles, such as carbon, sulfur, nitrogen, and oxygen, and its redox state determines the retention or release of (micro) nutrients. Since iron is often present as solid phases, microorganisms need to use special strategies to utilize iron. A better understanding of the role that microorganisms play in sediments is vital for improving our knowledge of these ecosystems, also with respect to element recycling and ecosystem sustainability.

Dr. Jeanine Geelhoed, Scientist, Microbial Fitness Group



A scientist on deck of a research ship prepares a sampling device for deep sea employment.

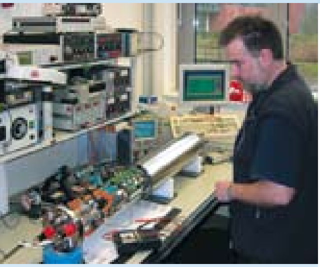
One million bacteria live in one milliliter of seawater. However, we do not always know what they live on, since their food – dissolved organic matter – is rather scarce in the open ocean. I am fascinated by these frugal (oligotrophic) bacteria and how they can survive and even multiply under those extremely limited conditions. In my studies I combine traditional cultivation methods with modern techniques like genome sequencing.

Dr. Anne Schwedt, Scientist,
Ecophysiology Group

As a young student I became fascinated with the chemistry of natural waters, and I soon realized how important the biological and chemical processes in the sea floor are in regulating the composition of the seawater. Acting like a huge filter, this enormous, and reactive, reservoir affects the seawater composition in timescales of tens to millions of years. When we study the chemistry and microbiology of our sediment samples we have to think in terms of these large geological time and space scales.

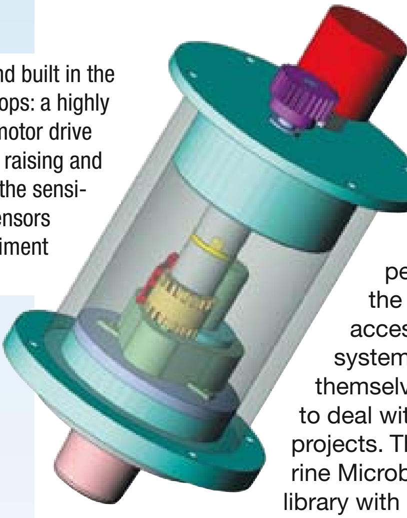
Tim Ferdelman, PhD, Scientist, Department of Biogeochemistry

No Science without Support Staff



The sensitive measurement electronics are encased for protection inside a robust high-pressure cylinder.

Commercially available measuring apparatus and equipment are of little help when it comes to novel experimentation methods and unusual research locations. What can be bought is modified; what cannot be bought is designed and built – in the institute's own, well equipped workshops for electronics and mechanics. Both have their separate staff and facilities, but they work together. The mechanics workshop, for example, constructs precision equipment and other millimeter-scale components; the electronics workshop adds the electronics. The electronics workshops alone has developed almost 200 technical modules since the institute was founded, including various kinds of electronic control systems and a new kind of measurement technology using optical instead of chemical sensors.



Designed and built in the MPI workshops: a highly adjustable motor drive controls the raising and lowering of the sensitive microsensors into the sediment layer.

To pursue their research, scientists are reliant not only on the workshops, but also on other support staff, for example the computer specialists in the computing department, and the three staff members responsible for building services engineering, who perform daily maintenance on the ventilation, cooling, fire alarm, access control and other technical systems, remedy or repair minor faults themselves, and call in specialized firms to deal with major problems and complex projects. The Max Planck Institute for Marine Microbiology also has an excellent library with numerous books, journals, daily newspapers and its own librarian. There are also several administrative staff who handle the bookkeeping, human resources management and the procurement of office and laboratory equipment.

The technical staff in the laboratories are needed in a variety of areas.

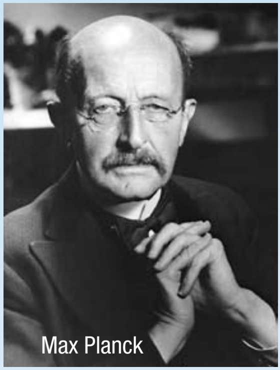
To ensure that the scientific staff do not just publish in specialist magazines and journals and deliver presentations at conferences, the press department informs the general public about the research being conducted and the main findings obtained – by issuing press statements, conducting guided tours of the institute, publishing information material and organizing various campaigns, for example on the annual Girls' Day or other nationwide initiatives.

The Max Planck Society

The Max Planck Society for the Advancement of Science is a research organization rich in traditions yet also at the cutting edge of research. For decades, using methods and equipment that are continuously being improved and advanced, the society explores what 'holds the world together in its innermost being' (J. W. Goethe). This basic research also establishes the basis for novel therapies and technologies. 'Insight must precede application' is a basic principle of the society and was coined by Max Planck (1858-1947), the physicist and Nobel laureate after whom the society is named.

A co-founder of quantum theory, Planck channeled all his efforts into basic research and fought for the freedom of science – as the Max Planck Society continues to do to this day.
The current president, Prof. Peter Gruss, once wrote: 'The point is to network research worldwide, without surrendering the diversity that exists. The scientific community must preserve its freedom to choose its own topics and set its own goals.'
This is also a clear expression of the organization's mission: to complement the work done at universities and other research establishments with its range of life sciences, natural sciences and humanities, and to make knowledge freely accessible.
There are 80 Max Planck Institutes in Germany, organized into three main sections: the Biology and Medicine Section, the Chemistry, Physics and Technology Section, and the Humanities Section.
Additional research institutes and several subsidiary offices are located in other countries. The Max Planck Society employs more than 13,000 people in total, of whom one in three is a scientist. They are joined by more than 7,000 students and guest scientists who study and research at the institutes. Conversely, scientists from the Max Planck Institutes are invited as guests to other research establishments all over the world.

The Max Planck Society enjoys an excellent reputation at both national and international levels, not least because it has produced 17 Nobel laureates to date – two more than its predecessor, the Kaiser-Wilhelm-Gesellschaft, established in 1911. The latter was much respected worldwide, but after the Second World War it was imperative that a fresh start also be made in German science and research. To this end, the Max Planck Society for the Advancement of Science was founded on February 26, 1948. Although it was mainly financed with public funding from the federal and state governments, it is not a state institution, but a non-profit and independent organization.



Max Planck

Nobel laureates from the Max Planck Society

2007	Gerhard Ertl (Chemistry)
2005	Theodor W. Hänsch (Physics)
1995	Paul J. Crutzen (Chemistry)
1995	Christiane Nüsslein-Volhard (Medicine)
1991	Erwin Neher (Medicine)
1991	Bert Sakmann (Medicine)
1988	Johann Deisenhofer (Chemistry)
1988	Robert Huber (Chemistry)
1988	Hartmut Michel (Chemistry)
1986	Ernst Ruska (Physics)
1985	Klaus von Klitzing (Physics)
1984	Georges Köhler (Medicine)
1973	Konrad Lorenz (Medicine)
1967	Manfred Eigen (Chemistry)
1964	Feodor Lynen (Medicine)
1963	Karl Ziegler (Chemistry)
1954	Walther Bothe (Physics)

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ICBM

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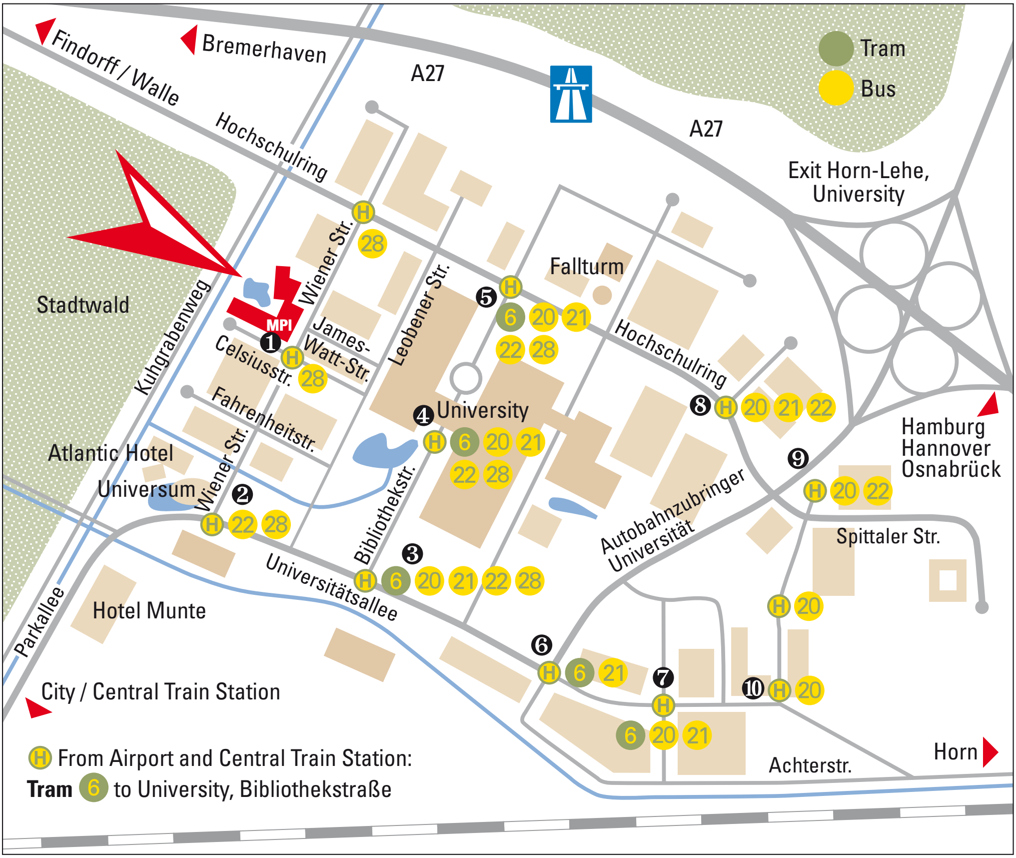

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