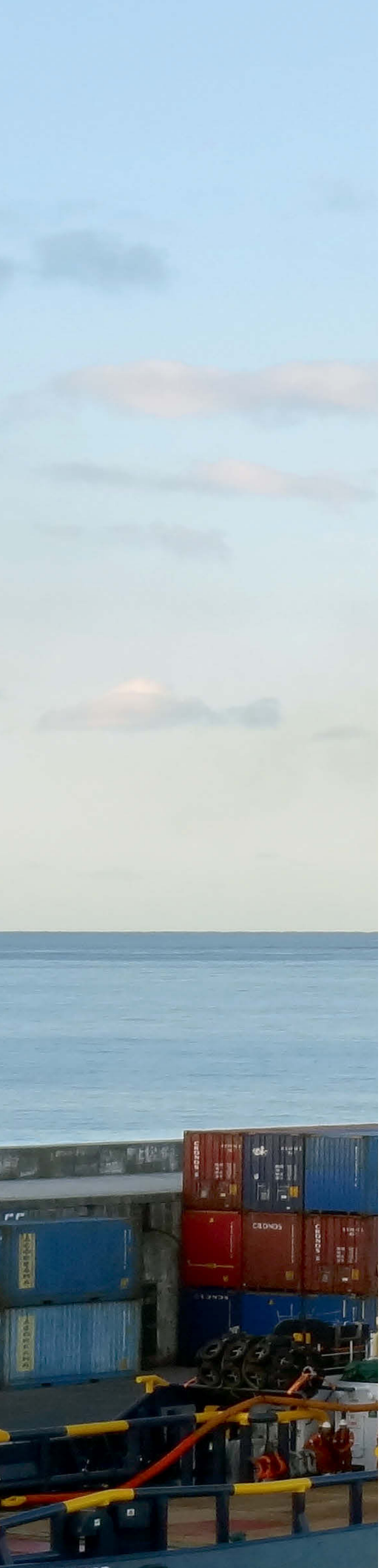


Sailing
Close to the Wind

Ralf Schiebel has already undertaken more than 30 research cruises. The geologist has headed the micropaleontology working group at the **Max Planck Institute for Chemistry** in Mainz since autumn 2015. With each expedition, he has accumulated plankton and sediment samples, folders stuffed with logs and data – and memories of adventures that he will probably tell his grandchildren about.

TEXT **CATARINA PIETSCHMANN**

Haul in the net and let's get out of here pronto!" While Ralf Schiebel quickly stows his samples, the ship's crew members batten down the hatches. Rough seas are not uncommon in the North Atlantic, especially in mid-winter. The force eight gale is just a taster: a cyclonic storm 200 kilometers across is bearing down on their position in the middle of the ocean, at 47 degrees north, 20 degrees west. There's no way their research vessel, the *Meteor*, can escape now.

Battling winds of up to 230 kilometers per hour, the ship bravely breasts the waves towering 20 meters above it. "We were drinking water and eating chocolate bars," Schiebel recalls. Suddenly the howl of the wind subsides as the *Meteor* enters the eye of the storm, only to pick up again with undiminished force soon after.

Fortunately, perilous situations like this are rare, but Schiebel will never forget his trip in January 1994. He was 28 years old at the time. "When we finally came back on deck, we found utter chaos." Schiebel's plankton samples, which had been stowed below, were the only scientific yield of the entire expedition.

AT HOME IN THE MIDDLE OF THE NORTH ATLANTIC

Last autumn, the geologist returned to 47 degrees north, 20 degrees west – the spot in the Atlantic Ocean that was practically his living room in the 1990s. All in all, he spent almost two years there. Together with colleagues, he was studying carbon exchange between the ocean and the atmosphere on a moored plankton trap equipped with a flow meter, a temperature sensor and a salt probe. "It was very interesting to collect plankton again at the very same site after more than two decades. After all, the oceans have become more acidic due to increased levels of carbon dioxide in the atmosphere, and the pH of the water has dropped from 8.2 to 8.1," the researcher says. >

Photo: Ulrike Weis/MPI for Chemistry

Roaming about: Geologist Ralf Schiebel, here on board the research vessel *Maria S. Merian*, is continually drawn to the sea. There, he and his colleagues collect plankton and sediment samples containing calcareous single-celled organisms, which they use as climate indicators.

Above A seasoned mariner: Ralf Schiebel has undertaken more than 30 research cruises to many corners of the world.

Below The satellite photo shows the cyclonic storm the *Meteor* weathered in the North Atlantic in January 1994.

Ralf Schiebel studies climate change by examining foraminifera, tiny single-celled animals whose calcareous shells range in shape from spherical to elongated to spiral. Depending on the species and the latitude, masses of them live at various depth levels of the water column. Some species also thrive on or in the sediment.

Foraminifera (from Latin, meaning "hole bearers") are basically amoebas but with a shell. They can project finger-shaped pseudopods through minute openings. "Forms that live in the soil actually use this method to crawl across the ground," says Schiebel. The foraminifers use the sticky tips of their "feet" to capture prey. Many of them even grab morsels that are much larger than themselves, such as small crab-like plankton called copepods.

Because they evolved early in the history of the Earth and their calcareous shells are very durable, fossilized foraminifers and other calcareous unicellular organisms, such as coccoliths, serve geologists as index fossils. When the tiny organisms die, they sink to the ocean floor and become part of the sediment. When the researchers ram their sampling tubes into the seabed and lift samples from the depths, what they are essentially doing is bringing the Earth's climate archives to the surface.

A CLIMATE ARCHIVE COMPOSED OF FOSSIL SHELLS

The data is compared with that of foraminifers living in the oceans today. By studying the shell composition in the sediment layers, scientists can reconstruct a region's climate through glacial and warm periods.

Some of these organisms prefer conditions between the ocean surface and a depth of 30 meters. Others thrive at depths of 60 to 100 meters, while still others live in the twilight zone below 100 meters and as far down as 2,000 meters. There are even species that alternate between depths: they sink

Photo: Ulrike Weis/MPI for Chemistry

» Nature will adapt to climate change. The question is whether humans, given their habits, can do likewise

down to deeper layers to reproduce, and the new generation rises back up.

The researchers sample water from the desired strata using multi-nets, which automatically close at defined depths as they are pulled up. Under the microscope, the organisms are treated with formaldehyde, sorted by species and then further analyzed. "Otherwise, the bigger ones would then eat the little ones, and the snapshot would be distorted," Schiebel explains.

As small as foraminifers are, they are just big enough for the scientists to create tiny holes in their shells with a laser beam. The ionized debris flies through a mass spectrometer, which captures the chemical elements and isotope ratios in the shells. "The ratio of magnesium to calcium in the shells, for example, is a record of the temperature ratios of the past. The warmer the climate was, the more magnesium the foraminifers incorporated into their shell calcite. When the climate grew colder, calcium dominated more," Ralf Schiebel explains.

At the Max Planck Institute for Chemistry in Mainz, the researcher and his colleagues, as members of the new Department of Climate Geochemistry, are now able to analyze foraminifers and other climate archives and to refine and calibrate them for use as climate indicators. The new labs for organic and inorganic geochemistry and micropaleontology have state-of-the-art equipment and sufficient capacity to carry out large measurement series.

"Working with the other groups and departments at the institute is extremely motivating and productive, and support from the management is fantastic," Schiebel says. Together with German and international partners, the team will continue to collect samples from the ocean basins over the coming decades. There is also a constant exchange of technological information at all levels.

WILL CALCAREOUS PLANKTON DISAPPEAR?

Ralf Schiebel hopes that borders will remain open and that the researchers will be able to continue working with international teams to improve our understanding of the environment: "That's our best shot for maintaining our current quality of life."

So far, the oceans have absorbed a lot of carbon dioxide thanks to the calcium carbonate production of countless sea creatures. But if the carbon dioxide content of the atmosphere continues to rise, the oceans will become so acidic that this buffer could fail. Does this mean that calcareous plankton will vanish entirely one day?

"We haven't yet observed a definite decline, though we do expect the shells to become thinner. Laboratory experiments with coccolithophores – single-celled algae with calcareous skeletons – have shown that, of six clones, five stopped producing calcite in acidic water. The sixth group, in contrast, still produced copious amounts of calcite," Schiebel says. This means that the species composition of the oceans – and therefore of the entire ecosystem – is likely to change radically.

Geologists are known for thinking in terms of eons rather than years. There have been many warm periods in Earth's history. What makes the current period different from earlier ones? After all, 90 million years ago, the carbon dioxide content of the atmosphere was five times greater than it is today, yet coccolithophores were still producing calcite. The oceans and land ecosystems were able to absorb large quantities of carbon dioxide because the process was very, very slow. In addition, flowering plants began to emerge and accelerated the formation of soil, which also absorbed carbon dioxide from the atmosphere.

It is therefore extremely difficult to predict what will happen, not least because the current anthropogenic rate of climate change is unprecedented in the planet's history. Would Schiebel nevertheless venture to guess what the future holds? "Nature will adapt to climate change. The question is whether humans, given their habits, can do likewise." Their preference for living in coastal regions, for instance, which will be the areas hardest hit by rising sea levels.

As in previous warm periods, however, the carbon dioxide rise in the atmosphere can also have some positive effects. According to Schiebel, some

Above In a refrigerated storeroom, geologist Janne Repschläger takes a sediment core off the shelf. The cores are stored at 4 degrees Celsius, the temperature of the water near the seafloor. This prevents any volume change or chemical processes from taking place. The image on the right shows various species of calcareous microplankton, including foraminifers.

Right page Ralf Schiebel uses foraminifers as climate indicators. The new laboratories at the Max Planck Institute in Mainz feature state-of-the-art equipment and sufficient capacity to carry out large measurement series. The shelves hold thousands of slides of samples from research trips (right).

plants are sure to produce more biomass. Moreover, warmer air can hold more moisture, so the Sahel region, for example, will become greener.

Even as a boy, Ralf Schiebel knew that he wanted to become a geologist someday. His father's profession was certainly a factor. "He was a geodesist, and as a boy I used to accompany him in the field and hold the stadia rod." His favorite books were the World Atlas and the Bertelsmann encyclopedia. When he painted, he mostly depicted researchers driving through the desert in Jeeps. He loved to play handball – not surprising for a boy living in the German handball hub of Lemgo. A number of injuries meant that he spent a lot of time at the orthopedist, which stimulated his interest in medicine.

At the age of 19, he moved to Kiel, which was also handball-crazy. "I wanted to play more handball. While I was waiting to be accepted to study medicine, I enrolled in a geology course. However, my beanpole physique – 1.92 meters tall and weighing 70 kilos – was unsuitable for a sports career in handball, and my plan to study medicine was also soon abandoned."

"Studying geology was terrific! I immediately gave up competitive sports, sold my surfboard and hit the books." He met his wife in the department and became a father at the age of 22. "From that point on I had a single goal: to complete my studies as quickly as possible."

WATCHING THE JELLYFISH FEED

During his basic studies, Ralf Schiebel trained as a research scuba diver. For two summers he mapped the seaweed fields in the shallow waters of Eckernförde Bay for the University of Kiel. It was a relatively pleasant task; for another project, he dived off Sylt in the winter at water temperatures just two degrees above freezing. His task was to study the state of an artificial sandbag reef off Westerland, on the island of Sylt. "Afterwards, we had to be pulled out of the water because we were so numb with cold that we could barely move," he recalls. "When the mouthpiece was finally removed, your mouth stayed molded to its shape and gaped open. For a while we were unable to eat or drink."

But the pleasant moments far outnumbered the unpleasant ones. "As you drift in the Baltic Sea in the summer below the thermocline and look up to watch the jellyfish feeding, you come up with a lot of ideas about exchange processes in the ocean. And when the current in the Fehmarn Belt tugs at you, you can feel on your own body the very same forces that transport the sand there."

Ralf Schiebel supervises students doing internships, which introduced him to his current field of research: micropaleontology. His doctoral dissertation was on benthic – that is, bottom-dwelling – foraminifers.

Photos: Thomas Hartmann (left), MPI for Chemistry (right)

» I have a really cool job. And when things go wrong, you just have to pick yourself up again.

Research soon took Schiebel to many corners of the world. Each excursion was different and brought fresh surprises. He has collected samples off Mexico as well as in the radioactive waters off Fukushima. During a trip on the Aegean Sea, his ship sailed into a blizzard and had to take shelter on the leeward side of an island for three days.

Sometimes Schiebel and his colleagues hired on board large cargo vessels, for instance to study the ecological impact of oil platforms off the coast of the Republic of the Congo. "Due to a lack of space, I had to share a cabin with the Congolese sailors. During the day they were intrepid seafarers, but at night the light had to stay on, and the bosun told stories to drive away evil spirits," Schiebel recalls. "When you gazed around you from the deck in the evening, you could see hundreds of lights from the drilling and production platforms."

Things haven't always gone as planned in his life. The path for the geologist proved to be a rocky one on more than one occasion. At the age of 17, he almost lost his eyesight at a New Year's Eve party when a friend lit a firecracker close by. The lens of one of his eyes was destroyed. Replacing it with an artificial one restored full vision.

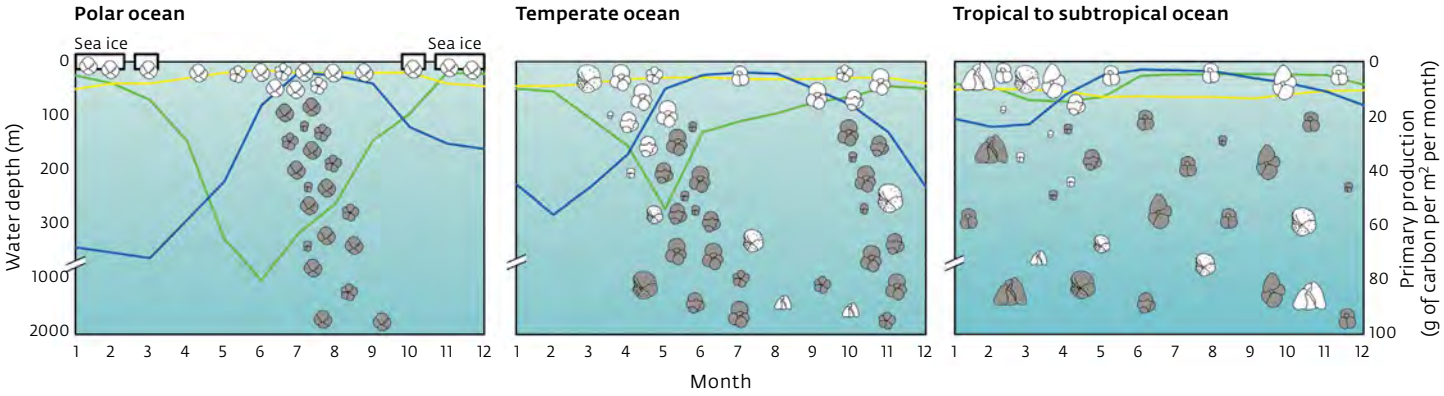
FROM CABIN TO DECK WITH HIS EYES CLOSED

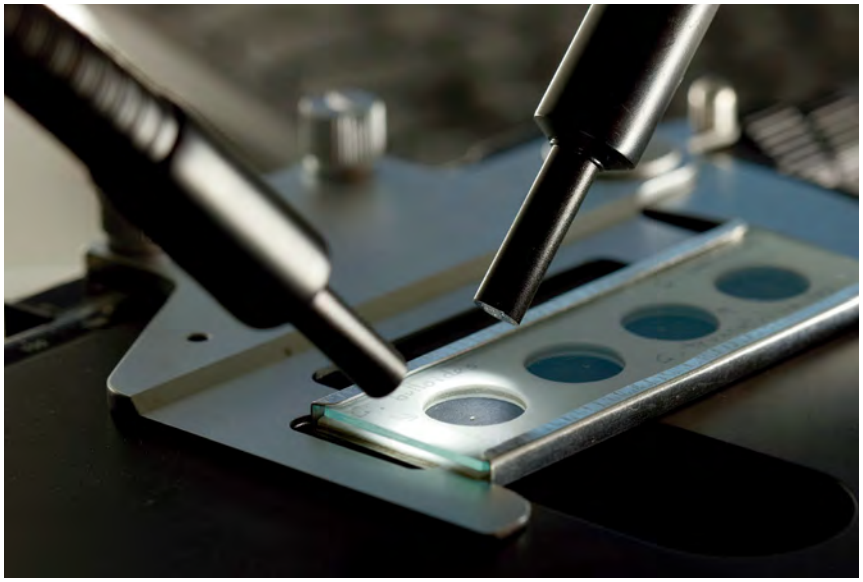
"I had gotten into the habit of counting my steps. Wherever I go, I still count the steps on every staircase." When Ralf Schiebel first sets foot on board a research vessel, he always paces from the cabin to the deck with his eyes closed. He wants to make sure he can find his way to the deck in an emergency even in the dark.

His private life hit a rocky patch. Weeks-long expeditions on board research vessels are good for science but hard for relationships. After eight years as a postdoc in Tübingen, sometimes with contracts for just three months, Schiebel took a position at ETH Zurich, where he remained for four years.

In 2008, long after his career had really taken off and he was conducting research at the National Oceanography Centre in Southampton, UK, a ladder slipped out from under him while he was working on the facade of his house. He landed hard on the ground, resulting in painful open fractures of both ankles. "'We'll probably have to amputate' – that was the last thing I heard before the anesthesia kicked in," he recalls. But the doctors managed to repair the crushed bones with titanium plates and screws.

These experiences have left their mark. Ralf Schiebel appears serious only at first glance. When you talk to him, you quickly realize that he is a very open and approachable person. Far from discouraging him, his experiences challenged him. Perhaps they also made him more laid back. "I have a re-





Above Oceanic productivity at middle and high latitudes varies seasonally. Foraminifers are more uniformly distributed in the plankton throughout the year in subtropical and tropical areas than at higher latitudes. Planktic foraminifers (white symbols) live only in the top layers of polar and subpolar seas, whereas they also thrive at depths of more than 1,000 meters in temperate and tropical seas. Once they reproduce, these single-celled organisms die off and their empty shells (gray) sink to the seafloor. Their fossil remains serve as a climate record of the past 100 million years. Green line: primary production; blue line: mixing depth; yellow line: one percent sunlight limit. The diagram applies to the northern hemisphere.

Left Single-celled organisms under the microscope: Measuring up to half a millimeter across, *Globigerina bulloides* can just be made out with the naked eye. The spherical shells of these foraminifers occur in oceanic sediments around the world. By analyzing the chemical composition of the shells, researchers can reconstruct the Earth's climate in past periods of time.

ally cool job. And when things go wrong, you just have to pick yourself up again. I don't panic in critical situations; I become calmer the more serious the situation becomes."

RED TAPE HOLDS BACK RESEARCH

Still unsteady on his feet after months of being bedridden, he began his professorship at the University of Angers in western France. He taught his first mapping course in the mountains of Haute-Provence while still on crutches. Research and teaching make him happy, but increasingly his work day is consumed by bureaucracy: "If it were up to me, I'd have remained a postdoc forever! But I suspect no one can do that."

Or maybe they can. As a Group Leader at the Max Planck Institute for Chemistry, he now seems to have found his niche. Largely freed from annoying paperwork, Schiebel can concentrate fully on his research. He once again has a young family, "despite the fact that I thought I would become a grandfather before becoming a daddy again," he says with a grin. "I'm very happy to come home in the evening, feed my baby and put him to bed – it's wonderful!"

If Ralf Schiebel goes to sea in the future, it will most likely be on the Max Planck Institute for Chemistry's research sailboat. The futuristic 22-meter yacht was designed by Milanese marine architect Lorenzo Argento. When it's completed in late 2017, it will open up new opportunities for the scientists at the Institute in Mainz. "On big research vessels, you're always under enormous time pressure. Now we can let ourselves drift for a week or so and drop the nets 20 times a day to help us gain an understanding of the daily rhythms of plankton," Schiebel says.

The spring plankton bloom in the Arctic could be another destination. Winter storms bring to the surface nutrients that microorganisms feed on.

As a result, the flora and fauna of the oceans are subject to seasonal changes. The researchers want to follow the currents from the Canary Islands to the subtropical gyre to analyze the change from nutrient-rich to nutrient-poor waters.

Ralf Schiebel and his colleagues have more than enough ideas to keep them busy. Once the new vessel has completed sea trials in the Baltic Sea, the first big trip will be in 2018: the Canary Islands, Cape Verde and then perhaps as far north as Iceland. The exact route hasn't been decided yet, but one thing is certain: The North Atlantic in winter? Never again! ◂

GLOSSARY

Foraminifera: Single-celled marine organisms that form a simple or multi-chamber calcareous shell, called a test. Most are microscopic, but some species have reached a diameter of up to five centimeters. When they die or reproduce, they sink to the seafloor to form thick layers of sediment. Depending on the environment in which they were formed, the layers contain different assemblages of species. Foraminifers therefore serve as index fossils for identifying and analyzing specific geological periods.

Ocean acidification: Carbon dioxide from the air can dissolve in seawater, where it then occurs in the form of various compounds, including a small percentage as carbonic acid. If the carbon dioxide concentration in the atmosphere were to double by 2100, the quantity of carbonic acid in the water would increase significantly, and the pH – a measure of the acidic or alkaline nature of an aqueous solution – would fall from 8.1 today to 7.8. That would have an impact on calcareous organisms, since calcium carbonate shells form more easily in an alkaline milieu. Calcareous plankton and corals are at particular risk.