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Press release

Leibniz-Zentrum für Marine Tropenforschung (ZMT)
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03/13/2025
http://idw-online.de/en/news848939

Scientific Publications
Biology, Environment / ecology, Geosciences, Oceanology / climate
transregional, national

Taking the seagrass taxi: How foraminifera move from the coast to the depths of the Red Sea

Foraminifera are single-celled marine organisms with a calcareous shell. They not only provide evidence of past habitats, but also play an important role in sediment formation. Along tropical and subtropical coasts, large benthic foraminifera live on the seabed of light-flooded shallow water habitats, in many cases attached to coral rubble or plant substrates. In the ocean, they can travel long distances by attaching to seagrass or algae and drifting across the sea surface. This journey by hitchhiking – technically known as 'rafting' – has rarely been scientifically documented.

During a Red Sea expedition of the research vessel METEOR, an international team, which included marine scientist Marleen Stuhr from the Leibniz Centre for Tropical Marine Research (ZMT), made a discovery that confirms rafting transportation for this region.

In a submarine brine pool, more than 600 metres deep at the bottom of the Red Sea, the scientists found well-preserved seagrasses with attached foraminifera of the genera Amphistegina, Sorites and Amphisorus. These species are not normally found any deeper than 100 metres. The foraminifera had been transported to this depth by 'hitchiking' with the seagrass. The discovery was recently described in the renowned research journal Scientific Reports. It shows how even the smallest benthic marine species can cover long distances.

In autumn 2023, the RV METEOR set out on a four-week expedition (M193) in the Red Sea to gain new insights into the formation and deposition of carbonates in the depths off the Saudi Arabian coast. ZMT scientists Marleen Stuhr and Hildegard Westphal travelled on board together with researchers from the University of Hamburg, the King Abdullah University of Science and Technology (KAUST), the ISMAR-CNR in Bologna, and a Remote Operated Vehicle (ROV) team from MARUM – Centre for Marine Environmental Sciences at the University of Bremen.

During the research cruise, the scientists secured an extensive collection of sediment samples and began analysing them on board. In samples from depths of 400 to 1,000 metres, they repeatedly discovered remains of large benthic foraminifera, which normally thrive in tropical to subtropical shallow water areas down to a depth of around 30 metres.

"We regularly found single calcareous shells of foraminifera in our sediment samples from these deep-water zones, located 25 to 50 kilometres away from the shallow-water habitats where these species of foraminifera actually live," explains Marleen Stuhr, senior scientist at ZMT and first author of the publication.

"We asked ourselves how these foraminifera could travel such long distances and came up with the idea that they were probably transported attached to seagrass or macroalgae that was set afloat on the sea surface, a mechanism known as 'rafting'," adds Hildegard Westphal, head of the Geoecology and Carbonate Sedimentology working group at ZMT and co-chief scientist on the expedition.

+++Surprising discovery at the end of the METEOR journey proves hypothesis+++

However, the scientists had no concrete evidence for this hypothesis until they made an astonishing find almost by chance.

Shortly before the end of the expedition, the RV METEOR headed for a little-known submarine brine pool in the Red Sea. "On the way to Jeddah harbour, we made our last stop off the coastal town of Umluj to sample the deep-sea brine pool there," recalls expedition leader Thomas Lüdmann, a geologist from the University of Hamburg.

When sediment samples from this location arrived on deck, the strong odour already gave the team decisive clues. Describing the samples Marleen Stuhr says: "The water and sediment from this submarine brine pool smelled extremely strongly of sulphur. Both were very salty and devoid of any oxygen. As a result, biological processes that normally lead to decomposition of organic material were extremely slowed down."

The researchers expected to gain new insights into carbonate sedimentation in the Umluj brine pool from this sample which contained a unique record of the sedimentation history.
They were in for a surprise when sieving of the fine sediment revealed very well-preserved seagrass leaves and roots as well as macroalgae remains with large benthic foraminifera (e.g. Sorites spp.) attached to them. What made this discovery so unique and unusual was the fact that these foraminifera, just like the ones in previous samples, are normally only found in shallow waters, usually down to a depth of 30 metres.

Marleen Stuhr recalls earlier research experiences from the northern Red Sea, when in shallow waters she had often observed foraminifera that had been attached to seagrass. "They were exactly the same species that we had discovered by chance in our sediment samples from the Umluj brine pool. Hence, we were able to confirm our theory that the foraminifera had been transported to the deep by passively drifting and 'hitchhiking' with the seagrass."

"Our discovery shows that marine organisms can drift by 'macrophyte rafting', i.e., attaching to seagrass and algae. This means that they can potentially reach new habitats or, like in our case, drift from shallow zones into the deep sea, where they are deposited in deep-sea sediments as an ecological foreign body," explains Hildegard Westphal.

Some of the foraminifera found by the ZMT researchers in the Red Sea (e.g. Amphistegina lobifera) have been spreading through the Mediterranean as invasive species in recent years. Alongside these foraminifera, the invasive tropical seagrass species Halophila stipulacea is also increasingly found there.

"The fact that both groups, the seagrass and foraminifera, have travelled from the Red Sea to the Mediterranean and are spreading rapidly suggests that 'rafting' mechanisms play a role in the movement of shallow-water organisms and could contribute to the co-dispersal of invasive species," concludes Marleen Stuhr.

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Original publication:

Stuhr, M., Westphal, H., Marchese, F. et al. Seagrass-rafted large benthic foraminifera transported into the deep Red Sea. Sci Rep 15, 5724 (2025). https://doi.org/10.1038/s41598-025-90047-7

The foraminifera in the photo was found in a sediment sample from the Umluj brine pool in a depth of more than 600 metres. Algae remains are visible in the shell.
Marleen Stuhr, ZMT

Microscope image of seagrass leaf found in the sediment of the Umluj brine pool at a depth of more than 600 metres.
Marleen Stuhr, ZMT