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## Little helpers: Phosphorus anomaly in the Black Sea can be explained by bacterial removal

*A team led by microbiologist Heide Schulz-Vogt from the IOW was able to show that conspicuous phosphorus anomalies in the Black Sea can be attributed to the fascinating abilities of certain large bacteria. Until now, the scientific community was not able to explain this phenomenon. In a recent article in* The ISME Journal*, the authors now show that so-called magnetotactic bacteria, which are capable of accumulating polyphosphate and can migrate in a directed manner within the water column thanks to their magnetic properties, are the main cause of phosphate displacements. In this way, they help to control the phosphate content in surface water.*

The Black Sea is an ideal place to study the effects of oxygen deficiency on marine matter cycles, as here, the boundary between the two worlds "with oxygen" (oxic) and "without oxygen" (anoxic) is very stable. Moreover, in contrast to many other sea areas with oxygen deficiency, a water body several decimetres thick can be found underneath the oxic layer, which no longer contains oxygen but is still free of toxic hydrogen sulphide ($H_2S$). In this "suboxic" zone, processes that occur after the depletion of oxygen, can be studied in high resolution.

It was discovered as early as the mid-1980s that the suboxic zone appears to have a major influence on the distribution of phosphorus in the water: With the onset of the oxygen deficiency, i.e. at the upper boundary of the suboxic zone, the concentrations of dissolved phosphate drop to a minimum, while at its bottom, where $H_2S$ is spreading, a pronounced maximum occurs. Furthermore, one can always detect a significant accumulation of particulate phosphorus located in-between.

Heide Schulz-Vogt, head of the Biological Oceanography department at the Leibniz Institute for Baltic Sea Research Warnemünde (IOW), and her colleagues now report in the international journal *The ISME Journal* a process that can comprehensively explain the phosphorus anomaly. They postulate that large magnetotactic bacteria, such as *Magnetococcus*, store phosphates in the form of polyphosphates when entering the oxygen deficiency zone at its upper boundary and release them again when they get in contact with $H_2S$ at the lower boundary of this zone.

Heide Schulz-Vogt has long been interested in the fascinating world of large bacteria: "When we refer to large bacteria, we are talking about 5 µm – only one twentieth the diameter of a hair – but still at least 5 times the size of normal bacteria." Such a difference in size enables large bacteria to absorb 125 times more polyphosphates than their small relatives. "We were able to detect *Magnetococcus* in the relevant zone and were also able to show by gene expression that in the area of the phosphate maximum polyphosphates are degraded by different bacterial groups," Schulz-Vogt explains the methodological approaches. However, the crucial clue came from the scanning electron microscope, the SEM: "At a 10,000-fold magnification of phosphor particles from the suboxic zone, we were able to recognize the chain structures that are typical for magnetotactic bacteria. Only then did we know what to look for."

Magnetotactic bacteria are highly mobile. Their embedded magnetosomes help them to orient themselves along the earth's magnetic field. This enables them to "commute" between the top and the bottom of the suboxic layer and thus create an effective phosphate shuttle. This bacterial transport of phosphates into deeper water layers keeps these nutrients away from the upper productive zone, which, for example, prevents them from triggering cyanobacterial blooms. The role of this process in the Baltic Sea, where massive blue-green algae blooms occur every summer and dramatically increase the oxygen consumption in the deep water layers after dying off, needs to be further investigated. However, there is also evidence of such a bacterial phosphorus shuttle in the Baltic Sea.

**More information:**

Schulz-Vogt, H. N., Pollehne, F., Jürgens, K., Arz, H. W., Beier, S., Bahlo, R., Dellwig, O., Henkel, J. V., Herlemann, D. P. R., Krüger, S., Leipe, T., Schott T. (2019): *Effect of large magnetotactic bacteria with polyphosphate inclusions on the phosphate profile of the suboxic zone in the Black Sea*. The ISME Journal, https://doi.org/10.1038/s41396-018-0315-6

**Expert contact:**

Prof. Dr. Heide N. Schulz-Vogt | Head of the IOW department Biological Oceanography
phone: +49 381 – 5197 200 | heide.schulz-vogt@io-warnemuende.de

**Press and public relation:**

Dr. Barbara Hentzsch | +49 381 5197-102 | barbara.hentzsch@io-warnemuende.de
Dr. Kristin Beck | +49 381 5197-135 | kristin.beck@io-warnemuende.de

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