**Revisiting Dogmata in Nitrification Research**

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No other biogeochemical cycle is as dependent on specialized microbes as the global nitrogen cycle. Nitrification, the microbially-mediated sequential oxidation of ammonia to nitrite and nitrate, is a crucial process in the nitrogen cycle as it links N-input and N-loss in the environment. Even though the microbes that carry out this process have been investigated for over 100 years, the last decade brought many new insights that transformed the research field, and demonstrated with the discovery of ammonia-oxidizing thaumarchaeotes that archaea fundamentally contribute to nitrification. The findings of our group and others demonstrate that many of the long – and firmly - held beliefs in nitrification research need to be reconsidered. Our research sheds light on a broad physiological potential of nitrifying microbes, indicates use of novel substrates, hitherto unknown interactions and new players in nitrification.

In this talk, I will present evidence that not all thaumarchaeotes make their living from nitrification1. Furthermore, we found that ammonia and urea are not the only substrates for ammonia oxidizers, but show that cyanate can be used as sole substrate for nitrification by an ammonia-oxidizing archaeon2. Traditionally, nitrification is thought to be initiated by ammonia oxidizers, which supply nitrite oxidizers with their substrate – nitrite. We found that nitrite oxidizers can partly reverse these dependencies by remineralizing urea3 and cyanate2 and supplying their ammonia-oxidizing partners with ammonia in a reciprocal feeding scenario. Furthermore, I will report on the discovery and physiological characterization of a complete ammonia oxidizer (Comammox) that catalyzes both ammonia and nitrite oxidation and is found widespread in aquatic and terrestrial environments4.

Taken together, our findings draw a much more complex picture of activities and environmental functions of nitrifying microbes than previously expected and indicate that many exciting features still remain to be elucidated.

**1** Mußmann M., Brito I., Pitcher A., Sinninghe Damsté J.S., Hatzenpichler R., Richter A., Nielsen J.L., Nielsen P.H., Müller A., Daims H., Wagner M. and Head I.M. 2011. Thaumarchaeotes Abundant in Refinery Nitrifying Sludges Express amoA but Are Not Obligate Autotrophic Ammonia Oxidizers. *Proceedings of the National Academy of Sciences* 108 (40): 16771–76. doi:10.1073/pnas.1106427108.

**2** Palatinszky M., Herbold C., Jehmlich N., Pogoda M., Han P., von Bergen M., Lagkouvardos I., Karst S.M., Galushko A., Koch H., Berry D., Daims H. and Wagner M. 2015. Cyanate as an Energy Source for Nitrifiers. *Nature* 524 (7563): 105–8. doi:10.1038/nature14856.

**3** Koch H., Lücker S., Albertsen M., Kitzinger K., Herbold C., Spieck E., Nielsen P.H., Wagner M. and Daims H. 2015. Expanded Metabolic Versatility of Ubiquitous Nitrite-Oxidizing Bacteria from the Genus Nitrospira. *Proceedings of the National Academy of Sciences* 112 (36): 11371–76. doi:10.1073/pnas.1506533112.

**4** Daims H., Lebedeva E. V, Pjevac P., Han P., Herbold C., Albertsen M., Jehmlich N., Palatinszky M., Vierheilig J., Bulaev A., Kirkegaard R.H., von Bergen M., Rattei T., Bendinger B., Nielsen P.H. and Wagner M. 2015. Complete Nitrification by Nitrospira Bacteria. *Nature* 528 (7583): 504–9. doi:10.1038/nature16461.