Letters

Nitrogen Oxidations in Bacterium-Plant Interactions

After reading D. J. Arp and P. J. Bottomley's insightful discussion of nitrification in the May 2006 *Microbe*, p. 229–234, we thought it apropos to point out some noteworthy roles for nitrogen oxidations in bacterium-plant interactions.

Nitrification activity in soil correlates with suppression of infection by certain fungal root pathogens (D. M. Huber, Soil Sci. **100:**302–308, 1965; M. F. Cohen and M. Mazzola, Plant Soil, in press). This phenomenon may be related to a central role for nitric oxide (NO) in activating plant systemic acquired resistance (M. Delledonne, Y. Xia, R. A. Dixon and C. Lamb, Nature **384:**585–588, 1998), since nitrification is the major source of NO in non-flooded soils (M. F. Cohen, H. Yamasaki and M. Mazzola, Soil Biol. Biochem. **37:**1215–1227, 2005, and references therein).

Many gram-positive bacteria, including several species that are commonly found associated with plants, produce NO via an alternative route: oxidative deamination of arginine catalyzed by NO synthase (NOS). Though NOS activity is a minor contributor to global production of nitrogen oxides relative to autotrophic nitrification, there is a growing appreciation for its importance in bacterial physiology and ecology. The selective advantage in possessing NOS can vary according to circumstances. NOS activity confers protection against reactive oxygen species (I. Gusarov and E. Nudler, Proc. Natl. Acad Sci. USA **102:**13855–13860, 2005) and, thus, the observed enhancement of H_2O_2 tolerance combined with induction of NOS and catalase activities in cells of an endophytic *Rhodococcus* sp. exposed to sucrose may be adaptive for plant-associated survival (M. F. Cohen and H. Yamasaki, Nitric Oxide **9:**1–9, 2003). Some phytopathogenic *Streptomyces* use NOS in a novel biosynthetic capacity, performing a nitrosylation step necessary for the phytotoxicity of thaxtomins (J. A. Kers, M. J. Wach, S. B. Krasnoff, J. Widom, K. D. Cameron, R. A. Bukhalid, D. M. Gibson, B. R. Crane, and R. Loria, Nature **429:** 79–82, 2004).

Undoubtedly, many potentially far-reaching impacts of bacterial NO production on eukaryotes remain to be explored.

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Combined Antibiotic Treatment

The May 2006 issue of *Microbe* contained a letter from John S. Hibbard in which he presented a cogent case stating that ". . ..all infectious diseases should be treated with a combination of two antibiotics with different mechanisms of action. . ." His premise is a good one, but is 46 years too late. It's been done! I refer him to: (i) W. E. Herrell, A. Balows, and J. Becker. Erythrocillin: a new approach to the problem of antibiotic resistant staphylococcus. J. Antibiot. Med. Clin. Ther. **7:**637–640,1960; (ii) W. E. Herrell, A. Balows, and J. Becker. Alpha phenoxypropyl penicillin & propionyl erythromycin against resistant staphylococci, Antimicrob. Agents Chemother. 1961:723–733, 1962; (iii) W. E. Herrell, A. Balows, and J. Becker. Bacterial effect of the combination of Cephalothin & Streptomycin against Strep. viridans. Antimicrob. Agents Chemother. 1964:350–354, 1965. In each of the above publications we provided data to show that the effect of the combined antibiotics in serum attainable levels was bactericidal as opposed to the ineffectiveness of the maximum dosage of each antibiotic when given singly.

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