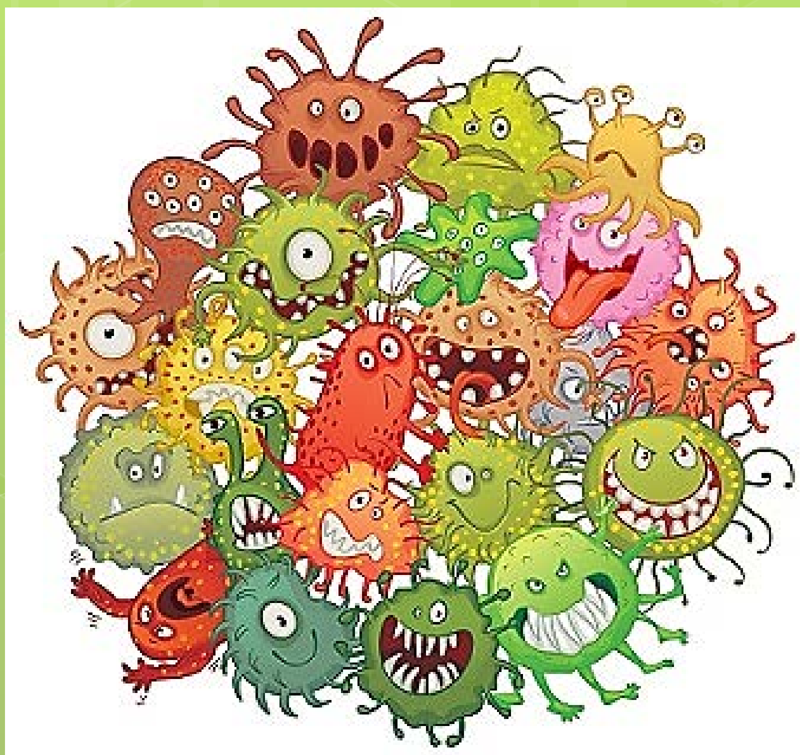

27febbraio 2019 Incontro del Gruppo di lavoro sui BIOFILM

Società dei Naturalisti in Napoli, via mezzocannone 8

Ore 9.30

The invasion Model. A first step to model ecology in biofilms

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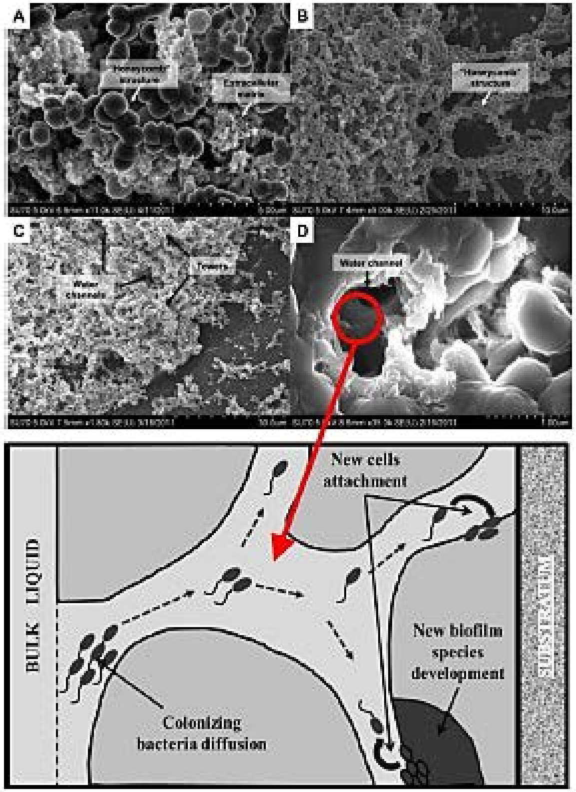
Invasion in biofilms

infiltration of planktonic cells within the biofilm matrix and further establishment in sessile form

ψ_i planktonic bacteria $\rightarrow X_i$ sessile bacteria

Key features:

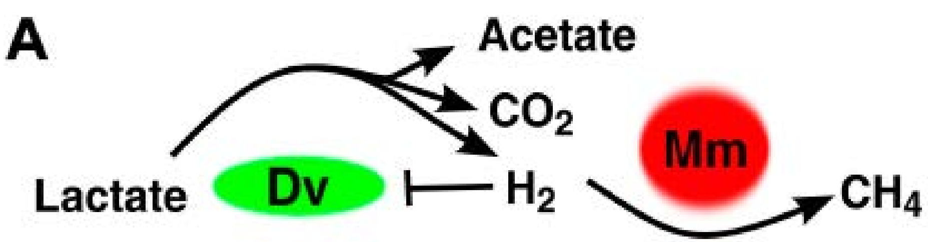
- *Ecological succession*
- Formation of *environmental microniches*
- Random movement or regulated cellular motility
- Rapid alterations in biofilm populations: *eradication or syntrophy*
- Biofilm reactors

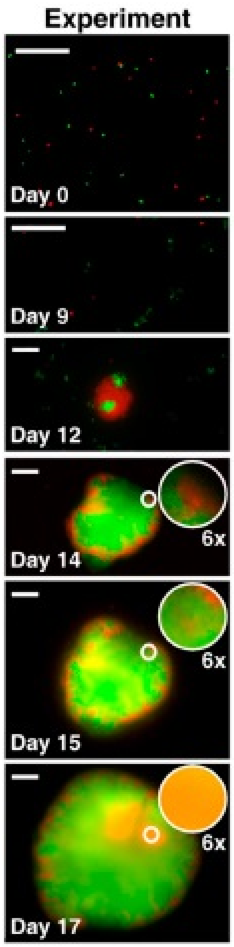


MODEL APPLICATION 1

- Particulate components
  - X_1 Desulfovibrio vulgaris DV
  - X_2 Methanococcus maripaludis MM
- Dissolved components
  - S_1 Lactate
  - S_2 Acetate
  - S_3 Carbon Dioxide
  - S_4 Hydrogen
- Invading species
  - Ψ_2 invading bacteria ψ_{MM}

Obligatory cooperation through redox-coupling leads to partner intermixing.
In the absence of sulfate and hydrogen, *DV* and *MM* cooperate through *redox coupling*. *DV* ferments Lactate and produces mainly Acetate, CO_2, and H_2. H_2 is used by *MM* to reduce CO_2 to methane.





eLIFE elife.elifesciences.org RESEARCH ARTICLE

Strong inter-population cooperation leads to partner intermixing in microbial communities

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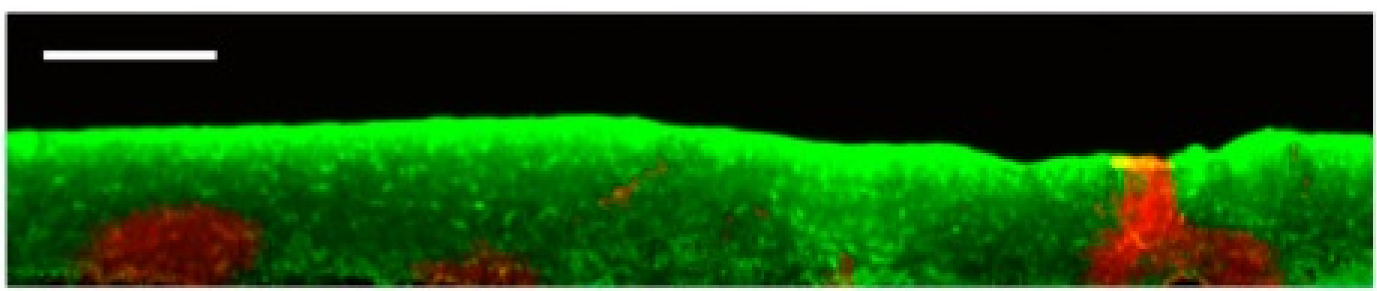
Abstract Patterns of spatial positioning of individuals within microbial communities are often critical to community function. However, understanding patterning in natural communities is hampered by the multitude of cell–cell and cell–environment interactions as well as environmental variability. Here, through simulations and experiments on communities in defined environments, we

EXPERIMENTAL OBSERVATIONS

- Biofilm Thickness $L = 80\mu m$
- Biofilm Composition (Inner Layer) = 60% DV 40% MM
- Biofilm Composition (External Layer) = 80% DV 20% MM



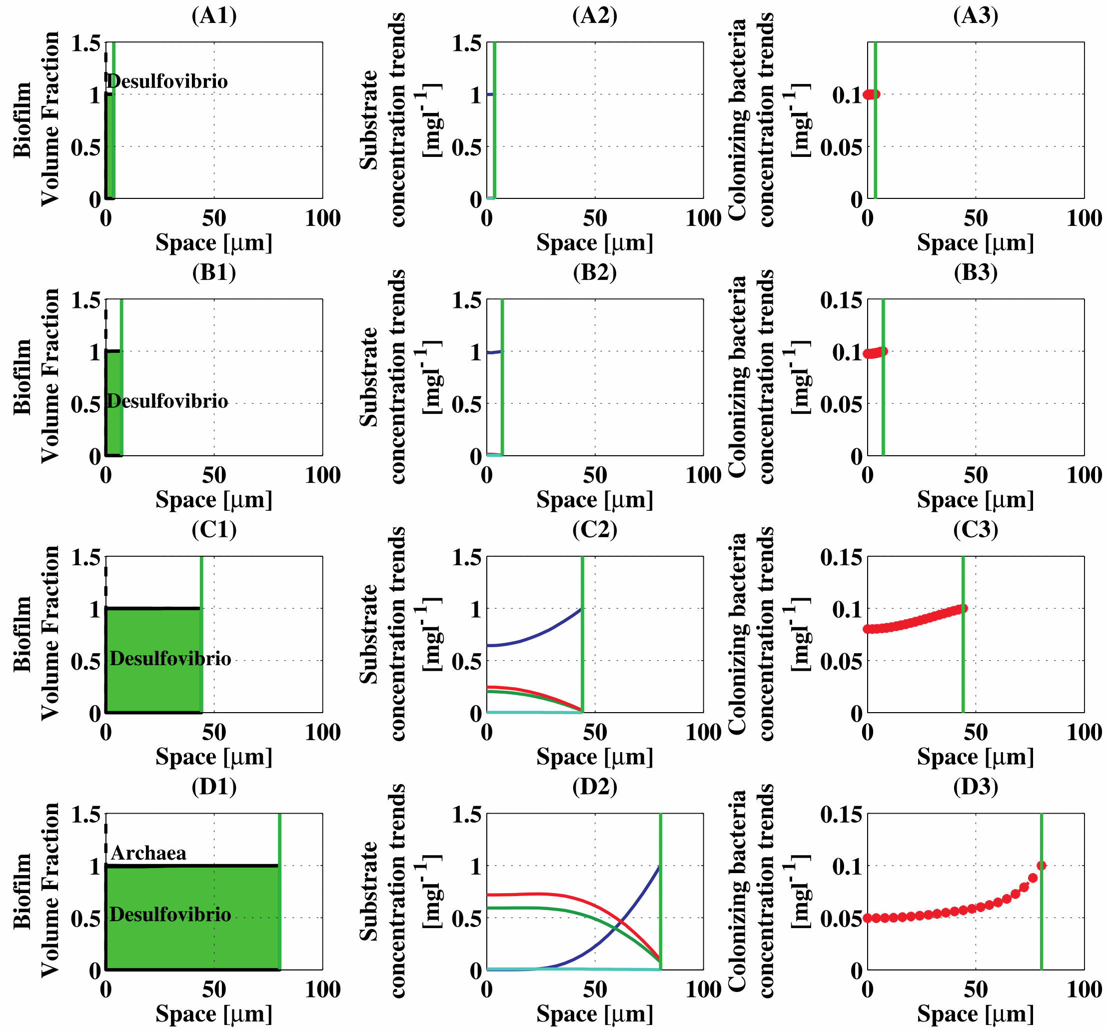


Figure: Effect of colonization on bacterial volume fractions, substrate concentration profiles, and ψ_2 profile within biofilm after 1 (A1, A2, A3), 2 (B1, B2, B3), 5 (C1, C2, C3), 10 (D1, D2, D3) days. Blue line - Lactate; red line - Acetate; green line - Carbon dioxide; ciano line - Hydrogen.

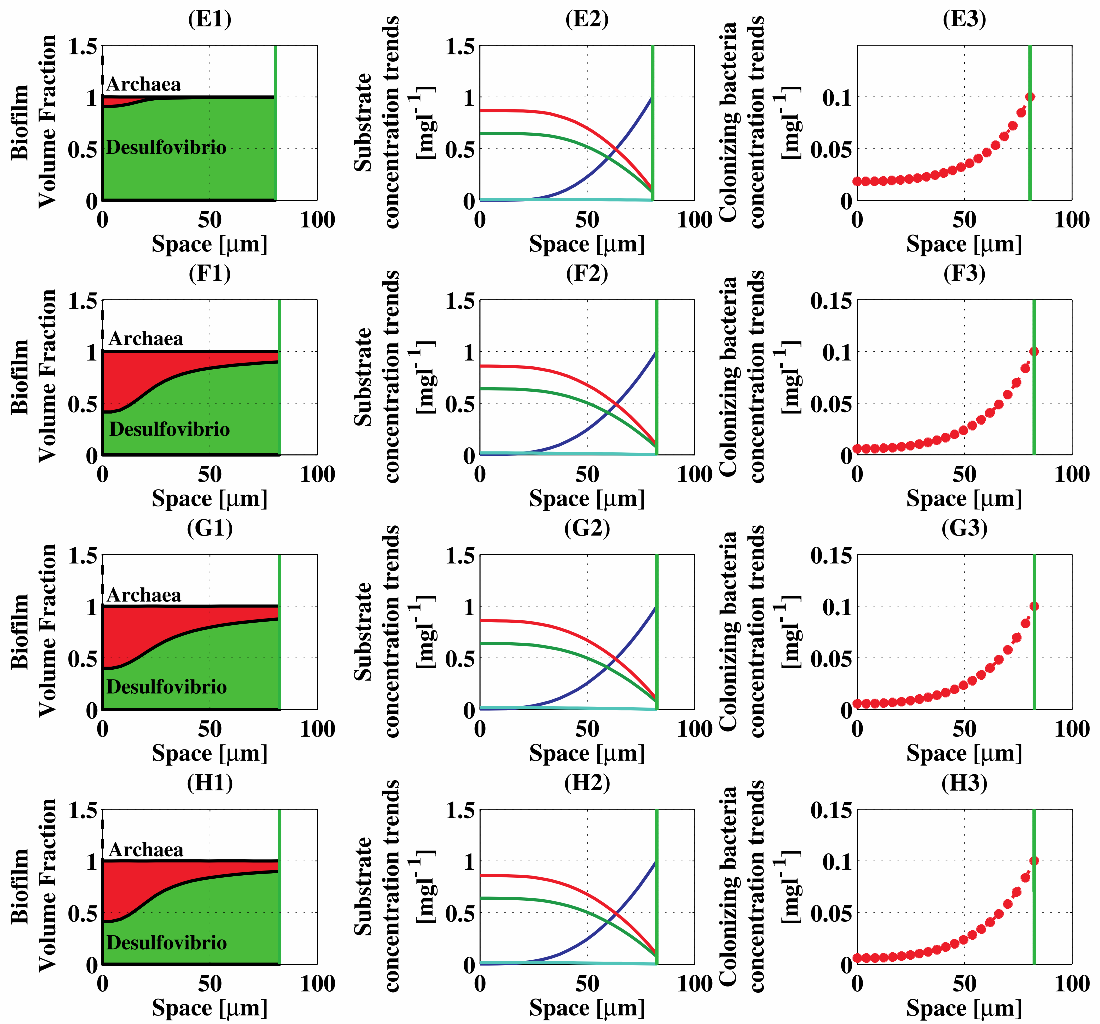
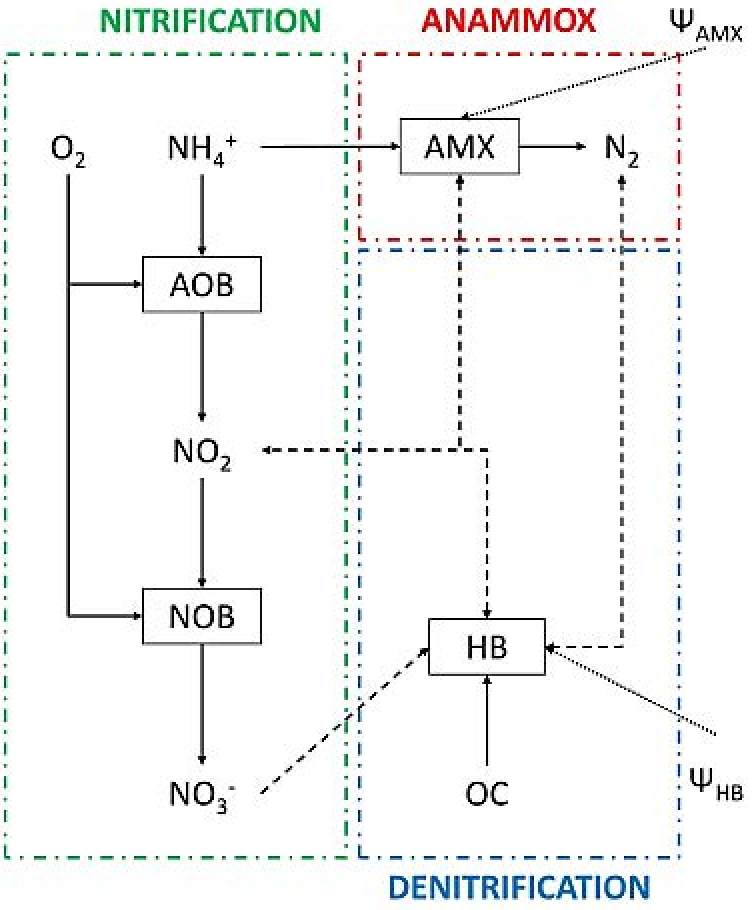


Figure: Effect of colonization on bacterial volume fractions, substrate concentration profiles, and ψ_2 profile within biofilm after 20 (E1, E2, E3), 30 (F1, F2, F3), 50 (G1, G2, G3), 90 (H1, H2, H3) simulation days. Blue line - Lactate; red line - Acetate; green line - Carbon dioxide; ciano line - Hydrogen

MODEL APPLICATION 2

- Particulate components
  - X_1 Ammonium Oxidizing Bacteria *AOB*
  - X_2 Anaerobic Ammonium Oxidizing Bacteria *AMX*
  - X_3 Nitrite Oxidizing Bacteria *NOB*
  - X_4 Heterotrophic Bacteria *HB*
  - X_5 Inert material *I*
- Dissolved components
  - S_1 Ammonium S_{NH4}
  - S_2 Nitrite S_{NO2}
  - S_3 Nitrate S_{NO3}
  - S_4 Organic Carbon S_{OC}
  - S_5 Oxygen S_{O2}
- Invading species
  - Ψ_2 invading bacteria ψ_{AMX}
  - Ψ_4 invading bacteria ψ_{HB}



Simulation 2 - *AMX* & *HB* invasion

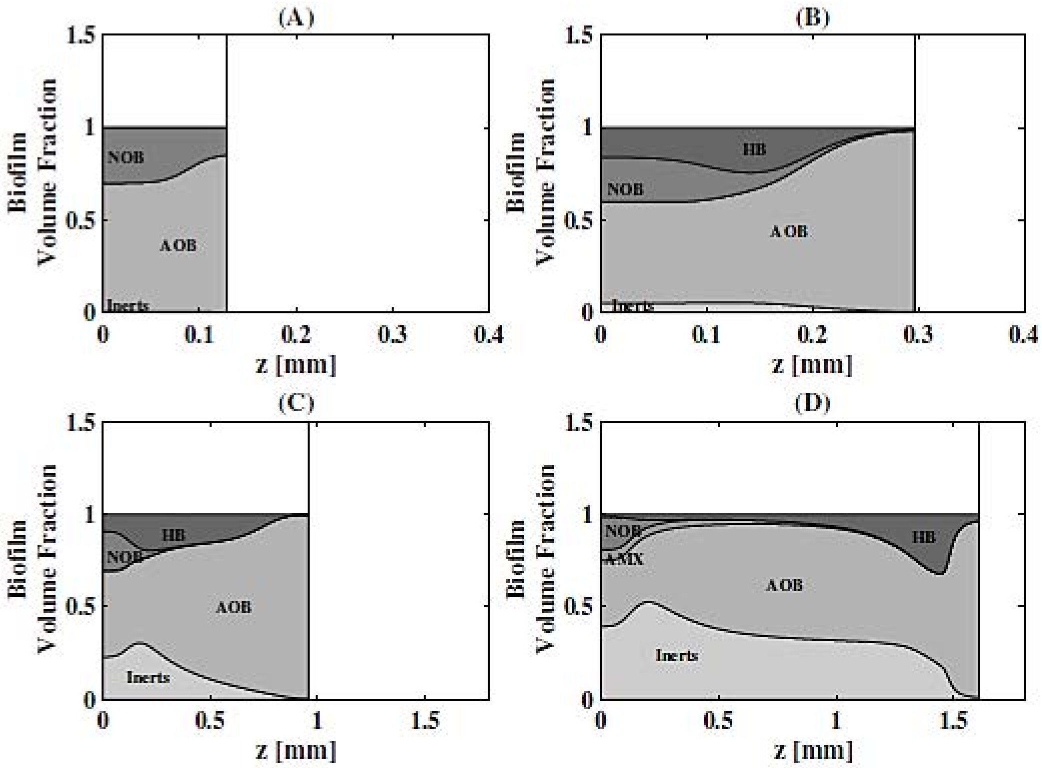


Figure: Microbial species distribution of a multispecies biofilm undergoing ψ_2 and ψ_4 colonization after 2(A), 5(B), 20(C), 50(D) days simulation time. The substratum is placed at $z = 0$.