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## The social dimension of microbial niches

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1 **Microbial ecology:** The social dimension of microbial niches

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10 **Standfirst:** For long, the ecological niche concept was less popular for microbes than for other  
11 organisms. A new proxy of a microorganisms's ecological niche breadth, based on the variability of  
12 the communities it associates with, allows interrogation of the correlates of being a social generalist  
13 or social specialist.

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16 **Main text:**

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18 Species vary in the range of abiotic and biotic conditions that they can cope with; generalist species  
19 can thrive in a variety of habitats or situations, while specialists are restricted to a smaller set of  
20 conditions. Microbes vary on this continuum as well, with generalists (e.g. most of our heavily  
21 studied cultivable model bacteria) having a wider ecological niche and specialists like strict  
22 endosymbiotic bacteria, having a narrower one<sup>1</sup>. Defining an organism's niche requires a solid  
23 understanding of the conditions in which it persists. This is hard enough for larger and better-studied  
24 organisms, and feels nearly impossible for the microbial world, for which micrometre scale conditions  
25 and interactions matter. Fortunately, the era of DNA sequencing derived from environmental samples  
26 has changed the game – so what can we learn about microbial niches from the thousands of available  
27 datasets? Writing in *Nature Ecology & Evolution*, Von Meijenfeldt et al<sup>2</sup> define one aspect of the  
28 microbial niche, the “social niche”, reflecting how much is constrained the community of other  
29 microbes the species is observed with in environmental samples.

30 Some microbial species occur in a variety of compositionally dissimilar communities, while some  
31 other always share their surroundings with a consistent suite of other microorganisms. The authors  
32 classified over 20'700 microbial taxa from all ranks along a gradient based on their Social Niche  
33 Breadth (SNB) and examined genomic correlates of being a social specialist versus a social generalist  
34 species. The SNB is defined as the mean of the pairwise compositional dissimilarity between the  
35 samples in which a taxon is found (Fig. 1). The rationale for using the SNB score as a proxy of  
36 ecological niche breadth is that the broader are the environmental conditions a species can cope  
37 with, the more likely it is to share its habitat with a wide array of other species. This thinking has  
38 already been used for plants and animals<sup>3,4</sup>.

39 Von Meijenfeldt et al<sup>2</sup> computed SNB scores for every known prokaryote taxon from over 22  
40 thousand published environmental samples. Importantly, the SNB score can be calculated at any

41 taxonomical rank level, from phylum to species; this taxonomic distinction allows them to show that  
42 higher taxonomic levels that are social generalists can contain subtaxa that include either social  
43 generalists or specialists. For example, the family *Flavobacteriaceae* is a social generalist, but the  
44 clade contains daughter taxa that are mostly social specialist genera. On the other hand, the social  
45 generalist *Lactobacillaceae* contains many social generalist genera. This suggests numerous and  
46 independent social specialization or niche range expansion throughout evolution.

47 The study also explores the various ecological properties of being a microbial social generalist or a  
48 social specialist. Notably, social specialists have a relatively even abundance across samples in which  
49 they appear, whereas social generalists tend to locally dominate the communities but with a more  
50 variable relative abundance across samples. This result supports the hypothesis that social specialists  
51 have a low but constant abundance near carrying capacity (K-selected), and some social generalists  
52 are opportunistic taxa that reach high relative abundance when circumstances permit (r-selected)<sup>5,6</sup>.

53 Secondly, the SNB score was correlated with genomic properties, such as genome size and additional  
54 related features (i.e., the number of nucleotides, of genes, or of unique functions, as well as genome  
55 size variation within the genus, pan-genome size and openness). Indeed, a number of recent studies  
56 support the theoretical association between genome size and niche breadth, with ecological generalists  
57 having larger genome to adapt to diverse conditions and specialists having reduced genome due the  
58 loss of unnecessary genes<sup>7</sup>. Here, the authors found no direct correlation between genome size and  
59 SNB score, but the genomes of social generalists were found to be more variable in size than the  
60 genomes of social specialists that encode for a smaller and more closed pan-genome. These  
61 properties point to an increased genomic fluidity of social generalists, as confirmed by their  
62 enrichment in invasive mobile elements (plasmids, phages), highlighting a possible mechanism by  
63 which social generalists keep open pan-genomes.

64 In addition, social specialists are overall enriched in fewer gene categories than social generalists.  
65 This is because the functional genes kept during specialization depend on the conditions encounter  
66 by the taxon. The analysis also demonstrates different properties of social specialists typically found  
67 in communities of low or high biodiversity, with high-diversity specialists having more enriched  
68 functions. Overall, the authors suggest that social specialization comes in many forms in the  
69 microbial world.

70

71 Future work will need to test how SNB scores compare to other niche breadth metrics (e.g. based on  
72 genomics<sup>8</sup>). How much will the metric be adopted. and contributory to the scientific community –  
73 being either “specialists” research groups focused on specific taxa or habitats, or “generalists” driven by  
74 general questions in microbial ecology? Most importantly, one can look forward to seeing how the SNB  
75 score will improve ecosystem fate predictions<sup>9</sup> by understanding ecological properties (e.g. invasion  
76 and colonization capacity, ecological relationships such as competition or mutualism, resistance and  
77 resilience to perturbations, etc) of studied taxa or communities in order to promote our overall  
78 understanding of microbial ecology.

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## 80 **Competing Interests**

81 The author declares no competing interests.

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83 **References**

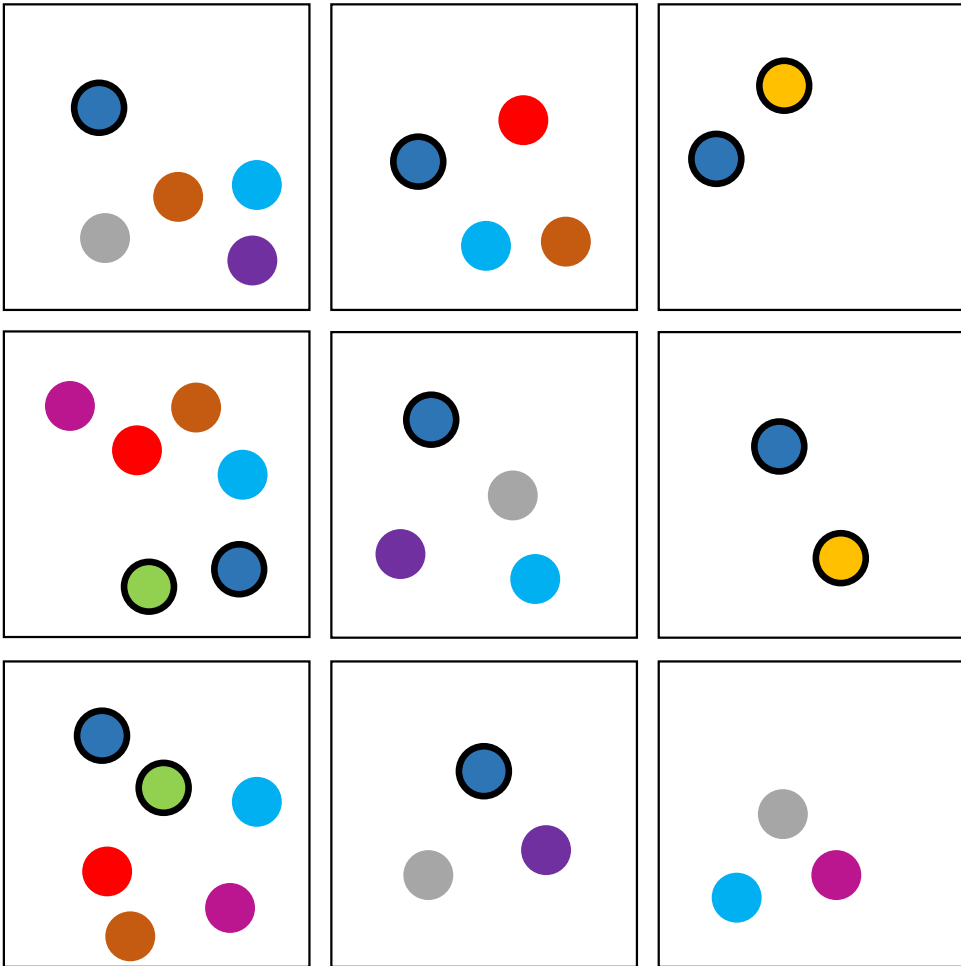
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104 Figure 1. **Community composition similarity as a quantitative ecological feature of the microbial**  
105 **« social niche »**. The graphic is a simplified depiction of how von Meijenfeldt et al<sup>2</sup> determined  
106 microbes' Social Niche Breadth (SNB). The squares represent independent environmental samples  
107 (from published datasets), comprised of several microbial taxa depicted as colored circles. The dark  
108 blue microbe occurs in compositionally very dissimilar communities across the different samples; its  
109 SNB score would be high and thus considered a social generalist. The yellow microbe always occurs  
110 with the same dark blue taxon; its SNB score would be low and it should be considered a social  
111 specialist. Social specialists can be found in either low-diversity samples, like the yellow microbe, or in  
112 high-diversity samples, like the green microbe, which is always found in samples with the same  
113 composition.



- Environmental sample
- A microbial taxon
- A low-diversity social specialist
- A high-diversity social specialist
- A social generalist

Biodiversity