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Bacteria and Island Biogeography

In their Brevia "Larger islands house more bacterial taxa" (24 June, p. 1884), T. Bell *et al.* show that the bacterial diversity in bark-lined water pans ("treeholes") at the base of beech trees tends to increase with water volume. This result is explained in terms of the theory of island biogeography (*1*).

The result is intriguing, but the interpretation offered would seem most unlikely. The theory of island biogeography implies that in "islands" such as treeholes, species numbers represent a dynamic balance between local extinction of species populations and immigration of species that were not previously present. Absolute population sizes increase with increasing island size, and larger populations are less likely to suffer stochastic extinctions. Larger islands also represent larger targets for immigrating propagules, and so they tend to support more species [although surely the small (~50-ml) treeholes dry out periodically?].

Insofar as there are probably no bacterial species that are exclusively confined to bark-lined holes at the base of beech trees, these habitats can hardly be considered as islands; rather, they are rapidly inoculated by bacteria from the surrounding soil and litter, from rainwater running along branches and down tree trunks, and by atmospheric deposition of ubiquitous bacterial spores. Furthermore, bacterial densities in such water bodies are likely to be at least 10^7 to 10^8 cells ml ^{1}, and although these may comprise many species, such huge population sizes would preclude stochastic extinctions. The assumptions underlying the theory of island biogeography are therefore not met.

Bell *et al.*'s species-area curve does not really fit the predicted power function very well; rather, bacterial diversity seems to increase stepwise at treehole volumes around 1 liter. It is likely that the larger water bodies support additional microhabitats. One possibility is that large treeholes include an anaerobic layer at the bottom that accommodates large populations of other physiological types of bacteria.

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The long-lasting debate about the ubiquitous distribution of microbes has recently received considerable attention. In the microbial world, is everything potentially everywhere provided that the environmental conditions are adequate? Or do the same rules apply as for macroscopic organisms?

With their Brevia "Larger islands house more bacterial taxa" (24 June, p. 1884), a study on bacterial diversity in water-filled treeholes, T. Bell *et al.* brought an interesting contribution to this debate by showing that, as for larger organisms, a steep microbial taxa-area relationship (i.e., the value of slope z of the regression between diversity and sampling area) is possible. This finding brings support to the proponents of the possible local distribution of microorganisms by contradicting one of the supposed fundamental differences between microbes and larger organisms (*1*).

Although these new results are potentially important, I believe that they are undermined by a methodological limitation of the study. Because Bell *et al.* homogenized the water extracted from the treeholes before analyzing the community composition, they could not provide a measure of within-habitat heterogeneity, an important potential source of overall bacterial diversity in the water-filled treehole. Indeed, the observed increase in bacteria diversity may at least partly be due to one or more of the following confounding factors that may be associated with a larger body of water: (i) increased potential ecosystem stability (e.g., lower probability of drying out during extended warm and dry periods, lower solute concentration fluctuation resulting from partial evaporation and rain events, and lower temperature fluctuations); (ii) micro-niche diversity (e.g., stratification within the water body and the organic sediments) (*2*); and (iii) food-web complexity (e.g., diversity of metazoa inducing top-down effect) (*3, 4*).

An estimate of possible treehole heterogeneity would allow reassessment of the full value of their results. The lack of this information unfortunately does not allow us to establish if their results indeed are in contradiction with the "everything is everywhere" postulate.

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