dubious owing to the nonindependence of points, but visual inspection of the data may nonetheless reveal gross patterns (e.g., more distant samples having higher complementarity).

When species lists are complete for two communities, complementarity is a straightforward parameter describing the difference between them. When complementarity is between samples, however, complications arise (Koch 1987; Cobabe and Allmon 1994; Colwell and Coddington 1994). A major difficulty in assessing community differences is distinguishing "sampling zeroes" from "structural zeroes." Imagine two urns, each of which contains balls of various colors. A sample from the first urn contains red balls; a sample from the second does not. We cannot tell whether the absence of a red ball in the second sample is due to red balls being present in the second urn but not captured in our sample, or red balls being absent in the second urn. In a species-by-sample matrix generated by a sampling program, an entry of "0" or "absent" for a species may be due to undersampling (the species was present in the community, but missed by the sampling), or the species may be truly absent. Gaston (1994) refers to the former as sampling zeroes and the latter as structural zeroes. The inability to distinguish them is a fundamental problem in biodiversity inventory. Teasing out the effect of undersampling is a subject of current investigation (Chen et al. 1995; Colwell 1997).

A major realm for the analysis of patterns of association among samples is ordination and classification (Gauch 1982; Pielou 1984; Ludwig and Reynolds 1988; Kent and Coker 1992; Jongman et al. 1995; see also Mike Palmer's Web site for ordination: http://www.okstate.edu/artsci/botany/ordinate). Pielou introduces her treatment of ordination with a geometric model. Imagine a hyperspace with as many dimensions as there are species in a species-by-sample data matrix. Each dimension is one species. Each sample can then be plotted as a point in the hyperspace, with the coordinates being the abundance values for each species. In the case of presence-absence data, the values are all 0 or 1. The complete data set is represented as a cloud of points, one point for each sample, in this S-dimensional space (S is the number of species). The objective of ordination is to project this cloud of points, which we cannot visualize, onto a two- or three-dimensional subspace, which we can visualize, in such a way that patterns in the data are revealed. Such patterns might be clusters of points, such that samples from particular habitats group together.

Examples of studies of ant communities that use ordination and classification techniques include Andersen (1991d), Andersen and Yen (1992), and Oliver and Beattie (1996b). Large numbers of rare species may cause problems in ordination, and Pielou (1984) suggests that it might be best to exclude them prior to analysis.

Conclusion

Ants are a dominant element of most terrestrial environments and thus are frequent subjects of ecological sampling. Methods of analysis of ecological data are constantly evolving, a function of changing research questions and improved analytical tools. The species-by-sample matrix is likely to remain the basic data structure, with research questions dictating how the samples are taken and new analytical tools influencing the analysis. Measuring true relative abundances in nature will always be problematic because of clumped spatial distributions and biased sampling methods. However, many questions can be asked of ant communities that do not require precise knowledge of relative abundance. We can ask inventory questions regarding degree of completeness and rate of approach to completeness. We can ask whether sample diversity and composition are related to