
Levels, Hierarchy, and Scale

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Abstract

Biologists often rely on the assumption that nature is hierarchically organized into levels. In its simplest form, the assumption is that each entity at level n is a part of strictly one entity at level $n+1$. When analyzing competition between populations, for example, we would like it to be the case that each individual is a member of only one population. This assumption is intuitive, but probably not correct. If we delimit genuine populations as bound together by certain sorts of interactions between individuals, then because these interactions often fail to be transitive, individuals may be members of several populations - contradicting strict nesting. Other problematic cases abound. Ecosystems, for example, are not composed solely of communities of organisms. The transfer and distribution of molecules such as nitrogen are also constitutive of ecosystems. There are several important implications to be drawn from the problems with strict nesting. First, levels are not "sealed off." Entities interact across levels, even levels that are compositionally "distant." Second, the failure of strict nesting raises problems for the claim made by many ecologists that associated with each change in level there is an associated change in spatio-temporal scale. Finally, while much attention has been paid to compositional levels, I argue that this focus has blinded us to issues of scale, in particular to issues about the scale-dependence of empirical patterns and epistemic issues of cross-scale inference.

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