
When ecosystems do reproduce.

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Abstract

The analogy between communities and organisms proposed by Clements (1916) has long been criticized, but is nevertheless at the origin of the still lively concept of ecosystem (Tansley, 1935). A major debate on this subject opposed Lovelock, the father of the Gaïa hypothesis, to evolutionary biologists such as Dawkins. Dawkins pointed out that our planet cannot undergo natural selection since there is not "a set of rival Gaïas, presumably on different planets" and "some kind of reproduction whereby successful planets spawned copies of their life form on new planets" (Dawkins 1982, p236). Similar arguments regarding the absence of ecosystem's populations and reproduction are often opposed to the idea that ecosystems could evolve by natural selection. The main idea of this paper is that ecosystems *do* reproduce. To begin, I propose an overarching definition of reproduction, which encompasses both sexual and asexual reproduction as a cycle of increase and decrease in genetic information. This definition applies to both organisms and ecosystems and allows identifying situations in which ecosystem *do* reproduce. A first one is experiments of ecosystem artificial selection (Swenson et al., 2000a & b; Blouin et al., 2015). I will present the main results obtained on microbial ecosystems as well as conditions responsible for variation and those required for heritability. Second, I will introduce the recent concept of coalescence of microbial communities (Rillig et al. 2015), an enlargement of the meta-community concept to the dispersal of a set of species transmitted together with abiotic components. Ecosystems that undergo coalescence in the wild *do* reproduce in some specific cases. In these two situations, the three conditions required for selection to occur (Lewontin, 1970) are fulfilled: there is variance in properties among the different ecosystems experiencing selection, this variance is heritable and differences in ecosystem properties are linked with different fitness values.

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