Biodiversity: Causes, Consequences and Conservation

G. David Tilman

2014 Balzan Prize for Basic/Applied Plant Ecology

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Period: 2015-2020

G. David Tilman is Regents Professor and McKnight Presidential Chair in Ecology at the University of Minnesota and Director of the Cedar Creek Ecosystem Science Reserve. He is also Professor at the University of California, Santa Barbara, and Honorary Professor at the China Agricultural University in Beijing. Tilman has spent his career pursuing answers to three major scientific questions related to biodiversity. First, why is life so diverse? Second, how do changes in biodiversity impact the productivity, stability and other ways that ecosystems function? And finally, why and how are human actions leading to the loss of biodiversity, and how might such losses be minimized or prevented?

In trying to answer these questions he has formulated a "universal tradeoff" hypothesis, which suggests that a deep underlying unity of causation explains why the world became so diverse and why biodiversity has such large impacts on how ecosystems function.

The second half of Tilman's Balzan Prize is being used for a project in which he is working with younger scholars to address three issues related to this "universal tradeoff" hypothesis and its implications:

(1) how do evolutionary and ecological processes interact to cause coexistence or competitive displacement, and to determine which species can invade into new regions;
(2) why are the effects of biodiversity on ecosystem functioning are so unexpectedly large;
(3) what are the mechanisms whereby human actions cause species extinctions, the number of species so threatened, and ways to prevent such extinctions.

1. Causes of Biodiversity

Theory predicts that high biodiversity – particularly the long-term coexistence of many competing species – requires that all coexisting species have tradeoffs in their traits. Tilman's research has pursued the goal of testing the applicability of this universal tradeoff hypothesis using both experimental and observational approaches. For both cases, data gathered on the traits of plant species were used to predict species abundances or species diversity when many different plant species compete with each other. Work currently in progress is expanding such studies to include herbivory and predation along with competition.

2. Why are Biodiversity Effects so Large?

Current mathematical theory predicts that the productivity of a plant community is an increasing function of its plant diversity, however, the observed effects of diversity on productivity in long-term experiments are much greater than theory predicts. Analyses of experimental data suggest that current theory omits a major factor. The initial diversity-dependent increase in productivity has a positive feedback effect on soil fertility, and this increased soil fertility causes productivity to increase through time. Tilman and his researchers are working to modify theory to include this feedback effect.

3. Causes of Extinctions, and Ways to Prevent Extinction

Because of the urgency of global, human-caused extinction risks, much of our efforts have focused on various aspects of this issue. Existing evidence and related mathematical theory on human-caused extinction threats are being synthesized, with the aim of testing existing theories and seeking new theories that can integrate the simultaneous effects of multiple stressors to predict their interactive effects on extinctions. Tilman's group has found that the greatest single current and future threat to biodiversity is caused by the ways that humans meet their food needs. They have also identified how both expansion of classical conservation methods and how adoption of pro-active conservation policies aimed at preventing further land clearing and halting "bushmeat" hunting could help prevent extinction of the Earth's remaining large animals.

Publications

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