Biodiversity: Causes, Consequences and Conservation

G. David Tilman

2014 Balzan Prize for Basic/applied Plant Biology

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Affiliated Institution: University of Minnesota
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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 will be used for a project in which he will work with young scholars to address three issues related to his "universal tradeoff" hypothesis and its implications:

(1) how evolutionary and ecological processes interact to cause speciation and diversification;
(2) why the effects of biodiversity on ecosystem functioning are so unexpectedly large;
(3) the mechanisms whereby human actions could cause species extinctions, the number of species so threatened, and ways to prevent such extinctions.

1. Causes of Biodiversity
Tilman's goal is to thoroughly test the limits of applicability of the universal tradeoff hypothesis and seek data sets that might refute it. This will be done by determining if its logical implications are supported by a reexamination of the fossil record, by deeper exploration of the mechanisms that allow competing species to coexist, and by examination of the forces that allow multispecies coexistence across the full range of trophic interactions, not just competition. The evolutionary implications of the universal tradeoff hypothesis must also be tested, for example, by determining if the pattern of micro-evolutionary changes in multispecies communities are consistent with the universal tradeoff hypothesis, and with how such tradeoffs then might influence speciation and subsequent coexistence.

Research staff planned: Tilman with the assistance of one or two younger scholars (PhD students or postdoctoral researchers), whom he would recruit based on their skills and interests.

2. Why are Biodiversity Effects so Large?
Although Tilman's experiments in the Midwest USA as well as those of other researchers have found large effects of biodiversity, there is as yet no rigorous theoretical explanation for the magnitude of the diversity effects. In conjunction with either a PhD student or a postdoctoral researcher, Tilman will re-explore both underlying theory and data gathered over the past twenty years of biodiversity experimentation.

3. Causes of Extinctions, and Ways to Prevent Extinction
In collaboration with a postdoctoral researcher or a graduate student, Tilman will synthesize existing evidence and related mathematical theory on human-caused extinction threats, 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.

Collaboration and Publication
Over the next five years, younger scholars will be involved as collaborators and co-authors of papers on the research proposed above, hopefully publishing them in disciplinary journals, as well as in multidisciplinary journals such as *Science* and *Nature*.

Tilman also plans to immediately start work on writing a book that would summarize his past work and establish the conceptual foundation for the issues outlined above. The book will not be multi-authored, but will involve mentoring an advanced undergraduate university with a stellar academic record in ecology or evolution who can benefit greatly from spending a year assisting with his research.

Duration of the Project and Collaborating Institution
Tilman intends to use Balzan research funds over a five-year period, with funds allocated to supporting two postdoctoral researchers, two or three PhD students and advanced undergraduate students (or students who have recently completed their undergraduate degrees). Other funds will be used to cover research supplies and travel costs.

The funds are to be administered by the University of Minnesota Foundation, with Dr. Clarence Lehman and Dr. Forest Isbell of the University of Minnesota (St. Paul) Department of Ecology, Evolution and Behavior acting as Deputy Supervisors.