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# The intellectual content of taxonomy: a comment on DNA taxonomy

**Diana Lipscomb[1], N. Platnick[2] and Q. Wheeler[3]**

[1]Department of Biological Sciences, George Washington University, Washington DC 20052, USA
[2]Division of Invertebrate Zoology, American Museum of Natural History, Central Park West at 79th Street, New York, NY 10024, USA
[3]Department of Entomology, Comstock Hall, Cornell University, Ithaca, NY 14853, USA

Tautz *et al.* [1] propose to 'solve' the lack of adequate classifications and effective identification tools (the so-called 'taxonomic impediment') by replacing existing classifications with a system in which an infinitesimally tiny fraction of an organism's genome is sequenced and used both to classify and identify the organism in question. The rationale for this suggested change, however, is specious and unlikely to produce a progressive research program. Such a system is already in use for unculturable prokaryotes, where the best we can do at present is collect sequence data from the environment, compile data bases of the results, and construct 'classifications' that reflect only the degree of similarity displayed by those sequences. This produces what is at best a caricature of real taxonomy, in which sequences that diverge by $<5\%$ are considered 'conspecific' (never mind that humans and chimpanzees might be far less divergent than that). Microbiologists would be the first to agree that, when the organisms can be cultured and their other attributes studied, we can do far better than this. Why, then, reduce the taxonomy of all other organisms to this impoverished state? The supposed advantages of DNA taxonomy do not stand up to rigorous scrutiny. For example, the claim that a sequence 'is not influenced by subjective assessments' ignores the difficulty of aligning sequences of different length, distinguishing paralogs from orthologs, or even selecting appropriate genes for any particular taxonomic study. Similarly, the supposition that DNA identification will lessen the confusion that sometimes results when taxonomic names change is unjustified. The only way that a DNA sequence identification tag could ameliorate confusion would be if the gene sequence used were constant among all members of the species but different in all other species. There is no evidence that most genes meet these criteria, and any diagnostic character that meets these criteria would work – it need not be molecular.

The 'taxonomic impediment' is more effectively addressed by other means. Tautz *et al.* [1] are, in essence, suggesting that if we all become as ignorant of our organisms as are, perforce, those microbiologists working on currently unculturable taxa, the world would no longer suffer when knowledgeable specialists in a group die without having communicated all their knowledge to others. Programs such as the US–NSF's PEET [Partnerships for Enhancing Expertise in Taxonomy (2003): http://www.nsf.gov/pubsys/ods/getpub.cfm?nsf00140], which provides funding to train a new generation of systematists, represent solutions far more effective than simply discarding everything we have learned to date about organismic diversity. Taxonomy might indeed be threatened, but the greatest threats might be from those who would usurp the resources that it needs to grow and thrive.

Tautz *et al.* [1] emphasis on the task of identification indicates a fundamental misunderstanding of the intellectual content and rigorous hypothesis testing that characterize contemporary taxonomy. Reducing taxonomy to identification alone makes it a technical task rather than a hypothesis-driven science. There is no credible reason to give DNA characters greater stature than any other character type. When species descriptions are based on a broad range of data, they become interesting scientific hypotheses making explicit predictions about the distribution of attributes among organisms. We reconstruct phylogenies to explain patterns of organismic diversity. Molecular data certainly contribute, but when nothing is known about organisms except their DNA, there are no evolutionarily interesting patterns to explain – just a tedious pattern of sequence similarity. The advocates of DNA taxonomy seem not to understand the peerless

*Corresponding author:* Diana Lipscomb (biodl@gwu.edu).

intellectual content of taxonomy based on all available information, or the hypothesis-driven basis of modern revisionary work. The many levels of hypothesis testing in taxonomy, from characters to species to clades, are essential for all evolutionary biology. To relegate taxonomy, rich in theory and knowledge, to a high-tech service industry would be a decided step backward for science.

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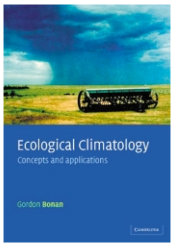
Book Review

# Computing the world around us

**Ecological Climatology. Concepts and Applications** by G. Bonan. Cambridge University Press, 2002. £38.95, pbk (678 pages) ISBN 0 521 80476 0

## David Beerling

Department of Animal and Plant Sciences, University of Sheffield, Sheffield S10 2TN, UK




As the dust begins to settle on the political landscape after yet another frustrating Earth Summit, this time in Johannesburg, measuring stations on the other side of the world reveal the inexorable rise of global atmospheric $CO_2$ levels. And compelling evidence for global warming continues to mount. The surface air temperature of the Earth increased by 0.5°C during the 1900s, outstripping anything seen in the past five centuries. Surface oceans have increased by 0.3°C since the 1950s, spring snow cover is decreasing, alpine glaciers and permafrost are melting, Arctic pack ice is shrinking and sea-levels rising. Our current preoccupation with the threat of future global warming is perhaps understandable – it has apparently arrived.

Future projections of the effects of rising levels of greenhouse gases on global climate rest heavily on understanding the forcing mechanisms and their intimate relationship with a heterogeneous landscape. Gordon Bonan, a scientist at the National Center for Atmospheric Research (NCAR) in Colorado. USA, has written a text focussing extensively on these interactions. He aims to merge seamlessly ecology and climatology, two fields that he considers as different as 'day and night', to provide a new interdisciplinary framework for understanding the place of terrestrial ecosystems in global climatology. I'm not convinced, however, that these disciplines have been as isolated as he suggests. His vision of *Ecological Climatology* necessitates a tour through the principles of global climatology, climate variability, hydrology, soils, land-surface energy fluxes and vegetation dynamics. And having taken that tour, and arrived somewhat jetlagged at chapter 14, I couldn't help but feel that Bonan's sales pitch in chapter 1 was simply a clever ruse for repackaging bioclimatology. Consultation with two widely read treatments of environmental biophysics [1,2] confirms much common ground.

But, that said, this is an excellent book, elegantly summarizing and uniting, in a single volume, a wealth of new research through an extensive synthesis of the literature. As we might expect from Bonan, who has made many significant research contributions on the topic, the strengths of *Ecological Climatology* are its discussions concerning the interaction between vegetation and climate. Three chapters are devoted solely to this theme. So we learn that, according to climate model simulations, boreal forests, a particular favourite of the author, can warm the land surface by 3–7°C in the spring, by masking snow cover. The effects are felt well into the summer because the higher spring air temperatures warm the waters of the Arctic and North Atlantic oceans. The oceans, with their high heat capacities, then moderate polar climate long after the direct effect of the boreal forests on climate has been annulled. It is inevitable, as continental configurations shift and climate fluctuates, that vegetation–climate interactions of this nature will have a considerable antiquity. Perhaps one of earliest examples occurred towards the close of the Permo–Carboniferous glaciation when, as the vast continental ice sheets retreated, the land surface rapidly became colonized by forests of the earliest gymnosperms [3]. From a modeling perspective, this has yet to be investigated, but it has been shown by work at NCAR [4] that forests in the Cretaceous significantly warmed high northern latitude climates by altering the exchange of energy between the land surface and the atmosphere.

To paraphrase the remarks of an ecologist some years ago 'it is easier to build a model than to go out into a muddy field and make observations'. This is probably an unfair comment on modeling as a scientific endeavour; practitioners know that it is every bit as demanding as field-based disciplines, with the successes as rewarding as the failures are disappointing. Of necessity, *Ecological Climatology* has a firm emphasis on modeling. The author, to his

*Corresponding author:* David Beerling (d.j.beerling@sheffield.ac.uk).