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DEB Essay
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An Exploration of the Application of Dynamic Energy Budget Theory through Individual Based Modeling

Much in the spirit of van der Meer [1] and Thiele and Grimm [2] I would like to start by an overall review of my interpretation of the value and some of the assumptions made when one chooses a method to model some aspect of reality. At initial observation, my mind runs to the idea that an effort to determine an entirely cross-taxa mechanism for the concentration of energy to build gradients and organization sounds exceeding grandiose and would be totally limited by data collection and interpretation limits. However, I'm firmly convinced by the data and logic that suggests energy is the main motivator for the function of our biosystems as wholes and as individuals (See Odum [3] for an older but interesting and thorough review) and this suggests that there is perhaps one such mechanism to be uncovered. Another interesting angle that arrives very early in my initial observational stages, is the value of "observing the specific in the general" and the vice versa "observing the general in the specific." When one chooses to observe the environment from the viewpoint of a single cell and anticipates to explain the function of all increasingly complex biosystems, I would argue this sets a path-dependent precedent that would need to be considered. By contrast, the focus only on massive consolidation of individuals and functional guilds into ecosystems as simple trophic structures (in the style of Fath et al. [4]) one makes the same sorts of path dependent assumptions and it becomes complicated to determine which method is "right" as each has interesting and valuable output, but they come from completely different scales and intended interpretations. This is where my argument begins that in some cases simplification may just hold the answers.

It lies in the area of application of bioenergetic models—where the flow of energy through organisms is described in an effort to explore or predict the outcome of scenarios. When one makes the decisions about what organisms and system parameters to focus on, one has largely assumed themselves into a corner that may not be helped by a methodology that reaches across all organisms or systems. This is especially important when one may have a specific timeline or audience for the tools and models developed—and complexity or theoretical assumptions (however well supported they are by data) may not be of great value in much the same sense that statistical significance may not be of realistic value [5]. If a "failure" rate of 10-20% is acceptable, then is extra time teaching a new method really that valuable?

As an academic, my exploration of the dynamic energy budget theory has been a wonderful learning experience and I have come to appreciate the vast efforts to make the theory and the data come to a reasonable connection, but my specific goal involves putting a bioenergetic intra-organism process inside of an inter- and extra-organism model that explores the dynamics of an ecosystem population fluxes through energetic availability and behavioral interactions. Thus, my argument for a simplification much like van der Meer [1] where we incorporate the largest and most important aspects of dynamic energy budget theory—non-age based growth, the concept of reserves as a control of influx of energy, and ignoring the dynamics of fecal matter but maintain a framework that can be quite easily implicated into a behavioral and spatial model.

This likely sounds similar to the work of Martin et al. [6] because I'm basing the framework upon their efforts. My initial efforts of adding additional trophic levels have been stymied by simple computing power, so we're in the process of slimming the number of processes occurring in each timestep and this will require skipping some of the details of dynamic energy budget in order to account for important behavior processes like predation. I am confident that the simplified functions put forth by van der Meer[1] will suffice as they are supported by a strong database of thoroughly explored parameters and allow the most important connection of food in the environment (functional response “f”) to the size, maintenance requirements, and contribution to reproductive processes by making use of the half-saturation concentration (“K”) and prey item populations (“concentrations” “X”) in the specific patches that are occupied by the predators.

The target of the simplification being a model that can be easily implemented by fairly untrained conservation managers to understand implications of environmental and chemical stress upon the energetics of interacting organisms.

Literature Cited

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