E. Danchin, also by P. Bateson); development (A. Love, S.A. Newman, and A. Minelli); and inheritance (F. Merlin, T. Uller, and H. Helanterä, also S. Schmitt). Some of these names are well-known contributors to this sort of exercise, others are younger and fresher voices, and the mix is particularly welcome.

As usual in edited collections, some chapters are more convincing than others, although in this case the quality of the writing and cogency of the ideas are impressive all round. Even when I happen to disagree with the author's main thesis, for instance Newman's insistence that the EES is a radically novel theory that will overrun the 'reactionary consolidation of [the old] idealistic ideology among defenders of the Darwinian faith' (p. 228), or when Francesca Merlin draws what I think is too sharp a distinction between inheritance and transmission (Chapter 9), I find that the chapter pushes me to think more carefully about precisely what I find objectionable in it.

David Depew's discussion of what he terms 'the recovery of development' (Chapter 1) is a good example of one of the long-standing problems with the MS that the EES is attempting to solve: the unfortunate exclusion of developmental biology from the development of evolutionary theory in the 1930s and 1940s, by which Ernst Mayr, one of the architects of the MS, was famously not particularly bothered [4]. An example of a novel element in EES, something demonstrably entirely missing from the MS, is the concept of evolvability, the evolution of which, so to speak, is magistrally traced in Chapter 7 by Alessandro Minelli.

Other entries are both fascinating and a bit puzzling. For instance, Stéphane Schmitt traces the history of the idea of serial homology in Chapter 11, highlighting how easily the concept has been rethought in order to adapt it to whatever paradigm biologists happened to be working under, from the 18th century (and therefore well before Darwin) until now. But it is not very clear, in the end, why the author thinks serial homology poses a 'challenge' to modern evolutionary theory, which seems to me to have plenty of conceptual tools to adequately deal with it.

Again, though, this is a book that anyone, scientist or philosopher, seriously interested in the current status of discussions in evolutionary theory ought to read, and have their graduate students discuss it.

Challenging the Modern Synthesis: Adaptation, Development, and Inheritance by Philippe Huneman and Denis Walsh, Oxford University Press, 2017. 9780199377176, £47.99, $74.00.

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Letter

Towards a Meta-Social-Ecological System Perspective: A Response to Gounand *et al.*

Pierre-Cyril Renaud,[1,*] Fabio de O. Roque,[2,3] Franco L. Souza,[2] Olivier Pays,[1] François Laurent,[4] Hervé Fritz,[5,6] Erich Fischer,[2] and Christo Fabricius[6]

The meta-ecosystem approach has significantly advanced ecosystem science and landscape ecology by explicitly addressing the flow of elements (live organisms, biotic and abiotic materials) among ecosystems at different temporal and spatial scales [1,2]. Gounand *et al*. [3] recently argued that the conciliation of theoretical and empirical studies on meta-ecosystems needs better quantification of spatial flows in terms of movements (dispersal, foraging, life-cycle, and migration), feedbacks, and resources. While their proposed framework is indeed a promising contribution, we submit that moving from a meta-ecosystem to a meta-social-ecological approach would add value. Including a social-cultural dimension to the framework would improve its predictive abilities and practicability.

Gounand *et al*. [3] acknowledge that humans are important drivers of landscape changes around the world, creating new systems and borders, consistently influencing the flow of matter and energy among ecosystems. We contend that human choices and decisions, ameliorated by institutions and governance systems, are key drivers of meta-ecosystem dynamics in the Anthropocene. The vast majority of latter-day terrestrial ecosystems exist in anthropogenic landscapes or 'peoplescapes' where humans are not only a beneficiary of ecosystem services, but a key influencer of ecosystem dynamics. This extends beyond our direct management actions. Individual attitudes, values, and mental models [4] have a cascade effect on institutions and governance systems, from local to national and international levels [5]. Mental models, far from being static, vary in space and over time, with profound impacts on resource flows and fluxes. Imagine several habitat patches coupled by dispersion of two interacting non-human animal species: an archetype of dispersal-oriented metacommunity [2]. In the case of human populations acting as consumers of both species with similar intensity in each ecosystem, this will dynamically influence the resource flow within ecosystems and among them. As human technology, culture, and population size continuously change, the consumption of one of those species may stop in some ecosystems, influenced by new mental models (taboos for example), laws, or any anthropogenic dynamic unrelated to environmental conditions. Changes in social rules as an adaptive management response has been widely documented [6]. Therefore, a species-sorting process operates in the meta-ecosystem, influenced by socio-cultural drivers on ecological relationships, affecting the flow of organisms. In Zimbabwe, for example, changes in the values and priorities of communities neighbouring Hwange National Park have influenced people's relationships with wildlife, with spill-over effects into government policies and approaches to legislation [7]. The international conservation strategies to save elephants are rooted in contrasting mental models about the relative importance of trade or conservation (e.g., individual elephants are special and selling ivory is morally wrong versus ivory provides a sustainable revenue source for conservation and livelihoods) [8]. These mental models orient how people act in relation to elephant conservation law enforcement in different African countries, in a way that can create source-sink dynamics in their populations. A last example is in Brazil, where a shift from indigenous mental models of nature to the profit-seeking mental models of industrial farming corporations has influenced landscape structure and processes over the past decade [9]. For this example, the international commodities market has driven mental acceptance that human wellbeing increase can only be reached by creating a contrasted landscape, with industrial agricultural land and protected land separated by clear boundaries, instead of a softer edged interface landscape type.

The spatial and temporal variability in human values, mental models, and attitudes, and our governance systems and institutions, are at the core of our relationship with the biosphere and a crucial determinant of meta-ecosystem dynamics in the Anthropocene. This signals hope for transformative change to sustainability. The dynamic nature or human attitudes, mental models, and therefore governance systems hold promise for transformative change in our relationship with the natural environment. Shifts from egoistic to altruistic and biospheric approaches, are indeed possible through awareness raising, learning, and personal experience [10], as was demonstrated by recent shifts in attitudes towards illegal ivory trade [8] or changes in farmers' environmental values, linked to shifts in agricultural practices [11]. However, an important missing piece in the Gounand *et al*. [3] paper is the human actions embedded in complex systems, with variable socio-cultural, economic trends and flow of ideas and knowledge establishing a real 'peoplescape', with its own specific rules and feedbacks, that can shape meta-ecosystem dynamics [12].

In conclusion, human actions are significant drivers of the flow dynamics in coupling ecosystems, as Gounand *et al*. [3] observed. Nonetheless, human actions dynamically change, based on cultural and economic trends, therefore human social systems have a cascade effect on the ecosystems. Incorporating complex social system into meta-ecosystem approaches will be more useful towards a better understanding of our changing world.

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