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Interactive comment on "Fundamental molecules of life are pigments which arose and evolved to dissipate the solar spectrum" *by* K. Michaelian and A. Simeonov

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We thank Kees Hulsman for his kind remarks on our paper. We are particularly grateful to him for pointing out the relation between Lotka's principle of natural selection of organisms that augment available (free) energy channeling through an ecosystem and our suggestion of thermodynamic selection of pigments and their organismic vehicles of dispersal that together augment the dissipation of the free energy available in the solar photon flux. The two suggestions are similar, and indeed appear to reflect what actually occurs in Nature. They only differ somewhat regarding the premises on which they are based. In Lotka's words,

"But the species possessing superior energy-capturing and directing devices may accomplish something more than merely to divert to its own advantage energy for which others are competing with it. If sources are presented, capable of supplying available energy in excess of that actually being tapped by the entire system of living organisms, then an opportunity is furnished for suitably constituted organisms to enlarge the total energy flux through the system. Whenever such organisms arise, natural selection will operate to preserve and increase them. The result, in this case, is not a mere diversion of the energy flux through the system of organic nature along a new path, but an increase of the total flux through that system." (Lotka, 1922)

Lotka saw the opportunity for the origin of a new species through the latching on to a new channel of free energy, the available energy for which all life competes, and that this would thereby allow ecosystems to grow and become more adequate for sustaining life. One could say that this observation was, in some way, an "energetic" precursor to the theory of Gaia in which organisms co-evolve together and with their abiotic environment to increase the suitability of Earth for themselves and all life in general. Our contribution, presented in the manuscript and elsewhere, is to suggest that these new channels for latching on to free energy most often become available through the evolution of new, more efficient, organic pigments which cover, over evolutionary time, ever more of the solar spectrum, as well as the evolution of their associated organismic vehicles which allow the pigments to spread into inhospitable regions of Earth's surface. This happens not for making Earth more suitable to life, but for the greater thermodynamic role of increasing the solar photon dissipation rate of the biosphere. In our view, there can be no inherent "interest" in self preservation assigned to life, but rather it must be viewed as a dissipative structure (process) which surges and wanes in response to the impressed solar photon potential and to secondary impressed chemical potentials derived from it. Other, what are traditionally considered as being more abiotic, routes to this entropy production are also available (such as Earth's water cycle or the giant southern vortex on Venus) and which route Nature takes (whether biotic, abiotic, or a coupling of the two) will depend strongly on initial conditions and subsequent perturba-

tion, but will be guided by the principle (probabilistic) of increasing the global entropy production of Earth in its solar environment (Michaelian, 2012).

In the Discussion section of the revised version of the manuscript we have included Lotka's observation and its relation to our suggestion concerning photon dissipation. We thank Kees Hulsman for bringing this to our attention and for his kind review of our manuscript.

References:

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