

Open systems living in a closed biosphere: a new paradox for the Gaia debate

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While energetically open, the biosphere is appreciably closed from the standpoint of matter exchange. Matter cycling and recycling is hence a necessary and emergent property of the global-scale system known as Gaia. But how can an aggregate of open-system life forms have evolved and persisted for billions of years within a planetary system that is largely closed to matter influx and outflow? The puzzling nature of a closed yet persistent biosphere draws our attention to the course of evolution of fundamental metabolic strategies and matter-capture techniques. It suggests a facet of the Gaia hypothesis, framed in terms of persistence. The oceans, atmosphere, soils and biota constitute a complex system which maintains and adjusts matter cycling and recycling within the constraints of planetary closure such that open-system forms of life can persist. This weaker version of the Gaia hypothesis may be useful because it readily lends itself to at least one form of test. What is the solution to the closed biosphere puzzle, and does it indicate that Gaia merits status as a discrete entity? We suggest several disciplines within the field of biology that might provide tools and perspectives toward reaching a solution. These disciplines include artificial closed ecosystems, prokaryote evolution, the nexus of thermodynamics and evolutionary biology, and hierarchy theory in ecosystem modeling and evolution theory.

Keywords: Biosphere; Closed systems; Endosymbiosis theory; Evolution; Gaia; Geophysiology; Hierarchy theory.

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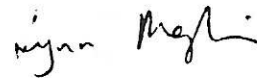
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Dear Connie,

Your paper is seminal, amazing to me and brilliantly clear. It's effect on the Gaia debate ought to be totally positive. I feel strongly that Steve Schneider publish it with his collection of works from the meeting, so that it receives more attention from relevant readers. I've made a few suggestions on the text. Please send me the final version.

Will we perhaps see you in Seattle this summer?

Sincerely,



Lynn Margulis

cc: Peter Bunyard
Steve Schneider