Gaia Hypothesis

A Definition

"A complex entity involving the Earth's biosphere, atmosphere, oceans, and soil; the totality constituting a feedback or cybernetic system which seeks an optimal physical and chemical environment for life on this planet."

Through Gaia, the Earth sustains a kind of homeostasis, the maintenance of relatively constant conditions.

Organisms on Earth respond to change to maintain and regulate an environment conducive for life.
Daisyworld: A Gaian System

Schematic

- Black and white daisies
- Temperature depends on balance of absorption of solar energy and its reflection.

The Gaia Hypothesis

Ranges of Influence

- Influential Gaia: biological influence
- Co-Evolutionary Gaia: reciprocal relationship between environment and biology
- Homeostatic Gaia: biological influences as an active, adaptive control system
- Teleological Gaia: homeostasis is controlled by biology for its own benefit
- Optimizing Gaia: biology as the manipulator
Biogeochemical History of Earth

• What controls Earth’s physical environment?
  • temperature, atmosphere, climate, etc.
  • how have they varied over time?
• What controls Earth’s chemical environment?
  • atmosphere, climate, ocean, biology, etc.
  • how have they varied over time?
• How have the changes affected habitats for life?
  • do they influence evolutionary processes?
• What evidence survives in the rock record?
  • nature of biogeochemical records

Environmental Variables: Multiple Feedbacks

• Physical characteristics
  • solar energy → temperature → climate → ice
    → albedo → temperature → wind strength →
    ocean circulation → nutrients → plankton →
    atmosphere → temperature
• Chemical characteristics
  • atmosphere → ocean chemistry → biological
    productivity → sulfur cycle → atmosphere →
    cloud cover → precipitation → salinity →
    ocean circulation → temperature
Element Cycles

Global Carbon Cycle

- Reservoirs
- Storage
- Fluxes
- Transfer
- Temporally variable

G302 Development of the Global Environment