Symposium: Global Ecology April 17, 2003

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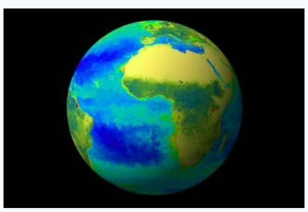

The interaction between the physical earth and life is essential to the functioning of the global ecosystem The earth is a complex system, characterized by the interplay between the biosphere and geosphere. Life contributes to the regulation of the atmosphere; life plays an essential role in many biogeochemical cycles; life is essential for the maintenance of the hydrological cycle. At the same time, life is dependent on each of these cycles and on the physical earth through nutrients derived from erosion. Physical earth provides a substrate for life, and regulates the atmospheric composition through volcanism on a scale that is able to impact on life profoundly.

In view of the changes that our global system faces due to human action, it is not surprising that Biogeosciences or Biogeology, the discipline that addresses the interaction between life and the solid earth, is a rapidly expanding field. Major questions are for instance: What is the essential difference between Earth, and for instance Mars and Venus? How stable is the Earth's ecosystem and what is the magnitude of natural processes versus changes induced by mankind? What are the essential elements to keep the global ecosystem in its present state and how far can we perturbate these before irrevocable changes take place?

This one-day meeting on Global Ecology marks the start of the national Dutch Centre for Biogeology in which many prominent groups in the fields of ecology, biogeochemistry, microbiology, palynology, paleontology, paleoecology and (organic) geochemistry intend to collaborate.

Organisation

Organisation:
Prof. Bert van der Zwaan, Research Group Stratigraphy and Paleontology, Faculty of Earth Sciences, Utrecht University.

Logistics: Marieke Bootsma, Netherlands Institute of Ecology.

Advice and overview: Hans de Kroon

For practical questions:
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Location of the Global Ecology Symposium

Date: April 17, 2003
Venue: WICC, Wageningen The Netherlands
Admission, including lunch: € 15,= (Students & PhDs: € 10,=, Necov members € 2,= reduction)
Starting time: 9.30 hrs.
Registration: Click to open Registration form

Address and route to the Wageningen International Conference Centre (WICC).

Programme

Print version

09.30-10.00	Registration and coffee
10.00-10.40	**Kenneth Nealson** (University Southern California, USA): Global ecology over time: Earth and Mars as Contrasting Systems
10.40-11.20	**Frances Westall** (Centre de Biophysique Moléculaire, CNRS, Orleans, France): Why did life evolve on earth?
11.20-12.00	**Jaap Sinninghe Damste** (Royal Dutch Institute of Sea research, The Netherlands): Biogeochemical cycling in a greenhouse world
12.00-13.00	Lunch
13.00-13.40	**Tim Lenton** (Centre for Ecology and Hydrology – Edinburgh,UK): How stable is Gaia?
13.40-14.20	**Henry Hooghiemstra** (Institute for Biodiversity and Ecosystem Dynamics (IBED), The Netherlands): The evolution and dynamics of tropical forest systems
14.20-15.00	**Leon Lamers** (Centre for Wetland Ecology/ University Nijmegen, The Netherlands): The importance of global wetland systems
15.00-15.30	Tea
15.30-16.10	**Marten Scheffer** (Aquatic Ecology, Wageningen University, The Netherlands): Stability of ecosystems
16.10-16.50	**John Grace** (Ecology and Resource Management, University of Edinburgh, UK): The global carbon-cycle and options for the future
17.00	End

Global ecology over time: Earth and Mars as Contrasting Systems

Kenneth Nealson

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Those who would search for extraterrestrial life must constantly remind themselves that, even if life does exist elsewhere, it might be different from what we know. Thus, one must use approaches that are, as much as is possible, non-earthcentric (i.e. not dependent on specific properties of earthly life for their success). In order to meet this challenge, we have established a two-fold approach to life detection, the first of which follows a line of complexity and chemistry, and the second, which exmines thermodynamics and kinetics properties. For the complexity and chemistry approach, complex sites, which are identified via data compression, are then analyzed for their specific chemical properties. The logic that drives this approach is that life will of necessity (because it needs to convert and store energy) have some complex structures involved in energy conversion, energy storage, cellular structure, etc. Physically complex structures, which can be readily identified, must be chemically analyzed, looking for the chemical complexity which must also be a part of life. Detailed analyses include elemental composition, or amino acid content and chirality, stable isotope fractionation, and complex molecular chemistry. These measurements, taken together make a good case for life, either extant or extinct, and if extant, either active or passive. The thermodynamics and kinetics approach searches for chemical disequilibria due to biological activities. Because life uses resources and produces waste products, its very success leads to depletion of some things, and accumulation of others. These depletions and accumulations can often be easily measured, and are excellent biosignatures. For example, on Earth, such kinetically driven chemistry leads to the nearly universal presence, in stratified environments like sediments, of layered microbial communities or LMCs, which can be found at scales ranging from 100s of meters in the Black Sea to micrometers in biofilms. Such LMCs may be the best biosignatures of extant life that we know of on Earth. Would such approaches work on Mars? This question will be discussed in terms of our current understanding of the geochemical and geophysical comparisons of the two planets.

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Why did life evolve on earth?

Frances Westall

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Click here to see Francis Westall's Hompage.

Abstract under development

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Biogeochemical cycling in a greenhouse world.

Jaap Sinninghe Damste

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The mid-Cretaceous Earth was a greenhouse with atmospheric CO_2 concentrations much higher than today. Large fluctuations in CO_2 concentrations, however, occurred due to massive burial of organic matter in marine sediment. In this respect, it is a good example of how earth shapes life and life shapes earth and, thus, how biology and geology show strong interactions. In this presentation I will use organic proxies (so called biomarkers or molecular fossils) to reconstruct the changes that occurred during the Cenomanian/Turonian anoxic event. It will be demonstrated that anoxia of the oceans resulted in extensive burial of organic matter, leading to a 40-80% drop in pCO_2. This enabled C4 plants to develop on the continent, revealing a tight link between marine productivity and the evolution of terrestrial ecosystems. I will also address the issue of how marine productivity was sustained in a stratified ocean in which nutrient (predominantly N) were trapped below the chemocline and probably converted to nitrogen gas by bacteria capable of anaeorobic ammonium oxidation (anammox). Planktonic cyanobacteria seemed to have played an essential role in this respect. Subsequent further opening of the equatorial Atlantic Gateway resulted in ventilation of the proto-North Atlantic Ocean. This may have led to increased levels of nitrate in surface waters and the rise of an important group of present-day marine diatoms, the rhizosolenoids.

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How stable is Gaia?

Tim Lenton

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A central question for biogeology is: How stable is the global system of life tightly coupled to its environment at the surface of the Earth? Scientists still differ over how to define this system and what to call it, so I'll start by defining what I mean by the 'Gaia' system. The talk will then address how our scientific understanding has developed since Lovelock and Margulis first put forward the Gaia hypothesis of atmospheric homeostasis by and for the biosphere. The Gaia hypothesis rather over-emphasised the stability of the system. It's replacement by the Gaia theory and the more complex notion of self-regulation addressed observations that Earth history is characterised by long intervals of relative stability interspersed by short periods of rapid change. This is also to some degree encapsulated in the Daisyworld model. A review of examples from Earth history leads to an even richer picture. In particular, during the mid-Cretaceous, a series of quasi-periodic Oceanic Anoxic Events may be the signature of a self-sustaining oscillation of the system at that time. The recent ~100kyr period glacial-interglacial cycles also show the importance of internal dynamics and what happens when positive feedback begins to dominate over negative feedback. Our actions as a species, perturbing the system from within, appear to be particularly badly timed, given the recently demonstrated instability of the system on timescales of relevance to us. However, on longer timescales, simulations of Earth future suggest that the long-term carbon dioxide and temperature regulator is surprisingly robust. Eukaryotic life is predicted to persist on Earth for about another 1 billion years.

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The evolution and dynamics of tropical forestsystems.

Henry Hooghiemstra

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Ever increasing temporal resolution of records of tropical forest ecosystems show an unprecedented magnitude of natural change. First results illustrate that tropical forest ecosystems respond precisely and continuously to perturbations of natural climate change. Ecosystems seem most stable in the central areas of its geographical distribution, but incrasingly unstable to the borders of its disctribution area, where transitional stages to other ecosystems occurr. Therefore, high resolution studies of climate change and ecosystem dynamics are most sensitive at sites located in, or close to transitional areas. Depending the scale of the mosaic in which regional vegetation types do occurr, vegetation of a ‘transitional’ character may reach significant percentages on a subcontinental scale. Thus, instability of ecosystems rather is the rule than the exception. This statement will be illustrated with case studies in the savanna-rainforest transitional area in the Colombian lowlands (80-150 m alt.), and in the paramo-montane forest transitional area in the Colombian Andes (ca. 2600 m alt.).

Pollen records of the last glacial with highest resolution document climate change during Stages MIS 2 through MIS 6 (the period from 20 to 160 kyr BP) on centennial time-scales. These records from 4°N illustrate the presence of climate variability at millennium time-scales comparable to Dansgaard-Oeschger clycles in high latitude records in ice, marine sediments and terrestrial pollen archives. ‘Stability’ in ecosystems seems a human constuct when ecosystems are observed at human time-scales. But ‘equilibrium states’ and ‘climax floral composition’ seem ephemeral concepts when observing tropical ecosystems with high temporal resolution at millennium to centennial time-scales.

On time-scales of tens of thousands of years significant changes in the floral composition is documented. Colombian pollen records show periods dominated by Quercus, and Polylepis, alternating with mixed forest types within a narrow set of boundary conditions. It is subject to study if specific (successive) environmental conditions, evolutionary trends, or aspects of chaotic behavior of an ecosystem play a role.

Our understanding of high frequency climate variability, and the high frequency dynamics of ecosystems is too poor to be able to assess the magnitude of natural change versus the magnitude of perturbations induced by mankind. This field of ignorance is masked by numerous model studies. Although model studies and inversed modelling contributed significantly to a better understanding of single parameters and to possible mechanisms at work, finally it are the records with high temporal resolution and superb chronological control that document the factual degree of natural stability/natural magnitude of change. Records with such qualifications hardly exist, hampering a break through in ‘global ecology’.

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The importance of global wetland systems.

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Abstract under development

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Stability of ecosystems.

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Click here to see Marten Scheffer's Homepage (Don't forget to listen to Martin's music!).

Abstract under development

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Global ecosystems, the Cretaceous and the Daisyworld.

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