Environmental control of plankton: interactions with planktonic control of the environment

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Physical and chemical properties of the environment, which can be considered as bulk-average values plus and minus variation, determine the current, local environment of all organisms, and may partly define ecological niches in the Hutchinsonian sense of environments in 3 dimensions and time, suitable for a particular species. Darwinian selection will therefore favour genes which myopically influence organisms to intensify or enlarge pre-adapted niches to their advantage. Niche intensification or enlargement may have both primary and collateral effects. A "primary" effect is defined here as affecting the species that produces it: a "collateral" effect, in contrast, has essentially no effect on the species that produces it. Primary effects involve time-dependent interaction between physical and chemical properties and the genes of the species, and are therefore subject to natural selection, acting with spontaneous pattern formation. As collateral effects affect only *other* species and their niches in one direction only, they cannot directly affect any natural selection going on in the primary species. The biota largely control the O, C, N, P, and Si cycles among others, at all scales. Other potential niche-conditioning tools of plankton organisms act at scales both < 1cm, including adhesion, microzones around cells sea-surface films, and at larger scales, including differential heating of plankton-rich thin layers, water column clearance through flocculation and settlement, changes in drag coefficients at the sea bottom and the sea surface, modulations of air-sea exchange in both calm and rough weather, patterns in global climate, ocean circulation, ocean and air chemistry, and probably modulation of teleconnection patterns. While many patterns occurring on and in biological systems (e.g. organisms, populations, the ocean) are due to purely physical and chemical processes, gene expression, through physiology, also modulates other such patterns.

Interactions among these processes, even weak, may make spatial and temporal patterns even more complex. Through *Homo sapiens*' sudden niche enlargement with its collateral effects, and probably for the first time, the natural system is acquiring self-awareness, self-management, prevision and conflict of purpose. This is diversifying the scope, magnitude, speed of change and perhaps the complexity of biogeochemical patterns and processes, perhaps preceding simplification. The effects on the plankton and their roles in the system are likewise changing and will require constant reassessment.