Container growth and replicator dynamics in pre-biotic chemistry

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At the transition from non-living to living matter, the distinction between genotype and phenotype, as well as genome replication and ontogeny, is not clearly defined. In primitive organisms, without central control of genome replication, a conflict between selfishly reproducing genes and genes useful for the replication of the whole organism occurs. This raises the question of how, and when, such systems can evolve into contemporary organisms with well-defined separation between the genotype and phenotype, and a coordinated replication.

We study the evolutionary dynamics of systems consisting of self-assembling container aggregates that contain populations of self-replicating information carrying molecules: proto-genes. The aggregates can be viewed at primitive proto-organisms. Their genome consists of an evolving population of proto-genes, which in a steady state may form a quasi-species. The aggregates themselves grow by successively incorporating new building blocks. Eventually the aggregates become unstable and spontaneously divide, whereby a replication of the proto-organism has occurred. The production of new building blocks (e.g. amphiphilic polymers) is controlled by the proto-genes (e.g. through an electron charge transfer process). A strain's ability to self-replicate and its chemical properties critical to the growth of the aggregate are assumed to be uncorrelated. Certain strains of proto-genes are efficient as self-replicators, whereas other strains are more active in the production of new building blocks, and thereby contribute to the reproduction of the container. The evolution of the system as a whole is then characterized by a conflict reminiscent of group selection. The central question is under which conditions selections favors co-existence of selfish genomes and genomes that are active in the growth of the aggregate.

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