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Genesis of ectosymbiotic features based on commensalisic syntrophy

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The symbiogenetic origin of eukaryotes with mitochondria is considered a major evolutionary transition. The initial interactions and conditions of such symbiosis, along with the phylogenetic affinity of the host, are widely debated. We focus on a possible evolutionary path toward an association of individuals of two species based on uni-directional syntrophy. With the backing of a theoretical model, a commensalistic system based on the syntrophy hypothesis is considered in the framework of coevolutionary dynamics (density-dependent dynamical system) and mutant invasion (evolutionary substitution) into a monomorphic resident system. We investigate the ecological and evolutionary stability of the consortium (or symbiotic merger), with vertical transmissions playing a crucial role. The dynamics of the population densities of the involved species are represented using a set of ordinary differential equations, and the growth rates of each species are represented using novel Malthusian functions based on a branching process. The ecological fixation of the ectocommensalistic association is modeled in terms of the local asymptotic stability (linearization) of certain fixed points corresponding to the coevolutionary dynamical system. We find that the transmission of symbionts and the additional costs incurred by the mutant determine the conditions of fixation of the consortia.