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Dynamics of evolutionary radiation under ecological neutrality

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Abstract

The most spectacular phenomenon of evolutionary biota is the explosive radiation that occurs in depauperate environments in which there are fewer competitors and predators, such as oceanic islands and crater lakes. Adaptation to divergent niches has been proposed as a major cause for this accelerated speciation. Here, we show that neutral mutation, genetic drift, and neutral community dynamics are sufficient to lead to radiation. In addition, these processes yield overshooting dynamics with a decline in species richness in the later stages of radiation. We constructed an ecologically neutral model for a community on an island with a uniform environment. For the speciation process, we introduced a null model with minimal assumptions in which the incompatibilities between alleles in different lineages evolve by a random accumulation of mutations via genetic drift. Our simulations showed that the speciation rate, extinction rate and genetic variation of the species colonizing the island rapidly increased to a sharp peak followed by a decrease that approached zero. Because the extinction rate reached a peak later than the speciation rate, the species richness initially increased, but declined in the later stage, exhibiting "overshooting." The highest species richness was found for the largest island at the largest initial population size. Accordingly, speciation is accelerated by the large population size of depauperate biota, whereas it is decelerated with increasing species richness from the decreasing population size. Explosive radiation without ecological divergence can occur in depauperate environments via neutral stochastic processes.