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The interplay between costly reproduction and unpredictable environments shapes the stability of cooperative breeding

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Abstract

All sexually reproducing organisms are faced with a fundamental decision: to invest valuable resources and energy in reproduction or in their own survival. This trade-off between reproduction and survival represents the 'cost of reproduction' and occurs across a diverse range of organisms. It is widely assumed that cooperative breeding behavior in vertebrates — when individuals care for young who are not their own — results in part from costly parental care. When caring for young is too costly, parents need help from related or unrelated individuals to successfully raise their offspring. Cooperatively breeding birds and mammals are also more commonly found in unpredictable environments than non-cooperative species, suggesting that decisions about when to breed or help may represent complex yet critical choices that depend on the energy individuals have available to dedicate to reproduction given the harshness of the current environment. Here, we introduce a novel, socially-tiered model of a cooperatively breeding species that incorporates the influence environmental stochasticity. Through numerical and analytical methods, we use this model to show that costly reproduction and environmental variability are compounding factors in the evolution and maintenance of cooperation.