Delayed costs and their effect on adaptive growth rates

Jonathan M. Yearsley[1] , Ilias Kyriazakis[2] and Iain J. Gordon[3].

It is widely recognised that growth can carry a mortality risk, and that these costs of growth can influence an animal's growth rate [3, 2, 6]. The adaptive significance of costs upon an animal's growth rate has been extensively modelled [7, 8, 9, 4, 1], but all studies have assumed that growth costs are instantaneous. In contrast, data suggest that the costs of growth need not always be instantaneous, but can act over a range of time-scales [5].

We present an adaptive growth model in which the costs of growth are delayed for period of time, with the time-delay defining the time-scale of the growth cost. The model is generally applicable to any two parameter growth curve, and is used to look at the effects of time-scale upon the adaptive growth strategy. The optimal growth rates are calculated assuming one of two possible fitness measures; the reproductive rate, R_0 and the intrinsic population growth rate r.

The effect of an increasing time-delay in the costs of growth is to weaken the strength of selection on growth rate. A second implication of a time-delay is to suggest a new explanation for the strategy of compensatory growth following a period of growth limitation. It is shown that the time taken to reach maturity is a threshold time-delay: if the costs of growth are delayed until maturity then growth compensation can be an adaptive strategy, even if the environment is unchanging. The results are dependent upon the measure fitness, indicating that the form of the population regulation plays a role in determining adaptive growth strategies.

[1]The Macaulay Institute, Craigiebuckler, Aberdeen, U.K., AB15 8QH (e-mail: J.Yearsley@macaulay.ac.uk).

[2]Animal Nutrition and Health Department, Scottish Agricultural College, West Mains Road, Edinburgh, U.K., EH9 3JG (e-mail: I.Kyriazakis@ed.sac.ac.uk).

[3]The Macaulay Institute, Craigiebuckler, Aberdeen, U.K., AB15 8QH (e-mail: I.Gordon@macaulay.ac.uk).

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