Size-dependent visual predation risk and the timing of vertical migration: An optimization model

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ABSTRACT: Diel vertical migration (DVM) by zooplankton to deep, poorly illuminated habitats during the day is thought to reduce the probability of attack by visual predators at the cost of decreased net energy gain. Herein, I develop a trade-off model used to predict the timing of vertical migration of zooplankton. The model is based on Gilliam's rule, the notion that animals will select habitats that minimize the ratio of mortality risk/energy gain, and incorporates light- and size-dependent vulnerability to visual predators. The model predicts that smaller, less vulnerable prey should ascend into food-rich surface waters earlier and descend later than larger, more conspicuous organisms over a wide range of conditions. The model has been parameterized for a population of *Euphausia pacifica* in Saanich Inlet, British Columbia, and predicts that 7-mm (larval) animals will ascend/descend ~35 min earlier/later than more conspicuous 24-mm adults. These predictions are consistent with acoustic observations of the timing of DVM in this population. The proposed mechanism for size-dependent timing of DVM is based on the potential for increased energy gain in surface waters and diel changes in vulnerability to size-selective predators. These conditions prevail in both freshwater and marine pelagic environments, and size-dependent DVM is likely to be widespread in zooplankton.