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Optimal foraging for simple organisms, the single-input marginal value theorem

Most organisms devote a great deal of time and energy to locating and consuming food, making efficient foraging crucial for their evolutionary success. Consequently, Optimal Foraging has been widely studied, but mainly in relatively complex animals with strong sensory and cognitive abilities. However, most living organisms, from bacteria to lower invertebrates, lack these abilities and still must forage efficiently. Here we extend one of the main theorems in Optimal Foraging, the Marginal Value Theorem, to organisms with minimal sensory and cognitive abilities; in particular, we consider individuals whose only sensory input is their feeding rate. To do so, we reformulate a continuous version of the Marginal Value Theorem, finding that individuals should adapt their speed to achieve a marginal feeding rate equal to the average feeding rate for the environment whenever possible, where the marginal feeding rate is defined as the feeding rate they would have if they returned to an Iready-visited location. We also find that, when faced with uncertainty, moving intermittently is more efficient than moving at constant speed, because this speed variability enables more robust estimates of the marginal feeding rate. Our results generalize Optimal Foraging Theory to organisms with strong sensory constr