Development of a Mathematical Model to Assess Territory Establishment by the Fiddler Crab, Uca lactea, Based on Tracking Walking Trajectories

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Several studies have attempted to model territory establishment by small animals. However, verification of these models is often difficult by insufficient data. The small crab, Uca lactea, was selected for this study, as the white carapace of this species contrasts clearly with the tidal wetlands it inhabits, facilitating the collection of motion analysis data used for validating the developed model. Time-series movement data captured on video camera was analyzed by genetic programming. Specifically, functions were developed to predict the direction in which the crabs would move based on the proximity of adjacent crabs. The functions revealed walking patterns common to individuals. Each function narrows down an individual's predicted position to 5.7-24% of the entire activity area to an accuracy of 70%, and showed that not only immediate neighbors, but also second and third closest individuals influenced the walking patterns of crabs. Crabs typically establish circular territories with burrows at the center. Burrows of different sized crabs that were in close proximity to each other were expected to have asymmetrical territories. However, territory size was defined by the perpendicular bisector of the line connecting the two burrows, implying that boundaries were determined based on the proximity and position of burrows relative to other burrows. This relation, which was independent of carapace width, also showed that walking activity was inversely correlated with population density. The development of more accurate functions will increase our understanding of territory establishment and the upper limits of density the carrying capacity of an environment. Furthermore, this technique could be employed to analyze territory establishment behavior for other species.

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