

Quantitative Biology > Populations and Evolution

Scale-free correlations in bird flocks

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From bird flocks to fish schools, animal groups often seem to react to environmental perturbations as if of one mind. Most studies in collective animal behaviour have aimed to understand how a globally ordered state may emerge from simple behavioural rules. Less effort has been devoted to understanding the origin of collective response, namely the way the group as a whole reacts to its environment. Yet collective response is the adaptive key to survival, especially when strong predatory pressure is present. Here we argue that collective response in animal groups is achieved through scale-free behavioural correlations. By reconstructing the three-dimensional position and velocity of individual birds in large flocks of starlings, we measured to what extent the velocity fluctuations of different birds are correlated to each other. We found that the range of such spatial correlation does not have a constant value, but it scales with the linear size of the flock. This result indicates that behavioural correlations are scale-free: the change in the behavioural state of one animal affects and is affected by that of all other animals in the group, no matter how large the group is. Scale-free correlations extend maximally the effective perception range of the individuals, thus compensating for the short-range nature of the direct inter-individual interaction and enhancing global response to perturbations. Our results suggest that flocks behave as critical systems, poised to respond maximally to environmental perturbations.

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