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Wild swarms of midges linger at the edge of an ordering phase transition

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The most notable hallmark of collective behavior in biological systems is the emergence of order: individuals synchronize their state, giving the stunning impression that the group behaves as one. Birds flocks, fish schools and mammal herds are just a few common examples of polarized animal groups. Mating swarms of mosquitoes and midges, on the other hand, do not display global order and it is therefore unclear whether swarms are a true instance of collective behavior or a mere epiphenomenon of the independent response of each insect to an environmental stimulus. The crucial task for a group, however, is not simply to achieve an ordered state, but to respond collectively to the environmental stimuli. For this to happen, correlation must be large, namely individuals must be able to influence each other's behavioral changes on a group scale. In this work, we experimentally study wild swarms of midges and find that, despite the lack of collective order, swarms display strong correlation, comparable to that found in highly ordered groups of vertebrates. Correlation is orders of magnitude larger in natural swarms than in random systems, indicating the existence of large clusters of insects responding together. We also find that the total amount of correlation, i.e. the susceptibility, increases sharply with the swarm density, a distinctive mark of an incipient ordering phase transition. Swarms, however, live at the near-critical edge of this transition, never plunging in the ordered phase, suggesting that their size and density are tuned to maximize collective response.