Size-dependent diffusion promotes the emergence of spatiotemporal patterns

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Spatiotemporal patterns, indicating the spatiotemporal variability of individual abundance, are a pronounced scenario in ecological interactions. Most of the existing models for spatiotemporal patterns treat species as homogeneous groups of individuals with average characteristics by ignoring intraspecific physiological variations at the individual level. Here we explore the impacts of size variation within species resulting from individual ontogeny, on the emergence of spatiotemporal patterns in a fully size-structured population model. We found that size dependency of animal's diffusivity greatly promotes the formation of spatiotemporal patterns, by creating regular spatiotemporal patterns out of temporal chaos. We also found that size-dependent diffusion can substitute large-amplitude base harmonics with spatiotemporal patterns with lower amplitude oscillations but with enriched harmonics. Finally, we found that the single-generation cycle is more likely to drive spatiotemporal patterns compared to predator-prey cycles, meaning that the mechanism of Hopf bifurcation might be more common than hitherto appreciated since the former cycle is more widespread than the latter in case of interacting populations. Due to the ubiquity of individual ontogeny in natural ecosystems we conclude that diffusion variability within populations is a significant driving force for the emergence of spatiotemporal patterns. Our results offer a perspective on self-organized phenomena, and pave a way to understand such phenomena in systems organized as complex ecological networks.

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