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Skin pattern formation in a hermaphrodite angelfish

March 13, 2003 - The angelfish genus *Genicanthus* is noted for the ability of females in populations lacking a dominant male to switch genders in a process known as protogynous hermaphroditism. This is a highly visible process, as Genicanthus females are relatively plain-patterned, while males (including transsexual males) are vividly striped. Since the proposal of the reaction-diffusion mechanism model of pattern formation by Alan Turing in 1952, it has been suggested that the generation of regularly spaced patterns, such as spots, stripes and networks, can be achieved through interactions between a local activator and a long-range inhibitor.

In 1995, Shigeru Kondo provided the first convincing case for the reaction-diffusion mechanism in skin patterning when he demonstrated that the Turing model sufficiently describes the stripe formation process in *Pomacanthus*, a different genus of angelfish, spurring a new wave of interest in the mathematical modeling of skin and body patterning. However, the Turing model cannot account for the directionality of stripes, which is significant in the case of *Genicanthus*. To investigate the principles underlying stripe direction, Kondo studied two closely related species, *Genicanthus watanabei* and *Genicanthus melanospilos*, which are similar in nearly all regards save the direction of the males' striping. (*G. watanabei* stripes are vertical while those of *G. melanospilos* are horizontal.) The results of this work are published in the April issue of *Developmental Dynamics*.

Kondo approached the problem from the mathematical side, searching for an adjunct to the Turing mechanism capable of explaining the difference in stripe direction. The results of extensive theoretical modeling show that unequal diffusion (anisotropy) can provide that missing factor. By factoring different anisotropic states into simulations of Turing's reaction-diffusion equation, Kondo found it is possible to generate stripe patterns arrayed in specific directions in stages that closely mirror the gradual development of stripes in both species of *Genicanthus*. In these simulations, even slight variations in anisotropy can account for marked changes in directionality. Kondo speculates that in the case of *Genicanthus*, the source of the anistropic diffusion lies in subtle differences in scale structure between the two species. These results provide new insight into a previously unexplained phenomenon in pattern formation, and may shed light on similar directional striping in the skin of other species.

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