Pattern formation on skin of tropic fishes

Hiroto Shoji[1] • Atushi Mochizuki[1] • Yoh Iwasa[1] • Shigeru Kondo[2]

1 Dept. of Biology Kyushu Univ.
2 Faculty of the Integrated Arts and Science Tokushima Univ.

The stripe patterns observed on skin of tropical fishes have been explained by applying reaction-diffusion principle. According to the principle proposed by Turing, simple dynamics include a few substances coupled by substance-diffusion can generate spatially periodic patterns. However, the basic reaction-diffusion model can't explaine the fact that most of the fish stripe are either parallel or perpendicular to the body axis, where the direction depends on the species. In this talk, we study a reaction-diffusion model including anisotropic diffusion to explain specificity of the direction of the fish stripe. On the fish skin, each scale comes out to the direction of body axis. It makes structural difference in epidermis between parallel and perpendicular direction to the body axis. The model is the following:

$$\begin{cases} \dfrac{\partial u}{\partial t} = (D_u(\theta_u)\ u) + \gamma F(u,v) \\ \dfrac{\partial v}{\partial t} = (D_v(\theta_v)\ v) + \gamma G(u,v) \end{cases}$$

$$D_\sigma(\theta_\sigma) = \frac{D_0}{\sqrt{1-\delta_\sigma \cos 2(\theta_\sigma - \varphi)}} \qquad \sigma : \text{u or v}$$

, where q_s indicate the angular difference between gradient of the variable and the x-axis, and j indicate the specific direction to which the substance diffuse faster. The parameter δ_σ indicate the degree of anisotropy.

The result depends on the ratio between anisotropy of activator and that of inhibitor. When the anisotropy of activator is larger than that of inhibitor, the direction of stripe is likely to be parallel to the direction to which the activator diffuse faster. When the anisotropy of inhibitor is larger than that of
activator, the direction of stripe is likely to be perpendicular to the direction to which the inhibitor diffuse faster. When the anisitoropies are almost same between the two substances, the specificity of the stripe direction disappear. This result does not depend either other parameter value nor the form of the reaction term. From the result, we can make hypothesis that the machanism of spatial transmission may be different between two substances in tropical fish skin.