Life Sciences

Genome Analyses Reveal the Origin of Specialized Body Plan in Flatfishes

Flatfishes have evolved one of the most specialized and unique body plans (flat and asymmetry) among the teleosts. However, the origin and the formation mechanism of the peculiar morphology of flatfishes remain unknown.

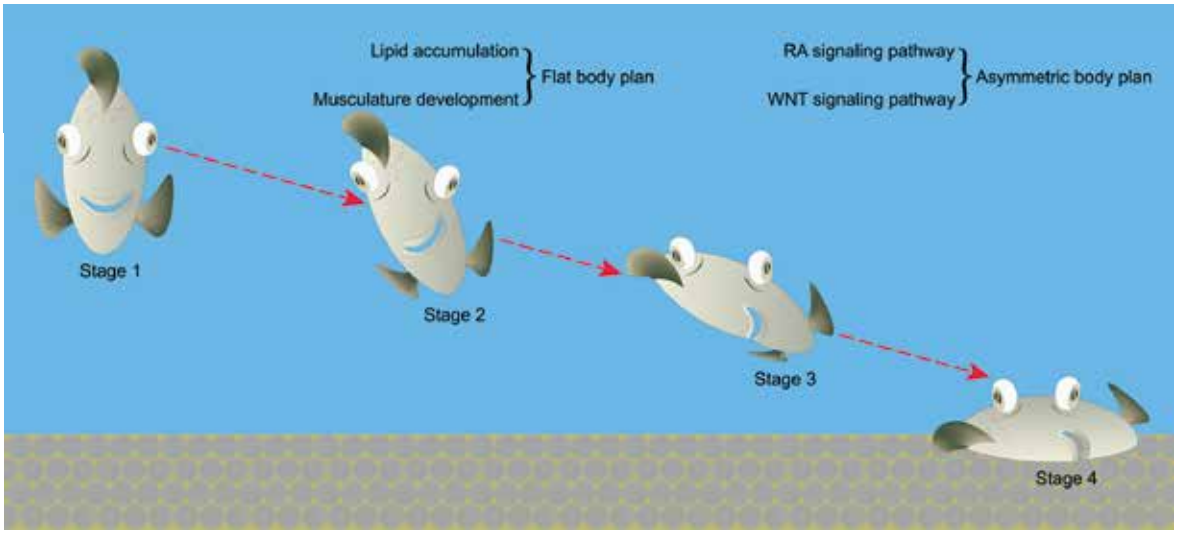
A research team consisting of scientists from Chinese Academy of Sciences (Kunming Institute of Zoology, South China Sea Institute of Oceanology, and Institute of Hydrobiology), Zhejiang Ocean University and Northwestern Polytechnical University, has unraveled the evolutionary and genetic origins of the specialized body plan of flatfish through comparative genomic analyses. The study, entitled "*Large-scale sequencing of flatfish genomes provides insights into the polyphyletic origin of their specialized body plan*," was published in *Nature Genetics* on April 19, 2021.

By combining ten *de novo*-assembled genomes with eight previously published genomes from teleost species, researchers found that Pleuronectoidei and Psettodoidei do not form a monophyletic group, indicating independent origins from different percoid ancestors.

Researchers found that several genes related to visual perception, immune response, hypoxia tolerance, and cardiac function have occurred significant alteration, possibly suggesting a similar remodeling of their visual, immune, respiratory and circulatory systems in benthic adaptation to seafloor colonization.

Genes associated with musculature development and lipid accumulation have occurred marked changes in flatfishes. Experiments on one flatfish fat-related genes found fast lipid oxidization and decreased fat accumulation in flatfish and thus may correlate with the evolutionary origin and development of their flat body plan.

Besides, the researchers found that multiple genes from WNT and RA signal pathways, which have key roles in normal body axis development, have undergone remarkable genetic alterations in flatfishes, suggesting



Flatfishes, like flounders, undergo a change of body structure to become flat and dwell on the water bottom. (Image by the courtesy of Dr. LI Yongxin)

their roles in the evolution of asymmetric body plan.

Using *Paralichthys olivaceus*, commonly known as Japanese flounder, as a representative species, researchers found that multiple genes in both RA and WNT signaling pathways exhibited obvious transient expression fluctuations during metamorphosis, with marked left–right asymmetrical expression initiating from the premetamorphic stage, climbing to an asymmetrical climax during the prometamorphic and metamorphic climax stage and then recovering to symmetry in the post metamorphic stage. These analyses provide gene evolution and expression evidence for the possible involvement of WNT combined with RA signaling pathways in shaping the asymmetric body plan in flatfishes.

The findings have substantially clarified the long-standing controversies over the phylogeny of flatfishes, while the genes highlighted in this study lay a blueprint for future functional characterization of the molecular mechanisms underlying the unusual body plan of flatfishes.

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Reference

Z. Lü, L. Gong, Y. Ren, Y. Chen, Z. Wang, L. Liu, . . . Y. Li, (2021) Large-scale sequencing of flatfish genomes provides insights into the polyphyletic origin of their specialized body plan. *Nature Genetics* 53, 742. doi: 10.1038/s41588-021-00836-9.