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Zebrafish Hox Paralogue Group 2 Genes Function Redundantly as Selector Genes to Pattern the Second Pharyngeal Arch

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Abstract

The pharyngeal arches are one of the defining features of the vertebrates, with the first arch forming the mandibles of the jaw and the second forming jaw support structures. The cartilaginous elements of each arch are formed from separate migratory neural crest cell streams, which derive from the dorsal aspect of the neural tube. The second and more posterior crest streams are characterized by specific Hox gene expression. The zebrafish has a larger overall number of Hox genes than the tetrapod vertebrates, as the result of a duplication event in its lineage. However, in both zebrafish and mouse, there are just two members of Hox paralogue group 2 (PG2): *Hoxa2* and *Hoxb2*. Here, we show that morpholino-mediated “knock-down” of both zebrafish Hox PG2 genes results in major defects in second pharyngeal arch cartilages, involving replacement of ventral elements with a mirror-image duplication of first arch structures, and accompanying changes to pharyngeal musculature. In the mouse, null mutants of *Hoxa2* have revealed that this single Hox gene is required for normal second arch patterning. By contrast, loss-of-function of either zebrafish Hox PG2 gene individually has no phenotypic consequence, showing that these two genes function redundantly to confer proper pattern to the second pharyngeal arch. We have also used *hoxb1a* mis-expression to induce localized ectopic expression of zebrafish Hox PG2 genes in the first arch; using this strategy, we find that ectopic expression of either Hox PG2 gene can confer second arch identity onto first arch structures, suggesting that the zebrafish Hox PG2 genes act as “selector genes.”

Keywords

zebrafish; Hox; hindbrain; pharyngeal arches; morpholino; knock-down; selector genes; redundancy; Meckel's cartilage

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