

TRACKING ADAPTIVE EVOLUTION IN THE STRUCTURE, FUNCTION AND MOLECULAR PHYLOGENY OF HEMOGLOBIN IN NON-ANTARCTIC NOTOTHENIOID FISH SPECIES

C Verde, D Giordano, L Grassi, E Parisi, L Bargelloni, G di Prisco

¹*Institute of Protein Biochemistry, CNR, Via Pietro Castellino 111, I-80131 Napoli, Italy,*

²*Department of Public Health, Comparative Pathology and Veterinary Hygiene, University of Padova, Viale dell'Università 16, I-35020 Padova, Italy*

In polar fish, the hemoglobin (Hb) evolution includes adaptations at the biochemical, physiological and molecular levels. The availability of phylogenetically related notothenioid taxa living at different latitudes (in the Antarctic and Sub-Antarctic regions) allows to look into the molecular bases of environmentally driven gene birth and death. Bovichtidae, Pseudaphritidae, Eleginopidae, Nototheniidae, Harpagiferidae, Artedidraconidae, Bathydraconidae and Channichthyidae are the families of the suborder Notothenioidei. Three notothenioid families, i.e. Bovichtidae (only one out of ten species is Antarctic), Pseudaphritidae and Eleginopidae, presumably diverged during the Eocene and became established in waters around areas corresponding to New Zealand, Australia and high-latitude South America before separation from the Antarctic continent. Attention was focused on the Hb system of these non-Antarctic notothenioids, namely *Pseudaphritis urvillii* (family Pseudaphritidae), *Cottoperca gobio* and *Bovichtus diacanthus* (family Bovichtidae). These fish essentially never experienced near-freezing water temperatures. Because of their geographical origin, these species are especially important for calibrating the evolution molecular clock in Antarctica.

Although *P. urvillii* has never developed cold adaptation, similar to most Antarctic notothenioids, this species has a major component Hb 1 (95% of the total), and a minor one, Hb 2 (5%). In the phylogenetic tree, the basal position of *P. urvillii* Hbs appears congruent with the postulated divergence before the appearance of AFGPs. Unlike most Antarctic notothenioids, sub-Antarctic *C. gobio* and temperate *B. diacanthus* have higher Hb multiplicity, higher globin diversity, higher oxygen affinity and higher pH regulation. It seems that this oxygen-transport system has been maintained as a response to temperature differences and fluctuations of temperate and sub-Antarctic waters, much larger than in the Antarctic. A single Hb present in lower amounts than in temperate fish can be regarded as the consequence of a less critical role of the Hbs in Antarctic notothenioids, possibly in relation to their sluggish life style, slower metabolism, as well as to the peculiarity of the cold environment (high stability and constancy of physico-chemical conditions).