j35 Emergence of the vertebrates < hox gene doubling >

> Natural selection is never aware of the long-term future. It is not aware of anything. Improvements come about not through foresight but by genes coming to outnumber their rivals in gene pools. ... There is no foresight. —Dawkins: *Unweaving the Rainbow*.[1]

Major transitions in evolution require explanation.[2] In all animals, an identifiable group of genes, called *hox genes*, organize the body during the early stages of embryonic growth into a front, a middle, and a hind region. Invertebrates have one cluster of hox genes. By comparison, almost all vertebrates have four clusters of hox genes; each on a separate chromosome. A similar multiplicity jump is found for dozens of widely varying gene groups that like hox genes play roles in development and for others that perform housekeeping functions in the cell.

In vertebrates, the number of genes is much greater than in invertebrates. For example, Linda Z. Holland and Nicholas D. Holland have studied genes that code for the myosin light chain (MLC) part of the body's muscle machinery.[3] In vertebrates, there are dozens. In amphioxus, a hemichordate, only one MLC gene is present.

A surprise is that all vertebrates regardless of type have roughly the same number of genes. Invertebrates also have a constancy as to their number of genes. Jumps to higher gene numbers occurs within the phylum Chordata.

Susumo Ohno in 1970 suggested that somewhat before 500 million years ago, vertebrates resulted from gene duplication in a hemichordate (empty-of-nerve notochord).[4] (*Note*: chromosome duplication is a frequent occurrence in nature. For example, Down's syndrome is the result of an extra copy of a particular chromosome, in that case unfortunate, in a human. Also polyploidy wherein the entire chromosome set is duplicated through mitotic or meiotic misdivisions, is not uncommon, and is so for >90% of extant angiosperms).[5] Peter Holland and Jordi Garcia-Fernàndez in 1996 added the caveat that the gene doubling gave the first vertebrate (which probably resembled amphioxus) a double set of chromosomes. In descendants, the first set of genes went on performing its original role.[6] The duplicate set, however, was co-opted to perform new functions. This mechanism for making new genes, was first conjectured by Calvin Blackman Bridges (1889-1938) in 1918.[7] Possibly, a second genetic doubling was needed to give rise to vertebrates with jaws (***Figure j35.1***). In 1983, Carl Gans and R. Glenn Northcutt pointed out that the essential difference between the invertebrates and vertebrates is the evolution of "a new head," with features, lacking even in amphioxus, such as paired sensory organs and a complex, three-part, brain.[8] For example, the conodont animal was finally established to be a vertebrate when its distinctive eye muscles (which never occur in the invertebrates) were found in one fossil that was described in 1995.

There is also the question as to when consciousness arose. For this there is no answer. Indeed, and moreover, "nobody," to quote Jerry Fodor, "has the slightest idea how anything material could be conscious."[9] A noire thought, in *Exploring Consciousness/Unconsciousness*, 2002, by Rita Carter, is that consciousness is an epiphenomenon without any survival value.[10] ❑

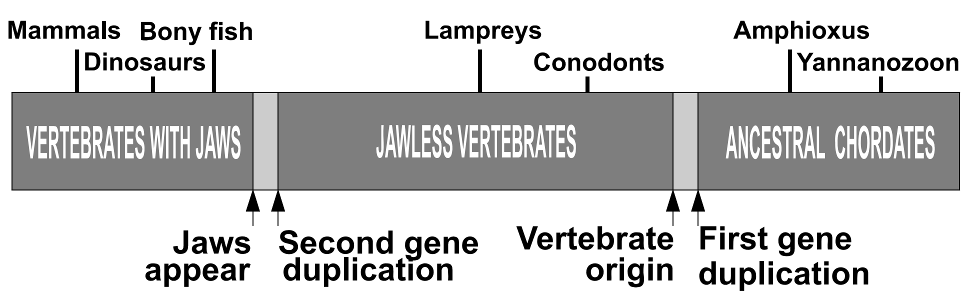

Figure [11] ***j35.1***

Possible stages in the emergence of vertebrates from spineless ancestors.