EARLY METAZOAN EVOLUTION AND THE CONCEPT OF PROGRESS

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The number of cell types present in a metazoan body is a reasonable metric of its complexity. If evolutionary progress is defined as increase in complexity, from "lower" to "higher" forms, then progress occurs as cell-type numbers are increased. Using a lumper's definition of cell type, living metazoans range from 4 (placozoans) to over 210 (higher mammals) somatic cell types. The earliest fossil traces may be 580 my old and require an organism of about 30 cell types, while the primitive members of higher invertebrate phyla, appearing near 525 my ago, require about 50 cell types, an increase of about 0.3 cell type/my. Average Phanerozoic cell-type increase was about 0.4 cell type/my. These estimates are indistinguishable considering their crudity, and imply an origin of metazoans between about 645 and 680 my ago. While it may have been episodic rather than gradual, evolutionary progress would seem to have continued throughout metazoan history.

The Cambrian "explosion" occurred chiefly among organisms of 50 or so cell types, but so far as one can judge represented no major leap in the complexity of body plans. Rather it was characterized by a radiation of a number of clades that were at about this same level of complexity, one that permitted the construction of a rich variety of body plans, within a few million years. The diversity of the daughter body types was thus spectacularly broad. Though it may have been only a locus on a sweeping trend of continuing progress, the Cambrian explosion was something special in the history of life.

Concomitant with the rise in cell type numbers during the late Precambrian, the genetic regulatory apparatus that characterizes most metazoans was assembled, involving a cascading, hierarchical system of genes with feedback mechanisms and with informational systems that are not directly encoded. This flexible and open-ended regulatory architecture underlies evolutionary progress in metazoans, and permitted the evolution of cell differentiation. It may prove possible to judge the steps in the assembly of this regulatory system from the early metazoan record of body types, and conversely, it may prove possible to reconstruct the pattern of divergence of clades and the rise of body types as comparative data on pattern-formation systems become available for a variety of major taxa.