

EVOLUTIONARY NOVELTIES: INTERACTIONS BETWEEN GENETICS, DEVELOPMENT AND SELECTION

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INTRODUCTION: Body plans are remarkably well conserved, but on (very) rare occasions important novelties evolve. Such novelties involve changes at the genotypic and phenotypic level affecting both developmental and adult traits. At all levels duplications play an important role in the evolution of novelties. Mutations for duplications, including mutations for duplications of body parts, as well as mutations for other body plan changes, in particular homeotic ones, occur surprisingly frequently. Hence mutation limitation is relatively unimportant for the conservation of body plans. However, mutations for duplications of body parts and homeotic changes rarely persist in populations.

RESULTS & DISCUSSION: We argue that the root cause of the conservation of body plans is the strong interactivity during the patterning of the embryonic axes, including the interactivity between patterning and proliferation processes. Due to this interactivity, mutations cause many negative pleiotropic effects (malformations and cancers) that dramatically lower fitness^{1,2}. As an example we have shown in humans extreme selection against negative pleiotropic effects of the, surprisingly frequent, mutations affecting the number of cervical vertebrae (Fig. 1). Moreover, we argue for the relevance of relaxed selection, which temporarily allows just arisen novelties to persist, for the effective breaking of pleiotropic constraints. We illustrate this with two empirical examples, domesticated dogs and extinct *Semionotus* fishes that invaded newly formed rift lakes in North Eastern America in the late Triassic and early Jurassic and that radiated into a species clade³.

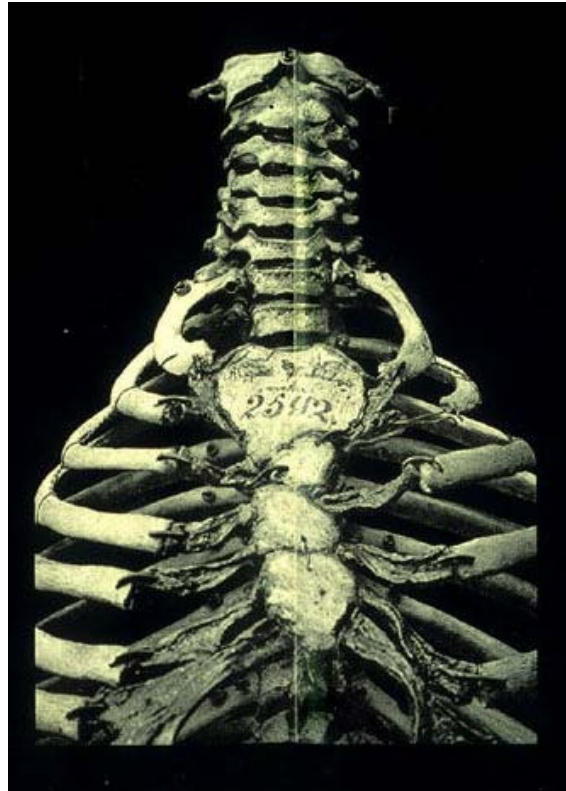


Figure 1. Adult human skeleton with a complete cervical rib, i.e. a rib on the seventh cervical vertebra. This change represents both the duplication of a structure, i.e. a rib, and a homeotic change, the change of identity of the seventh vertebra into that of a thoracic vertebra. Reproduced from ref. 3.

REFERENCES: ¹ F. Galis, T.J.M. van Dooren, H. Feuth, S. Ruinard, A. Witkam, M.J. Steigenga, J.A.J. Metz and L.C.D. Wijnaendts (2006) *Evolution* **60**: 2643-2654. ² F. Galis and JAJ Metz (2001) *J exp Zool B (Mol Dev Evol)* **291**: 195-204. ³ A. Fishel (1906) *Anatomische Hefte* **31**:462-588. ⁴ A.R. McCune (1990) *Evolution* **44**:71-85.