Integrating proximate/ultimate causation

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Abstract

Ever since Mayr's formulation in 1961, the distinction between proximate and ultimate causation has had a great influence on the practice and interpretation of evolutionary biology, suggesting an incommensurable "division of labor" within biological sciences. Although such a complete division has been challenged by recent works in Evo-Devo that aim to integrate developmental and evolutionary processes, no similar attempts have been made in evolutionary genetics – the stronghold of ultimate causation – whose basic framework dates back to the modern synthesis.

In this talk, I set forth a theoretical framework that incorporates proximate or developmental causal relationships into a mathematical model of evolution. The new framework not only shows how selective pressures (i.e. "ultimate causes" of evolution) propagate through "proximate" causal relationships among phenotypes, but also enables us to predict their short-term evolutionary consequences. Furthermore, it is shown that models that fail to address such phenotypic networks may result in an incorrect or misleading picture of selection and evolution.

There are several conceptual consequences of this proposed theoretical framework. First, it highlights the possibility or even necessity of integrating proximate causation into the study of ultimate/evolutionary causes. Second, it offers a novel perspective on evolution where selection acts on a whole network of phenotype-genotype mapping, rather than on just one level such as genes (as in population genetics) or phenotype (as in quantitative genetics). Implications for other philosophical issues such as units of selection will also be discussed if time allows.

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