Life, the universe and everything

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Life's Solution: Inevitable Humans in a Lonely Universe
by Simon Conway Morris
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Life's Solution: Inevitable Humans in a Lonely Universe is a successful response to Stephen Jay Gould's arguments about contingency (irreproducibility) in evolution, even Gould's most ardent supporters will enjoy the book for its wide-ranging summary of so many aspects of science—from the origin of solar systems to intelligence. The book covers both the principles and the details, all meticulously referenced.

The theme is twofold. The first is that, because of the universality of physical laws, there may be only a limited number of ways to solve a particular problem (such as vision). Thus, if many different animals evolve eyes, then we expect the same form of eye to arise more than once—even though details differ. The author's starting position is the mainstream evolutionary one that basic physical principles are major evolutionary constraints. But if we were able to observe evolution rerun again, either on another planet or from some earlier point in our Earth's history, we could expect the same general features to recur. We have to be careful here. It is the principles that are important, not the details

(such as humans having precisely 32 teeth, and whether we have alanine at position 13 in α -haemoglobin).

The central part of the book demonstrates the theme with examples of many convergences: compound eyes, camera-eyes, colour vision, sabre-teeth, eusociality, agriculture (including insects farming fungi!), plant adaptation to desert conditions, long-distance migration, pathogenic chemicals and toxins, bipedalism, rumen digestion, vivipary, echo-location, mimicry, electric fish, endothermy, tool use, oral communication, and so on. Convergence is the norm at this level. "The evolutionary routes are many, but the destinations are limited," is the author's conclusion.

Although discussions at the organismal level comprise the central part of the book, it extends in both directions. The very early chapters discuss the features required for planets to have the conditions to support the origin of life through "fairly ordinary chemical reactions", plus the long-term stability of orbit over billions of years that allows long-term evolution. For example, a significantly larger planet would have much higher gravity and higher erosional forces, which would probably result in all land being covered by sea—not a good scenario for the control of fire and developing metallurgy. There is extended coverage of both topics, modelling the origin of planetary systems and the origin of life.

This all leads up to whether the origin of intelligence is inevitable given multicellular animals existing over, say, a billion years. Perhaps a brain is inevitable to integrate sensory perception and allow the animal to respond. It is not much use having an eye, or another receptor, if the animal cannot use the information. But similarly, brain size has increased in many lineages—indeed, until 1.5 million years ago, dolphins had the largest 'encephalization coefficient' (ratio of brain weight to body weight) on the planet.

Despite my thorough enjoyment of the book, I had two significant problems (one negative and one positive). The first is the embarrassing chapter at the end of the book on "the theology of evolution" with a bit of a diatribe against "ultraDarwinism" (an undefined word of course). What is required here

is a proper analysis of the evolution of religion; how many ways are there to get intelligent beings with an individualistic inheritance system to act as a self-integrating social unit? Is it possible that, in the spirit of the book, it is almost inevitable that some form of belief system will evolve that unifies larger and larger groups so that they act cooperatively? There certainly could be strong selection for such a belief system. Regardless of the details, perhaps the author should follow his own advice here and take off his own dark glasses and see what Darwin called (at the very end of *The Origin of Species*) the "grandeur" of his view of life.

The other problem is much more positive. We need a (mathematical?) formalization of the overview presented in this book. Some of the major transitions in evolution are considered both unlikely but inevitable (given large numbers, long timescales and the right circumstances). It is too simple to use the unthinking approach of some statisticians and just say that the law of large numbers, combined with a very long timescale, virtually guarantees even very unlikely events. Rather, we need a more process-oriented understanding of the problem. A landscape analysis is a possibility: there might be many separate ways of solving a particular biological problem, but only one or two may allow the opportunity of leading to a subsequent breakthrough. There is one hint of this approach in the book. An alternative might be the concept of strange-attractors and chaos theory—again there is one hint in the book. This is really more of a compliment that the book has achieved its major aim so well that we now need a more formal framework for analysing the underlying processes.

In summary, the book is both interesting and highly informative, and establishes a good case for both the limited number of solutions to many biological problems and the fact that each one can be very hard to find. A masterpiece.

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