Lecture 18
Darwin on the History of Life

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Introduction (290)

Let us now see whether the several facts and laws relating to the geological succession of organic beings accord best with the common view of the immutability of species, or with that of their slow and gradual modification, through variation and natural selection.

We'll look at a selection of the facts discussed by Darwin.

New species have appeared continuously

Evidence (290)

New species have appeared very slowly, one after another, both on the land and in the waters. Lyell has shown that it is hardly possible to resist the evidence on this head in the case of the several tertiary stages; and every year tends to fill up the blanks between the stages, and to make the proportion between the lost and existing forms more gradual. In some of the most recent beds, though undoubtedly of high antiquity if measured by years, only one or two species are extinct, and only one or two are new, having appeared there for the first time, either locally, or, as far as we know, on the face of the earth. The secondary formations are more broken; but, as Bronn has remarked, neither the appearance nor disappearance of the many species embedded in each formation has been simultaneous.

Application of the law of likelihood

Let A = new species have appeared continuously, N = species arose by natural selection, C = species were created independently.

- A is expected given N, since N says new species are produced slowly as small modifications accumulate.
- A isn't expected given C, since C allows that all species could have been created in a short period of time.
- So, $p(A|N) > p(A|C)$.
- So, by the law of likelihood, A favors N over C.

Species have become extinct continuously

Evidence

- It has been estimated that 99.9% of species that have existed on earth are now extinct. This extinction has occurred continuously.
- *The old notion of all the inhabitants of the earth having been swept away by catastrophes at successive periods is very generally given up, even by those geologists . . . whose general views would naturally lead them to this conclusion. On the contrary, we have every reason to believe, from the study of the tertiary formations, that species and groups of species gradually disappear, one after another, first from one spot, then from another, and finally from the world.* (293–94)

Application of the law of likelihood

Let E = species have become extinct continuously.

- E is expected given N.

  > *The theory of natural selection is grounded on the belief that each new variety, and ultimately each new species, is produced and maintained by having some advantage over those with which it comes into competition; and the consequent extinction of the less-favoured forms almost inevitably follows.*
  > *(295–96)*

- E isn't expected given C, since each species could be created to fill an unoccupied ecological niche and need not drive other species into extinction.
- So, $p(E|N) > p(E|C)$.
- So, by the law of likelihood, E favors N over C.

Intermediate periods have intermediate species

Evidence (305)

The fauna of each geological period undoubtedly is intermediate in character, between the preceding and succeeding faunas. I need give only one instance, namely, the manner in which the fossils of the Devonian system, when this system was first discovered, were at once recognised by palæontologists as intermediate in character between those of the overlying carboniferous, and underlying Silurian systems.

Application of the law of likelihood

Let I = intermediate periods have intermediate species.

- I is expected given N.

  > *The species which lived at [any one] stage of descent . . . are the modified offspring of those which lived at the [preceding] stage, and are the parents of those which became still more modified at the [following] stage; hence they could hardly fail to be nearly intermediate in character between the forms of life above and below.* *(305)*

- I isn't expected given C, since species that were created independently at one time need not be intermediate between those created earlier and those created later.
- So, $p(I|N) > p(I|C)$.
- So, by the law of likelihood, I favors N over C.

Objection of missing links

The objection

- *By the theory of natural selection all living species have been connected with the parent-species of each genus, by differences not greater than we see between the natural and domestic varieties of the same species at the present day; and these parent-species, now generally extinct, have in their turn been similarly connected with more ancient forms . . . So that the number of intermediate and transitional links, between all living and extinct species, must have been inconceivably great. But assuredly, if this theory be true, such have lived upon the earth.* (266)
- *Why then is not every geological formation and every stratum full of such intermediate links? Geology assuredly does not reveal any such finely-graduated organic chain; and this, perhaps, is the most obvious and serious objection which can be urged against the theory.* (264–65)

Darwin's answer, part 1

- Formations (groups of rock strata with similar properties) are separated from each other by large time intervals. Strata within a formation are also often separated by large time intervals. Hence fossils don't give a continuous record of species at a site.
- *The frequent and great changes in the mineralogical composition of consecutive formations, generally implying great changes in the geography of the surrounding lands, whence the sediment was derived, accord with the belief of vast intervals of time having elapsed between each formation.* (272)
- *Many cases could be given of the lower beds of a formation having been upraised, denuded, submerged, and then re-covered by the upper beds of the same formation,—facts, showing what wide, yet easily overlooked, intervals have occurred in its accumulation.* (277)

Darwin's answer, part 2

- New varieties of a species usually develop in a small locality and then spread after they have a significant advantage over the unmodified form. Hence the fossils at other locations won't show the intermediate forms.
- *Most animals and plants keep to their proper homes, and do not needlessly wander about; we see this even with migratory birds, which almost always return to the same spot. Consequently each newly-formed variety would generally be at first local.* (72–73)

Conclusion of Darwin's answer

We have no right to expect to find, in our geological formations, an infinite number of those fine transitional forms which, on our theory, have connected all the past and present species of the same group into one long and branching chain of life. We ought only to look for a few links, and such assuredly we do find. (282)

Application of the law of likelihood

Let M = there are "missing links" (i.e., the fossil record doesn't show all the intermediate forms that must have existed according to N).

- The objection says M is expected given C but not given N.
- Darwin's reply says M is expected given N as well as given C.
- Suppose that $p(M|N) = p(M|C)$. Then, by the law of likelihood, M doesn't favor either theory over the other.

Questions

1. State a fact about how new species have appeared that Darwin cited as supporting his theory. Does this favor natural selection over independent creation as the origin of species? Justify your answer using the law of likelihood.
2. State a fact about the extinction of species that Darwin cited as supporting his theory. Does this favor natural selection over independent creation as the origin of species? Justify your answer using the law of likelihood.
3. State a fact about the relation between species at different times that Darwin cited as supporting his theory. Does this favor natural selection over independent creation as the origin of species? Justify your answer using the law of likelihood.
4. What did Darwin regard as perhaps "the most obvious and serious objection" against his theory? What was his answer to this objection?

Reference


Charles Darwin.
On the Origin of Species.
London, 6th edition, 1872.
At darwin-online
Numbers in parentheses are page numbers of this edition.