Philosophy of Science // Fall 2015

Handout 20

Evolution: Sober

Definition of evolution. Sober begins with the question of the subject of the evolutionary theory. Some have proposed to define it as a 'change in gene frequency'. There are several objections to this idea. (1) There can be a change in genotype frequencies without a change in gene frequency. This happens in the case of non-random mating. Suppose before mating there were 400 individuals with 100 *AA*, 200 *Aa*, and 100 *aa* genotypes. The relevant frequencies are 1/4, 1/2, 1/4. The frequencies of both *A* and *a* are 1/2. A simple application of the Hardy-Weinberg principle shows that a non-random (assortative) mating would produce a change in those frequencies: 3/8, 1/4, 3/8 respectively. But the gene frequencies have not changed, remaining 1/2. However, it is not credible to deny that this process is not evolutionary. (2) There are elements outside the chromosomes that can influence inheritance. These hereditary features can affect phenotype. Consequently, it should be plausible to label these changes too as evolutionary. (3) A change in the number of organisms in the given species does not necessarily entail a change in gene frequencies. But such a change may still be evolutionary. (4) Finally, evolution was in play already before the emergence of the first genes.

The place of evolution in biology. Here we have to note that the evolutionary theory deals with (the already familiar) ultimate explanations. In explaining the behaviour of the given organism it looks into the distant past for identifying relevant causes. It is not interested in the mechanisms responsible for producing such behaviour. It rather asks why these, and not other, mechanisms emerged in the first place.

Elements of Darwinism. Many of the points made here are familiar from Kitcher's discussion. Darwin's theory rests on two major claims, the tree of life and natural selection. The tree of life claim consists in the speculation that many present species share common ancestors. This idea entails evolution, a change from one species to another. Moreover, in contrast to Lamarck, there is a single tree of life.

The claim of natural selection can be split into three components. (1) There is phenotypic variation among organisms. (2) There is fitness variation among organisms presumably caused proximally by phenotypic variation. Some are better adapted in terms of survival and reproduction than the other. (3) Phenotypic traits are inherited. Heritability must be understood probabilistically. On average, parents with a certain trait pass it down to their offspring.

The tree of life contains two kinds of events, macroevolution and microevolution. The latter is relatively clear. There is a random emergence of an organism with a novel trait. Then there is a mating and inheritance of that trait. Macroevolution is much more controversial. Here we entertain the possibility that a new species can emerge from a another species. That is a major change. In explaining that kind of change, Darwin repeatedly insisted on graduality. Minute variations accumulate in time to result at the end in big variations. This is anagenesis. Then there is cladogenesis. Migration and environmental pressures can lead to a branching split of the given species. Interestingly, Darwin himself insisted on a single evolutionary mechanism in play in causing microevolution and macroevolution. He did that without much empirical data to support it. Current evidence seems to corroborate his speculation.

Evolutionary causes. Some of the causes we have already mentioned in passing. *Natural selection* ('survival of the fittest') is obviously one of them. *Migration* causes inflow and outflow of genetic material into and from the given population. Here we have a cause that is not all biological in nature. *Mutation* and *recombination* are two other causes. Special note should be taken of the *random genetic drift* (see illustration on the board). This phenomenon occurs due essentially to sampling error in a finite population. Consequently, it is felt much more strongly in relatively small isolated populations.

Biology and physics. Every biological phenomenon is obviously also a physical phenomenon. Organisms and their genetic material consist of the molecules and atoms that obey the laws of physics. Nevertheless there is preciously little to say about the links between biology and physics. Even if a reduction were possible in principle, its possibility is in no way (so it seems) helpful for the actual biological research.

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