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CETERIS PARIBUS – AN INADEQUATE REPRESENTATION FOR BIOLOGICAL CONTINGENCY

ABSTRACT. It has been claimed that *ceteris paribus* laws, rather than strict laws are the proper aim of the special sciences. This is so because the causal regularities found in these domains are exception-ridden, being contingent on the presence of the appropriate conditions and the absence of interfering factors. I argue that the *ceteris paribus* strategy obscures rather than illuminates the important similarities and differences between representations of causal regularities in the exact and inexact sciences. In particular, a detailed account of the types and degrees of contingency found in the domain of biology permits a more adequate understanding of the relations among the sciences.

1. *CETERIS PARIBUS* LAWS AND BIOLOGICAL CONTINGENCY

Biological systems are evolved, multi-component, multi-level complex systems. Their features are, in large part, historically contingent. Their behavior is the result of the interaction of many component parts that populate various levels of organization from gene to cell to organ to organism to social group. It is my view that the complexity of the systems studied by biology and other sciences has implications for the pursuit and representation of scientific knowledge about such systems. I will argue that a proper understanding of the regularities in biological systems should influence our philosophical views on the nature of causal laws and, in particular, the role of *ceteris paribus* qualifications.

A well-known problem for the special sciences, and biology in particular, is the failure of generalizations about evolved, complex systems to meet what have been identified as the defining characteristics of scientific laws. This is alleged to be a serious problem because of the special role that laws play in science. They are what science supposedly seeks to discover. They are supposed to be the codifications of knowledge about the world that enable us to explain why what happens, happens, to predict what will happen in the future or in other circumstances and provide us the tools to intervene in the world in order to reach our pragmatic goals. As such, they have been taken to be the gold standard of modern scientific practice. Philosophers have analyzed and re-analyzed the concept of a scientific

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law or a law of nature in the hopes of specifying a set of necessary and sufficient conditions that postulations of laws have to meet in order to be the "real thing" and hence be able to perform the functions of explanation, prediction, and intervention. The "received view" of what conditions are required of a law include:

1. logical contingency (having empirical content)
2. universality (covering all space and time)
3. truth (being exceptionless)
4. natural necessity (not being accidental)

Some hold that laws are not just records of what happens in the universe but are stronger claims about what must happen, albeit not logically, but physically in our world and hence have the power to dictate what will happen or what would have happened in circumstances which we have not in fact encountered. Thus laws are said to support counterfactuals. It is not clear that anything that has been discovered in science meets the strictest requirements for being a law. However, if true, presumably Newton's Laws of Motion, or The Laws of Thermodynamics, or the Law of the Conservation of Mass/Energy, would count. The closest candidates for being a law and test cases for a philosophical account of scientific law live most commonly and comfortably in the realm of physics. Many philosophers have pointed out the fact that few regularities in biology seem to meet the criteria for lawfulness enjoyed by the laws of physics.

How are we to think about the knowledge we have of biological systems that fail to be characterized in terms of universal, exceptionless, necessary truths? Their inferior status is sometimes blamed on the contingency of biological causal structures. The ways in which biological systems are organized has changed over time, they have evolved. Their causal structures thus not only could have been different but in fact were different in diverse periods in the evolution of life on the planet and in distinct regions of the earth and most likely will be different in the future. Thus exceptionless universality seems to be unattainable. The traditional account of scientific laws is out of reach for biology. Should we conclude that biology is lawless?

If so, how can we make sense of the fact that the patterns of behavior we see in a social insect colony or the patterns of genetic frequencies we see over time in a population subject to selection are caused, are predictable, are explainable, and can be used to reliably manipulate biological systems? The short answer is that biology has causal knowledge that performs the same epistemological and pragmatic tasks as strict laws without being universal, exceptionless truths, even though biological knowledge consists of contingent, domain restricted truths. This alone raises the question of whether laws in the traditional sense should be taken as the gold standard against which to assess the success or failure of our attainment of scientific knowledge.

But perhaps we should not be too quick to abandon the standard. There is, after all, a well-worn strategy for converting domain restricted, exception ridden claims into universal truths and that is by means of the addition of a *ceteris paribus* clause. Take the causal dependency described by Mendel's law of segregation. That law says; in all sexually reproducing organisms, during gamete formation each member of an allelic pair separates from the other member to form the genetic constitution of an individual gamete. So, there is a 50:50 ratio of alleles in the mass of the gametes. In fact, Mendel's law does not hold universally. We know two unruly facts about this causal structure. First, this rule applied only after the evolution of sexually reproducing organisms, an evolutionary event that, in some sense, need not have occurred. Second, some sexually reproducing organisms don't follow the rule because they experience meiotic drive, whereby gamete production is skewed to generate more of one allele of the pair during meiotic division. Does this mean than Mendel's law of segregation is not a "law"? We can say that, *ceteris paribus*, Mendel's law holds. We can begin to spell out the *ceteris paribus* clause: provided that a system of sexual reproduction obtains, and meiotic drive does not occur, and other factors don't disrupt the mechanisms whereby gametes are produced, then gamete production will be fifty-fifty. Finer specifications about possible interference, *especially when they are not yet* identified, get lumped into a single phrase – "*ceteris paribus*" – when all else is equal, or provided nothing interferes. This logical maneuver can transform the strictly false universal claim of Mendel's law into a universally true, *ceteris paribus* law. With the *ceteris paribus* clause tacked on, even biological generalizations have the logical appearance of laws.

But, the cost of the *ceteris paribus* clause is high. First, although making a generalization universally true in this way can always be done, it is at the risk of vacuity. Woodward (this volume) makes this argument clearly and rejects *ceteris paribus* laws entirely, advocating instead a revision of our account of explanation that does not require universality. Others, like Pietroski and Rey (1995) have suggested that there are ways to fill out the *ceteris paribus* clause to make it contentful. However, the ability to fully fill in the conditions that could possibly interfere may well be an impossible task. Indeed, in evolutionary systems new structures accompanied by new rules may appear in the future, and hence we could never fully specify the content of potential interfering factors. Still others, Lange (2000, this volume) have argued that vagueness is not equivalent to vacuity.

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