JIM WOODWARD

THERE IS NO SUCH THING AS A *CETERIS PARIBUS* LAW

ABSTRACT. In this paper I criticize the commonly accepted idea that the generalizations of the special sciences should be construed as *ceteris paribus* laws. This idea rests on mistaken assumptions about the role of laws in explanation and their relation to causal claims. Moreover, the major proposals in the literature for the analysis of *ceteris paribus* laws are, on their own terms, complete failures. I sketch a more adequate alternative account of the content of causal generalizations in the special sciences which I argue should replace the *ceteris paribus* conception.

1.

The so-called problem of *ceteris paribus* (hereafter cp) laws is one of those cases – unfortunately common in philosophy – in which interesting and important issues have become enmeshed in a framework that interferes with their constructive exploration. As I understand it, the dialectic surrounding the problem of cp laws goes something like this: Many philosophers hold the following set of beliefs. (1) A genuine science must contain "laws". (2) Whatever else a law is, it must at least describe an exceptionless regularity. In particular all laws have the "All As are Bs" form of (U) universally quantified conditionals in which the condition in the antecedent of the law is "nomically sufficient" for the condition in its consequent. (3) Laws are required for successful explanation and to ground or support causal claims. Even if the DN model of explanation didn't quite get the details right, explanation is at bottom a matter of providing nomically sufficient conditions for an explanandum and this requires generalizations that are laws. (4) Putting aside generalizations that are explicitly probabilistic in form, if a generalization is to be testable at all (if it is to have empirical content rather than being vacuous), it must take the form (U). If it does not, we cannot use the generalization to make determinate predictions.

These views raise an immediate problem when we confront them with the generalizations of the special sciences, few of which seem to be exceptionless or of form (U). One possible response is that this shows that the special sciences are not really sciences and that they largely employ generalizations that cannot figure in explanations and are untestable. Most

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philosophers have been unwilling to accept this response. Instead, the most common strategy has been to continue to accept beliefs (1)–(4), but to search for a way of construing the generalizations of the special sciences as "laws", despite appearances to the contrary. It is this strategy which motivates the *ceteris paribus* laws literature. The idea is that the generalizations of the special sciences, despite failing to state (at least explicitly) nomically sufficient conditions for outcomes, nonetheless (at least sometimes or if appropriate conditions are met) can be regarded as a special kind of law – a *ceteris paribus* law. Because they are laws, cp laws can figure in explanations and are testable. Thus the scientific status of the special sciences is vindicated. The project for enthusiasts for cp laws thus becomes one of specifying the conditions under which a cp law is, in the language of Earman and Roberts (1999), "scientifically legitimate" (true, non-vacuous, testable, supported by evidence, capable of figuring in explanations etc.)

On my view, this entire enterprise is misguided. First, and most fundamentally, each of the motivating assumptions (1)–(4) is wrong-headed. It is false that to qualify as genuine science a discipline must contain laws. Among other things, the notion of a law of nature is not sufficiently clear and the borderline between law and non-law too hazy for it to play this sort of demarcative role.[1] It is also false that successful explanation requires laws and false that the provision of a nomically sufficient condition for an explanandum is either necessary or sufficient for explaining it. Finally, the argument about testing sketched under (4) above is misguided for many reasons, the most immediately relevant of which is that relies on an overly restricted view of what can be predicted from a generalization. Because assumptions (1)–(4) are misguided, there is, as far as I can see, no motivation for the whole cp laws enterprise, understood as the project of construing the generalizations of the special science as laws of a special sort and then searching for general conditions for them to be legitimate.

Nor is this the only problem with the cp laws literature. A second fundamental difficulty – one that ought to carry weight even with those who do not share my conviction that the motivational assumptions that guide the enterprise are mistaken – is that the major proposals in the literature for the analysis of cp laws are, on their own terms, complete failures. Moreover, the pattern of failures makes it hard to believe that the analyses are fundamentally on the right track, correctly capturing core cases, but breaking down when applied to devious, unusual counterexamples. Instead, the analyses fail quite systematically – they don't return the right answers even in core cases. I believe that this systematic pattern of failure derives from the falsity of the motivational assumptions that guide the cp project.

There are other reasons as well to be skeptical of the notion of a cp law. Although many philosophers seem to be under the impression that generalizations that explicitly incorporate "*ceteris paribus*" clauses or other qualifying expressions of similar indeterminacy but different meaning ("if no interfering or disturbing factors are present" etc.) are common in the special sciences, it seems to me that this is simply not the case. To the best of my knowledge the only discipline in which the "*ceteris paribus*" locution itself is explicitly used with any frequency is economics, where it has a very specific meaning that does not readily generalize to other contexts. The idea that the generalizations of the special sciences should be regarded as incorporating *ceteris paribus* or other qualifying clauses is a philosopher's gloss on how these generalizations should be understood, and not an idea that draws any support from the way in which those generalizations are actually formulated by the researchers who use them. One consequence is that it is often unclear what in the special sciences corresponds to the notion that is supposedly reconstructed in the cp laws literature. This makes it hard to judge the adequacy of those reconstructions.

A closely related point concerns the great diversity and heterogeneity of the generalizations that philosophers propose to analyze in terms of the category of *ceteris paribus* laws. Some of these, like the generalization (E) considered below, which tells us about the effect of certain chemotherapy drugs on tumor remission, explicitly use words like "cause" and tell us about an effect produced by some causal factor, but do not have the form of deterministic generalizations, it being understood instead that the cause will produce the effect only when certain other circumstances, not specified in the generalization, are present. Other generalizations that are taken by philosophers to have an implicit *ceteris paribus* clause attached to them are most naturally understood, not as claims about the overall or net effect that will occur when other conditions are present, but rather as generalizations about some component or feature of the effect that is attributable to the operation of specified set of causal factors, when these are taken by themselves or are conceived as operating in isolation. For example, the gravitational inverse square law (which on my view should be understood as describing the gravitational component of the total force experienced by a mass) is sometimes claimed to be implicitly qualified by a *ceteris paribus* clause (referring to the absence of non-gravitational forces) since (it is argued) it is incorrect when non-gravitational forces are present (Cartwright, 1983; Hausman, 1992).[2] Still others, like the ideal gas law PV=nRT, are (I would argue) causal in character, but unlike (E) have the form of deterministic generalizations, even though it is common knowledge that they break down or have exceptions in various circum-

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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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CETERIS PARIBUS LAWS: CLASSIFICATION AND DECONSTRUCTION

ABSTRACT. It has not been sufficiently considered in philosophical discussions of ceteris paribus (CP) laws that distinct kinds of CP-laws exist in science with rather different meanings. I distinguish between (1.) *comparative* CP-laws and (2.) *exclusive* CP-laws. There exist also *mixed* CP-laws, which contain a comparative and an exclusive CP-clause. Exclusive CP-laws may be either (2.1) *definite*, (2.2) *indefinite* or (2.3) *normic*. While CP-laws of kind (2.1) and (2.2) exhibit deductivistic behaviour, CP-laws of kind (2.3) require a probabilistic or non-monotonic reconstruction. CP-laws of kind (1) may be both deductivistic or probabilistic. All these kinds of CP-laws have empirical content by which they are testable, *except* CP-laws of kind (2.2) which are almost vacuous. Typically, CP-laws of kind (1) express invariant correlations, CP-laws of kind (2.1) express closed system laws of physical sciences, and CP-laws of kind (2.3) express normic laws of non-physical sciences based on evolution-theoretic stability properties.

1. INTRODUCTION: COMPARATIVE VERSUS EXCLUSIVE CETERIS PARIBUS LAWS

Philosophers of the last decades have repeatedly pointed out that most law statements, especially those in the non-physical sciences, do not express strict (i.e., universal and exceptionless) laws. Rather, they express so-called ceteris paribus laws, in short CP-laws.[1] The scientific 'dignity' of CP-laws, however, is a controversial matter.[2] In this paper I will try to show that "ceteris paribus" is a deeply *ambiguous* notion. It is better to differentiate the possible meanings before starting the attempt of explication. First of all, one should distinguish between two (families of) conceptions of CP-law: comparative versus exclusive.

The comparative sense of CP-clauses derives from the literal meaning of "ceteris paribus" as "the others being equal". A *comparative CP-law* makes an assertion about *functional* properties, henceforth called parameters.[3] It claims that the increase (or decrease) of one parameter, say f(x), leads to an increase (or decrease) of another parameter, say g(x), *provided* that all other (unknown) parameters describing the states of the underlying system(s) remain the same. Thus, a *comparative CP-clause* does not exclude the presence of other 'disturbing' factors, but merely

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requires that they are kept constant. More precisely, a comparative CP-law compares the states of two systems of an underlying application class, one state where the parameter f has not been increased, and another state where the parameter f has been increased – and it requires both states to *agree* on all parameters which are causally *independent* from f (i.e., not affected by f). In particular, the quantitative parameters being compared may be the *probabilities* of some qualitative properties (expressed by predicates). Here are three examples:

(1) Ceteris paribus, an increase of gas temperature leads to a (proportional) increase of gas volume (Gay-Lussac's gas law).

(2) Ceteris paribus, increase of rain leads to an increase in growth of vegetation.

(3) Ceteris paribus, (an increase of) alcoholization of the driver leads to an increased probability of a car accident.

While in (1) a *quantitative* relation between the increases is known (the relation of proportionality), in (2) only an *ordinal* relation between the increases is predicted (i.e., increase leads to increase). Finally, (3) is an example of a probabilistic comparative CP-law, where the consequent parameter g expresses a probability increase.

In the philosophical debate, however, CP-laws have usually been understood in the different exclusive sense. An *exclusive CP-law* asserts that a certain state or event-type expressed by a (possibly complex) predicate *Ax* leads to another state or event-type *Cx provided* disturbing influences are *absent*. Ax is called the *antecedent* and Cx the *consequent* predicate. Thus, an exclusive CP-clause does not merely require keeping all other causally interfering factors constant; it rather *excludes* the presence of causally *interfering* factors. In agreement with this exclusive understanding, Cartwright has remarked that "the literal translation is 'other things being equal'; but it would be more apt to read 'ceteris paribus' as 'other things being right' " (1983, p. 45). Joseph (1980, p. 777) has spoken of "ceteris absentibus" clauses, and Hempel (1988, p. 29) calls exclusive CP-clauses "Provisos" ("...*provided* disturbing factors are absent"). Consider the following examples of exclusive CP-laws – (4) comes from physics and (5, 6) from psychology:

(4) Ceteris paribus, planets have elliptical orbits (Lakatos op. cit.).

(5) Ceteris paribus, people's actions are goal-oriented, in the sense that if person x wants A and believes B to be an optimal means for achieving A, then x will attempt to do B (Fodor, 1991; Dray 1957, pp. 132ff).

(6) Ceteris paribus, frustration leads to aggression (Schurz 1995).

In (4), the CP-clause requires that other (non-negligible) forces on the planet except that of the sun are – not merely constant but – *absent*. Likewise, the CP-clause of (5) requires any factors causing irrational behavior to be absent. Note that (5) governs various special CP-laws, such as "CP people who want water try to get water" (Fodor 1991, p. 28). In (6), finally, the CP-clause excludes interfering factors of both psychological sort (e.g., depression) and physical sort (e.g., the influence of drugs).

The distinction between comparative and exclusive CP-laws is not disjoint. There are CP-laws which have both comparative and exclusive character, as in the following example from theoretical economy:

(7) Ceteris paribus, an increase of demand leads to an increase of prices.

Not only must the compared economies agree in remainder factors; various interferes (such as political price regulations) must be excluded. We call these CP-laws *mixed* and treat them as (implicitly) governed by a comparative *and* an exclusive CP-clause; all what we say in the following about comparative and exclusive CP-clauses transfers to mixed CP-laws. The fact that comparatively formulated CP-laws are often mixed in character may explain why, historically, the two kinds of CP-laws have usually been conflated.

One may object to our distinction that some exclusive CP-laws can be reformulated in a comparative form, by interpreting *events* as *changes* in the values of certain parameters (cf. Gadenne 1984, p. 43f). In this way, the frustration-aggression law (6) may be reformulated as follows:

(6*) Ceteris paribus, an increase of frustration leads to an increase of aggression.

But this reformulation does not at all diminish the difference. (6*) is *still* an exclusive CP-law, because interfering factors such as influences of certain drugs are not merely required to be constant, but must be absent. Otherwise, an increase of frustration will *not* lead to an increase of aggression. Generally speaking, if a CP-law "CP, if Ax then Cx" is truly