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The Nature of Darwin's Support for the Theory of Natural Selection

1. DARWIN'S VIEWS

William Whewell and Sir John F. W. Herschel, the most influential writers in philosophy of science in the mid-nineteenth century, both held Newtonian physics aloft as the model form for a scientific theory. In order to demonstrate Darwin's sophistication concerning contemporary philosophical and methodological issues, I shall quote him extensively, in this section, from his private correspondence.

One crucial aspect of the laws of motion insisted on by philosophers and scientists alike was that they could be directly tested or proved. Darwin was well aware of the example provided by Newtonian physics, and was equally well aware that the theory of natural selection could not be tested by direct inference from the evidence.

When we descend to details, we can prove that no one species has changed [i.e. we cannot prove that a single species has changed]; nor can we prove that the supposed changes are beneficial, which is the groundwork of the theory. Nor can we explain why some species have changed and others have not. (Darwin 1919, 2:210)

On another occasion, Darwin wrote of F. W. Hutton:

He is one of the very few who see that the change of species cannot be directly proved, and that the doctrine must sink or swim according as it groups and explains phenomena. It is really curious how few judge it in this way, which is clearly the right way. (1919, 2:155)

Lloyd, E. A. (1983). The Nature of Darwin's Support for the Theory of Natural Selection. *Philosophy of Science*, 50, 112–129.

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Darwin explained his approach as follows:

I have always looked at the doctrine of natural selection as an hypothesis, which if it explained several large classes of facts, would deserve to be ranked as a theory deserving acceptance. (1903, 1:139–140)

It is clear from the following letters that Darwin believed his hypothesis to be analogous in this respect to the physical hypothesis concerning light, and accordingly thought that presenting indirect evidence for this theory, as a parallel form of support, should be acceptable scientific practice. He wrote to Asa Gray (1919, 2:80):

Your distinction between an hypothesis and theory seems to me very ingenious; but I do not think it is ever followed. Every one now speaks of the undulatory *theory* of light; yet the ether is itself hypothetical, and the undulations are inferred only from explaining the phenomenon of light. . . . It seems to me that an hypothesis is *developed* into a theory solely by explaining an ample lot of facts.

Darwin made an explicit comparison in a letter to Henslow (1967, p. 204):

In a letter to me, [Sedgewick] talks much about my departing from the spirit of inductive philosophy. I wish if you ever talk on [the] subject to him, you would ask him whether it was not allowable (and a great step) to invent the undulatory theory of light – i.e. hypothetical undulations, in a hypothetical substance, the ether. And if this be so, why I may not invent [the] hypothesis of natural selection (which from analogy of domestic productions, and from what we know of the struggle of existence and of the variability of organic beings, is in itself probable) and try whether this hypothesis of natural selection does not explain (as I think it does) a large number of facts in geographical distribution – geological succession – classification, morphology, embryology, etc. – I should really much like to know why such an hypothesis as the undulations of the ether may be invented, and why I may not invent . . . any hypothesis, such as natural selection. . . . I can perfectly understand Sedgewick or any one saying that natural selection does not explain large classes of facts; but that is very different from saying that I depart from right principles of scientific investigation.

Having defended natural selection as a legitimate scientific hypothesis, Darwin supported it with considerations that served either to connect empirical facts to the theory in various ways, or to show that the hypothesis would be useful to biological science in other respects.

Much of Darwin's support for his theory offered in the *Origin* and in correspondence with other scientists consists in linking the theory to

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empirical evidence in widely varying branches of science. Darwin presented his specific claims regarding his theory in a letter to the journal, *Athenaeum*:

As far as I can judge, no theory so well explains or connects these several generalizations (more especially the formation of domestic races in comparison with natural species, the principle of classification, embryonic resemblance, etc.) as the theory . . . of natural selection. Nor has any other satisfactory explanation been ever offered of the almost perfect adaptation of all organic beings to each other, and to their physical conditions of life. (1919, 2:207)

Darwin also supported his hypothesis of natural selection by appealing to its value to the science of biology as a whole through promotion of research:

Whenever naturalists can look at species changing as certain, what a magnificent field will be open – on all the laws of variations, on the genealogy of all living beings, on their lines of migration, etc. (1919, 1:485)

At this point, it may seem quite plausible that Darwin is arguing for his theory chiefly on the basis that it provided the “best explanation” for the different phenomena from widely varying fields. Following a brief summary of the “inference to the best explanation” view of theory choice, I shall argue that such an interpretation of Darwin’s theory support is inadequate and misrepresents Darwin’s main concerns.

“Inference to the best explanation” has been claimed by Gilbert Harman to be the rule of rational inference basic to all nondeductive inferences (Harman 1965, p. 89). As a rule of inference governing theory choice, inference to the best explanation means that we should infer the hypothesis, which explains a given set of evidence better than any competing hypothesis at hand. Harman’s suggestions regarding the criteria used in determining *which* hypothesis is better include simplicity, plausibility, minimal *ad hoc*-ness, and ability to explain a larger quantity of evidence.

Paul Thagard has claimed that Darwin’s support for his theory of natural selection is a clear-cut example of an argument to the best explanation; he claims that Darwin supported his theory chiefly on the basis that its explanations were consilient, simple, and analogical in nature, and thus fulfilled some of the prime criteria used in evaluating explanatory theories (Thagard 1978, p. 89). Thagard emphasizes that consilience, simplicity, and analogy (and explanation in general) are primarily concerned with the actual *use* of the theory within a specific social and historical context.

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Context-centered features of a theory should be seen in contrast to other features, such as its logical structure (logical relations inside the theory), or its semantic relations (the relations between the theory and the facts). I shall show that although Darwin did use arguments from consilience, simplicity, and analogy to support his theory, his main defense did *not* amount to claims concerning its explanatory power but, rather, to claims regarding its semantic properties. It should *not*, therefore, be considered a clear-cut case of an inference to the best explanation, nor be used as support for that view of theory choice.

2. DARWIN'S SUPPORT

Before proceeding to the actual discussion of Darwin's support for his theory, I would like to introduce an account of the structure of the theory which I will use throughout the rest of the paper. Morton Beckner has argued that natural selection theory is best understood as presenting a family of related models (1959, p. 160). A particular model used in an explanation is constructed by using principles of the theory in combination with certain assumed conditions; the outcome of the model is supposed to be consistent with observed empirical phenomena. A good example is the case of the emergence of two types of wolves, in which Darwin describes an imaginary situation wherein the outcome would be of a certain (testable) kind, given natural selection and granting certain conditions (1964, p. 90).

Particular models serve to show that the theory is compatible with observed phenomena, viz., empirical generalizations and particular facts of evolution, by providing a specific way in which the theory plus certain specific assumed conditions would produce a fit with the empirical results. This account of theory structure, called the "semantic" view, is a recently developed alternative to the so-called received view or covering law approach (see van Fraassen 1972, especially pp. 304–306; van Fraassen 1970, pp. 328–329; Beatty 1980, pp. 399–401, 419–420). Many interpretations of Darwin's support for his theory, including those by Ruse and Kitcher, are guided by the assumption that "good" or "scientific" theory structure must conform to the covering law view (Kitcher 1981, p. 509; Ruse 1979, pp. 109, 236, 270; see especially Ruse 1975a, pp. 221–224). It has been a special problem of the received view to search for empirical laws in theories under analysis; the semantic view circumvents this problem

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(see Beatty 1980). Throughout the rest of the discussion, I shall rely on a simplified semantic account of natural selection theory as a standard and unifying picture of the structure of the theory. Details concerning the use of natural selection theory in models will be discussed in Section 2.4.

2.1. Consilience

Darwin, as quoted in Section 1, explicitly defended natural selection theory on the basis that “it explained several large classes of fact” (1903, 1:139). I would like first to consider the view that Darwin’s claim to consilience is best interpreted as a claim regarding the theory’s ability to produce explanations of a certain sort. Following a brief criticism of an explanation-based view of Darwin’s claim, I shall suggest an alternative interpretation that grounds consilience instead in the semantic properties of the theory.

According to William Whewell, who coined the term, “consilience” can occur either when an hypothesis can explain at least two known classes of fact, or when it can predict or explain cases of a new and different kind from those cases considered in forming the hypothesis (Laudan 1971, p. 371; Butts 1977, p. 74). Note that these classes are not to be understood as arbitrary sets; evaluation of consilience presupposes a division of facts into natural classes. Whewell’s notion has been adopted by Thagard, who claims that consilience can indicate *how much evidence* a theory explains (Thagard 1978, pp. 79–80). This notion can be used in a comparative way; for example, if Theory A explains three classes of facts, and Theory B explains four classes of facts, including the three classes explained by Theory A, then Theory B should be considered more consilient than Theory A. Since this definition is couched in terms of explanations, it seems that consilience is based upon the performance of the theory in explanation. Throughout this discussion, the term “explain” is used in a substantive sense, in which it is contrasted to mere description, prediction, fitting, or accounting for.

Consider, however, the specific support Darwin gave for his claim to consilience: despite his (quite ordinary) use of the word “explain,” it does *not*, in fact, involve the level of complexity of an explanation-centered criterion. The use of the word “explain” is nontechnical: it can be replaced by a more neutral term like “account for” without loss to the support given. He claimed that his theory explained “several large classes of fact” (see Darwin 1919, 2:13; 1903, 1:13); these explanations produced with natural

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selection theory were of a certain type and quality. Given that natural selection can be understood as presenting a family of related models, the form of an explanation using the theory must be a demonstration of how the observable phenomena in question *could* have happened, given moves authorized by the theory plus certain conditions. One evaluates a model by independently testing the assumed conditions and by comparing the outcome of the model with empirical observations, including observations not available at the time of model construction, if possible. In the case of natural selection theory, then, consilience of inductions would consist of the many models one has constructed, using the theory, which have been shown to be at least minimally empirically adequate. Thus, if consilience is defined strictly in terms of explanations, Darwin has not really defended his theory on the basis of consilience. If, by contrast, consilience is seen as based on the relationship or fit between the theory and empirical data, we can make better sense of Darwin's actual defense, as follows. At the heart of Darwin's declarations of the importance of the consilient nature of natural selection theory was his conviction that the theory had proven capable of "saving" the phenomena. In other words, Darwin had shown himself, in the course of his researches, and using his strictest testing criteria, that the theory could be used to construct outlines of models that would give results that *conform to the empirical data*.

The semantic nature of the criterion of consilience is a problem for those who support inference to the best explanation as the rule for theory choice. Those who argue that many scientists have supported their theories on grounds of consilience are correct; the question is whether this support is based on the fact that their theory *explained* the most (in a substantive sense of "explain") – consilience seems to be an index of this sort – or whether consilience is seen instead as an index of the empirical adequacy of the theory, as argued in the preceding paragraphs. If the latter is the case, as I claim, then the inference being made and supported by consilience is *not* an inference to the best explanation, but rather an inference to the most empirically adequate theory.

The fact that Darwin supported his theory by claiming that it was consilient seems to indicate that he was concerned with the "explanatory power" or success of his theory. Because the notion of consilience is basically semantic, Darwin's defense can be more appropriately recognized as a set of claims about the fit of empirical data to various models constructed with the use of natural selection theory. The particular way in which Darwin tested his models, and thereby his theory, is the subject of Section 2.4.

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2.2. *Simplicity*

Simplicity, an important constraint on consilience, has been characterized as a function of the number and type of auxiliary hypotheses used in explanations provided by the theory under consideration (Thagard 1978, pp. 85–86). This apparently amounts to evaluation of the use of *ad hoc* hypotheses in explanation – an *ad hoc* hypothesis being one that is only good for explaining the phenomena which it was introduced to explain. I shall first reject the appropriateness of applying a criterion of simplicity of this sort to Darwin's argument. Then I shall discuss Darwin's claim that his theory was valuable because "so many phenomena can be thus grouped together and explained" (1903, 1:184), a claim that seems to involve *some* notion of simplicity.

Consider the nature of explanations from natural selection theory: they consist of models that include the basic theory plus certain empirical hypotheses. For example, an explanation of the present populations of mosquitoes in a certain area would include basic assumptions regarding the fitness of the present occupants' ancestors, in addition to details concerning the availability of food sources for the different species of mosquitoes present. An explanation that includes the additional hypothesis, "there have been no new species of food source plants introduced into the area during the last 200 years," could, when considering the question of the mosquitoes' present food source, make a *better* explanation, that is, one more informative and more persuasive, than an explanation which omits this extra assumption. Thus, in natural selection, explanations are often *improved* by the addition of untested assumptions that were introduced only to explain the phenomenon in question. These empirical assumptions have a strong ring of *ad hoc-ness* until further research reveals more information about them. The initially plausible definition of simplicity based on the number of *ad hoc* hypotheses in the explanations seems therefore completely inappropriate to apply to natural selection theory.

There is, however, a certain simplicity to natural selection theory to which Darwin appeals explicitly. I would like to suggest an alternate formulation of the notion of simplicity, intended to capture the characteristic by which Darwin actually supported his theory.

The set of related models that comprise natural selection theory could more accurately be called a group of model types. Van Fraassen has defined "model type" as the description of a structure in which certain parameters are left unspecified; "model" refers only to specific structures

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“in which all relevant parameters have specific values” (and van Fraassen has suggested that in its typical use by scientists, “model” has the sense of “model type”) (van Fraassen 1980, p. 44). When natural selection theory is said to present a set of related models, it is meant that there are certain model types which are given in the theory to account for observed phenomena; the variables of these model types are specified and instantiated through hypothesis and testing in a recursive manner. For example, a model type used to explain the presence of certain instincts would contain variables corresponding to the possible range or variation of the instinct, its profitability in different sets of circumstances, and the economies of related behaviors, in addition to standard natural selection assumptions concerning the existence of fine gradations of instinct and change in instinct.

A slightly different model type might be used to explain the predominance of one species over related species. Such a model type would include variables representing each species’ method of obtaining food, changes in the food supply, flexibility with regard to food supply, and climatic changes, in addition to basic natural selection assumptions regarding the effects of competition and the existence of natural variation. These model types serve as formats for explanations; the particular terms or factors in a model type vary in each application, depending on the outcome of the model and various assumed conditions.

One way to evaluate simplicity of a theory that consists of a set of models is to see how many separate models and terms are necessary to account for the phenomena; roughly, a simpler theory has fewer model types. If a theory is both *simple* in the manner defined above, that is, consists of only a few basic model types, and is *consilient* as well, then it can be considered to *unify* the phenomena. Kitcher has recently given a similar interpretation which, except for its syntactic presentation, presents a similar view of the nature of the unification involved in Darwin’s theory: “a theory unifies our beliefs when it provides one (or more generally, a few) pattern(s) of argument which can be used in the derivation of a large number of sentences which we accept” (1981, p. 514). Darwin often supported his theory on the basis of its unifying nature (cf. quote p. 113). This virtue is not one of consilience alone; it also involves the fact that the basic plans for explaining so many classes of phenomena are included in a relatively straightforward and small set of model types.

In other words, the manner in which natural selection theory is simple is that it consists of only a *few* interrelated model types, yet these model types can be filled in with contingent facts and assumptions for *any* specific

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phenomenon in the extremely large range of phenomena the theory claims to account for. This ability of outlines of evolutionary explanations to be instantiated with different details is also emphasized by Kitcher as a vital aspect of the success of the theory: “[an] eventual unification would consist in derivations of descriptions of these phenomena which would instantiate a common pattern” (1981, pp. 514–515). Thus, simplicity is a relation between the theory, the empirical data, and the explanations constructed from the theory; it cannot, therefore, be considered a relation concerned exclusively with explanation.

2.3. Analogy

As a form of theory support, analogies are generally supposed to improve the explanations provided by the theory. Such support seems to be heuristic support: take the case in which an analogy between phenomena improves the explanations because the first explanation provides a model for the second; the nature of this improvement is an improvement in understanding. Analogy is then playing a heuristic or psychological, rather than confirmatory, role in the justification of the theory.

Darwin's use of artificial selection in support of natural selection is usually brought forth as an example of analogical support; the “familiarity” of artificial selection is supposed to increase the explanatory value of natural selection theory (Thagard 1978, p. 91). Darwin did claim that “the belief in Natural Selection must at present be grounded entirely on general considerations including the analogy of change under domestication by man's selection” (1919, 2:210).

The strategy of Darwin's presentation, wherein the first two chapters of the *Origin* concern artificial selection and abundance of variation in wild organisms, respectively, suggests that he was aware of an heuristic use of the analogy. The situation becomes less clear-cut, however, when we consider that contemporary popular and scientific opinion held that results from domestic variation and artificial selection were strong evidence *against* the transmutation of species (Ruse 1979, pp. 177, 203).

Michael Ruse has argued, in the context of a discussion on the hypothetico-deductive nature of Darwin's theory, that “Darwin's discussions of artificial selection and of variation do have a justificatory role in his thought” (Ruse 1975a, p. 226). Ruse argues as follows: in the course of arguing for natural selection theory, Darwin claims that there *do* exist favorable and injurious variations, on which populational and environmental demands can then exert differential pressure. What evidence does

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Darwin give for this assumption, crucial to natural selection theory? He argues from artificial selection: because variations that are useful to people have occurred in domestic animals, it should not be “thought improbable” that variations that are useful to the organism itself in “the battle of life” should occur spontaneously in wild organisms (Darwin 1964, pp. 80, 467).

The assumption that there are heritable variations useful to the (owner) organism should not be confused with the class of individual empirical assumptions that appear in particular applications of natural selection theory. The analogical argument serves as *supporting evidence* for the basic construction of the model types; after this assumption has been made, it becomes possible to assume the existence of *some* heritable favorable variation. The task is then to determine its nature through functional analysis or other research methods. The use of the analogy from artificial selection as supporting evidence for an assumption common to all natural selection model types clearly outstrips a merely heuristic application. Darwin does not use analogy just to improve the explanations by improving understanding (a use which has a basically psychological appeal), nor does the explanation in artificial selection simply serve as a model for explanation in natural selection; rather, analogy seems to be used by Darwin chiefly as the strongest type of evidence by which he could support a certain assumption of his theory (see Ruse 1975a, p. 235; Ruse 1979, pp. 177–178, 203–205).

One last point: it could possibly be misleading to accept Darwin’s own interpretation that the supporting role of artificial selection in natural selection theory is analogical. Van Fraassen has suggested that the case of artificial selection might have been serving as a specific, narrow case of a certain process; this process was then generalized from a limited, artificial environment to the natural environment (personal communication).

2.4. Independent Testing of Model Assumptions

The preceding sections contained several references to the fact that Darwin was concerned with testing his theory and its adequacy to empirical facts. I have found that Darwin’s concern for consilience was based on his conviction that his models satisfy at least minimal conditions of empirical adequacy, and that theory support criteria that focus on characteristics of explanations neglect the type of argument, significant in terms of both volume and detail, which relates the theory to empirical data and observations.