

BioEE 207/Hist 287/STS 287: Evolution

Essay Assignment #1

In the *Origin of Species*, Darwin lays out the core of his argument in Chapters 1 through 4, covering variation in domesticated animals and plants, variation in nature, the struggle for existence, and natural selection. The remaining chapters of the *Origin* provide evidence to support his theory. Although this evidence is important, as it convinced many of the scientists of his time, it is not central to his argument for natural selection, nor is it necessarily evidence against other alternative theories of the origin and evolution of life.

The way that Darwin makes his argument in Chapters 1 through 4 is different than the way he uses evidence to support his argument throughout the rest of the book. In class, we have considered several forms of logical reasoning, including:

- **transductive reasoning** ("transduction", or arguing by analogy)
- **inductive reasoning** ("induction", or arguing from particular cases to a generalization)
- **deductive reasoning** ("deduction", or arguing from a generalization to particular cases)
- **abductive reasoning** ("abduction", or validation by inclusion under a more inclusive generalization).

Your Essay Question:

In an essay of between four and eight pages, you must critically evaluate the arguments and evidence for evolution by descent and for natural selection in the first four chapters of the *Origin*. As you do so, indicate what kind(s) of reasoning Darwin used to make and validate his argument(s), and decide if he was successful or not in his attempt. In your answer, please answer the following questions (and include examples, where appropriate):

- What kind(s) of reasoning did Darwin use in Chapters 1-4 of the *Origin*?
- Was Darwin's use of reasoning in these chapters effective? Why or why not?
- Could Darwin have made his argument in some other way and, if so, how?
- What kind(s) of evidence (if any) could he have used in this case?

Hints:

- "Critically evaluate" means subjecting the arguments and evidence to careful analysis. A critical evaluation does not necessarily mean "negative" evaluation and might lead to the conclusion that the arguments and evidence are accurate, inaccurate, or some mix thereof.
- Support your arguments primarily with evidence from the *Origin* itself. Citation of page numbers is sufficient.
- Supply references for all material taken from elsewhere. Plagiarism has very serious consequences, so be sure to cite any ideas and references that are not your own. Use of the WWW is fine, but all necessary URL's must be documented. References to material presented in lecture can be cited by reference to lecture date.
- Divide the paper into sections.
- Keep sentences, paragraphs, and technical jargon to reasonable lengths.
- Write clearly and concisely – excess verbiage and needless digressions will be penalized.

We encourage the use of word processor spelling and grammar checkers.

[name]

Prof. MacNeill

HIST 287

[date]

Greetings, [name]:

I have reviewed your essay using the "Track Changes" tool in MicroSoft Word. I have inserted comments throughout your essay and included your grade at the end. Please contact me after class or via email at adm6@cornell.edu if you have any questions.

Sincerely,

--Allen

Essay 1: The Argument For Evolution According To Darwin

Charles Darwin outlines his reasoning for evolution in the first four chapters of his book, *On the Origin of Species*. To explain natural selection, a critical component of evolutionary theory, Darwin carefully assembles a body of evidence and well-reasoned generalizations that rely upon each other for support.

At the outset of the first chapter, Darwin elucidates one of the fundamental prerequisites required for evolution to occur: natural variation within a population (*Origin*, pg 7). He observes that variability is apparent even in a controlled environment, such as in populations of cultivated crops and domesticated animals (*Origin*, pg 8), and he goes on to conclude after offering the example of the so-called "sporting plants" (*Origin*, pg 9) that such variability is somehow passed to the offspring by its parent organisms (*Origin*, pg 10). Although Darwin admits ignorance regarding the complete function of inheritance (*Origin*, pg 13), he asserts that traits are indeed passed from generation to generation and regulated by something he terms "natural selection" (*Origin*, pg 15).

The first part of chapter one so described serves primarily as an exposition for the critical ideas expressed in the chapter: that variability of traits is often present within a population and that traits are heritable. The rest of the chapter serves to outline these principles by citing evidence from controlled, domestic conditions in which both are demonstrated.

Darwin briefly illustrates his idea that variable, heritable traits exist in populations by citing real-world examples. He challenges the notion that domestic animals and plants are somehow special in their variability compared with wild organisms (*Origin*, pg 17), and he

contends, by extension, that any organism can be significantly modified based solely on variations that occur naturally within a population. Darwin proves this point through his study of domestic pigeons, first citing the fact that there are many different kinds of pigeons with many different, unique traits (*Origin*, pg 21-22), yet, following the main idea of the chapter, he asserts that all these different varieties of pigeons have probably come from one variety of pigeon alone (*Origin*, pg 23), and the different varieties are merely the result of the inheritance and amplification of traits that exist variably and naturally within the population.

To bolster his point, Darwin questions the probability that some of the more extreme varieties of pigeon could ever be found in nature (*Origin*, pg 24). He also observes that two extremely different kinds of pigeons, when crossed, will invariably display a phenotype similar to that of the wild type, the common rock pigeon (*Origin*, pg 25). Darwin points out that the offspring of the crossed organisms are fertile, suggesting that they are of the same species (*Origin*, pg 26).

Having explained the likelihood for a common ancestry amongst the many different kinds of pigeons, Darwin addresses selection, the mode through which changes might be induced in a population. Before addressing the topic of selection, Darwin makes clear that he now refers solely to artificial selection, for the environment cannot produce exotic breeds of animals such as a race horse (*Origin*, pg 29). With his discussion of selection Darwin clarifies his previous points. He has argued that differences within a population are likely, but he concedes that differences as vast as those found among the different breeds of pigeons are unlikely to have been produced by random variation (*Origin*, pg 30). He draws upon the other part of the main idea expressed in the chapter, that differences are heritable, to explain the amplification of unique traits in a population through the vehicle of artificial selection (*Origin*, pg 30). Darwin then cites several examples from horticulture and husbandry in which unique organisms have been produced by carefully controlled crosses between organisms featuring some distinguishable trait (*Origin*, pg 32). Adding more evidence to his case, Darwin cites the fact that among certain kinds of domestic plants there are many shared characteristics, yet one or two markedly different characteristics, suggesting that each had a common origin and underwent selection that led to the marked expression of the selected trait (*Origin*, pg 33).

After outlining a series of similar examples, Darwin concludes that the mechanism behind artificial selection is merely the "wants and fancies" of human beings (*Origin*, pg 38). He

goes on to state that different breeds of organisms do not have a definite origin, pointing out that, at some point, a breeder happened upon a desirable variation that occurred naturally in a member of a population and decided to encourage that variable trait through selective breeding (*Origin*, pg 40). With that said, Darwin concludes that those traits most desirable to the human being are most likely to be promulgated within a population through artificial selection (*Origin*, pg 41).

Finally, Darwin summarizes the first chapter (*Origin*, pg 43). While variability is not necessarily inherent in a population, it does occur in populations through reproduction amongst organisms and is regulated by uncertain means. The variable traits that arise in a population are heritable, and these can be passed along from one generation to the next. Certain traits, when selected by some criteria, such as human agency, can be expressed more obviously in a descendant organism and the population at large.

Essentially, Darwin has outlined with the first chapter the basic ideas behind his theory of evolution. He has related these ideas as observed in a controlled environment, but at this juncture he does not apply them to the wider world. The objective of the first chapter is simply to prove that concepts such as he describes can and do exist. **Right!**

Darwin's logic in the first chapter is primarily inductive, and through this logic generalizations and principles are constructed that segue into the deductive logic of the second chapter. Darwin knows that the natural state of a domestic species was some sort of wild type in a variable population. He also knows that the state of domestic species subject to human selection is one composed of many varied breeds of organisms. After citing numerous examples where these two things are true, he concludes with the generalization that variable populations have heritable and selectable traits. Such a generalization fits neatly with the given evidence. The reasoning he uses here is effective. Most importantly, Darwin makes no initial assumptions about the subject; rather, he builds all generalizations from observations. He could not really have made his argument any other way for this first chapter, and the evidence given aptly reinforces his points. **Excellent analysis!**

From the second chapter onward, the generalizations of the first chapter that were constructed from observations of artificial conditions are applied to natural conditions. The second chapter and subsequent chapters, unlike the previous one, are exercises in deductive reasoning using principles that have since been established by inductive reasoning. In these later chapters Darwin also more fully elucidates some of his ideas.

The second chapter concerns itself primarily with variation in nature. Darwin has already established with the first chapter that variation and, by extension, selection can occur amongst domesticated and cultivated populations of organisms, and Darwin extends this generalization to the natural world while explaining the need for variation as a cornerstone of evolutionary theory in greater detail.

Although he has not explained the principle of natural selection yet, Darwin writes that variation is critical for its occurrence (*Origin*, pg 45). Variation is indeed present in nature, and Darwin cites several examples, such as the locations of nerves and muscles in insects (*Origin*, pg 46). The problem of what Darwin terms "doubtful species," groups of organisms whose status as a distinct species is ambiguous, is described in several pages (*Origin*, pg 47-52). The discussion and evidence given is not really so significant as the conclusion Darwin draws from it, which is that individual differences may give rise to varieties, then subspecies, and, finally, distinct species (*Origin*, pg 52). Darwin further adds that dominant species and species belonging to larger genera tend to vary the most (*Origin*, pg 54-55). Although Darwin has not yet explained natural selection, the idea that differences in organisms may accumulate through natural selection just as in artificial selection validates the generalizations he has made and is relevant to his theory at large.

That variation allows natural selection and from this "varieties...become converted into new and distinct species" (*Origin*, pg 59) is the primary point made in the second chapter. Unlike the first chapter, the second chapter features deductive reasoning as its primary logic. **Right!** Darwin has made a generalization from observations of artificial selection as described in the first chapter variation makes selection and trait-amplification possible, or some statement to that effect, yet Darwin concentrates mainly on variation with the second chapter. Having made this generalization, Darwin looks for specific cases to fit that generalization and, upon discovering those cases, he may reasonably conclude that his generalization is correct. Darwin cites the work of others who have studied species and variations amongst species, and through their work and the manner in which species are organized concludes that variation is indeed a key aspect of selection and modification.

While Darwin's reasoning here is effective, his argument is perhaps needlessly verbose and contains extraneous information. He has already satisfactorily explained variation in the first chapter and needs only to apply his generalization to examples in nature. He does indeed do this

in the second chapter, but he could have easily stopped with the statement describing the transition of varieties to species. His discussion on "doubtful species" (*Origin*, pg 47-51) provides ample evidence for his generalization insofar as he is able to effectively describe the incredibly large amount of variation that exists in nature.

At the conclusion of the second chapter, the reader is impressed only with the idea that variation naturally exists in populations. Darwin has expressed this idea very well, but he has not yet really explained how species arise. Darwin makes note of such at the beginning of the third chapter, and he explains that in order to describe natural selection, he must first describe the struggle for existence (*Origin*, pg 60-61).

Darwin first points out that by the phrase "struggle for existence" he not only refers to the struggle for survival, but also the struggle for reproductive success (*Origin*, pg 62). Reproduction, as revealed in the first chapter, is critical in passing on variations in a population.

Darwin proceeds to outline some assumptions about the nature of organisms and populations that are critical for understanding how the struggle for existence comes about. He first points out that all populations tend to increase at a high rate (*Origin*, pg 63). He cites the fact that even populations of slow-breeding cattle and horses as proof for his assertion (*Origin*, pg 64). Darwin surmises that, because populations do not increase indefinitely, as the earth is not absolutely brimming with organisms of all sorts, there must be some regulator of population increase (*Origin*, pg 64, 67). Darwin then outlines some limits to population growth, such as predation (*Origin*, pg 67), a limited food supply (*Origin*, pg 68), and a climate or environment that can only support so many organisms (*Origin*, pg 69). He of course offers real-world evidence for each of these factors, most notably relating how many of the birds on his property died during a harsh winter (*Origin*, pg 68).

Other factors contribute to the struggle for existence, most notably interactions between species (*Origin*, pg 71). Darwin relates a personal anecdote in which he observed that Scotch fir trees did not exist on grazing lands, leading him to conclude that the presence of cattle severely limited the population of that tree (*Origin*, pg 72). Finally, the limiting effect of occupying a particular ecological niche is described. Citing the example of birds, among other species, affecting the populations of their closely-related cousins through competition over similar resources, Darwin concludes that even populations of closely-related organisms struggle for existence, perhaps even more intensely than those of distantly-related organisms (*Origin*, pg 76).

Like the first chapter, the third chapter relies primarily on inductive reasoning to draw conclusions. Darwin is confronted at first with a problem: all populations tend to increase very rapidly, yet populations do not grow indefinitely at an exponential rate. To draw a conclusion, Darwin examines real-world data and evidence. From his studies of the effect of competition and climate, among other things, on organisms, he concludes that there is a struggle for existence that limits all populations. While organisms certainly reproduce in great numbers, their growth is held in check by limiting factors. His reasoning is effective because the conclusion he makes fits well with the data, and his argument and evidence are similarly solid, as he provides numerous examples of when, where, and how populations are limited, whether the population is one of birds, rats, trees, or cattle.

The first three chapters are united by the fourth, in which Darwin describes natural selection. Up to this point, Darwin described only those factors that made natural selection possible without explaining natural selection itself.

In the first chapter, Darwin described how change could arise through human action based on preference. Natural selection is, however, unlike artificial selection in that it selects characteristics that an organism finds useful in its given environment (*Origin*, pg 83). Indeed, those variations that do not contribute favorably to an organism's struggle for existence are removed from the population, whereas those that do contribute favorably are multiplied within the population (*Origin*, pg 84) and amplified within the organism (*Origin*, pg 85), often leading to new, unexpected variations (*Origin*, pg 86). Darwin also briefly touches upon sexual selection, wherein an animal that possesses certain qualities is more attractive to members of the opposite sex and, thus, more likely to mate and pass along its variations (*Origin*, pg 88-89).

Darwin cites several examples to illustrate his points, the best of which is the example given with flowering plants and insects. Those flowering plants which by nature secrete more nectar are more likely to be visited by insects, which pollinate other flowers belonging to other plants of the same species. Since the plant with the trait of secreting more nectar is more likely to reproduce, that trait will receive a larger representation among the population. Thus, a plant whose flowers secrete more nectar than those of other plants has been selected by virtue of its reproductive fitness (*Origin*, pg 92).

Although Darwin goes on for some length about the intricacies of natural selection, his other points merely serve to bolster and support his primary assertions, adding little new material

to his arguments other than several short digressions on topics such as hermaphroditism and extinction.

The fourth chapter is the culmination of the points made in the first three chapters. In those previous chapters Darwin proposed a system whereby variable, heritable traits in organisms could be enhanced through selection. Under natural conditions, such selection is prompted by an organism's struggle for existence or reproduction. Darwin gives a name to this process in the fourth chapter: natural selection, wherein organisms featuring traits best suited for their environment survive and reproduce while those that are not ideally suited are gradually culled from the population (*Origin*, pg 127).

To make such a conclusion, Darwin uses a process of deductive reasoning that builds off previous generalizations he has made and compares the derived generalization, in this case the idea of natural selection, to quite a good bit of evidence, most of which is outlined in the fourth chapter. Indeed much of the logic used throughout the book builds on logical constructs introduced earlier. The arguments of the first chapter were the result of inductive reasoning, wherein actual cases and situations were considered. The second chapter built off the first, using deductive reasoning to reconcile generalizations with the facts. The third chapter introduced a new set of generalizations based on facts through inductive reasoning, which led to the deductive argument for natural selection that could be constructed in the fourth chapter.

Overall, Darwin presents with his *On the Origin of Species* a well-constructed argument in favor of evolution that uses facts and examples to build generalizations that, in turn, are used to construct more generalizations. Each of the four chapters builds off the previous chapter in some way, to the argument for natural selection each chapter contributes its own vital argument, forcing each generalization to rely on the others for support within the large framework of evolutionary theory. As Darwin provides plenty of evidence for his ideas and very carefully presents his case, one is pressed to find a way in which his observations could have been better put.

Citations:

Darwin, Charles. *On the Origin of Species: A Facsimile of the First Edition*. 1964.

Cambridge: Harvard University Press, 2000.

Greetings, [name]:

This was an outstanding paper, masterfully and concisely argued, with virtually no grammatical and syntactical errors. You did an outstanding job of analyzing Darwin's various arguments, and showing how he derived his conclusions. Overall, an outstanding effort, of which you can be very proud. Keep up the good work!

As always.

--Allen

Grade on This Essay: A+