

Analysis and critique of the concept of Natural Selection (and of the neoDarwinian theory of evolution) in respect (Part 1) to its suitability as part of Modernism's origination myth, as well as (Part 2) of its ability to explain organic evolution

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I would point out here that, despite the widespread conflation of the concept of evolution with the Darwinian theory to explain it (we now begin to hear phrases like "natural evolution", which tends to forge a conflation with natural selection), the following remarks apply strictly to the neoDarwinian theory. Concerning this theory, I believe that we might question (or at least note) the following:

PART 1: Polemics

(1) Its derivation from classical capitalist economic theory

This is not just ad hominem because we live in a sociopolitical system that itself derives from classical capitalist ones. This throws suspicion on the theory, in that it may be widely supported (as it is) by folks in many fields of inquiry just because it fits so intelligibly within the world we have created around us. This obscures questions of its "truth", so that this becomes undecidable under philosophical inspection. As will be explained in (8), below, the values implied by this theory derive from its privileging of short term gain, expedience and opportunism, which are essential aspects of capitalism.

(2) Along these lines, it ought to be noted that the theory of natural selection is itself very fit in the conceptual world generated by our culture.

Being a theory that works on the principle of competition, it is itself very capable of outcompeting theories native to various fields (in this way it is self-referential). For example, in the field of immunology, it outcompeted instructionist theories. How necessary was this replacement? Yes, the selectionist theory works there, but are we sure that (in a different conceptual environment) an insurrectionist theory could not be constructed that would work as well? ("Work" here means being fruitful in the pursuit of pragmatic knowledge.) If we have a choice of several kinds of theories, all of which are adequate to drive investigation in some discourse, certainly the one that best fits into our current cultural and discursive environments will be chosen. Again, its general 'truth' is suspect.

(3) Its material emptiness.

This is demonstrated by the fact that it has jumped from field to field in the last decades. Formally, all that are required to get natural selection (from Richard Lewontin) are (a) preexisting variability in (b) fittingness to an environment, when any of the variants (c) might be propagated by a system of replication with equal facility and cost. (The degree of differential propagation is referred to as fitness.) So there is little restriction on the kinds of systems that might be susceptible to a selectionist interpretation.

Materially empty theories are theories of anything. When we couple this with (1) and (2) above, we see the possibility of a 'Borgesian' theory that cannot be resisted, or, at least, could be plausible in any field.

Of course this may not make any difference with respect to the social function of science -- which is to predict, or learn to control, natural processes. It is possible that, in the face of an indefinitely complex and generative world, this function could be carried out with any number of different, even incompatible theories. The point is to get the job done, not to understand truly. [I refer to natural selection's practical usefulness to society in (4,b).]

If this theory is materially empty, we might wish to know what kind of theory it actually is. I would say that it is a semiotic theory -- that is, a theory of meaning. Selection is a principle of matching between configurations, where one configuration represents, reflects, or is a sign of,

another. Ultimately, meaning, in its biological application, is held to be stored in DNA sequences and configurations. So natural selection is about meaning, and meaning is held in informational configurations, not in material dynamics (Howard Pattee).

(4) Its social function in the anticipation and control of Nature has, until recently, been vestigial. Nevertheless the theory grew like topsy in the Twentieth Century. (a) Let us ask why. And then (b) let us try to see what its social function has (or might) become.

(a) There is reason to believe that natural selection has won our minds because it has been the only (thereby being representable as the only possible) modern theory of organic (biological) evolution. I here simply note that the concept of evolution in general (including cosmic, organic and cultural evolutions) has itself captured the imagination of our society in the Twentieth Century for various reasons, among which has been a struggle to get free of religious bonds standing in the way of various projects. In this light, we need to see that neoDarwinism is only one theory of evolution, of which there might be others (this realization itself is liberating!). True, there is not at present any competing, equally well-developed, theory of organic evolution (which is partly due to the competitive operations of selectionists believing in the validity of their theory). The question of why natural selection has grown so formidably in adherents despite having had few practical implications is referable back to (1), (2) and (3) above.

So, it can be seen that, until very recently, natural selection has had a largely ideological role, as supplying a conceptual mechanism for what we can view as Modernism's origination myth -- evolution (I use "myth" in its ethnographic sense here, as a believed story of why we are here, how we got here, and what we are doing here). It has not yet succeeded in colonizing evolution theories in all fields -- it still is not prominent in cosmic evolution, for example. In part this is because some so-called theories of evolution (so-called "general theories" in particular) are in reality theories of development. Natural selection has, however, broken into studies of ontogeny (the 'evo-devo' approach to organismic development), at the same time that many students of phylogeny (organic evolution), especially 'cladists', questioned its usefulness there.

(b) Recently there has been a championing of natural selection as a medical principle, thereby gaining for it a more pragmatic importance in order to better justify monies spent studying it. The major insight here is that microorganisms (and some insect pests as well) can mutate and evolve incredibly rapidly -- especially when challenged with antibiotics (or pesticides), or, indeed, antibodies. The response to these challenges can be understood easily using a selection model. This realization has led to altered uses of these agents, and so the selection model has had practical results. (I do not here include the relation of the selection concept to breeding programs on domesticated organisms. These were under way, and mostly completed, long before natural selection was thought of, and, indeed, the idea was originally only a metaphor for them -- Nature doing the selecting instead of people. So the influence was the other way around here.) Recently (see *Science* 311: 1071), real and supposed uses of natural selection in medicine have been presented as a rhetorical challenge ("Medicine Needs Evolution") to those advancing the Intelligent Design program as an alternative to biological evolution studies in high schools.

Various trends in biotechnology are based in genetics, and, since genetics has become central to modern neoDarwinian theory, this seems to confer upon this theory some panache by association. However, most of what transpires in biotechnology could go on without any theory of evolution at all. Genetics validated the Darwinian theory (by supplying material causes for inheritance), not the other way around. We can do genetic manipulations without considering natural selection, or even evolution, at all. But, of course, the neoDarwinian theory fits snugly into our current rage for genetics in biology.

In the realm of computing we have various programs that instantiate the theory of natural selection (e.g., genetic algorithms), or something like it. Certainly here the theory came first, and it has been influential in, say, robotics as well. Even in this area, however, much of its seeming influence may really have come from behaviorism, another mechanistic theory which formally has the same structure as selection theory -- selection by consequences -- as pointed out by B. F. Skinner.

I think it fair to conclude that natural selection's social role is still primarily to supply an ideological mechanism for a favored myth in the capitalist framework.

(5) its privileging the centrality of competition.

In an increasingly overcrowded world, it happens that more people are coming to believe in the evolution of organisms -- including that of people -- by way of natural selection, which works fundamentally on the principle of competition between types. You and I as individuals cannot compete in this game, but, as tokens of various types (blue eyes / brown eyes; dark skin / light skin -- each of us is a nexus of many genetically coded types) our reproductive success contributes to the competition for representation of these types in the population (and of the genes governing them in the gene pool). It is curious that there is an obvious correlation between holding liberal political views and believing in evolution by natural selection -- seemingly, in this context, a flat contradiction! This connection to competition probably ought to be the most troubling aspect of selection theory for liberals. Darwinian models have supplied motivation for social Darwinists of one kind or another ever since World War I, ranging from the German High Command at the turn of the Twentieth Century to some contemporary sociobiologists (now morphed into 'evolutionary psychologists'). We might note here that many sociobiologists hold that competition between populations (e.g., among humans, warfare) is a reasonable way to sublimate competition between types within a population (see discussion of interspecific competition in the last paragraph of (6), below). Irons' review of R.D. Alexander's book The Biology of Moral Systems concludes that the fact that it presents such an unpleasant perspective doesn't make it wrong. The answer to this view is to bring up the social construction of knowledge, where we see that what is desired can generally be constructed as true. Even Elliott Sober and David Wilson's recent book, Unto Others, devoted to tracing the evolution of altruism, is nevertheless based on competition, as any neoDarwinian text must be.

(If one wishes to catch the moral and philosophical flavor of Darwinian implications, the Alexander book cited above, and Jacque Monod's Chance and Necessity are central readings.)

It has often been suggested that such social Darwinist applications are "misuses" of the theory. Well, I think that a theory that has so strong a propensity for this kind of (mis)use could properly be held to be suspect when its adherents are growing apace along with the world population. Or, more innocently, we might ask in just what way a theory that privileges competition as the source of everything is ideologically appropriate to an increasingly overcrowded world. Perhaps it is!

PART 2: Technicalities

(6) Moving now into consideration of details of the formal properties of the concept of natural selection, we can start very broadly by noting that it is basically a theory of, as Einstein might have remarked, higgledy-piggledy. That is, it is a theory of constraints on randomness -- or, indeed a theory of accidental changes.

Randomness is deeply fundamental to the theory in the sense that its major purpose was to find a model of evolution that did not involve any force giving it direction. This relates directly to its ideological challenge to religious views on the origin of humans. (It is amusing -- and perhaps important -- to note that one cannot distinguish between a random event and an arbitrary act! The former is just a default reading of the latter, which would be a creative act.)

The randomness in neoDarwinism has been read into the mutation process, which seems eminently plausible given the DNA model of genes -- and this continues to be appropriate even after it had been shown that some combinations of DNA bases are less stable than others. After all, almost any material system will have structural biases, and the effects of contingency just work around these, delivering various random distributions like the lognormal, the negative binomial, and so on, in different cases. They are all equally random.

Actually, these numerous distributions bring up a subsidiary point about use of the term "random". Random distributions are knowable by way of the various statistical moments, like the mean, calculable from ensemble and population data. External forces might be thought to be able

to influence these statistical moments in subtle ways (as if they were of large scale with respect to organisms), and so we see that randomness is not really the best way refer to what the Darwinians need here. Richard Lewontin has suggested that they use 'capriciousness' instead. Each and every change must be capricious, reflecting pure contingency. This means also that choice is being made here between two major interpretations of randomness -- as being a result of ignorance on the part of the observer, or as reflecting a basic indeterminacy in a system. For neoDarwinians the choice must go to the latter. Otherwise, again, some external force, unknown to us, might be influencing relevant statistical moments.

Stated exactly (Mary Williams), the Darwinian randomness of mutations means random with respect to the needs of the organisms experiencing them. So, not only is there to be no external force influencing evolution, organisms themselves cannot be allowed to be agents in their own evolution either. This puts away most Lamarckian models, in which organismic agency is the main point. And it allows the theory to be, as it is, mechanistic.

So, mutation is held to be random. Randomness functions elsewhere in current models of organic evolution, most notably in speciation. The most widely supported model of speciation is the allopatric model of Ernst Mayr. In this model selection need not have any role at all. All that is needed is for populations to become isolated from each other so that gene flow between them is interrupted for significant periods of time, and then the genomes will diverge randomly by way of mutation until the point where, if the populations were to become contiguous (sympatric) again, they could no longer interbreed successfully. (The process of becoming isolated is also taken to be random with respect to any agency of, or within, the populations -- as, e.g., separation by way of continental drift.) Selection could speed up the process of divergence, and it might also work to reinforce it upon renewed sympatry, but it is logically not a necessary part of the model. Sympatric speciation models, on the other hand, all require natural selection, but no one suggests that they would be responsible for other than a small number of speciations that posed problems for the allopatric model. And in these cases, as in all, mutations would still be random.

Further applications of randomness to the Synthetic Theory of evolution (neoDarwinism extending its conceptual reach into morphology, ontogeny, paleontology and ecology) include genetic drift, preadaptation (prospective adaptation), and environmental change itself.

Genetic drift is interesting because it shows well how neoDarwinism is at base a theory of hazard. As populations become smaller, sampling errors conspire to drive their gene pools apart statistically because deterministic forces (as selection is often imagined to be -- but see below) cannot function as effectively in small populations. In these models we clearly see that selection is just a bias on randomness, and its effects weaken as the effectiveness of statistical predictive techniques weaken as a population's size declines. Furthermore, although usually described as a force that can oppose selection in small populations, in populations of modest size (as in most animals and plants) one of the major roles of drift is to give the coup de grace to any genes that have become reduced in frequency (as by selection) below a certain level. Only this force -- the chance deaths of the few remaining survivors -- is capable of totally eliminating an a piece of information (an allele) from a gene pool.

Preadaptation is the situation where, by chance, some characteristic(s) of a kind of organism would allow it to explore, even if not very effectively at first, some new way of life. Such unexpected potential utilities would be an unavoidable property of any complex system. Providing that environmental changes make such a new way of life possible, and providing that no other populations are working some similar way of life in the same region, then a population might partially at first and then gradually shift into a new ecological niche, with time for selection to improve its ability to live this way without competition from other populations. The shift is often seen as being carried by behavioral exploration, which, however, might be problematic for Darwinians in that, unless we can take organisms to be machines, this could open up possibilities for their agentive action in their own evolution (as in the 'niche construction' heresy). As I will show, organisms are taken to be mechanistic by Darwinians, and so exploratory behavior can be viewed as just the occasional, and not necessary, realization of accidental propensities via random fluctuations and excursions.

Since there is in Darwinism no theory of the environment, environmental change is always viewed as formally accidental (in models it is just an arbitrary declaration), and it often occurs in any case at a scale that is beyond any effects a population might have on its environment. Even if some larger force were directing such changes, they could not have any direct or predictable relation to the needs of populations of organisms or their responses.

Insofar as the environment of a population is composed of populations of other species, there is a kind of theory of the environment in neoDarwinism in what Darwinians have called “community ecology”. We can begin with Gause’s competitive exclusion principle, which states that not more than a single population can occupy a given (Hutchinsonian) ecological niche. If it should happen that there comes to be niche overlap between sympatric populations, the process of character displacement (W.L. Brown and E.O. Wilson), (by way of which phenotypes in a population that exploit resources most different from those exploited by other contiguous populations will tend to succeed better than others) will drive all the populations in a region apart ecologically. This will deliver a niche plenitude such that all available energy gradients in a region will tend to get exploited. Leigh Van Valen has postulated that this situation will deliver a “continuous deterioration of the environment”, since any population that does better for a few generations, expanding its hegemony, will create energy shortages for some other populations, and that this will spread in a region, resulting in a continual jostling for resources among contiguous populations that can never settle down because, even just by way of fluctuations, some population will eventually come to do better than it has done. (The implication here is that each population has maximized its energy throughflow, and that energy is fungible from niche to niche, delivering an energetic zero-sum game.)

Summing up, we can see that the import of the Darwinian theory of evolution is just unexplainable caprice from top to bottom. What evolves is just what happened to happen. For neoDarwinians, organic evolution is, precisely, pointless.

(7) It incorporates no theory of origins.

Despite the title of Darwin’s book, he disavowed any application of his selection idea to origins. For him in his book, the origin of species was just the gradual transformation of organisms in a given population as a result of selection over a long period of time, so that, if a naturalist were to examine specimens from the original population and some from the latest, he would be inclined to declare them to be from different species. George Simpson called this phyletic evolution, as opposed to lineage splitting (Bernhard Rensch’s cladogenesis). (Darwin even rejected the idea of an allopatric model of cladogenesis when it was put to him by Moritz Wagner, probably because, as mentioned above, that model does not require selection). A few workers have recently been trying to incorporate variation generation into the idea of natural selection, but without eliciting any general interest, or having much success. Selection, formally, is just culling or weeding (see below).

It is perhaps worth mentioning that the core of neoDarwinism, population genetics theory, is fundamentally mathematical. In mathematics, crisp as that (which has been used) is, nothing new can be generated -- except by way of error. (If the theory were to be translated into fuzzy set theory, or, even better, recast in some kind of logic of vagueness, the possibility might arise of having a mathematics that could generate new categories.)

After variants are generated at random with respect to needs, the selection regime itself is just a negative, mechanical, process of culling. In the resulting mythology we are, as George Wald quipped, the products of editing, not of writing. To make this more clear, consider monkeys at keyboards. If they type lines of letters, these could be made, by deleting and joining adjacent letters, into a series of words, which, with further editing and leaving spaces, could be joined up into simple texts. This would be analogous to adaptation (here, the generation of meaning) within some environment (in this case, a language and its traditions) based on a random generation of units. (It may be objected that the deletion and joining done here actually reflects intentional activity, and so this would be a model of artificial selection rather than of natural selection. Well, intentionality of some sort is a necessary part of the system when using a linguistic model. In that framework I would model artificial selection as above, but with there being a given text in mind

when the cutting and joining is done.)

The negativity of the action of selection is clearly reflected in the equations of population genetics, where, in the Fisher version, the fitness of given types, \underline{m} , = births minus deaths (and failures to reproduce). That is, it reflects deductions from hopeful beginnings. In the Wright-Dobzhansky version, fitness, \underline{W} , = 1 minus the selection coefficient. That is, selection is represented as a deficit from maximum performance. The action that is modeled in population genetics is not variability generation, but its culling (see discussion of the Wright-Dobzhansky model in the next section for a small qualification).

A related point arises with frequent use of the phrase ‘selection for something’. This is just an oxymoron of loose usage, as I will explain further in (9), below.

(8) its failure to explain, as Darwin hoped it would, evolutionary improvement of phenotypic characters and behaviors.

It has been noted that much of the history of Darwinism in the Twentieth Century involves a gradual divestment of all notions of progressive evolution. Another way of putting this would be that the theory has been purified of all developmental aspects. This has also moved the theory away from theories of general evolution. Unwittingly (one would suppose) this has undermined the possibility for Darwin’s idea of the improvement of traits as well.

In mid century, improvement was discussed under the heading of evolutionary trends. These were later deconstructed by noting that they were actually constructed from contemporary (target) morphological forms of special interest, working backward through the fossil record so as to reconstruct intelligible stories when read forward. When examined more closely, most of these stories fell apart, or, at least, became much more complicated and ambiguous. Coupling this with the actual form of neoDarwinian theory (see below for more details) showed that it gave no support for evolutionary trends except as accidental by-products of the survival of populations from one generation to the next. The phrase “the evolution of this or that”, so common in museum displays, became oxymoronic. For example, the putative selection processes that left certain dinosaurs with feathers could not be assimilated to a story of the evolution of flight, or of the evolution of wings, except as a post hoc view from the present. There would have been, in a neoDarwinian interpretation, no processes that actually operated as the ‘evolution of’ anything, rather just a haphazard survival of concatenations of populations adapting one way or another in the short term to local conditions.

NeoDarwinians do acknowledge that there might be biases in the directions that evolution might take in given lineages, but these are viewed as having been built into the system as results of historical accident, preserved by a kind of developmental inertia (the system has a memory, and does not go back to square one with the development of every new organism).

Natural selection can be directly demonstrated in laboratory and field experiments, and has many times been shown indirectly to (most likely) have been occurring in nature, but its connection to long term evolution is an inference only -- especially since the theory shows no detailed structure that would allow such a connection (see below). Observations of the effects of selection in natural populations support the idea that selection plays a negative role in preserving well-adapted types. Experiments on microorganisms have shown that some trait, originally poorly represented in a population can come to predominate after the environment was altered. The idea that traits can be improved by selection has had its empirical support from just these two (one indirect) lines of evidence.

There are two major theoretical prongs in neoDarwinism: the Fisherian dynamical approach and the Wright-Dobzhansky kinetic approach. Neither delivers real long term evolution. In Fisher’s version, which does track over many generations, we begin with a population having a degree of variability in characters that could link to fitness. The environment changes, and, as a result of differential reproduction, some variants are discarded from the population while a few as a result increase in frequency of representation. This process, generation after generation, results in a net decrease in population variability in fitness as population fitness with respect to the altered environment improves (Ronald Fisher’s ‘fundamental theorem of natural selection’). Variance in

fitness is exchanged for adaptation. This genic improvement could reasonably be linked to some phenotypic evolutionary trend. By the time the population has achieved an adaptive gene pool configuration (if it hasn't gone extinct for lack of appropriate variability), it has lost variability to the extent that, if the environment should change again, extinction would be a likely result. The population has become overspecialized. In this model, evolution leads to the brink of extinction. Of course, one would posit the introduction of new variability by way of mutations to replace what was lost, but that is not represented in the theory, only stuck on for verisimilitude in the minds of biologists. We might note that there are examples of ecologically seemingly overspecialized organisms (using only a single food supply, for example), and these tend to be statistically quite rare, often with small populations in inaccessible environments, suggesting that slight environmental changes would lead to their extinction. Fisher's model perhaps works well enough to explain these.

Turning to the Wright-Dobzhansky model, this is concerned with preserving variability from one generation to the next, and does not track evolution over the generations as does the Fisher model. The purpose of this version is not to show evolution, but to model how populations contrive to survive from one generation to the next. Crucially, the environment deteriorates each generation, and the game is to try to get, or preserve, as much variability as possible, so as to be ready to survive the next generation's unpredictable environment. Gene frequencies shift back and forth from one generation to the next, getting nowhere in particular. Observations on natural populations of Darwin's finches in the Galapagos Islands reflect this pattern. One might have the bright idea to combine Fisher with Wright-Dobzhansky (and many evolutionists do so implicitly), but that is not really possible technically because m is a dynamical, continuous variable, while W is a discrete variable. The purposes and techniques of the two models are different. That is, the overall theory, if one can call it that, is incoherent. One might loosely combine the two into a general philosophical viewpoint, and what one comes up with then is: evolve at your own risk; instead, just try to stay in the game as long as possible!

This reminds one of the Dan Brooks-Deborah McLennan view that the major role of natural selection is just to preserve existing adapted phenotypes by weeding out abnormalities -- that is, to maintain adaptedness. It should be mentioned in this connection that many of the indirect demonstrations of selection in nature evidently refer to a process of this kind. They show (a) that individuals that tend to get eliminated by drastic environmental deteriorations (winter storms, etc.) are those with measurements at or beyond a standard deviation from the average type for the population, or (b) that traits demonstrated (or more likely) to be more crucial to survival tend to be less variable than traits that seem less important (as if the former have been subjected to greater selection pressures). There has been no demonstration in nature of long term evolution of a new adaptive configuration following an environmental deterioration. Some putative examples, like industrial melanism in moths, turned out to be much more ambiguous than at first thought. Others (as in studies of Darwin's finches) show selection in different directions resulting from repeated experiences of the same environmental problem (drought), rather than the reinforcement of the direction of selection from one episode to the next that would be required for directional evolution to deliver improvement.

Selection experiments with microorganisms running over many of their generations do show improved adaptation of a trait (usually resistance to some toxic substance) in a given direction. Beyond noting that this kind of experiment, considering the high intensity of the selection pressure constructed on a single trait, is very like artificial selection experiments, I will point out below that population genetic theory can indeed support directional evolution of single traits. It just has not been demonstrated in nature.

Here we should note two large reviews of many studies of natural selection in natural populations (Endler, 1986, and Kingsolver et al., 2001). They both found evidence for the balancing selection mentioned above, which merely maintains the adaptedness of populations. The more recent study claims that there is as much evidence for "disruptive selection" in the data. The implication within this study is that this disruptive selection (the variability of the trait is greater after selection) could actually be directional selection, which I am throwing into doubt here. But

there are other kinds of selection that could be responsible for increasing the variability of a population, which have been argued by some to be very important in nature -- forms of balancing selection like density and frequency dependent selection, which do not lead to evolution. And directional selection should have this effect only early in its progress, thereby providing evidence only for the beginnings of improvement here. In passing I should mention that Kingsolver's study noted that for the most part selection is a very weak force in nature, and A.P. Hendry has recently abetted this view in *Nature*, Vol 433, 2004). Is this held against the idea of selection? Not at all! It is what would be expected within the general Darwinian view that evolution by selection is a very slow, long drawn-out process -- therefore untestable within finite lifetimes.

We should note again here (see 1, above) that the values that emerge implicitly from thinking about our own evolution in these ways are: short term gain, expedience and opportunism. Natural selection, being a mechanistic process, cannot foresee the future. It works ("tinkers", as François Jacob said) with whatever raw material is at hand to produce (population and genotype) survival now. Herbert Simon achieved a Nobel Prize by applying this principle to economics, with his idea of "satisficing". He showed that, over the long haul, global planning for the future does no better in cost / benefit analysis than the local strategy of reacting, and fixing things serially, as problems emerge. But this was just a reading back into economics of a principle that, in light of Darwin's being influenced by classical capitalist economic theory, came from there originally (Nietzsche thought Darwin thought like an English shopkeeper!). Of course, Simon's achievement was a mathematical one, and, once again, I would point out that explicit mathematics is a mechanistic system, and so we do not really know to what degree satisficing would be the best strategy in the natural world which, although it appears to have some properties that may be approximately modeled as mechanisms, is certainly not a machine.

So, with current neoDarwinian theory, we can claim that it does not model evolution, only short term survival from one generation to the next.

(9) its failure to model generally the evolution of more than a single phenotypic trait during a given period (I would suppose that there might be multi-trait models for special ideal (unrealistic) conditions, like haploidy, no population structure, non-overlapping generations, very large populations, etc.).

This came to light when J.B.S. Haldane noted that the fitnesses of independent traits would have to be combined multiplicatively, and that this would so rapidly increase the cost of natural selection (in the number of deaths / failures required for favorable alleles to replace others) as more traits are considered, that one could not imagine the simultaneous evolution of more than one or two phenotypic traits in populations of moderate sizes (as in most animals and plants), given reasonably effective (even if slow) rates of evolution.

Are phenotypic traits actually selected independently? Of course, more than a single unfavorable character state could occur, and be eliminated simultaneously, in the same individual, but Haldane considered this in his calculations. One might note that traits would really function independently only in machines. But it is clear that organisms are considered to be mechanistic in the calculations used in science, including neoDarwinian theory. Crisp, explicit mathematics requires this drastic approximation. Read any description of organismic adaptation and you will find that traits are described separately (for whatever reason) as if they were tools used by organisms for adaptation. The measurement of bird beaks is a commonly cited example. Length, width and height are each considered separately. Even if multivariate statistics finds a way to combine such measurements, the beak would still be considered separately from, say, the legs.

More recently we have had numerous studies of variance-covariance matrices (G- and P-matrices) used to study the correlated evolution of several traits simultaneously. The main import of these seems to be that the way one trait evolves will be constrained by the relationship of its variance in fitness with that of other traits -- in fact, showing how this imposes limitations on the effectiveness of selection on a single trait. But, yes, these studies do take into account the simultaneous evolution of several traits. Traits are considered, not simply as independent or not, but in a gradient of degrees of independence. My point is that, to the degree that they are

independent, their evolution would still be constrained by Haldane's calculation. To the degree that they are dependent, our verbal description of them as isolated entities (the beak, the tail fin) falsifies (and greatly complicates) our expectations of how they can evolve. And, of course, no one would go to the lengths of considering all traits to be connected up by significant covariance. In that case the rate of evolution would be significantly impacted.

Several workers came up with essentially the same general solution to 'Haldane's dilemma' (concerning the trade off, in moderate populations, between reasonable rates of evolution and the number of traits that may evolve simultaneously), but it comes at the price of not being able to consider individual phenotypic traits as subjects of evolution at all. Bruce Wallace's 'soft selection' is a well-known, representative technique. Beginning with the key Darwinian fact that organisms produce offspring way in excess over what can be supported by their environments, Wallace postulated that individual survival and reproductive success would be keyed to the number of favorable character states individuals had overall, in all of their traits. Those with serious developmental or physiological problems would be eliminated first, those not quite as badly off next, and so on down to reproductive competition between sound individuals as the population approaches its carrying capacity level. Organisms are being compared, not on the basis of this or that trait, but on global fitness. While only fitness is maximized, individual trait measurements would be jointly optimized. But no individual traits are represented in this theory, and so it is useless to those who, like evolutionary morphologists, consider the evolution of such traits. They would still be left with Haldane's dilemma, and so would be the layperson interested in the evolution of, say, eyes or brains, which have numerous traits influenced by numerous genes.

In *Science* (Vol. 302:1876) we have an article bearing upon the logical limitation to only one or two independent traits evolving adaptively simultaneously at moderate rates in moderate sized populations. It appears that empirical evidence shows that even very rapid overall evolution need not involve simultaneous evolution by selection of many independent genes at all. Here we find an estimate that about 1547 human genes have evolved adaptively in 5,000,000 years. That would be (given a generation time of somewhat less than 20 years), say, 1547 selectively mediated genetic changes per 300,000 generations. That would be about 0.005 such changes per generation, or about 1 adaptive change in about 200 generations -- rather slow to be associated with such large phenotypic changes! And humans are supposed to have evolved especially rapidly, with smallish population sizes! With rates like this in such populations, it would seem that we can reasonably visualize selection on only one or two genes mediating all of adaptive evolution. And so Haldane's cost of evolution calculation, while reasonable because logical, does not appear to impose a limitation on actual phenotypic evolutionary rates. How we can understand all the simultaneous modifications that must have been involved here in the light of so few accompanying genetic alterations seems to me raises yet another mystery. It might be tempting to invoke correlated evolution of many traits at once, but evidence on that head shows that rapid evolution disrupts the correlations.

I should mention the remarkable feats being reported concerning the use of selection in computation to design shapes, robots and products using the likes of 'genetic algorithms'. The claim here is that, given a complex shape coded for by several to many "genes", a selection process can be instituted to improve any function entraining that shape. The resulting shape changes are not predictable (not built into the program to begin with), nor is the trajectory taken during the improvement. In other words, this models a multigene selection process. However, it does not escape Haldane's dilemma, because there is only one function being selected at a time -- one selection pressure. Perhaps two functions might be optimized simultaneously, given a large enough population of robots. But this is not like selection among organisms, where only fitness is maximized, not any particular function (except, perhaps rarely, in some catastrophe). Another disanalogy can be seen when we note that much, if not most, genetic information in organisms is pleiotropic. This means that not just any old change that will improve some function can be selected in organisms without consequence for other functions. The selection model seems to work better in genetic algorithms than it could in organisms!

Reference to the opportunism of adaptation could be brought up here again. Given the

complexity of the phenotype, no particular solution to an environmental challenge could be privileged. If we have a population of mammals in a region which is getting colder, they could respond by (a) getting larger, (b) getting smaller and going fossorial, (c) growing thicker fur, (d) going dormant for the coldest season, (e) migrating seasonally, and so on. One could not really even define the environmental problem coming out of, say, a colder environment, without considering in detail the form and lives of a particular population.

We can here consider an oxymoron commonly used by evolutionists -- “selection for this or that trait”. Aside from the fact that selection pressure is modeled negatively in mathematical models (see (7), above), we can now see, using the quite reasonable soft selection model, or with correlated phenotypic traits, that no trait could be isolated as showing a character state that is favored by natural selection (any more than any other one evolving simultaneously). Selection for something can only be modeled in cases like artificial selection, where human agency repeatedly applies truncation selection on a given trait. Using the monkey at keyboards analogy again [see (7), above], we could model selection for something by having the inspection of the random letters be informed by a pre-given text. There is one other possibility where selection for could be used, but neoDarwinians are not likely to embrace it.

It would be possible to have a single-trait Darwinism in which traits are viewed as evolving one at a time, sequentially, with the information from each new allele being assimilated into a developmental system which oversees the construction of the phenotype. The problem with this for neoDarwinians is that this privileges the ontogenetic system as the site of all the action, with selection just providing tokens or memory benchmarks cueing that system into modulating some developmental processes. This view would also go against the current enthusiasm for genetic reductionism shown in phrases like “this trait is coded for by gene X”, and would make nonsense of the popular Dawkins / Dennett genic reductionism. Furthermore, this scenario would not escape Haldane’s problem, as important traits get added to the overall phenotype one at a time until very many would have to be scanned by some normalizing form of selection. As they evolve into importance, each trait would have to be maintained by way of its own imposed genetic load, so that the population would need to grow and grow as more important traits get added to its overall phenotype.

(10) The internal contradiction in its major theoretical cornerstone -- Fisher’s fundamental theorem

As mentioned above, Fisher’s theorem has it that population variance in fitness is exchanged over the generations for population fitness increase -- that is, for adaptedness. A corollary would be that traits having been subjected to heavy selection pressures, because of their importance in the lives of the organisms, should be less variable than less important traits. This has been found in traits judged to be of importance for jumping in frogs (Salthe and Crump, 1977), while these same traits were not found to be significantly less variable than others in populations of frogs that walk but do not jump. Now, at the same time, note that when asked which traits are most likely to be able to evolve, evolutionary biologists, again citing Fisher’s theorem, will reply, “those that have more variability in fitness”. That is to say, traits that have been most important in the lives of organisms up to this moment will be least likely to be able to evolve further! So Fisher’s theorem is “schizoid” when one compares its postures facing the future or the past. And once again one faces the possibility of single traits evolving sequentially, building up by way of ontogenetic agency an overall adapted phenotype subjected to an increasing genetic load directed at maintenance.

(11) its ability to explain only differences between characteristics of genealogically closely related types.

This follows from the fact that genetic configuration, rather than material processes, are considered to be the locus of inheritable information. Genetic information allows the developing system to place constraints on material processes, modulating them, slowing some down while speeding up others. Form itself, or behavior, as such, cannot be attributed to genes, because these phenomena are the products of physical activity. The cell uses DNA information to inform its

(formally preexisting) activities. You can inherit a different style or rate of construction, while you actually are a material locus of processes of construction. The material differences between a wolf and a deer are slight; their genetic information differentiates them functionally -- indeed, semiotically.

These facts are reflected in the techniques of genetics experiments, where, if there is no phenotypic difference between two types, no gene will imputed to exist. The operational definition of a gene is a difference in DNA that makes a difference to metabolic activities and resultant forms. Many examples of DNA differences unconnected to phenotypic signs are known. It is sometimes claimed that once the DNA-protein system was understood, the gene had become materialized, and so no longer needed to be tied to its operational definition as a difference. Yet, no functional gene is discovered without there first being an associated phenotypic difference. Especially now that we know that genetic information for given properties is scattered around in the genome and collected by post-transcriptional activities, rather than being localized according to traits, to speak of genes for this or that trait is a mere reification. Genes have now become operationally constructed as differences in patterns of molecular activity.

Given these views, we can see that only differences between types require genetic information in order to be explained. Indeed, some such differences may not be genetic either, but I think it fair enough for biologists to presume genetic differences where phenotypic ones are found -- when comparing closely related forms. Differences between such distantly related forms as snails and wolves need not reflect differences in particular genes. As well, similarities, even between closely related forms, require no genetic information to explain. From the point of view of genetics, similarities are taken to be just the absence of differences. They are non-phenomena. We may indeed find similar genetic forms among very distantly related organisms, as in the HOX genes, yet not infrequently these similar genes perform different functions (albeit in the same general system) in these different forms.

So, genetic information is needed currently to explain niche differentiation among recently diverged organisms. In fact, that is what natural selection can be used, with the above reservations [especially in (9)], to explain.

(12) its inability to explain similarities between organisms and ecological systems that are not related by descent.

Convergent evolution and ecological vicariance have no explanation using Darwinian models, which are based solely in descent with modification, which, as just considered, can explain differences, not similarities. (Parallel evolution can be explained simply enough as similar genes in closely related forms responding to similar selection pressures.) Hence important cases like the similarities in the eyes of cephalopods and vertebrates have no natural explanation within Darwinism -- except, once more, the all pervasive 'chance'. There have been some preliminary attempts to locate such similarities as results of a wholesale transference of genes, by way of viral infection, from one kind of organism to another. This would fit with neoDarwinian views, and we can expect this idea to be exploited for whatever it may be worth. In the meantime, convergent evolution tends not to get mentioned at all in important texts. To give another example of convergent evolution, consider chameleons and sea horses. Both, of similar size, are slowly creeping, bushwhacking predators. Both have independently movable eyes and prehensile tails used to hold onto foliage. Both are camouflaged. Using different genetic materials and working from completely unlike ancestors, it is as though they have been poured into the same mold.

Conclusion:

Finally, then, it is my conclusion that the neoDarwinian (Synthetic) theory of organic evolution, insofar as it is crucially driven by the concept of natural selection, is not suitable to be a part of Modernism's creation myth. At a time when the world is becoming crowded, it seems little conducive to peace to believe that competition, which is the basis of natural selection, is the source of all good (including ourselves), however well such a belief might fit within our current economic system.

As to its ability to explain the evolution of organisms (as opposed to the evolution of gene systems), it has not, after some 60 years of development, delivered a very convincing mechanism. It cannot explain origins, or the actual presence of forms and behaviors. It can generally explain only the evolution of adaptive differences as results of historical contingency, for only one or two traits at a time. It is limited to historical explanations, as it acknowledges no evolutionary tendencies that are not the result of accident preserved in genetic information. History is the source of everything in this theory, and that is just too simplistic to be plausible in a complex material world. I think it could be said that, were there another theory of organic evolution, the neoDarwinian one, fraught with problems as it is, would have more trouble surviving than it does. As it is, it is the “only game in town”, largely because of the competitive activities of the neoDarwinians themselves.

Postscript: As added support for the viewpoint projected herein, I cite two of Richard Lewontin's works. First, his The Genetic Basis of Evolutionary Change, (1974, Columbia University Press) has a discussion of the effects of linkage disequilibrium among genetic loci on the process of selection that makes it seem highly unlikely that selection could be very effective in improving a trait using a more realistic model of the genome than is usually used. Recently he has produced a paper for the Santa Fe Bulletin [Volume 18 (1), Winter, 2003] which raises four “complications” to the theory of natural selection that seem to me to cripple it altogether. For the mathematically inclined, there is also Fred Hoyle's work, posthumously published as Mathematics of Evolution, Acorn Enterprises, 1999