

Punctuation and Progression:

Can Environmental Variation Generate Information Gains?

Introduction

As a scientific theory, Punctuated Equilibrium has been slowly gaining acceptance within the popular media and the scientific community in general. Some of its proponents would even argue that its underlying concept of punctuation events (prompted by environmental variation) has been considered an essential element of evolutionary theory even since the time of Darwin, (though perhaps not in its currently fleshed-out form, and never in disagreement with a firm belief in the more basic concept of gradualism). But regardless of its position as a primary or secondary cause of progression, the basic requirement of at least some punctuation events in the history of evolution is fairly well ascribed to. The following paper will consider the effects that environmental variation will have on the information building process that is a fundamental requirement for progressive evolution. Although the theory of Punctuated Equilibrium asserts a positive role for these environmental changes, it will be argued that such changes will always, or nearly always, have a negative net impact on the amount of novel information that will be present in a population's genome and thus undermine any possibility of progressive evolution.

Local Maxima / Fitness Peaks

Given the assumption that progressive evolution *can* occur within a fixed environment, the average fitness value of any population being studied must necessarily gravitate towards a local maximum (fitness peak) in relation to its environment. If this population is then moved into a new environment, the original local fitness maximum may, or may not remain the maximum to which its organisms will continue to evolve.

If the old local maximum were to remain, the change in the organism's environment would have produced no significant effect on the evolution of the population and would therefore have served them no advantage. If the maximum did change it could either increase, decrease, or move so far away from the original value that none of the organisms that had been fitted to the original environment could ever survive within the new environment.

If the maximum were to move to a point in which the organisms could no longer survive, the progress of evolution would necessarily stop and the organisms would simply die off. Obviously, this kind of change cannot aid progressive evolution. Throwing a school of fish into the middle of the desert does not result in these fish growing limbs, or evolving lungs, it simply kills the fish. On the other hand, if the maximum were to move up or down, then the questions that should be considered are, "Would evolution progress at a faster rate if the organisms had always grown up in this new environment?", and, "Would the change in the environment incur a cost that evolution would be required to pay?"

Environmental Costs

The answer to the second question is "Yes". If organisms that have been well fitted to one environment are then placed into a new environment they will likely have both characteristics that are lacking in relation to this new environment, and those that are superfluous to it. Any characteristics that are lacking will need to be gained through the usual means of evolution, and thus, the change in the environment will not help to improve the speed of their evolution (environmental changes do not, and can not, accelerate the *basic* rates of evolutionary processes). On the other hand, any characteristics that are superfluous can only serve to reduce the organism's chances of survival, and thus, will be selected against and lost. This process of elimination will require the organism to

accumulate a certain number of mutations, in accordance with the amount of excess that is present in the genome (incurring a cost of production that will be required to facilitate their propagation). Thus, the net effect of environmental changes on the rate of evolution will most often be negative.

Fitness Overlaps

But can environmental changes benefit evolution at all, then? Yes, they can. If an organism cannot survive within a new environment in its current state, an intermediate environment could provide the organism with the opportunity to evolve some of the characteristics that will later be required by the new environment that were not required in the original environment. This is the type of mechanism that is commonly posited by evolutionists when they argue for life beginning in a small pond, then moving to the oceans, then slowly moving to land at the edges of the oceans, etc. (to oversimplify the argument a bit). In fact, evolution as a whole should progress the fastest when these overlapping requirements are able to change in accordance with the maximum rate that is required for the evolution of the corresponding characteristics.

As hopeful as this may sound to the evolutionist, this overlap will not increase the speed at which individual characteristics can evolve in their most *basic* sense. Overall, this scheme does allow for an increase in speed, but this speed is nevertheless still limited by the general rates that can be observed in fixed environments. Such an increase only really allows for non-existent rates of evolution to be improved to very slow rates (if this is even possible), not for slow rates to improve to the very rapid rates that evolutionists often appeal to in punctuation events. Fitness growth may require environmental changes in order to succeed, but the growth rate that is obtained will always depend on the more basic problem of information gain from random mutations and the selection of these mutations according to their corresponding fitness gains.

Homeostatic Limits

An advocate for the theory of punctuated equilibrium is likely to respond by pointing out that much of this argument can be granted – and might even argue that some of the concepts that have been mentioned above are essential to their theory – despite what the popular media might portray in its depictions. It can be conceded that active and passive changes in the environment do not occur at the optimum possible rate – in fact, this is why the fossil record looks so incomplete. Fixed environments and large populations will cause evolution to halt once a certain level of fitness is reached; the larger a population is, the less likely it is for a small mutation to survive the effects of genetic homeostasis, even if this mutation provides its host with minor benefits. For these reasons, most of the geological record should and does appear to be static. Environmental changes are not thought to actually increase the *basic* rate of evolution, rather, they are meant to explain how evolution could overcome homeostasis. The advocate of punctuated equilibrium will thus theorize that the basic rate of evolution is simply faster than the rate that is currently observed in large, static populations; not that new environments actually prompt an organism to actively adapt outside the normal means.

So then, beyond overcoming homeostasis, where does the theory of punctuated equilibrium really posit an increase in the rates of fitness gain? Essentially, it is in the increased transmission rates of positive mutations throughout the population due to the reduction in the population's size and higher selective forces. Presumably, some of this information is already inherently present in the genetic “library” of the small population before the environmental change occurs, and this information will be enhanced by the effects of genetic drift, while the rest will simply be obtained of necessity (by good fortune) due to selective constraints.

But if a significant proportion of the required genetic changes occur within the context of the larger population, how is it that these changes are able to withstand the effects of homeostasis within the larger population before its separation? If the acquired characteristics were significantly beneficial in the original environment, why wouldn't they have simply taken over the original population? If they were neutral, wouldn't they have been eliminated by the effects of homeostasis? And if they were negative, wouldn't they have been eliminated by natural selection? It would seem, then, that any mutation that is capable of conferring a selective advantage to an organism in its new environment would have either eventually propagated into the original population anyway, or quickly disappeared.

Genetic Drift

Geographically then, the organism that has this mutation must live close enough to the boundary between the two environments for this switch to be possible within a few generations, and those few generations that have been gifted with the new gene would need to migrate into this new environment as a group. Genetic drift could then enable one organism to propagate its genes throughout the small population relatively quickly, but it could just as easily wipe its advantageous mutations out. It is no wonder, then, that these punctuation events are considered to be rare: a positive mutation must occur that is advantageous in a new environment; this mutation must occur relatively close to the boundary with this new environment; individuals that have this mutation must migrate into the new environment (or the environment itself must change around the population); the mutation must survive the effects of homeostasis in the larger population; and the mutation must then survive the effects of genetic drift within the smaller population.

But, even granting these rare occurrences, one must still deal with the *overall* effects of genetic drift within the new population. Since the effect of genetic drift is the homogenization of the alleles that are present in the population due to random variations in gene frequencies during its reproduction, it is clear that genetic drift will neither favor the beneficial mutations that characterize this population, nor restrict its action to this small, characteristic subset of the population's alleles. The net result of genetic drift will thus be a fairly drastic reduction in the genetic variation that exists within the migrant population, or, to put it another way, the loss of a fair proportion of the alleles that had been present in the original population. This problem is further exacerbated by the initial reduction in allele variation that is associated with the extraction of the population from its parent population, as well as from the higher selective forces that are assumed to be present. If progressive evolution is to occur within such a context, this wholesale loss of information must necessarily be regained by the new species at some point in time.

Crossbreeding / Hybridization

Although some might look to crossbreeding with the original population as a mechanism to make up for this deficiency in allele variation, it is clear that this cannot be the case. Punctuated equilibrium is supposed to be an explanation for rapid speciation, and thus, no crossbreeding would be possible after this speciation had occurred (by definition, differing species cannot, or do not crossbreed with one another). Likewise, any crossbreeding that would have occurred before the species change would have simply nullified the supposed advantages that were to be gained from small population sizes and genetic drift, and thus render the entire theory useless.

Gains of the Gap

A more reasonable theory would be to locate the source of these neutral genes within the major gaps that separate punctuation events (to assign the gain to the period of time in

which the new environment is to be propagated may account for a small amount of this gain, but its contribution would be minimal, given the lack of time that would be available for mutation events to occur). If the new variation is to be found within these large gaps, then the fossil record should demonstrate this fact by displaying less variety during the assumed early ages of a new species' existence, and then showing more variety as it progresses through time (to my knowledge, this does not seem to bear out in the proposed ancestry line for humans, to mention but one case). Moreover, any new variation that could be obtained would still need to overcome the effects of genetic homeostasis within the established population, (perhaps through further, less "punctuated" environmental isolations). Thus, to a certain degree, punctuated equilibrium can be shown to *cause* many of the problems that it is designed to solve.

Species Building

But even ignoring these issues of code maintenance, how well would these environmental changes aid in the fundamental information building process that is required for speciation? It is clear from what has been discussed above that a large proportion of the changes that must occur during speciation must occur within the new environment. Speciation cannot occur in the parent population within the original environment, or else punctuated equilibrium would never be required. Likewise, it is difficult to see how a subpopulation could form into a new species and still be able to reproduce sexually with the parent population (this should be impossible given the definition of the term "species"). Once again, if these new mutations were relatively neutral to the parent population, genetic homeostasis would restrict the amount of change that would be possible before the subpopulation's move into the new environment. If wide-scale changes are able to occur within the parent population, they must be gained quickly, involve relatively simple mutations, and involve at least two steps before speciation could occur (in a sexually reproducing species). For all intents and purposes, then, at least half of the genetic changes required for speciation would need to occur within the new environment (that is, if punctuated equilibrium is to have any value at all).

While large, fixed populations have major problems in *retaining* novel mutations, small populations have a major problem in *obtaining* novel mutations. While a population that is one percent of the size of another population will have a smaller chance of *suffering* from negative mutations than the larger one does, it will also have a much smaller chance of *obtaining* positive mutations. And while genetic drift may increase the chances that new, positive mutations will fix themselves into the population, it also increases the chances of fixing new, negative mutations into the population. Higher selective forces may help to counter the effects of genetic drift, but they cannot entirely overrule these effects since genetic drift is drastic in small populations, while selective forces are relatively insignificant to the population if they are not fatal, or debilitatingly negative. It is true that major positive mutations could propagate more quickly within a smaller population, but these mutations are extremely rare. At the same time, small, negative mutations will be much more common, and thus, much more likely to dominate the evolution of the population's genome (as a hindrance to its progression).

Rearrangement / Horizontal Gene Transfer

Some will undoubtedly appeal to chance information copying and rearrangement (internally, or via horizontal gene transfer) as the source of the required novel structures within a new species. But while it is certainly true that organisms throughout the world share many common code sequences, the mere demonstration that one sequence could be replicated and used in a slightly different manner in another organism is insufficient to prove progressive capabilities. The reuse of sequences is not primarily at issue when information building is in view, it is the origin of these sequences themselves, and of new, novel sequences that is in

view; it is wonderful that the same nut can be used in both a car and a barbecue, but this doesn't account for the origin of the nut in the first place, nor does it explain why the nut fits so well in both of these objects. It is simply wishful thinking to assume that code sequences can easily fit, like gloves, into any location of the genetic code that they are placed into without requiring the addition of any new code to allow for their accommodation. Organisms as a whole are much too integrated to allow for such a simplistic view to be seriously entertained.

Meaningful mechanical systems must be designed with thoughtful foresight so that all of their components – interchangeable though they may be – can fit together into a tightly-knit, integrated system. Likewise, computer programs may contain interchangeable classes that can be used in multiple programs, but these programs can't use these classes unless they are given the ability to interact with them through their interfaces. In fact, any integrated system that utilizes an interchangeable part must include an accommodating code sequence/interface that is adequate enough to allow for its meaningful interaction with the given part's own interface. Some parts can be designed to function in the same, or slightly different ways after duplication, but they cannot function in entirely novel ways without further design being employed. Novel function cannot be obtained for free by simply jumbling code sequences about the genome any more than it can be obtained by unscrewing a bicycle nut, putting it into a box with the bicycle, and shaking it around for a while. While it may seem like a tempting idea to the evolutionist, workable code-shifting mutations would require a multitude of complementary point mutations to ensure their proper functionality. Such unlikely coincidences surely push beyond the limits of credibility.

Hidden Code

Since code-shifting and replication cannot account for the origin of novel information sequences, and since they require novel interface code to be properly employed within novel solutions, the only real source of drastic variation left to the punctuated equilibriist is inactive code hidden within neutral, or preexisting code. This type of solution, however, is fraught with just as many problems as code shifting. Any neutral code must either have already existed before it became neutral, or it would be equivalent to random code. If it had existed in the genetic code before, it could no longer be considered novel code; and if it was neutral, its integrity would have been naturally degraded by random point mutations over time. On the other hand, if the source is random code, there is essentially no chance that any given point mutation could possibly transform it into valid, functional code. And inactive functionality hidden within functional code is not much more likely to exist than it would be in random code, and any mutation that could activate this code would likely have a negative impact on the functional code's immediate fitness worth (although not necessarily in every case).

Neither of these two sources of substantial function gain is able to realistically solve the basic problem of information gain, and neither of them can be considered probable enough to be expected to occur within rare, short periods of time with small population sizes. Neither of these sources have ever been demonstrated experimentally, nor can they be expected to – now, or ever. What has been demonstrated in the lab, however, and what should be expected to occur within these small populations is much less useful to the evolutionist: the specialization of preexisting code.

Gene Interactions

Some fairly significant changes in gene interactions have been demonstrated both in the laboratory, and in nature. To understand how these changes could come about, one must understand the basic nature of gene interactions, and the information that underlies their makeup. Some genes code for basic functionality or structure, others code for the activation

of functional genes (trigger their production, or catalyze their functionality), and others code for their repression (stop their production, or inhibit their function). Various other interactions are also possible, but these categories will be sufficient for this discussion.

Positive and Negative Mutations

The code that specifies each and every gene that an organism employs must lie somewhere within the body of its cells, and will primarily be found in its DNA. When genetic changes occur, some of this information must be altered, and the genes that are affected will either lose all (or part) of their functionality, or gain some degree of functionality. As has been noted earlier, the likelihood that any given mutation will add functionality to its host is extremely small, while the likelihood of its causing a loss of functionality is high. To demonstrate this fact more clearly, consider the letter sequence "SAMPLE". Out of the 156 single-point mutations that are possible for this sequence, only one mutation exists that is capable of forming a new, functional word, (the "A" to an "I" to make "SIMPLE"). On the other hand, there are 155 single-point mutations that will generate a non-functional word (the "M" to an "S" to make "SASPLe", for example). Thus, the total percentage of mutations that are positive is about 0.6% of the total, whereas negative mutations account for 99.4% of the possibilities; and while this is itself a fairly drastic difference, the marked disparity that exists between positive and negative mutation counts will only worsen as the length of the word increases. Considering, then, that there are about 300 "characters" in an average protein coding (and even this is ignoring the question of whether or not any new viable protein that could be produced would actually be more fit than its predecessor) this amounts to an extremely high preponderance of negative mutations overall.

Now if the original word "SAMPLE" were to code for a specific gene, the chances that this gene would deactivate as a result of a mutation would be 154 times higher than the chances of it generating a new, functional gene (assuming that any new viable gene coding will improve the fitness of the organism). So the chances that any random point mutation will benefit the organism will be extremely low compared to the chances that it will harm the organism, right? Well, probably, if the environment never changes, but not necessarily in every new environment – it all depends on which constraints the new environment will impose upon the organism, and on which system will be effected by the mutation.

Repressor Mutations

If the new environment is one in which the supply of one type of sugar is eliminated from the diet of a given bacterium and the supply of another type is increased significantly, and if the system effected by the mutation was being used by the bacterium to convert the new (i.e. secondary) sugar into usable energy units, an information losing mutation to a repressor gene could very well benefit the bacterium. If the repressor gene was previously being used to regulate a sugar conversion protein and ensure that it is not overused or overproduced, the sugar conversion protein would be given the chance to convert more of the new sugar than before, thus allowing for an increase in the fitness of its host (compared to its predecessor in the new environment).

Activator Mutations

Likewise, a negative mutation in an activation gene could limit the utilization of resources that were previously being used to produce the proteins that were required for the conversion of the original, primary sugar source. Such a mutation could allow more of these resources to be put to use in the production of the secondary proteins that would be necessary for the conversion of the new sugar source, again conferring the bacteria with a fitness advantage over its predecessor.

Functional/Structural Mutations

As a final example, suppose the protein that is affected by the new mutation had previously served to provide tensile strength to the wing of a cricket, allowing this cricket to maintain the optimal amount of tension that is required for its characteristic "chirp" to be sounded. If a new predator were to be introduced into this cricket's natural environment that would be capable of homing in on the cricket's chirping sounds, a negative mutation in this code sequence could serve to effectively silence the cricket, and thus allow it to escape the attention of its predator and live on to pass its genes to the next generation.

Probabilities of Occurrence

All of these mutations would involve a loss of genetic information, and all of them would benefit the organism in its new environment (and thus increase its fitness). Positive changes, therefore, can be expected both from information gaining mutations (where these are available), and from information losing mutations (given the right environmental conditions). The question that should be asked, then, is whether or not the availability of information *gaining* pathways will be significant enough to account for a net information gain, given the impact of any beneficial information *losing* mutations that would also be available.

While the above information losing mutations would involve specific proteins, and thus involve a certain degree of improbability, any mutation that could possibly result in both fitness gain and information gain would face this same improbability. But unlike information gaining mutations, information losing mutations would require accuracy only to the point of occurring in the correct gene; information gaining mutations require an additional high degree of accuracy to the point of occurring in the correct base and codon. Moreover, while it is obvious that any gene can be deactivated, it is just as certain that not every gene can be improved upon.

Given the incredibly high ratio of non-viable to viable protein codings, then, one would expect the number of information *losing* mutations to vastly outweigh the number of mutations that would be able to provide information *gain* – and this is exactly what has been found. Numerous examples of information losing mutations have been documented within the scientific literature published so far, but not even one clear example of a mutation that could provide information gain has ever been observed (redefinitions of information "gain" notwithstanding). It is clear from this that the evolutionist's inference to progressive information gain comes about not from experiment, but by necessity according to an *a priori* commitment to naturalism, and from the bald fact that complex genetic information does, in fact, exist.

Specialization

What, then, can be expected when groups become separated by transportation, migration, or localized environmental changes? Is there any truth to the claims that punctuated equilibrium is able to provide a driving force for speciation and evolution?

Since certain environmental changes will require a change in some of an organism's characteristics for it to be able to survive in the new environment, it is clear that some of these environmental changes will certainly serve to drive certain species to evolve in one sense or another. This may occur if these changes are possible and if the population is lucky enough to obtain the required mutation (or if a sub-population has the required characteristic already). Moreover, there may be many cases where a change would not necessarily be required for survival, but would be beneficial to the organism nonetheless. Clearly, punctuated equilibrium appeals to the former case more than to the latter, but either case can serve as a driving force for evolutionary change. The question, then, is not so

much whether or not change is able to occur when environmental parameters are altered, but what kind of change can be expected to occur?

Evolution certainly can occur and be driven by environmental variation, but the kinds of changes that it would involve would not constitute the kind of evolution that a naturalist would be searching for. Evolution could be said to occur here only in its broadest sense, as in any form of change or variation (even though progression and novel information gain may never be involved). Speciation, likewise, is less well defined in practice than it is in principle. While a species can technically be defined as a group of organisms that do not breed with any other group, this definition does not preclude a species from being capable of hybridizing with another species (lions and tigers, for example, can naturally breed with one another to produce a “liger”, but since they do not normally breed together in the wild, they are considered separate species). These and similar types of speciation can occur, but this type of speciation will never progress beyond the basic original characteristics of the family to which it belongs, unless new information can be gained from some sort of progressive mutation.

Where evolution does occur in nature, it can be expected to occur primarily through specialization, and not from information gain. This specialization can be prompted and accelerated by environmental variation in one (or both) of two ways:

First, it can be gained without requiring mutations. In this case, genetic variety would be restricted within the species such that characteristics that once existed within the parent population no longer exist within the child species. This would be particularly effective whenever a parent population were to split into distinct groups that would breed within separate environments. In such cases, the separate environments might each impose distinct selective pressures on their respective populations, (possibly even favoring contrary attributes,) effectively causing the child populations to diverge from one another. While the new populations would then have become distinct from one another, none of these populations would have ever gained an attribute that the original parent population never had in the first place.

Second, specialization could be gained via informationally negative mutations. Such mutations would take away an attribute (or enhance an attribute by the suppression of another attribute, or through the loss of a repressor) that had previously existed within the parent population. Increased selective pressures and genetic drift within the small populations that would result from migration or separation could accelerate the propagation of such mutations throughout the population. Again, such mutations would create populations that would be distinct from their parent populations, but while new “attributes” could be gained, no real information will have been added to its genome (at least, none that would have conferred any novel function upon it).

In either case, where speciation is expected to occur, it will produce much less drastic variations than are called for by Punctuated Equilibrium. Both causes effectively reduce the amount of functional information present in their populations rather than increase it; and neither of these methods can be expected to contribute to progressive evolution in either the long or short-run. Specialization will thus not result in functional information gain, but will contribute to an increase in variety within the original family.

Conclusions

The theory of Evolution stands or falls on the reality or impossibility of information gain. While “evolution” technically occurs whether information is gained or lost, the whole aim of what is generally termed “Evolution” is that information be built through mutation and selection – this is as true at the higher level of functional structures as it is at the lower level

of DNA gene codings; and it was as true with Darwin's theory as it is with the modern Neo-Darwinian synthesis.

The driving force of major changes within a population's genome is often posited to be Punctuated Equilibrium via environmental variation. But, while this theory can explain genomic variety, (and thus evolution of a sort,) nearly all of the changes it can be expected to produce will ultimately reduce the informational content of the genome, rather than help to increase it.

Genetic drift may help to propagate new mutations into a population, but only at the cost of specialization (i.e. information loss), and any new mutation that could be provided to it would be much more likely to harm the organism than to help it. Even so, those mutations that will be able to aid the organism in its immediate context are almost certain to be ones that would deactivate all or a portion of an existing gene to one degree or another. Losses of function and restrictions of function can often benefit an organism within a harsh, new environment, but that does not mean that such a scenario would involve a meaningful progression – it certainly would not. Specialization and changes in gene regulation through deactivations can certainly increase variety, and this variety can indeed be driven by environmental changes, but variety itself is not the end goal of the theories of progressive evolution – information gain is.

If environmental changes really are required to provide a driving force for evolutionary novelty, they are woefully inadequate; *variety* surely can arise through specialization, but true *novelty* requires a force of intelligence.

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