Review of: "The evolution of E. coli is NOT driven by genetic variance but by thermodynamics."

Kevin J. Flynn[1]

1 Plymouth Marine Laboratory

Potential competing interests: No potential competing interests to declare.

Coming with an interest driven by practical implications for understanding and simulating evolution in ecological settings, I find this to be an interesting and thought-provoking article. I seek clarification on various aspects, driven by a curiosity in how this work can inform non-specialist understanding of evolution in real ecological settings.

My interpretation of the claims made here are that mutations of traits that are not of selective advantage cause increasing entropy, become increasingly disordered in their genetic code and thence become less efficient in their deployment. Thus, from Conclusion 2, this suggests that the code for under-exploited traits will be subject to increasing entropy and the trait parameters (e.g., substrate affinity) will deteriorate. Is it then plausible across an organism's genome, with the organism subjected to different conditions, that individual traits will de facto be subjected to periods of waxing and waning in their effectiveness as they are either subjected to selection for competitive advantage or entropy? Does the constant drive of entropy against all parts of the code thus require a countering continuous selective pressure for mutations that are positive for competitive advantage?

Is it then appropriate to infer that the evolution of species represents as much the failing and loss of traits conferring little or no competitive advantage (increase in entropy in the genetic code) as much as the appearance and fine-tuning of traits typically providing competitive advantage? (Noting, that there are limits to any improvements in trait expression.) Variation in the code thus means little or nothing; all that really matters is the useful expression of traits of competitive advantage vs the state of entropy of lesser important traits for competitive advantage.

If we accept that traits of little or no competitive advantage will indeed degrade, then those that are never expressed in the ecological setting will potentially be lost. This is where I question the LTEE experiment design for this work. This experiment is subjecting the organism to repeat cycles of the same limited scope for selection; many traits would be of limited and perhaps no expression value in providing competitive advantage. Is there thus, perhaps, a lot of (so-to-speak) trait-space available for entropy that would not normally be available? In nature there would be continuous variation in the factors affecting growth and, in consequence, traits would go through periods of being particularly important for competitive advantage, and periods when they may be of little/no consequence at all. I then question whether the statement in Conclusion 2, concerning the control of natural systems by the 2nd Law, can be generalised from the LTEE result. Can the authors provide some rebuttal against these concerns, to support the generality of their assertions?

I provide some suggestions to improve clarity below:

ABSTRACT

It would be helpful to have a 'in consequence ...' statement; what needs to be done next? Other than theoretical issues, how/why does this matter? As a general point, and perhaps an issue with the expression of English, evolution could never be ‘driven’ by variance only by enhanced survival, or lessened deaths, of phenotypes enabled by, selected from within, that variation, no? The abstract also makes no reference to thermodynamics; surely it should do so?

INTRODUCTION

The cells are 'consumed' by what? This suggests there is a predator in the flask. Is ‘consumed’ an analogy with a chemostat-like daily dilution?

The notion of evolution being driven via thermodynamics needs to be introduced here.

Evolution of what, of phenotype? Is part of the problem caused by the scientific, and indeed the popular, definition of ‘evolution’?

EVIDENCE

Should this say ‘(Figure 2 in Lenski & Travisano 1994)’? In the second paragraph, ‘Unexpectedly’ is an ambiguous term; was it unexpected in that these authors failed to test the correlation, or they did and it was (surprisingly) non-significant? And we have another ‘Figure 2’ (presumably it should be ‘Figure 2 in Barrick et al.’).

CONCLUSION 1

Is the use of ‘driven’ appropriate? – is this the term used in the original and successive claims? It cannot be driven by variance; variation can only provide a base from which competitive advantage is potentially emergent, yes? The question arises, however, and especially set against the above mentioned form of the selective pressure being applied here, as to whether the vast bulk of the variation in the LTEE is of no consequence, affecting traits that are not expressed in the culture conditions used.

DISCUSSION

Is Moore's 2003 (2 decades old) citation still applicable?

I see the arguments expressed in the final sentences of Discussion as at once important for this specific subset of science, but also as an exemplar to counter group-think in science in general, and problems with the whole basis of peer-reviewed and impact-factor-driven-citation science.

OVERALL CONCLUSIONS

Perhaps, LTEE should be said in full? And what was expected of the human genome project in this context?