The Relaxed Forces Strategy for Testing Natural State Theories:

The Case of the *ZFEL*[[1]](#footnote--1)

*Derek Turner*

*Connecticut College*

*New London, CT, USA*

*Derek.turner@conncoll.edu*

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Introduction

2. Darwin’s use of the relaxed forces strategy

3. McShea and Brandon’s predictive test of the ZFEL

4. A circularity problem for the relaxed forces strategy

5. Possible responses to the problem

6. Conclusion

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**1. Introduction.** In their recent book, *Biology’s First Law*, Dan McShea and Robert Brandon say that they are trying to bring about a “fundamental gestalt shift in how we view evolutionary theory” (2010, p. xi, Cf. p. 128). Their proposed Gestalt shift involves a resetting of the default, or zero-force expectation concerning structural complexity. By “structural complexity” they mean something like internal variance, or internal heterogeneity of parts. They are not talking about functional or adaptive complexity. According to what we might call the received view, stasis (i.e. no change in structural complexity) is the natural state of an evolutionary system, and any directional changes, such as complexity increase, need to be explained by invoking evolutionary forces such as selection. According to McShea and Brandon’s zero-force evolutionary law (or ZFEL), the default expectation is that complexity will increase over time. So if we see certain lineages—such as, say, bacteria—that persist for a very long time with no complexity increase, we might explain that on the hypothesis that there is selection against greater complexity. This, the proposed Gestalt shift turns the ordinary understanding of the relationship between selection and complexity on its head.

In this paper, I examine one initially promising strategy, which I call the relaxed forces strategy, for using empirical evidence to discriminate between rival natural state theories. The first step is to identify a case in which one has independent evidence that the relevant evolutionary forces are inoperative. Then one checks to see if the default expectation specified by the natural state theory in question is indeed satisfied under the relaxed forces condition. In section 2, I show how Darwin used this strategy to defend his Malthusian claim that the natural state of any biological population is geometrical growth. In section 3, I go on to show how McShea and Brandon use this strategy to help build their empirical case in favor of the ZFEL.

 I argue, however, that the relaxed forces strategy suffers from a serious defect. The problem is that what counts as a relaxed forces condition depends on the natural state theory that one already holds. It is not possible to identify a relaxed forces condition without presupposing the very theory that one wants to put to the test. I contend, in section 4, that this circularity problem means that the relaxed forces strategy cannot discriminate between rival natural state theories. Darwin’s main argument for his Malthusian theory of population is circular. This problem also weakens McShea and Brandon’s empirical case for the ZFEL. In section 5, I consider some possible responses to the failure of the relaxed forces strategy.

**2. Darwin’s use of the relaxed forces strategy**. Consider an example of two rival natural state or inertial state theories about population size:

 The first theory says that the natural state of any biological population is to remain stable at a given size. If the population has *n* members at a time, and if no external forces or pressures impinge upon it, then it will still have *n* members at the end of some specified time interval. If the population grows or shrinks, then the change in the population’s size is to be explained in terms of external forces acting upon it. The default expectation is no change in population size. Deviations from that expectation need to be explained.[[2]](#footnote-0)

 The second theory—Darwin’s—says that the natural state of any biological population is geometrical growth. If the population has *n* members at a time, and if no external forces or pressures act upon it, then it will have 2*n* members at the end of a specified time interval. Thus, a population that begins with 2 individuals will contain 4 at the end of the first time interval, eight at the end of the next interval, and so on. If the population grows at a slower rate or not at all, that deviation from what is expected is to be explained in terms of external ecological forces.

 These two theories have the same structure, but they introduce different default expectations. They make different claims about which is the inertial state of the population. We cannot easily discriminate between the two theories by studying actual populations in nature. Suppose we observe a population that’s growing, but at a rate much slower than the geometrical rate that is, in some sense, “predicted” by the second theory. Both theories need to explain what’s going on, but the explanations will run in opposite directions. The first theory needs to explain why the population is growing at all; the second needs to explain why it is growing more slowly than expected. In principle, both theories can handle any observed rate of growth, but they will do so in different ways, by appeal to different packages of external forces.

 Darwin knew well that actual populations in nature rarely, if ever grow geometrically, and that if they do, it’s only for a short while under special conditions. Virtually every population that we can observe violates the default expectation of his Malthusian theory of population growth. But far from treating observed populations as evidence against his theory, Darwin saw them as an opportunity to put his theoretical machinery to work. He offers a rich catalogue of external ecological forces—predation, disease, food scarcity, and so on—that serve as checks to population increase.

 There is an attenuated sense of “predict” in which a natural state theory predicts whatever it specifies as the default expectation. Thus, we might say that Darwin’s Malthusian theory predicts that populations will grow geometrically. This usage creates the impression that we can test the theory in question by checking to see whether the default expectation—the “prediction”—is satisfied. This usage is somewhat misleading, however. Nonconformity with the default expectation does not in itself constitute evidence against a natural state theory. It is, rather an opportunity to deploy the explanatory machinery of that theory.

 What then (if anything) would constitute evidence against a natural state theory? The *relaxed forces strategy* provides one initially promising answer to this question. Suppose we have independent evidence that the various external forces that may act upon a system are relaxed, so that the system is in something approximating the zero-force condition. In such cases, where we already know that the external forces are relaxed, we can then look to see whether the system conforms to the default expectation. If not, then that would be evidence against the natural state theory. In other words, violations of the default expectation do constitute evidence against the theory, but only in those cases where we already know that the relevant external forces are relaxed. [add: Natural state theories do seem to generate testable predictions about what the system will do when external forces are relaxed.]

 In the *Origin of Species*, Darwin at one point seems to use the relaxed forces strategy to argue for his Malthusian principle that “each organic being is striving to increase at a geometrical ratio” (1859, pp. 78-79).

But we have better evidence on this subject than mere theoretical calculations, namely, the numerous recorded cases of the astonishingly rapid increase of various animals in a state of nature, when circumstances have been favorable to them during two or three following seasons. Still more striking is the evidence from our domestic animals of many kinds which have run wild in several parts of the world: if the statements of the rate of increase of slow-breeding cattle and horses in South America, and latterly in Australia, had not been well authenticated, they would have been quite incredible … (1859, pp. 64-65).

Darwin’s reference to “favorable circumstances” suggests that he has in mind cases where the ordinary ecological checks to population growth are relaxed. The cases of introduced species that he proceeds to discuss are also plausibly cases in which many checks to increase, such as food scarcity and predation, are relaxed. Darwin’s argument seems to be that in these cases where the forces limiting population growth are relaxed, rare though such cases may be, we do in fact typically see growth at the expected geometrical rate.

 Few biologists today accept Darwin’s Malthusian claim that geometrical growth is the natural state of any biological population. This Malthusian view is no longer regarded as essential to the theory of natural selection. Darwin himself, however, thought that he had some empirical support for his preferred natural state theory. Insofar as biologists no longer find Darwin’s argument too convincing, it’s worth asking why. Is there some problem specific to Darwin’s own use of the relaxed forces strategy? Or is there some deeper problem with the strategy itself? In section 4, I will argue that the latter is indeed the case.

 Newtonian mechanics is another familiar example of a natural state theory. (Interestingly, McShea and Brandon draw an explicit analogy between the ZFEL and Newton’s theory [2010, p. 6].) The relaxed forces strategy clearly would not work well as a test of Newton’s theory. We’d have to identify an object that is not being acted upon by any physical forces, and then check to see whether the object exhibits uniform rectilinear motion. The problem here seems like a practical one: the relaxed forces condition seems impossible to bring about, or even to approximate, because the interfering forces are always operative. In other contexts, however, such as those involving evolutionary systems, we might really be able to observe a system in the relaxed forces condition.

**3.** **McShea and Brandon’s predictive test of the ZFEL**. Much as Darwin argued that biological populations have a natural tendency to grow at a geometrical rate, so McShea and Brandon argue that all evolutionary systems naturally tend toward greater structural complexity/heterogeneity. They readily acknowledge that the ZFEL is not an ordinary empirical generalization of the form, *All F’s are G’s* (2010, p. 7). They do insist, however, that it is empirically testable:

The ZFEL is not analytic. It is not true as a matter of logic or mathematics, as is biology’s so-called Hardy-Weinberg Law. Rather, it is synthetic, making an empirical claim about the way the world is (2010, p. 6).[[3]](#footnote-1)

In the course of the book, they argue that there is quite a lot of empirical evidence for the ZFEL, and they propose some empirical tests of it. Like Darwin, they use the relaxed forces strategy in order to build their empirical case for the ZFEL.

McShea and Brandon take care to define the ZFEL in such a way that it only applies to biological systems:

ZFEL (special formulation): In any evolutionary system in which there is variation and heredity, in the absence of natural selection, other forces, and constraints acting on diversity or complexity, diversity and complexity will increase on average (2010, p. 3).

Strictly speaking, the ZFEL does not apply to systems that do not exhibit variation and heredity. McShea and Brandon do at least consider a more generalized version of the ZFEL—the G-ZFEL—that would apply to all physical systems (p. 112).[[4]](#footnote-2) They use the example of a freshly painted picket fence to illustrate the ZFEL. Strictly speaking, though, the picket fence would only be an instance of the G-ZFEL, and not of the ZFEL proper, because the picket fence is not “an evolutionary system in which there is variation and heredity.”

 To begin with, all the pickets in the freshly painted fence look more or less the same; there is very little internal differentiation among the parts of the fence. Over time, however, the different pickets come to exhibit different patterns of weathering. The paint peels a little more on those most exposed to the sun. One or two of the pickets begin to rot away where they make contact with the ground. One is knocked loose by a soccer ball. Over time, what began as a homogeneous system becomes more and more heterogeneous. The fence gets more complex, in McShea a Brandon’s technical sense. It’s tempting to say—and McShea and Brandon do say—that in this example, increasing heterogeneity is what we should expect. If the fence remained homogeneous for a long time, that would be surprising and would need explanation. Maybe someone repaints it periodically. That, at least, is the kind of external force we’d have to invoke in order to explain why heterogeneity does not increase.

 Even here, though, with this lovely stage-setting example, it’s not clear that any evidence compels us to set the default expectation one way rather than another. One could also formulate a rival natural state theory in which stasis—i.e., no change in internal variance—is the default expectation and deviations from that are what need to be explained. Complexity increase, for example, would need to be explained in terms of the differential action of external forces—sun, wind, rain, soccer balls, and the like—on the pickets. The general point is that we seem to have some flexibility in determining what the default expectation is going to be, and hence some flexibility in deciding which natural state theory to work with. It’s not clear that any actual observations of the fence itself will tell us what the natural state is—whether it is increasing complexity or stasis. If we watch the fence, we’ll see that complexity does in fact increase, but both natural state theories can handle that observation equally well.

 In a recent review of McShea and Brandon’s book, Matthen (2011) describes what he seems to think is a counterexample to the generalized ZFEL (or G-ZFEL). Imagine a large mural on a wall, done in the pointillist style of Seurat. The mural has a huge amount of internal variance; each dot is slightly different from the others. Over time, the colors fade and the heterogeneity of the system diminishes. This increasing homogeneity seems just the opposite of what the ZFEL says we should expect.

 Matthen, in fact, does more than merely suggest that the fading pointillist mural is a counterinstance of the ZFEL. He wants to make a deeper point that whether complexity is increasing or decreasing may well depend on our level of description of the mural. It’s most natural, perhaps, to say that the fading of the mural involves decreasing internal variance. But what if we focused instead on the spatial locations of the molecules of blue pigment. Let’s imagine that there is just one bright blue region in the freshly painted mural. At the beginning of the process, the molecules of blue pigment have a low degree of spatial variance; they’re all in the same area. As the painting fades, and the molecules of pigment weather off, their spatial variance increases. Many of them end up out in the environment. And that’s an increase in complexity in McShea and Brandon’s sense.

There is a more straightforward point here that Matthen might have made but doesn’t. Even setting aside Matthen’s argument concerning levels of description, it isn’t entirely clear why anyone would think that the fading pointillist mural would be a counterexample to the ZFEL in the first place. Yes, the fading mural is a system that violates the default expectation of increasing internal variance. This just means that we have to invoke external forces—such as the sun and the elements—in order to explain the surprising decrease in complexity this case. A deviation from the default expectation of a natural state theory is not a counterexample to that theory. It is, rather, an occasion to put the theory to work by invoking external forces.

 Part of the appeal of the relaxed forces strategy is that it seems to permit novel predictive tests of natural state theories. Although there is quite a bit of debate about what makes a prediction novel, and why novelty should confer any extra evidence over and above the evidence we already get from showing that a theory has true observational consequences, some philosophers think of novel predictive success as the very best sort of evidence that one can give for a theory (see, e.g. Leplin 1997). And it seems possible to make novel predictions about what one will observe in cases where the external forces are relaxed.

McShea and Brandon argue that the ZFEL passes at least one interesting novel predictive test, and they propose some other tests in the same vein. I want to focus here on the test that they showcase a bit (2010, pp. 73-76).

 Consider the following experiment: Subject male mice to doses of radiation, and then look at the effects on the vertebral columns of their offspring. “The ZFEL prediction is that, absent selection and constraint, offspring will tend to be morphologically more complex than their parents” (2010, p. 73). One appealing thing about focusing on the vertebral column is that it is relatively straightforward to arrive at a measure of complexity. The mammalian vertebral column lends itself to division into part types (cervical, thoracic, lumbar, etc.). In the imagined experiment, one can come up with a list of possible changes in the rat vertebrae that would all count as increases in complexity in McShea and Brandon’s technical sense. These changes include:

* Dyssympysis, in which to pieces of a vertebra fail to fuse property during development.
* The total absence of one part of a vertebra, such as a neural arch.
* The duplication of one part of a vertebra.
* The fusion of two adjacent vertebra.
* Any malformation or change in size of one vertebra.

After irradiating the male mice, study the complexity of the vertebral columns of their offspring. How many of the changes observed led to increases in complexity, and how many led to decreases in complexity? Examining the offspring mice as newborns is a way of making sure that selection has no chance to operate (although McShea and Brandon acknowledge that there is some differential survival before birth), thus making this a relaxed forces case. Does complexity increase when selection is relaxed?

 It turns out that it does. In the 1960s, some scientists at Oak Ridge National Laboratory actually carried out the above procedure, though obviously not with the aim of testing the ZFEL (Ehling 1965). They divided the observed morphological changes into two groups. The class I changes occurred in just one animal, while the class II changes occurred in more than one animal. The researchers observed 20 class I changes in 10 animals, and 16 class II changes. After going back and reviewing Ehling’s study, McShea and Brandon determined that no fewer than 17 of the class I changes involved increases in structural complexity, while all of the class II changes did. The ZFEL predicts that when the relevant external forces (especially selection) are relaxed, complexity will increase. That prediction was clearly born out in this case. What’s more, the prediction is a genuinely novel one in the epistemic sense, which is the sense that counts. The ZFEL was not in any way tailored to accommodate these results. Even though the experiment was done back in the 1960s, McShea and Brandon presumably didn’t formulate the ZFEL with these results in mind.

**4. A circularity problem for the relaxed forces strategy**. The relaxed forces strategy requires that we be able to specify in advance which cases are the ones where the forces are relaxed. We are then supposed to look at those cases to see whether the default, or zero-force expectation is at least approximated. But how do we know what counts as a relevant interfering force in the first place? Rival natural state theories make different claims about which external forces are the relevant ones.

The picket fence affords a nice illustration of the circularity problem that afflicts the relaxed forces strategy. Suppose we want to test the theory (the G-ZFEL) which says that complexity increase is the natural state for a picket fence. In order to do that, we try to identify a case where all the external forces that might act upon the fence are absent or at least relaxed. What forces are those? Should we, for instance, try to find a fence that is not impacted by any stray soccer balls? No. Since soccer ball impacts serve only to increase the complexity of the fence—say, by knocking loose one picket but not the others—the stray soccer ball would not count as an external force in this case. What makes a force external is precisely the fact that it works to keep the system out of its natural or inertial state. Here a painter who re-fastens loose pickets and repaints the fence periodically would count as an external force. In order to know which forces are external, we have to know which is the natural state of the system. In order to identify cases where the external forces are relaxed, we have to know which forces are the external ones. For this reason, the relaxed forces strategy requires us to make assumptions about the natural state of the system. It requires us to assume the very claim that we thought we were testing.

 To make the above point more vivid, imagine a proponent of a rival natural state theory—say, the one according to which stasis (or no change in complexity) is the natural state of the picket fence. The advocate of the stasis theory would classify stray soccer balls as external forces, because they obviously work to keep the fence out of its natural state. So the proponent of the stasis theory and the proponent of the G-ZFEL would just disagree about which cases are the ones in which the external forces are relaxed.

 This circularity problem also undermines McShea and Brandon’s novel predictive test of the ZFEL. Again, one way to bring this out is to try to envision the response that an advocate of a different natural state theory might make. Consider how this experiment might look to a defender of the stasis theory. According to that view, the default expectation is that no change will occur in the complexity of the mouse vertebral columns from one generation to the next. In this case, complexity obviously increased. So on the stasis view, that deviation from the default expectation needs to be explained in terms of the operation of some external forces. Which external forces might those be? Selection will not do the trick here, because as McShea and Brandon point out, the experiment is set up in a way that guarantees reduced selection. The stasis theorist, however, has a different answer at the ready: the external forces that explain the complexity increase are just the scientists who irradiated the male parents. But for the radiation, the vertebral columns of the offspring mice would probably have exhibited about the same degree of complexity as those of their parents. Indeed, the stasis theorist could propose a relaxed forces test of her own: Just measure the complexity of the offspring’s vertebral columns without dosing the male parents with radiation.

 McShea and Brandon do not treat the scientists who dose the male mice with radiation as an external force operating on the system. That’s just because, given the natural state theory they defend—namely, the ZFEL—the external forces are, by definition, the ones that work against complexity increase. Since the scientists are causing complexity increase, they don’t count as an external force. This parallels the example of the picket fence and the soccer ball quite nicely. Stray soccer balls don’t count as external forces if we are assuming that complexity increase is the zero-force condition for the picket fence, because stray soccer balls do not work against complexity increase.

 In order to identify a relaxed forces case—or more precisely, in order to show that the case of the irradiated mice *is* one in which the external forces are relaxed—McShea and Brandon must presuppose the ZFEL. They must presuppose the natural state theory that they purport to be putting to the test. Someone who prefers a different natural state theory may simply deny that this particular case is a relaxed forces case. Nor is this problem an isolated one. It affects some of the other tests they propose. For example, they suggest that it might be illuminating to study the complexity of structures that are not under selection, such as the eyes of cave-dwelling crayfish (2010, pp. 76-77). Do cave-dwelling crayfish have more complex eyes than their surface-dwelling relatives? If so, then that would mean that complexity increases in the relaxed forces condition. Here again, it might be open to a proponent of a rival natural state theory to challenge the claim that the relevant external forces are really relaxed in the case of the cave-dwellers.

 Darwin’s argument for the Malthusian natural state theory of population growth (section 2) also runs afoul of this circularity problem. Darwin’s idea was to test the claim that populations naturally tend to grow at a geometrical rate of increase by looking at situations in which the usual checks to population growth are relaxed—for example, cases in which a newly introduces species has abundant food and no predators. However, someone who accepts a different natural state theory at the outset—say, someone who thinks that the natural state of populations is stasis with respect to size—would presumably not identify the interfering forces in quite the same way. On this rival theory, predation might count as an interfering force (for example, if it caused a reduction in the population size, and hence a deviation from the expected stasis), but it also might not. On this rival theory, the relaxed forces condition could be one in which there is significant predation.

 This circularity problem means that the relaxed forces strategy cannot discriminate empirically between rival natural state theories. The problem, in a nutshell, is that the strategy assumes that we already know what to count as the relevant interfering forces. But that is precisely what we are trying to find out. There might, however, be other ways of subjecting natural state theories to empirical assessment. And even if there were not—that is, even if the choice between rival natural state theories were underdetermined—such theories might still have an indispensable role to play in scientific inquiry. The failure of the relaxed forces strategy raises some larger questions about the status of natural state theories, and I will not be able to address those questions fully here. In the next section, however, I’ll try to advance the discussion by considering some possible responses that McShea and Brandon could make to the failure of the relaxed forces strategy.

**5. Possible responses to the problem.** How might McShea and Brandon continue to defend the ZFEL in light of the alleged failure of the relaxed forces strategy? The most natural response to the failure of the relaxed forces strategy would be to seek out some *other* means of subjecting rival natural state theories to empirical tests. While I would not want to rule out the possibility that some other strategy might be more promising, I confess that it is difficult to imagine what such a strategy might look like. In order to test a natural state theory, we must examine either a relaxed forces case or a non-relaxed forces case. (Every case falls into one of those two categories.) If it doesn’t help to look at a relaxed forces case, why would it help to look at a non-relaxed forces case?

In fairness to McShea and Brandon, the putative novel predictive test that I described in section 3 is just one small piece of the larger argument they make in favor of the ZFEL. It’s not clear that my critique of that “test” should derail the larger project. McShea and Brandon repeatedly stress the unifying or explanatory power of the ZFEL:

So what is the point of the ZFEL? First, it offers unity. A heretofore unconnected set of phenomena … are revealed to be instances of the same underlying principle (2010, p. 71).

Indeed, in the course of the book, they show how a wide variety of biological phenomena—from increasing disparity in macroevolution (pp. 36-38), to the observation that characters not under selection show greater variation (p. 70) – all seem to fall into place when viewed through the lens of the ZFEL. The crucial question, though, is perhaps not whether the ZFEL does a good job unifying biological phenomena that were “heretofore unconnected,” but whether it does a better job unifying those phenomena than a rival natural state theory, such as the stasis theory for diversity/complexity, would do. Darwin might provide a helpful comparison here: It is fairly easy to see how Darwin’s picture of populations “striving” to increase in the face of myriad constraints and checks can unify a wide variety of biological phenomena. The real question is whether it does a better job unifying those phenomena than the rival stasis theory would do. Assessing this appeal to the unifying power of the ZFEL is a larger project than I can take on here.

 A second possible response to the failure of the relaxed forces strategy is to make a subjectivist move. McShea and Brandon briefly flirt with such a move, but it is difficult to make out how much sympathy they really have for it (pp. 102-103). When we talk about the natural state of a system, we seem to be talking about the system itself. However, when we talk about expectations, we seem to be talking about ourselves. Expectation and surprise are merely subjective, psychological notions. One possibility is that there is nothing at issue here above and beyond what we expect, and hence no deep mind- or theory-independent fact of the matter about what the natural state of a system “really” is. We might expect biological populations to grow geometrically, or we might expect them to remain stable. When we talk about populations as having a natural state, we are merely reading our own expectations into the natural world. Which observations will surprise us and will seem to require explaining will also depend on our initial expectations. But there may be no fact of the matter about which expectations are the right ones to have. Moreover, each natural state theory picks out a set of relevant interfering forces or constraints that can make a difference to a system. There may be no fact of the matter about which is the right way to identify those interfering forces.

 At one point in the book, McShea and Brandon appear to make this subjectivist move:

[A]re there objective matters of fact that settle what count as forces in a particular science, and so what counts as the zero-force condition, or is this a matter of how we set out our theory, and so a matter of convention? (2010, p. 102)

We will not dare to try to answer this question in general, though we will share our suspicions: in some cases objective facts will settle the matter, but in most cases they will not. But in the present case it is clear that we must take a conventionalist stance … (2010, p. 103).

McShea and Brandon acknowledge that their decision to treat complexity increase as the natural state of any evolutionary system is a “choice,” and in the passage immediately following the one quoted above, they give some reasons for this choice. They point out that they have decided to focus narrowly on systems that involve reproduction, variation, and heritability. (Indeed, the special formulation of the ZFEL restricts its application to systems that exhibit variation and heritability). What’s not entirely clear is why the decision to focus on systems that exhibit reproduction, variation, and heritability would give us a reason to choose to adopt complexity increase (rather than, say, stasis) as our default expectation for evolutionary systems.

The subjectivist move may also be somewhat at odds with the larger project of McShea and Brandon’s book. One of their goals, as we have seen, is to build an empirical case for the ZFEL. But if one became convinced that there is no deep fact of the matter about whether the natural state of evolutionary systems is complexity increase vs. stasis—if one thought that the difference between these rival pictures is merely a matter of our subjective expectations—then the project of building an empirical case for one natural state theory over the other would seem unmotivated. If subjectivism is correct, then the most we can do is try to persuade others to change their expectations. Thus, although they do seem to sympathize somewhat with this subjectivist move, it may be more charitable to read McShea and Brandon as holding that there really is an objective fact of the matter about whether the ZFEL is correct.

To sum up the results of this section: There are at least three possible ways in which McShea and Brandon could respond to the failure of the relaxed forces strategy. (1) They might seek some other means of testing the ZFEL empirically, though it’s difficult at this point to see what such a strategy might look like. (2) They might appeal to the unifying power of the ZFEL, though it would also be necessary to show that the ZFEL has greater unifying power than rival natural state theories. Finally (3) they could make a subjectivist move and abandon the assumption that there is a mind- and theory-independent fact of the matter about which natural state theory is true of a given system. This all too brief discussion is just the beginning of an attempt to map out some of the logical space of possible responses. Most importantly, the failure of the relaxed forces strategy should be an occasion to revisit questions about the status of natural state theories and their role in empirical science.

**6. Conclusion.** Natural state theories have figured prominently in the history of philosophy, from Aristotle to Spinoza. They also show up repeatedly in natural science, from Newtonian mechanics to the idea that the Hardy-Weinberg equilibrium describes the natural state of biological populations. In this paper, I have examined one initially promising strategy for subjecting such theories to empirical tests. The relaxed forces strategy was employed by Darwin in the *Origin*, and it has been revived more recently by McShea and Brandon. I’ve argued that the strategy fails to deliver the goods, because it is plagued by a circularity problem. The failure of this strategy weakens McShea and Brandon’s empirical case for the ZFEL, but (as I argued in section 5) need not derail their project entirely. Nevertheless, the failure of the relaxed forces strategy should prompt philosophers to think further about the status and role of natural state theories in science.

 As far as I know, few biologists today think that we even need a natural state theory for population size. It’s not that biologists have abandoned Darwin’s Malthusian picture in favor of some rival natural state theory—say, a stasis theory. Rather, they have abandoned it in favor of no natural state theory at all, and they have done so in spite of the unifying power of the Malthusian view. Trends in population size are phenomena to be explained, but modern evolutionary theory makes no assumptions about natural tendencies in population size. McShea and Brandon do show how powerful a natural state theory of diversity/complexity can be. There is also a deeper issue here about which biological phenomena call for natural state theorizing and which do not. The failure of attempts to test natural state theories just brings that question into sharper relief.

**References**

Darwin, C. (1859/1964) *On the Origin of Species (A Facsimile of the First Edition)*. Cambridge, MA: Harvard University Press.

Leplin, J. (1997) *A Novel Defense of Scientific Realism*. Oxford: Oxford University Press.

Matthen, M. (2011) Review of Biology’s First Law: The Tendency for Diversity & Complexity to Increase in Evolutionary Systems. *Notre Dame Philosophical Reviews*. Available online at <http://ndpr.nd.edu/news/24573-biology-s-first-law-the-tendency-for-diversity-and-complexity-to-increase-in-evolutionary-systems/>. Last accessed 18 Mar 2012.

McShea, D., and R. Brandon (2010) *Biology’s First Law*: *The Tendency for Diversity & Complexity to Increase in Evolutionary Systems*. Chicago, IL: University of Chicago Press.

Sober, E. (1980), “Evolution, population thinking, and essentialism,” *Philosophy of Science* 47(3): 350-83.

1. This paper derives from comments on *Biology’s First Law* that I gave at an author-meets-critics session at the 2011 ISHPSSB meeting in Salt Lake City, Utah. I am especially grateful to Robert Brandon, Chris Haufe, and Dan McShea for their thoughtful responses to the comments, and for helpful conversation about the *ZFEL*. Thanks also for helpful comments from an audience at POBAM 2012, in Madison, Wisconsin. [↑](#footnote-ref--1)
2. Compare Sober (1980, pp. 360 ff.) on the general structure of natural state models. [↑](#footnote-ref-0)
3. McShea and Brandon’s views about the status of the ZFEL are quite nuanced. They say that the ZFEL is a synthetic, empirical claim, but then they also say, elsewhere, that it is “ultimately reducible to probability theory,” which at first blush would seem to suggest that the ZFEL is analytic. But McShea and Brandon also hold that “there is a bit of probability theory that is not pure math” (2010, p. 109). [↑](#footnote-ref-1)
4. This generalized version of the ZFEL is a descendant of Herbert Spencer’s law of the instability of the homogeneous. [↑](#footnote-ref-2)