

Chapter 1 of *Creative Evolution*: “The Evolution of Life: Mechanism and Teleology”

John Protevi / LSU French Studies / Lecture notes: DO NOT CITE.

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[protevi@lsu.edu](mailto:protevi@lsu.edu) / [www.protevi.com/john/Bergson/CE1lecture.pdf](http://www.protevi.com/john/Bergson/CE1lecture.pdf)

(With many thanks to my LSU Biology colleagues John Larkin, Dominique Homberger, and Vince LiCata for helpful comments. I won't note every case in which their comments helped me make things more precise, but as always in these cases in which professionals aid amateurs, they are only responsible for the good stuff; I'll take the blame for remaining infelicities, not to mention errors, blunders, and mistakes!)

1. BERGSON IS A PHILOSOPHER; *CREATIVE EVOLUTION* IS A BOOK OF PHILOSOPHY, NOT OF BIOLOGY. We can anticipate that Bergson's concern will be with identifying the reality of change. Remember that he is a process philosopher: changes do not happen “to” a substance or “thing”; rather, “things” are snapshots or utilitarian reifications of a process. We also have to remember that he is a philosopher *tout court*. He read the biology literature available to him, but he makes it clear that he is not a scientist, nor is he attempting to do science; he's trying to do philosophy.

We should also be clear that philosophy is different from science for Bergson: he would not be a “naturalistic” philosopher in the Quinean sense, i.e., as accepting that the scientific method is the only effective way to investigate reality, and that scientific truth claims can only be judged or overcome by other scientific truth claims. That's why it has to be a *project* to naturalize Bergson, that is, to render his claims consistent with current science. The reason that project is not too violent is that dynamic system modeling provides ways of at least in principle producing a qualitative and not just quantitative science.

2. I want to give a brief OVERVIEW OF SOME BIOLOGICAL CONCEPTS to provide a context for discussing Bergson.
3. CLASSIFICATION. Among the things biology does is classify living things (“taxonomy” – and with special attention to evolution, “cladistics”); it also studies growth (development), structures (anatomy), functions (physiology), relations (ecology), and other topics. In cladistics, we have to account for both similarity and difference at two different time scales: between parent and child at the organismic scale and between ancestor and descendant at the evolutionary scale.
4. ONTOGENY = development (organismic scale). Embryonic development, then “growth” and “transformation” at puberty, etc. [Bergson will claim this is one process.] Children resemble parents, but are not exact copies. Likewise, all members of a species resemble each other to some extent, but are not exact copies.
5. PHYLOGENY = descent and branching (evolutionary scale). [Along with ontogeny, the key to appreciate Bergson is to think these processes as durational: the whole of

the past accumulates and makes up the “edge” of the present. In biological terms, think of B’s notion of the body in MM3: “the actual state of my becoming, that part of my duration in process of formation.” IOW, your body is the last stage in a continuous process of both ontogeny and phylogeny: both developmental and evolutionary history.]

6. SPECIATION = appearance of new species via geographical isolation and consequent separation of reproductive groups. Changes accumulate in each group, but they drift apart because those changes can no longer be shared. At the point at which interbreeding no longer produces live, fertile offspring, we say that the two species have diverged (Mayr’s definition of species). [“Changes” here are considered to be at the level of genes for most biologists, but we will have to discuss this further in the context of the “unit of selection” controversy.]

While speciation is the multiplication of species and may result eventually in “new” (i.e., additional) species, “phyletic evolution” is the change over time of one species or population. “Child” species resemble “parent” species, but are not exact copies. Go far enough back, and we find most likely fairly similar life forms arising from fairly similar conditions. (Some people used to believe in a single origin of life, but this concept has been nuanced considerably, so that most think in terms of similar conditions giving rise to multiple origins. Now the fact that all bacteria, archea, and eukaryotes use the same DNA, RNA, amino acids, etc. is considered rather definite evidence of a single progenitor of all *current* life forms. There may have actually been many different origins of life, but one clearly out-competed the others and all extant life can be traced back to it. The point is that the early multiplicity was fairly “tight,” that is, had not yet attained the divergence we see today.)

We would have to discuss B’s notion of the “original impulse” (*élan originel*) in the context of today’s discussion of the “origin of life” question. Whatever we say about the origin of life, almost everyone agrees that we have now a huge diversity of life forms compared to the relative uniformity of early life forms. How did we get such evident diversity from relative uniformity? This accumulation of diverse forms lies behind B’s insistence on life’s process as one of divergence and dissociation (what Deleuze will call actualization as differentiation).

7. EVOLUTION is change over time. DARWIN proposed variation and selection as its mechanism. (There were other “evolutionists” before Darwin, who accepted historical change in living beings. What Darwin did was propose “natural selection” as the mechanism for evolution.) Darwin’s idea of variation and selection blends the two time scales (organismic and evolutionary).
8. First, let’s consider VARIATION. The key here is “population thinking.” Darwin taught us not to look at biological diversity as deviation from an “ideal type” (= “typological thinking”), but as the distribution of traits in a population. For instance, there is no ideal height for a tiger; there is a distribution of heights in the tiger population. Each height is a “variant”; there might be a statistical “norm” (= “mean”) of those variants

(just like there might be a statistical “mode” and “standard deviation”) but there is no “normative” norm, if you know what I mean: there is no “ideal” height that the “best” or “perfect” tiger is. And just as we can measure the distribution of variants synchronically (within the same generation), we can also track changes in that distribution diachronically (across generations). The statistical nature of means or norms entails that although the bulk of the natural distribution will approximate to the mean, no single individual need ever achieve the exact mean.

The source of heritable variation was thought by Darwin to be accidental mutation. This is important: according to Darwin, variations are produced without reference to how they help the organism adapt to its environment, that is, they are produced without reference to “fitness” (see below). The usual story is that Lamarck thought that variation was driven by adaptation; as an organism struggled in its environment, its differential use of its organs drove a variation. Thus variation was “acquired” and this acquired variation could be passed down to children. (The usual story, which pits Lamarck against Darwin, is quite unhistorical, as Darwin read and benefitted from Lamarck.)

The source of variation is an important contemporary issue. Lynn Margulis thinks most evolutionarily important variation comes from symbiosis [= “symploysis”]. Mary Jane West-Eberhard, building on Waddington’s work on “canalization,” points to “developmental plasticity” as an additional cause of variation. This amounts to a reconsideration of “Lamarckism,” as heretical as that may sound to many biologists. The connection of West-Eberhard and Lamarck is quite complex and deserves careful study.

9. Next, let’s look at NATURAL SELECTION. According to Darwin, selection is due to population pressures relative to the carrying capacity of the environment. (Many contemporary accounts provide for other ways in which selection occurs; what counts is differential reproduction, no matter how it’s achieved.) According to the usual story, a species would tend to fill its “niche” to the point where the [in]famous “struggle for survival” would kick in, creating a “selection pressure.” (This may in fact be more a notion due to Herbert Spencer than to Darwin, but that’s a matter for further discussion.)

This scenario needs considerable nuancing, as it presupposes a fixed environment against the “borders” of which immobile species press (a container image). But organisms are mobile and environments are not fixed (“niche construction” [see below] would need to be discussed here). This is not to deny that populations grow. Each population tends to produce more offspring than what would be necessary to replace the parent population. In other words, in general, sexually reproducing organisms produce more than two offspring over their life time. But the response to this population growth need not be “struggle”; it’s often the case that offspring move out of the core territory of their parents to find [and / or “construct”] their own niche. There are of course no guarantees; the new niche may be less favorable than the core territory, and the “emigrants” may not be successful. (Cf. the Deleuzian notion

of “deterritorialization.”)

Continuing with the popular story (again, which is more Spencerian than Darwinian), the “struggle” means that the “best” would survive and reproduce more; or the “worst” would be eliminated and reproduce less. The problem here is the presumed individualism. Organisms cannot “reproduce” (or even “survive” in any biologically meaningful way) in isolation. Even if you could somehow identify the “best” organism, this would have to mate with a less “perfect” individual, so that the offspring would automatically be less than “best.”

10. “FITNESS.” The usual picture needs to be turned around. Being the “best” doesn’t measure some overall adaptation to an environment. Rather biological “fitness” just measures reproductive success. In reality, organisms just need to be “good enough” (and not be unlucky) to interact successfully enough with the environment to survive long enough to reproduce. Once it reproduces, its “fitness” is out of its hands, as it were: it now depends on the survival and reproduction rates of its offspring. Again, there’s no “overall” adaptation: every organism is always a grab bag of characters, some being very well adapted to a particular environment, other not so much.

The key to “selection” is the assumption that some variants would affect “fitness” (= number of offspring produced per generation). The more a heritable variant helped an organism leave behind live and fertile offspring (organism scale), the more it would accumulate across generations (or, alternatively, the more “bad” variants hurt fitness, the more those traits would disappear – although you have to remember that new variants are appearing constantly). Thus you could measure evolution as the change in distribution of adaptive or positively fitness-affecting heritable variants or “traits” in a population across generations. At some point in this process a new species appeared *via* the accumulation of differing traits (evolution scale) and geographic isolation. (This “accumulation” need not be strictly quantitative. Theoretically, a single mutation may do the trick if it prevents interbreeding between populations that have been separated from each other and, thus, were prevented from interbreeding.)

Remember that there are not inherently “bad” or “good” variants (in modern terms, changes in genes and their expressions). Variants turn out to be “bad” or “good” depending on how they interact with the environment. For example, a particular variant may be bad in the arctic environment, but very good in a tropical desert environment.

11. ADAPTATION. There are lots and lots of debates about the “adaptationist” interpretation given just above. We can’t get into all the details, but there are indeed lots of nuances to add to this story. Probably the most famous critique of *complete* adaptationism is Gould and Lewontin’s “Spandrels of San Marco” article: some traits we see today were never selected for, but are just the accidental product of other selected traits.

In general, the “genealogical” strain in philosophy (Nietzsche, Foucault, Deleuze) would say that the current function of something is no absolute or foolproof clue to its origin, or in other words, that a structure can assume different functions over the course of its history, as it is subsumed in different “assemblages.” This would hold for both biological and social history according to these thinkers. (In our talk about “genealogy,” it is important to distinguish “function” (i.e., property) of a structure from the “biological role” of a structure within a natural environment. IOW, “functions” are relational, not substantial.)

My colleague Dominique Homberger confirms the prior existence of this idea in biology. She writes “It is actually known under the concept of *Funktionswechsel*, which was formulated first by Anton Dohrn in 1881 and which states that evolutionary changes of particular structures always entail changes of function.” However, Vince LiCata remind us to be cautious here. While the phenomenon of spandrels certainly occurs at many levels of biological organization, we should not unlink current function from origin *in general*, since all life forms are so strongly related that using current function as a clue to origin has been very successful in many, many cases. Thus we have to remember that Gould and Lewontin’s argument carries only against rampant or complete adaptationism, not adaptationism *per se*. (We also have to remember the debates about the role such a complete adaptationism plays in Gould and Lewontin’s *bête noir*, Evolutionary Psychology.)

12. NICHE-CONSTRUCTION. In all these debates there are also very interesting questions about “niche construction.” That is, an organism does not passively submit to the pressures of a pre-existing environment, but actively constructs its niche: its own activity will change the environment and hence affect the selection pressure. The notion of “niche construction” is closely related to the notion of “co-evolution” in which the activity of one species will affect the fitness of another species, and vice versa. The two (or more!) species then “co-evolve.” The simplest example of this is the “arms race” of predator-prey, but there are other modes of co-evolution.
13. CONSEQUENCES. What this means is that “species” is really just a name of a snapshot of a process of diversification. Let’s think in terms of synchronic and diachronic diversity.

With respect to synchronic diversity, where do you draw the line between two variants of a species and two different species? (This is somewhat analogous to the dialect vs language issue in linguistics.) Here species are like coagulations of a viscous liquid, whose spreading out on a surface you have arrested.

With regard to diachronic diversity, we have to remember our two temporal scales. Relative to our life span, to our organismic temporal scale, you might say that a species has a fixed identity (albeit with diversity of traits) – that’s if you solve the synchronic “variant vs species” problem noted above. But relative to the evolutionary scale, they are just snapshots of a process. [According to Gould, who perhaps

invented this to draw a distinction, Darwin was a “slow gradualist” with regard to the rhythm of evolutionary change: that is, there was only a single rhythm, and speciation takes a long time. Others {Gould and Eldredge} propose “punctuated equilibrium,” that is, a variety of rhythms of speciation, some faster than others. So while speciation is a term for the appearance of novelty, or an “event,” in some periods, there is a faster frequency of events.]

In philosophical terms, then, Darwin is a “nominalist” with regard to species: it’s a convenient name for a synchronic coagulation or a diachronic snapshot but it doesn’t hook on to an “essence.”

14. UNANSWERED QUESTIONS. Darwin did not have a mechanism for heredity (that is, the transmission from parent to child of variations; the accumulation of inherited adaptive variations is the key to speciation). The unit of selection has also always been a problem. Darwin thought the organism was the unit of selection, but there are other candidates today. But to explain the current candidates, we first have to talk about genes.
15. GENES were at first just abstract functional units thought to account for traits. When 20<sup>th</sup> C thinkers adopted Mendel’s laws and put them together with Darwin’s notions of variation and natural selection (“the modern synthesis”), they didn’t know what the physical structure of genes was; they just postulated them in order to account for the transmission of traits. With “population genetics,” evolution became thought of as the change in the distribution of genes in populations across time.
16. THE MOLECULAR REVOLUTION. In their famous “double helix” 1953 breakthrough, Watson and Crick deduced a chemical structure for DNA (as braided strings of nucleotides). Previously, in the 1940s and early 50s numerous researchers (not including W&C) had demonstrated, in a variety of ways, that DNA comprised the physical structure of genes. The combination of these two advances meant that genes were understood to be contiguous strings of nucleotides located on the chromosomes. The great thing about DNA is that it was supposed to account for both scales: development and evolution. It was supposed to account for development because it was thought to provide the “program” for development: which proteins to be coded for in which order. And it accounted for evolution (as change in distribution of alleles across generations) because it was passed on in the sperm and egg, in the nucleus of those cells. The “central dogma” links these two thoughts in a molecular reprise of Weismann’s “segregation of the germ-plasm” thesis: it said that DNA codes for RNA which codes for protein (development), but there’s no influence on proteins back to DNA; it’s a one-way process of “information” flow (hence the source of variation can only be random mutation, not mutation “directed” by “epigenetic” events).
17. There are many CONTEMPORARY NUANCES to note here. They can be encapsulated in the following slogan: “it’s not only about gene possession, it’s about gene expression.” Several things need to be noted here.

One is the problem of development and “cell differentiation.” All our cells have the same DNA, but some develop into blood cells, others into bone cells, others into liver cells, etc. How does the same complement of DNA “know” which cell should be produced? It turns out that for a protein to be produced from its coding DNA, that DNA has to be activated (= “gene expression”), and that activation depends not just on other “regulatory” genes, but also on the state of the cell it inhabits and on all sorts of biochemical networks linking it to other cells. Activation depends also on physical forces from the environment. Thus DNA alone cannot be thought to be the “program” for development.

Furthermore, separate stretches of DNA often are picked out in complex processes of “translation” and “transcription” in order to work together in synthesizing proteins. And some proteins can be produced using different stretches of DNA (this is why many “knockout” experiments don’t produce phenotypic differences).

Long story short, it’s more complicated than the cliché of DNA as “blueprint,” that is, DNA as a transcendent and unchanging source of one-way information flow. (It’s not that there is a two-way information flow; it’s just DNA alone it not its “source.” Some will say that “information” is itself only a retrospective and abstract way of looking at the process. Susan Oyama thus talks about the “ontogeny of information.”)

No one denies that DNA is a *necessary* part of the process; most people now just want to insist that DNA is a *part* of the process. And so we need to watch out that we don’t import uncritical political metaphors of DNA as the “command center” or “executive suite” or what have you. (These last bits are much more the result of popularizations than the result of considered contemporary scientific opinion, but we still have to be on the lookout.)

18. Today there are many candidates for THE UNIT OF SELECTION: in other words, what is it that “selection pressure” works on?
1. Selfish gene (Richard Dawkins: genes are replicators; organisms are vehicles. This position has attracted many supporters and critics. It would take us too long to disentangle all the arguments here.)
  2. Organism (Darwin)
  3. Group (Gould: species are individuals on which selection acts; others hold that groups *qua* groups [i.e., not organism or species as individuals] are the unit of selection. There are lots of debates about *altruism* here. Some see it as group selection. But the gene-centered folks talk about “kin selection”: If you sacrifice yourself for a kin, at least part of your genotype, the “altruistic” part that determines or at least influences self-sacrifice and that is [probably] shared with that kin, is passed on. On the other hand, the organism folks talk about “inclusive fitness,” which is individual fitness plus the effect the organism’s behavior has on other organisms’ fitness.)

Dominique Homburger writes: "Altruism has rarely anything to do with the macho notion of "self-sacrifice". Some biologists maintain that what we call altruism is actually fairly common and can be seen in motherly (of fatherly) behavior towards offspring and young animals in general (adoption and even trans-specific adoptions of deserted youngsters are observed fairly regularly, and herding animals can be seen eating side by side (in contrast to hummingbirds who will chase away other hummingbirds from a feeder even if they themselves cannot eat more). Most animals are to some degree social beings and as such, they feel good about pleasant interactions (e.g., reproduction, raising young, playing, feeling safe in company, etc.). Altruism, of course, is very important for the survival of highly social animals, such as social insects, naked moles, hyraxes, prairie dogs, and most of all human beings. Given their very precarious anatomy and physiology, human beings are very vulnerable as individuals (i.e., without tools and alone by themselves, human beings are unlikely to survive for very long in any truly wild environment). For human beings, hence, becoming one of the most "successful" species was possible only because of their highly developed social skills and altruistic interactions, which have been documented early on, such as the presence of handicapped and chronically sick individuals in graves of Neanderthals."

4. "Developmental system" (for "Developmental Systems Theory" or DST, it's the total "developmental system" or "life cycle," including social and environmental inheritances, which is the unit of selection; DST often adopts a "pluralist" position that selection works on many levels.)

I'm a big fan of DST. So my challenge is parallel to the "naturalizing Bergson" challenge of MM: can DST allow us to save something from CE, the way dynamic systems theory might allow us to save something from MM?

#### 19. Further reading:

Gould, SJ and RC Lewontin. 1979. The Spandrels of San Marco and the Panglossian Paradigm: A Critique of the Adaptationist Programme. *Proceedings of the Royal Society of London. Series B, Biological Sciences*. Vol. 205, No. 1161: 581-598

Jablonka and Lamb. 2004. *Evolution on Four Levels*. Cambridge MA: MIT Press.

Keller, Evelyn Fox. 2000. *The Century of the Gene*. Cambridge MA: Harvard University Press.

Oyama, Susan. 2000 [1985]. *The Ontogeny of Information*. Durham NC: Duke University Press.

West-Eberhard, Mary Jane. 2003. *Developmental Plasticity and Evolution*. New York: Oxford University Press.

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Now to move to Bergson and CE.

1. B begins CE 1 with a discussion of DURATION IN GENERAL. After a recap of familiar themes from TFW and MM, he gives us the famous dissolving sugar example. While in principle a scientific treatment of universe could remove time, WE, as embodied and living creatures, have to wait for physical / natural processes to unfold.

Bergson here distinguishes isolated systems from the “open whole” from which they are abstractions (not “parts,” but “partial views”). Scientifically isolated systems are not completely artificial. What they do is take the tendency of matter (“extending” as a process of becoming-separate) and pretend that it has reached its (unreachable) limit: that is, that it has accomplished a “being-extended.” Note the difference between the past participle “extended” and the present participle “extending.”

We can put this in terms of thermodynamics. “Isolated systems” are systems where no matter or energy may pass in or out. In this sense, there are certainly no biological isolated systems at all. Isolated systems can be created artificially, however – for all practical purposes, that is. Bergson will claim that physics shows that the ultimate reality is an interactional field in which all material points influence each other. It’s just that many of these influences can be ignored for our practical purposes. Thus science “creates” isolated systems for study.

Bergson then drops a bombshell (at least to readers of TFW who missed the relevance of MM4): “the universe endures” [*l’univers dure*]. This means the whole is an open whole: it’s a continually unrolling process. It has the nature of a psychological process, but despite some panpsychic temptations (remember the “perception” of “any material point whatever” in MM1), there’s no hint that the universe has or is progressing to any self-consciousness. Perception and science reify partial views of this process, turning them into “parts” (turn [concrete] time into space) and complete matter’s spatializing tendency to separation, breaking the “communication” of all material points.

2. With LIVING BEINGS, Bergson says that there is a natural individuality, but that this is again only a tendency; it is opposed by the tendency to reproduction. [Aristotle tried to recuperate reproduction within the circle of the same, using his “teleological semenology.” Maternal matter only provides individuation, whereas paternal form – in the ideal case – is reproduced in the father-resembling son.]

If we avoid the temptations of the “mechanistic instinct of mind” we can see that living beings, like universe as a whole, are durational. Change has a one-way direction, toward aging and maturation. We’re fooled into separating embryonic morphogenesis (transformation of form) from “growth” as allegedly happening to a

substance. Rather, there is one continual process of transformation of form, but with different rhythms (puberty and menopause being dramatically rapid phases). What we have to do is see that the whole of the past (organismic AND evolutionary past) conditions (not determines) the present and future of living beings. The only process determined by the immediate past is organic destruction. But creation is conditioned by the whole of the past.

3. Bergson now states a famous PARADOX. Our mechanistic habits of thought are oriented to action and are the result of an evolutionary process, but it's that very result that prevents us from understanding evolution! The solution will be to understand the difference between ("mechanistic" – and "teleological") intellect and intuition, which is a developed or "evolved" instinct.
4. When tackling MECHANISM AND FINALISM, Bergson pinpoints what they have in common: the denial of duration, that is, the assumption that "all is given": the parts are pre-given in *mechanism* and are just re-arranged by "laws" such that Laplacean denial of time is possible, while in *finalism*, the goals are pre-given. They are both beholden to our pragmatic habits of thought ("intelligence"): mechanism looks to efficient causality whereas finalism looks to the plan projected in advance of work (notice the way we call a production process a "project"). B's position is that of "external finalism." We'll come back to that later.
5. INTUITION AND INTELLECT. We have to get in touch with the intuitive "fringe" that surrounds our intellect. We don't "think" real time, B says, but we do "live" it. Thus we have to see that life extends beyond intellect, that is, that intellect is a product of life, a "condensation" from life which leaves a "fringe." And it's by means of this fringe that we can understand that reality is creation of novelty. What we have to do is develop a philosophy that creates new concepts that fit life, rather than rely on the concepts of the intellect, which are formed for pragmatic purposes and hence reify vital processes into fixed "species" and "organisms" rather than seeing them as processes which have tendencies to individuality, but that never achieve complete separation (just as matter never achieves complete separation).
6. A COMPLETED BIOLOGY AND THE PHILOSOPHY OF LIFE. These two points are separated in the text by a few pages, but I want to treat them together.

B has often referred to calculus and modern mathematics. In talking about what a truly modern (non-mechanistic) biology would be like, he develops an analogy. As modern geometry (as topology, the study of the transformation of spatial form) is to ancient geometry (the study of the properties of fixed forms) so would a modern biology be to physics and chemistry. B expands on this using his calculus imagery. Modern biology would study living systems as indivisible movements and relate to physics and chemistry as changes in position, just as one moves from functions (curves = biological processes) to derivatives (tangents = mechanical processes). You should recognize the logic by now: motion is indivisible, but we tend to think in terms of the divisible space traversed by the "thing" that is moving through a series

of positions. Later, B will show that mechanism considers only the positions (= the parts of a process), while finalism considers the parts and their order (= goal of the process). But both miss the processual nature of the process.

But even such an improved biology must be supplemented by a philosophy of life, which studies "life as a whole," but a whole that allows for conflict. Here B sketches his *élan vital* notion: each species retains something of the original impetus of life ("overcoming of matter" as we will see later), but it does this on a tangent as it were, on its own line of divergence. This creates room for conflict with other species (as well as for dead lines, extinctions, etc.). The key to B's "external finalism" is two fold: it is "external" in the sense that no one organism has a pre-given ("internal") goal or plan that it fulfills, and it's "finalism" is in a sense inverted, as the original impetus is a push from the beginning, not an attraction from the end.