

Adaptation and adaptivity in Canguilhem's *The Normal and the Pathological*  
in relation to West-Eberhard's *Developmental Plasticity and Evolution*

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## INTRODUCTION

What makes *The Normal and the Pathological* a masterpiece is its profound Spinozist / Nietzschean perspective on immanent modes of life, the degrees of power of a life. Adherence to norms as species-wide averages cannot define health nor can deviation from them define illness. Norms are not statistical averages of a population but that which an organism develops in its life course as it expresses its power in the range of its affects, what it can do and what it can undergo; illness is not deviation from a species-typical statistical profile but a narrowing of the norm-developing power of an organism.

We're going to concentrate on the biological rather than the medical aspects of Canguilhem's great book. The two editions of *Le normal et le pathologique* (1943, 1966) appear before and after the start of one of the most momentous periods in biological science, the "Molecular Revolution," among whose high points are Watson and Crick's 1953 paper in *Nature* describing the chemical structure of DNA, and Jacob and Monod's 1961 paper in the *Journal of Molecular Biology* on "genetic regulatory mechanisms in the synthesis of proteins," where the notions of "regulatory gene" and "genetic program" are laid out.

But before the Molecular Revolution came two other noteworthy periods: the Modern Synthesis bringing together Darwinism, Mendelian genetics, and population genetics; and Darwin's own revolutionary work. We will pass over the Modern Synthesis, but will note that Darwin established three necessary factors in evolution by natural selection: variation, heredity, and selection. The standard mid-twentieth-century formulation of the concept of natural selection posited genetic mutation as the source of variation; DNA as the material base of heredity, and environmental action as the source of selection pressure.

In the last few years an “extended synthesis” (Pigliucci and Müller 2010) has brought together new takes on the classical scheme: developmental plasticity (West-Eberhard 2003) as an additional source of variation; epigenetic factors in heredity (Jablonka and Lamb 2005); and niche-construction or co-evolution of organism and environment in selection (Lewontin 2002).

This talk will examine *The Normal and the Pathological* in light of the Extended Synthesis model, with particular attention to West-Eberhard’s *Developmental Plasticity and Evolution* (Oxford, 2003). Canguilhem distinguishes adaptation (retrospective; having been adapted to a given set of conditions) from adaptivity (a prospective potential to adapt to unforeseen changes in conditions). He discusses adaptivity in the physiological and evolutionary registers. We will bring these notions together with West-Eberhard’s notion of “developmental plasticity,” which is, we claim, adaptivity in the developmental register. What makes West-Eberhard’s approach exciting is her notion that environmentally induced developmental plasticity often leads the way in evolution by calling upon “unexpressed genetic variation”; she thus has an “eco-devo-evo” approach, as distinguished from the more well-known “evo-devo” approach.

## CANGUILHEM

We will treat three topics in *The Normal and the Pathological* here: 1) adaptation and adaptivity; 2) niche-construction; 3) development and DNA.

### ADAPTATION AND ADAPTIVITY

Canguilhem points us to the need to distinguish two notions of adaptation:

There is one form of adaptation which is specialization for a given task in a stable environment, but which is threatened by any accident which modifies the environment. And there is another form of adaptation which signifies independence from the constraints of a stable environment and consequently the ability to overcome the difficulties of living which result from a change in the environment. (262)

We will call these “adaptation” and “adaptivity” respectively. Adaptation is retrospective: its present and future are determined by its past. Adaptivity is prospective: its present and future are conditioned but not determined by its past. What the past gives to adaptation is its actual power to adapt to a range of conditions; what the past gives to adaptivity is its potential to adapt to a range of conditions that will exceed those of the present.

Some big metaphysical stakes are in play here whenever we talk about potentiality and actuality. Aristotle’s *Metaphysics* would be one pole of our discussion (“clearly actuality [*energeia*] is prior to potentiality [*dynamis*]” 9.8 .1049 b5), and Deleuze’s

*Difference and Repetition* another (the “potential” is virtual, that is, fully differential, so there is no priority of actuality).

Even in the physiological register (a relative short time scale relative to the life span of an organism) we encounter adaptivity as the ability of an organism to monitor and intervene in processes influenced by external events that are heading toward viability constraints of the organism. There’s been good work on this in the physiological register by Ezequiel Di Paolo, a leading researcher in the enactive approach to the biological and cognitive sciences (Di Paolo 2005). I will propose, bringing Di Paolo and West-Eberhard together, that we can think adaptivity in the developmental register as “plasticity,” and that this developmental plasticity plays a leading role in evolution. This “eco-devo-evo” account, which invokes developmental plasticity as a source of evolutionary variation, displaces Canguilhem’s wrestling with mutationist accounts of the origin of species in the *New Reflections* section from the 1960s (NP: 262-265).

Some more evidence that Canguilhem’s notion of adaptivity to presently unforeseen circumstances relies on a notion of potential can be adduced. Discussing the equation of anomaly in relation to individual’s activity as infirmity, Canguilhem writes: “the forced limitation to a unique and invariable condition is judged pejoratively in terms of the normal human ideal, which is the potential and deliberate adaptation to *every condition imaginable*” (142; emphasis added).

In the physiological register, adaptivity as a reserve of potentiality is the key to flourishing: “Man feels in good health – which is health itself – only when he feel more than normal [*lorsqu’il se sent plus que normal*] – that is, adapted to the environment and its demands – but normative, capable of following new norms of life” (200E / 132F).

Furthermore, to evaluate the normal and the pathological, “human life must not be limited to vegetative life” (200). If you survive even the most harrowing illness, you *have adapted* to imposed circumstance, you are normal qua normalized. But this retrospective adaptation is “paid for by renouncing all eventual normativity [*normativité éventuelle*]” (200E / 133F). We have to stress the “event” in “eventual” here, as that which brings forth, in an event, a new form of life. Adaptivity is this potential to follow new norms; it is the capacity to follow through on normativity as norm-generation.

There is much to think about here: “adaptation to every condition imaginable” relies on a potential, on adaptivity as capacity for innovation in the physiological register. While Canguilhem, as we will shortly see, addresses evolutionary adaptivity, we do not see him thematizing developmental adaptivity. We want to think this potential, this capacity for innovation in the developmental register as “plasticity.” Now in one sense it’s hard to distinguish physiological from developmental: development is just patterned serial physiology. But that’s a nuance we need not pursue. At stake is the potential to create novelties. “Normal man is normative man, the being capable of

establishing new, even organic norms" (142). That potential is physiological adaptivity and developmental plasticity.

Canguilhem invokes evolutionary adaptivity in his notion of anomaly. Anomalies (thought here as mutations as directly hereditary anomalies) are not pathological because they diverge from species average / type; their deviance has potential positive significance; it might be cashed out in the future: "In biology the normal is not so much the old as the new form, if it finds conditions of existence in which it will appear normative" (144).

Evolutionary adaptivity is also invoked in the idea that "a species' normality ... a certain tendency toward variety" obtains "a kind of insurance against excessive specialization, without reversibility and hence without flexibility, which is essentially a successful adaptation." Canguilhem continues: "in adaptation perfect or completed means the beginning of the end of the species (262-3).

Finally, we see that species variation is essential for evolution. "Unlike humanity which, according to Marx, poses only problems which it can solve, life multiplies beforehand the solutions to problems of adaptation which could present themselves" (265). The French deserves to be read here: "la vie multiplie d'avance les solutions aux problèmes qui pourront se poser" (199F). In the "pourront / could" we clearly see the notion of potentiality implied in evolutionary adaptivity.

## NICHE-CONSTRUCTION

With geo-bio-social-technical humanity, to which Canguilhem devotes memorable analyses under the titles of "comparative human physiology" or "man's ecology," we have a specific example of a general point that is currently addressed in the "extended synthesis" school as "niche-construction" or "co-evolution of organism and environment."

Niche-construction forces us to rethink the concept of adaptation, which did not, in fact, originate in biology; rather, originally, adaptation is a popular concept describing technical activity: adapting tools (and indirectly our organs) to the material / situation. In 19<sup>th</sup> C biology, the concept of adaptation retains "relation of externality, of confrontation between an organic form and an environment opposing it" (283).

There are in fact two externalist principles for conceiving "adaptation": 1. Teleological / optimum / search for functional satisfaction; 2. Mechanist / equilibrium / submission to necessities. But this external opposition of organism and environment misses niche-construction: "the organism is not thrown into an environment to which it must submit, but it structures its environment at the same time that it develops its capacities as an organism" (284; changing "he" to "it").

With regard to humans, we cannot accept the reification implicit in the phrase “social maladaptation”: “The psychosocial definition of the normal in terms of adaptedness implies a concept of society which surreptitiously and wrongly assimilates it to an environment, that is, to a system of determinisms when it is [instead] a system of constraints which ... contains collective norms for evaluating the quality of these relations” (282). Thus we see that niche-construction is particularly true for humans: “normal and abnormal” are determined less by the opposition of two independent causal series, man and environment, than by the ability of an organic agent to shape its environment (284).

But human niche-construction is only an example of a general process. Development and evolution is not just a process by which passive material molded by an active environment; “in fact the environment of the living being is also the work of the living being who chooses to shield himself from or submit himself to certain influences. We can say of the universe of every living thing what Reininger says of the universe of man: ‘Unser Weltbild ist immer zugleich ein Wertbild,’ our image of the world is always a display of values as well” (179).

#### DEVELOPMENT AND DNA

However, despite his insistence on innovative normativity and adaptivity, Canguilhem slides toward a certain genetic determinism. Written in the 1960s, in the first full bloom of the Molecular Revolution, in the immediate aftermath of Jacob and Monod’s powerful 1961 article introducing the notion of the genetic program, Canguilhem discusses the DNA string as “code or message.” Using these “concepts borrowed from information theory” we find that substituting one nucleotide string for another is “error” (276). But “error” needs semantics – a mutation has a biological meaning or sense -- which you don’t get in Shannon and Weaver’s information theory, in which information is sheer quantity: we get the same bits of information in normal genes and in mutations (Keller 1995: 18-19).

Canguilhem’s genetic determinism is clear in this passage: “Since enzymes are the mediators through which the genes *direct* intracellular protein syntheses, and since the information necessary for this function of *direction and surveillance* is inscribed in the DNA molecules at the chromosome level, this information must be transmitted as a message from the nucleus to the cytoplasm and must be interpreted there, so that the sequence of amino acids constituting the protein to be synthesized is reproduced, recopied” (NP: 276-77; emphasis added).

In the original *Essay*, in the discussion of “comparative human physiology and pathology,” Canguilhem has shown a multiplicity for human geo-bio-sociality, for political physiology (163). But here, in the post-Jacob and Monod discussion of DNA of the New Reflections section, he has put DNA in a transcendent command structure, as the “master molecule” trope Keller has done so much to deconstruct. So what we need to do is to show that progress of molecular biology has shown a multiplicity in eco-devo-evo that dethrones the master molecule.

## WEST-EBERHARD

I take off from some thought-provoking lines in Evelyn Fox Keller's *Century of the Gene* (Keller 2000), when she writes that we might "consider the mature mRNA transcript formed after editing and splicing to be the "true" gene. [JP: we're going to call this protein-synthesizing gene the "functional gene," as opposed to the DNA sequence as "hereditary gene."] But if we take this option (as molecular biologists often do), a different problem arises, for such genes exist in the newly formed zygote only as possibilities, designated only after the fact. A musical analogy might be helpful here: the problem is not only that the music inscribed in the score does not exist until it is played, but that the players rewrite the score (the mRNA transcript) in their very execution of it" (63).

What West-Eberhard suggests is that even if functional genes are constructed from "unexpressed genetic variation," that is, that the functional gene can be seen as potential, as only existing ex post facto, as constructed due to an environmental change, they can nonetheless "sometimes precede the evolution of the lineal sets of contiguous exons that characterize many [hereditary] genes" (DPE, 329). In other words, rather than function following structure / heredity, it precedes it, and leads to its consolidation.

But that means potentiality (the constructed functional gene is only potential in the unexpressed genetic variation) precedes actuality (the later evolved contiguous DNA strings). Some big metaphysical stakes are in play here whenever we talk about potentiality and actuality. Aristotle's *Metaphysics* would be one pole ("clearly actuality [*energeia*] is prior to potentiality [*dynamis*]" 9.8 .1049 b5), and Deleuze's *Difference and Repetition* another (the "potential" is virtual, that is, fully differential, so there is no priority of actuality). Furthermore, in West-Eberhard's concept of environmental induction of novel phenotypic traits as a source of evolutionary potential (DPE 145; 499ff), we will see what Deleuze calls "counter-effectuation": the move from the intensive to the virtual.

Recall how developmental plasticity is the creativity of the phenotype and environment (NOT the genotype and environment). When an adaptive phenotypic change has a genetic component, the gene expression networks (or more radically, the life cycle) for this adaptive phenotypic variant will now be selected (if the environmental change reliably recurs). Now these accommodated or now newly / creatively expressed gene expression networks (again, more radically put, the life cycle provoking the extended system of regulatory gene network and recurrent environmental conditions) were only "virtual," that is, only potentials of the pre-existing but unexpressed genetic variation that is only revealed ex post facto.

Here we see the meaning of West-Eberhard's phrase that gene networks are thus "followers" as opposed to "leaders" in evolution. Instead of being the sole causal factors, they are often just "bookkeeping." That is, it's the developmental plasticity

and the phenotypic adaptivity (in Deleuze's terms, intensive processes of individuation) that take the lead and bring out the potential to form the gene expression networks creating functional genes on the basis of the previously unexpressed potentials of hereditary DNA.

But here's the crucially important point: the potentiality of the hereditary DNA is not preformationism: there's no present / actual / homuncular / already-determined "unit" or "program" in the DNA that determines the actualization of the potential. The virtual is not "self-determining": it's determined, on the spot, each time, by the individuation process. (That's why Deleuze will say the condition is no bigger than the conditioned.) Recall Keller's musical analogy: "the problem is not only that the music inscribed in the score does not exist until it is played, but that the players rewrite the score (the mRNA transcript) in their very execution of it" (Keller 2000: 63).

It's the individuation process that takes the lead, which has to creatively produce something new into the world. This priority of individuation is what West-Eberhard talks about as developmental plasticity and phenotypic adaptivity, and is a perfect example of the reality of creative counter-effectuation.

We have seen the strong anti-genetic reductionist views of contemporary critical biology. There is a distributed / differential system of feedback among genes and multiple epigenetic factors guiding development. Deleuze would call the structure of this system a virtual pre-individual field. We've seen how this fits the notion of "unexpressed genetic variation." But not only that: in West-Eberhard's concept of genetic accommodation of environmental induction of novel phenotypic traits as a source of evolutionary potential (DPE 145; 499ff), we have seen counter-effectuation as a reality: we've moved from the intensive to the virtual.

So, we have to see both distributed-differential gene-environment networks as virtual and we have to see genetic accommodation as counter-effectuation, as changing the virtual, as bringing forth previously unexpressed potentials, from intensive processes.

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