Canalization and Creative Evolution: Images of Life in Bergson and Whitehead

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> *The status of life* in nature . . . is the modern problem of philosophy and of science.
>
> —Whitehead 1938: 202.

> And it must be compared to an impetus, because no image borrowed from the physical world can give more nearly the idea of it. But it is only an image.
>
> —Bergson 1998: 257.

Images and metaphors are essential to the organization of scientific discourse. We think through them, use them not only as explanatory aids, but as calipers first: without them, we're unable to grasp and articulate our objects of study at all, even before the endeavour to communicate what it is we've managed to grasp. In this paper I take up the 'canal' of modern embryology, an image for the way epigenetic landscapes operate in order to bring about, or canalize, a small number of end results from a larger landscape of developmental potentialities. I trace the history of that image from out of Bergson's *Creative Evolution*, through Whitehead's *Process and Reality*, and into the embryological theory of C.H. Waddington. I do three things in this paper: I situate the image of the canal in Bergson's philosophy of life; I demonstrate its utility to Whitehead's metaphysics; and I argue that the canal occupies a privileged position in Bergson's thought, and is therefore worth rethinking in terms of Whitehead's philosophy as well. For the canal is turned against itself, implemented (as an image) in order to expose the limitations of imagistic thought—of which science is a particularly significant case. The canal metaphorizes the limitations of thinking evolution through its material determinations. The image isolates and delimits what exceeds it. That means that the image of the canal purports to explain the relation between life and matter by way of the same operation of delimitation through which matter relates to life. I conclude the paper with a series of comments on this point: that it was the image of the canal that found its

way into modern embryology tells us something important about the relation between science and philosophy, or between image and imagination, matter and life. Here, Bergson and Whitehead converge on a philosophy of nature that is capable both of responding to scientific discoveries as well as of accommodating them within an enlarged process-oriented metaphysics.

Life, for Bergson, is not something other than matter; it is composed of virtual tendencies to differentiate that are immanent to materiality; it is, better put, the elaboration of those tendencies from out of materiality, negotiated against matter's own spatializing habits or proclivities. Life is the effort to develop as far as possible the indeterminacy it finds in matter. Whitehead calls it a "bid for freedom": life pushes against matter's habit to stay what it is, to return to what it was, opening it onto unrealized potentials and new possibilities. Life is, to be sure, importantly different from the materiality in which it's always embodied, but nonetheless, as Elizabeth Grosz puts the point, it "utilizes the same resources, the same forces, the same mobilities characterizing the material order" (2007: 11). Materiality is characterized by its uniformity, law-like regularity, its fixity, stability, even stasis. These are tendencies toward spatialization, toward the image.

Life is characterized by an opposing set of propensities: toward time, change, novelty, invention—all in excess over the delimitations of the material image. But the two are immanent to each other, co-imbricated, coterminous. There is no matter without some degree of indeterminacy, some minimal temporal spread, a vibratory duration; and there is no life apart from its material instantiations, its becoming-spatialized in its images. So life—the *élan vital*, the impetus driving evolutionary change—is that through which the actual is submitted to processes of change and transformation, materiality's organizing force. But organized bodies cannot, on Bergson's account, be decomposed analytically, cannot be attained by the combination of their constituent parts. Organization is, in a somewhat technical sense, strictly *indivisible*—which is to say, it is the work

of virtuality, the coexistence of divergent tendencies. Organization is not fabrication. To fabricate is to assemble, piece by piece, until a whole is achieved; but organization proceeds from the center outward, in explosive waves through which the whole is successively reconfigured anew (Bergson 1998: 92). The manufactured or fabricated thing reflects "exactly the form of the work of manufacturing it" (92). Each of its parts represents a part of the work that went into it. But the parts of an organism do not correspond to parts of the work of its organization. Organization is a process of actualization, of the contraction of virtual tendencies and their elaboration from out of materiality's own habits.

Bergson holds that the materiality of a living body "*does not represent a sum of means employed, but a sum of obstacles avoided*" (93). He calls it a "negation rather than a positive reality" (93). Take the eye. What obstacle is indicated in its material configuration? Of what is it a negation? The eye incarnates and facilitates a power of vision, which, "by right," should—in theory—attain to an infinity of visible things (93). But we can see, on Bergson's phenomenological account, only what we can act upon; visibility is coextensive with the world of effective engagement, our "niche." The determination of the power to see in terms of what the body can do suggests an inhibition: the function of the organ, restricted by its materiality. That materiality is a limitation on how far life can elaborate itself out of matter. Bergson calls the movement, or impulsion, behind that elaboration the positive reality of evolutionary change. It's what drives it. Materiality, then, insofar as it is organized by the vital force that it restricts, determines, or spatializes in turn, is the negative outline around life's positive thrust. But beyond a frustration, the materiality of the eye is also an achievement: it reflects the series of obstacles that the function of vision had to overcome in order to realize itself in the organ that it did. The bird's eye is testament to the progress made by vision beyond more primitive pigmentary masses.

When it comes to the relation between life and its material instantiation in the organism, Bergson calls on another image, that of the canal. The process by which a canal is formed cannot be explained by the accumulation of dirt that will become its banks. Neither can that dirt explain what the canal is, what it's for. Banks are dug, and they indicate the effort of digging them only negatively, in outline. A canal's banks function to facilitate a flow of water through them. But again, they suggest that flow only by silhouetting it. Canalization, understood as a process, refers to this double relation: of the banks to the effort of digging them, and of the canal to the flow that it contours. Both that effort and that flow stand to the banks as life does to matter. The one organizes the other while exceeding and moving through it. Canalization serves as an image for the work of the *élan*, which, considered in itself—independently of the matter to which it is always actually immanent—is an invisible movement whose products are the bodies organized by it, the same bodies that arrest or reroute its creative advance. The essence of a canal is its negative space—and in this respect, the composition of its banks is secondary to the fact that the banks work to guide a current of water through them.

Bergson initially invokes the image of the canal in the context of his discussion of organization. That a body is organized means, on his account, that it is something more than the sum of its parts. Organization is not the effect of combination. Parts and their possible arrangements are secondary issues: first comes the work of organization correlative with the organized whole, and only afterward can we decompose the body, study its parts, and try to build it back up out of them. This last step makes up the remit of scientific study. It's also why science tends toward mechanistic explanation. Scientific analysis works in terms of parts. Parts work mechanically. Bergson accepts this, but makes the study of parts derivative on the activity of organizing them. Organization is not fabrication. Fabrication, or the activity of producing an

artifact by working on some unformed material, works from the peripheries of its material toward the center, from the disaggregated many toward the made, integrated one. Fabrication operates along the axis of finalism (103). Organization corresponds, then, to the dissociative activity of the *élan* and its inverted finalism: effecting change from the center outward, from the one toward the many. That means that "to each part of the [fabricated] work corresponds a part of the result" (92), precisely because fabrication works part by part, building out of an initially disparate set of them a unified whole. Organization is different. A living body's parts reflect the work of its organization only negatively, only after the fact. Bergson thinks that science should treat organized bodies as if they were fabricated ones. It's only then that science can hope to grasp how they work. But in so doing, science decomposes—which is to say that it spatializes, delimits—bodies whose principle of organization evades that decomposition. It is in that productive omission that science gains its explanatory footing. And it is for this idea that canalization is supposed to serve as an image.

The eye is Bergson's organized body of choice. This is because the vision of a living being is always effective, "limited to objects on which the being can act" (93). Bergson calls vision's limitation "the work of canalizing" (93). The material configuration of a given visual apparatus in view of what it can see, on what the organism can act, is an effect of its canalization. This is what makes the organ's material parts like the banks of a canal—secondary to what flows through them, indicating that flow only in contour. That flow, for Bergson, is of course the *élan* itself. The visible structure through which it moves—the canal, its banks and floors; the visual apparatus—is only the present sediment of the effort by which it's constructed, the limits or outline of its canalized flow. The digging of the canal is a generative, but invisible movement, which is to say that its visible products represent it only negatively. The canal is the by-product of that work. By analogy, the visual apparatus is a material by-product of the invisible movement

flowing through it, the *élan.* The point is that organisms can't be understood in terms only of their material composition, because that composition is the sedimentation of the vital force that incited its organization.

Canalization is an image for how it is that one indivisible movement manifests itself in a series of determinate and (therefore) divisible material configurations. That movement, oriented in the direction of a perfected vision, is instantiated in various visual apparatuses across different evolutionary lineages. So the apparatus is like the canal in the two senses of that analogy already indicated. First, "the visual apparatus is no more explained by the assembling of its anatomic elements than the digging of a canal could be explained by the heaping-up of the earth which might have formed its banks" (93). Adaptationism holds that these elements had been coordinated gradually, through a series of accidents, until the function had been achieved—as if, in order to explain a well-built canal, it would suffice to describe its banks as accumulations of dirt. Finalism holds that the banks could have become functional only if they were constructed according to a plan. Both accounts hold that the effort responsible for the accomplishment of the functional canal can be divided into a series of acts, whether accidental or planned. Thus, both adaptationism and finalism treat organized bodies as if they were products of fabrication.

But processes of canalization are strictly indivisible. That's because the *élan* is time to the space of its material determinations. It endures through its spatializations. Or, to repeat an earlier formulation: the time of life elaborates itself out of matter's spatiality. We shouldn't miss, then, the resonances between the image of the canal and the ancient relationship established between time and a flowing river. Bergson thinks that the image of an invisible hand drawn through iron filings helps make the point. The filings arrange themselves around the trajectory taken by the hand. That trajectory is traversed—recalling Zeno's arrow—in one indivisible temporally

continuous movement, in accordance with the degree of effort that drove it. Adaptationists and finalists alike look only at the filings and see in them a positive explanation for their arrangement. Both accounts miss the fact that the filings *canalize* the movement of the hand: they resist it, organize themselves around it, and so express the effort responsible for the hand's movement only negatively (94-95). The functional integration of the visual apparatus is, on this image, not to be explained by the arrangement of its material parts, whether by accident or design, but rather by recourse to the effort responsible for its activation. The greater the hand's effort, the further will be its trajectory through the filings that resist it. This is Bergson's model for vision as well, for the visual organ's sophistication—its degree of complexity and coordination—stands in direct proportion to the effort or advancement of "the undivided act constituting vision" (95). The tendency toward vision canalizes the visual apparatus.

The act is also canalized by its material substrate. This is the image's second valence. The visual apparatus is not only an effect of the tendency toward vision, but also a means for its accomplishment. Here *another* image is brought into play. Bergson likens the relationship between the directions taken by evolution and what he calls its material "sinuosities" to the relationship between the construction of a road and the distance covered by it. "The road that leads to the town is," as Bergson says, "obliged to follow the ups and downs of the hills; it *adapts itself* to the accidents of the ground" (102). The soil on which the road is constructed is its indispensible condition. And yet, the "accidents of the ground" neither cause nor direct the course covered by the road. It is in vain that we look for that cause or that direction in the road's material conditions. It is to be found only in the fact of what the road is: i.e., a means for getting from one point to another. The fact that one can follow the road, journey across it—this is the road's essential meaning. Its materiality *facilitates* but does not explain this fact. Later, in the final pages of

Creative Evolution, Bergson returns to this image, supplementing the river for the road: "the movement of the stream is," he writes, "distinct from the river bed, although it must adopt its winding course" (270). So too must vision adapt itself to the material organ it has at its disposal. The visual apparatus conditions and facilitates the function. But it does not suffice to explain its cause. This is also what it means to say that vision is canalized by its organic embodiment. Vision is facilitated by the materiality to which it has to adapt itself. Matter canalizes life, provides it a substrate, bounds and limits it. But life is something more than its material actualizations, just as a road is insufficiently understood on the basis only of the ground on which it is constructed.

After establishing canalization as an image for life, Bergson proceeds to employ the word in a slightly different sense. The next time he uses the word, Bergson refers to the way an animal's nervous system concentrates "a rudimentary and vague activity" along definite directions as a *canalization* that intensifies what was initially diffuse and minimally effective (110). The canal becomes the mechanism by which a large, shallow spread is gathered together in a deeper, focused direction. In this sense, the distribution of water over a broad swatch of land is canalized as it begins to collect and stream along grooves in the ground. Bergson talks of basic organisms as uncoordinated systems of reactive movements (the sensory) and the ability to choose among a range of them (the motor). They seem like antagonistic tendencies, but even the most basic living thing demonstrates, on this account, a low-level ability to choose among possibilities in response to external stimuli. Choice among possible motor options is effected on the basis of an ongoing sensory receptivity. Bergson calls the connection between the two systems a kind of canalization (126). More sophisticated beings *canalize* more of their sensory field in terms of the motor possibilities available to them. And, indeed, by the end of *Creative Evolution*, canalization has

become a broad term indicating the consolidation of diffuse energy that is characteristic of life in general (256).

It shouldn't surprise us that Whitehead saw something powerful in Bergson's image of the canal. *Process and Reality* employs the concept of canalization as an essential principle in the explanation of the emergence of order. Whitehead sees in Bergson's explanation of the canal the insight that life can only act creatively within the confines of a material body. Without material "brakes" on its tendency to differentiate, life would be able to produce nothing stable at all, nothing on which natural selection could subsequently act. That wouldn't be a victory won on behalf of life, but a failure, for totally unrestricted evolution wouldn't be creative as much as just chaotic. It is this positive, productive sense to canalization that Whitehead affirms and develops—it supplies order, which is required for creativity and an increase in what he calls "intensity." Whitehead takes the image and reconfigures it: for him, the material of the canal is not a coagulation or sedimentation of the invisible movement flowing through it, but an *ordering* of that flow, the *articulation* of it.

Whitehead emphasizes the way Bergson utilizes the image at the end of *Creative Evolution*, as a mechanism for the concentration and intensification of an initially diffuse and vague activity. Whitehead takes this idea of productive concentration or limitation and decouples it from Bergson's *élan*. Canalization, in Whitehead's formulation, refers to the appropriation—Whitehead's "prehension"—of an inherited past of consolidated acts and relations. As the organism develops, it integrates more and more of its relations and transmits those integrations along a temporal line. The organism doesn't have to constantly decide how to relate to the world; in some sense, the outlines of its relation are increasingly rigidified for it—which implies a certain degree of irreversibility, just as it implies a developmental tapering in the space of possibilities. It

becomes for Whitehead a general metaphysical principle, capable of explaining everything from gene expression to the order and continuity required for conscious personality.

Canalization affords the organism an increase in order, which is just as necessary for the intensity of experience as is originality. Originality always moves away from—breaks the strictures of—the order out of which it emerges and into which it settles, even if after expanding or reshaping it. In biological terms, Whitehead might say that canalization allows the organism to take one relatively stable route through a massively chaotic environment—whether interior or external. It allows for the relatively reliable expression of phenotype, just as it ensures that different organisms of the same species behave in similar ways and so are able to survive in the same niche. Creativity, originality—or we might say mutation, anadaptation—requires that reliability as its starting point. "Thus life is a passage," on Whitehead's account, "from physical order to pure mental originality, and from pure mental originality to canalized mental originality" (1978: 107-8). Creativity, for Whitehead, necessitates some means by which societies of "actual subjects," or existent organisms, can interact with what has yet to come to pass. This is what is meant by "mental originality": the prehension or appropriation of what exists over and above the actual. This is the conceptual. If prehensions were simply physical, if they were related only to their actual pasts, then novelty would be made impossible from the outset. The universe would be caught in a cycle of repetition. Its creative advance is made possible on the basis of the creative decisions of actual subjects capable of prehending the physical past as in some sense *other* than it was; prehending the past, that is, *conceptually*—in the indeterminacy afforded it by what Whitehead calls "eternal objects." If physical feeling relates to the settled facts of the past, then conceptual feeling concerns the future, the formal possibilities left open by those facts. Every process of actualization therefore concretizes what is initially (or potentially) indeterminate by prehending the conceptual (that is,

the eternal objects) along with the actual, thereby adding another layer of realized actuality to the ongoing creative advance of the cosmos. Unity and continuity are, on this account, achievements—not starting points or givens (108). Canalization supplies the mechanism of their explanation.

C. H. Waddington—a developmental biologist responsible for instigating the conceptual revolution in the life sciences known now as "systems biology"—worked out his theory of the epigenetic landscape and its branching pathways of development while reading Whitehead's *Process and Reality* (Gilbert 1991). Waddington draws on Whitehead's reformulation of the image of the canal as the means by which to explain organismic order in the midst of environmental variability. For him, that means the reliable production of similar phenotypes in a highly variable population, scattered across significantly different environments. Waddington imagines a plane into which several divergent canals have taken shape (Waddington 1956: 412). What flows through them, on Waddington's account, is not the *élan*, but—according to a certain secularization of Bergson's principle—the cell instead. Before becoming canalized along one line of development, the cell's fate is plastic; it can follow any of a number of pathways, each of which is contoured by the interactions of various genes. But once the cell begins to develop along certain trajectories, it gains in expression—what Whitehead called "intensity"—what it loses in plasticity. That's the key to Waddington's take on the image: developmental irreversibility. Becoming canalized means falling into a groove, taking one pathway of development at the expense of initially possible others. "Developmental reactions," in Waddington's own words, "are in general canalized . . . they are adjusted so as to bring about one end result regardless of minor variations in conditions during the course of the reaction" (1941; quoted in Gilbert 1991: 197). Taking inspiration from Whitehead's schema and its redeployment of Bergson's image of the canal,

Waddington was able to develop a theory of epigenetics that, as Adam Wilkins has suggested, was nothing short of "a premature discovery" (1997: 257).

So it's not hard to see how productive an image can be. But even at their most fecund, our images come up against their limits in trying to capture the creativity of life. And that's instructive. Alia Al-Saji has recently taken issue with the image of the canal as Bergson developed it (2010: 152-153). She's right to note that the concern behind the image is Bergson's commitment to the claim that living bodies are more than the sum of their parts. Understand those parts materially (physico-chemically), and they end up—on his account—looking like the passive, inert products of a vital force that organizes them. But Al-Saji thinks that makes that vital force immaterial: and the specter of hylomorphism rears its head. I think she misses the fact that the canal is an image and not an explanation. But more importantly, I think she misses the relationship between the image and what it images on the one hand, and life and its material delimitations on the other. Life itself, I claim, operates according to the logic of the image. This is to say that by dissociating and differentiating itself through its material incarnations, by securing determination along a series of individual organic bodies, life becomes image. Organic bodies are the spatialized cessations to the creative impulse that images are to the material whole and the ontological past. Put differently, there is a structural isomorphy that obtains between the logic of the *élan* and the inability of the image to exhaust its explanandum; or yet again, between the relation of the *élan* to living things and the relation of perceptual images to the material universe, which is always in a process-relational movement of becoming that the image cuts and determines. This means that scientific analysis is also structurally analogous to perceptual experience, for both operate by isolating a thing from its relations, by dividing a whole into parts—which is not necessarily misguided, but

does risk taking for the whole what is only an isolated set of elements, as is the case with mechanist biology.

Understood in this context, the image of the canal is not the regrettable misstep Al-Saji takes it to be. In fact, it occupies a particularly interesting position in Bergson's understanding of life. The canal, as an image for the relation between life and matter, is an image, a halt or spatialization, deployed as a means by which to explain precisely that same limitation imposed on life by matter. That makes the canal an image that is turned against itself. Canalization is supposed to explain why it is that what is essential about living wholes cannot be captured spatially without recourse to the temporally self-differentiating vitality that activates them. But it is supposed to accomplish this as an image, which is, on Bergson's account, characterized by the same spatializing operation that it is implemented in order to expose. The canal is uniquely situated as an image; it is a spatialization of thought intended to demonstrate the inadequacy of spatialized thinking. I do not presume that to be coincidental. In fact, I take it to reveal something essential about Bergson's take on the scientific study of living things. Life unfolds through them by overcoming material obstacles but without ever fully attaining the heights toward which it tends. The *élan* is always incompletely realized, always in-process, frustrated by its material realizations. But just as the *élan* needs that materiality through which to unfold itself, we need images in order to think—even if through them we always necessarily fall short of our objects of thought. Life cannot be thought apart from its images. But these images work best when they can be turned back on themselves, made to reveal how they are functioning as images, what their imagistic limitations are. This, I claim, is the appropriate rejoinder to Al-Saji's suggestion that the image of the canal does not do justice to the complex relation of life to matter: of course not, it's an image, and life is precisely that which exceeds its material images, but those images are still essential to capturing

and delimiting it for purposes of understanding, just as for purposes of effective action. The canal achieves this as an image, while at the same time demonstrating the limitations of imagistic thinking.

Images of life aren't just necessary evils. They're potentially productive ingredients in the development of scientific theory in their own right. I want to conclude now with a distinction made by Peter Godfrey-Smith between philosophies of science and nature, and to suggest that both Bergson and Whitehead are situating the former within the latter, delineating its boundaries in accordance with the limits of imagistic thought, and granting to the philosophy of nature a meta-scientific purview. While the philosopher of science attends, on Godfrey-Smith's account, to the specificities of some domain of research, its requisite boundaries, presuppositions, and operative images, the philosopher of nature "comments on the overall picture of the natural world that science, and perhaps other types of inquiry, seem to be giving us" (2001: 284). Where the scientific thinker makes use of helpful images, expedient categorizations, and ontologically suspect distinctions in the service of some research program, the philosopher of nature feels no such obligation. This philosopher comes, in a certain sense, after empirical research, and tries to synthesize its findings with insights generated by other investigations in other domains in order to do as much justice as possible to the global complexity of the situation. Often this is unhelpful, even paralyzing for scientific research. Science has to delimit, cordon, isolate. That's how it works so well. But the philosopher of nature has concerns over and above explanatory utility.

Bergson and Whitehead ought, I think, to be understood as philosophers of nature in this sense. Their systems function both as commentaries on the findings generated by the biology of their time as well as attempts to supplement them with theories that remained foreclosed to their methodologies, that of life itself. If Bergson's *élan* and Whitehead's *creativity* are part of a

philosophy of nature, then their use of the image of the canal ought, I think, to be taken as part of a philosophy of science. For science proceeds by decomposing the living world into parts graspable in mechanistic terms and therefore conducive to analytic manipulation. That's exactly how images work. They isolate and delimit for some purpose, in service of some end. Images are always images-of, never all-inclusive, always located within a more complex whole; science, too, is always a study-of, never fully or finally exhaustive of its objects, always located within a philosophy of nature whose sphere is wider—and, indeed, metaphysical. By tracing embryology's concept of canalization back to the image of canal as it is situated, in both Whitehead and Bergson, within a larger field of activity—of temporality, creativity, life—I hope to have indicated one way in which these thinkers recommend a philosophy of science concomitant with a philosophy of nature that will always nonetheless necessarily outstrip it.

Bibliography

Al-Saji, Alia. 2010. "Life as Vision: Bergson and the Future of Seeing Differently." *Bergson and Phenomenology*. Ed. Michael Kelly. Palgrave Macmillan. 148-173.

Bergson, Henri. 1998. *Creative Evolution*. Trans. Arthur Mitchell. Mineola: Dover Publications.

Gilbert, Scott. 1991. "Induction and the Origins of Developmental Genetics." *A Conceptual*

History of Modern Embryology. Ed. Scott Gilbert. New York: Plenum Press.

Godfrey-Smith, Peter. 2001. "On the Status and Explanatory Structure of Developmental Systems Theory." *Cycles of Contingency: Developmental Systems and Evolution*. Eds. Susan Oyama, Paul E. Griffiths, and Russell D. Gray. Massachusetts: MIT Press. 283-297.

Grosz, Elizabeth. 2007. "Deleuze, Bergson and the Concept of Life." *Revue internationale de philosophie*. Vol. 3, Issue 241: 287-300.

Waddington, C.H. 1941. "Canalization of Development and the Inheritance of Acquired Characters." *Nature*. Vol. 150, Issue 3811: 563-565.

———.1956. *Principles of Embryology.* New York: Macmillan.

Whitehead, Alfred North. *Modes of Thought*. New York: Macmillan, 1938.

———. 1978. *Process and Reality: An Essay in Cosmology.* Ed. David Ray Griffin and Donald W. Sherburne. New York: Free Press.

Wilkins, Adam. 1997. "Canalization: A Molecular Genetic Perspective." *BioEssays*. Vol. 19, Issue 3: 257-262.

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