Is a Science of Beings Possible?

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The wolf does not become a lamb even if it eats nothing but lambs all its life. Whatever it is that makes it wolf, therefore, must obviously be something other than the "hyle," the sensory material, and that something, moreover, cannot possibly be a mere "thought-thing" even though it is accessible to thought alone, and not to the senses. It must be something active, something real, something eminently real.

I read this passage from the nineteenth-century philosopher Vincenz Knauer (1892) for the first time about forty years ago while I was in college. It gave me occasion to reflect then, and it still does today. In one sense it is a straightforward thought: wolves eat lambs (and much else) and remain wolves; koalas eat almost exclusively eucalyptus leaves and remain koalas; frogs eat slugs and flies and remain frogs. All animals overcome their food to maintain themselves. And think of plants. Poppies, asters, and milkweeds, to name a few, all take in carbon dioxide, water, and some minerals, and with the help of light create their own living substance and form. But how different they are from the water, air, and minerals they take in, and how different they are from one another!

Knauer is pointing to the fact that organisms are activities. It is not the substance of the food that makes them what they are. It is the specific way of transforming and forming that makes the wolf a wolf, the frog a frog, the poppy a poppy.

We gain a most vivid sense of this creative activity when we observe the development of an organism. When a tadpole metamorphoses into a frog, virtually all tadpole characteristics are broken down and disappear—for instance, the long tail, the gills, and the long intestine (see Holdrege 2015). New organs form—four legs, lungs, stomach, teeth—while other organs reconfigure, such as brain, eyes, kidneys, and skin. The developmental process entails unceasing transformative activity. The resulting adult is wholly other than the larval tadpole in its bodily configuration, physiology, and behavior. What we in the end call the adult frog works its way into appearance—becomes flesh—through development.

The frog-as-activity does not cease to exist once it reaches adulthood. Certainly, there is more stability of form and substance in the adult. But the frog is always engaged in maintaining its form and continually building up, breaking down, and transforming its bodily substances, all in relation to its needs and what it encounters in its surroundings. The frog never "is" in a static sense. It is continually producing and maintaining itself. Its body is at any moment the result of ongoing creative activity.

But What About Genes?

I can imagine some readers are thinking: That is all fine and good, but it is the genes that make both tadpole and frog. The genes, after all, stay more or less the same during the life of the animal, and, for that matter, remain relatively stable for generations. They make the frog a frog. Just as we can say that the frog-as-body moves, so we can say the frog-as-its-genes makes the frog. There is always some "thing" (body, DNA) that is the doer. The "thing" is primary and all activity is simply the interaction of things (substances).

That is certainly our habitual way of thinking about how life works, and it is precisely the habit that I want to move beyond. I think that Knauer got it right: the organism-as-activity is something "real, something eminently real" and yet it is not some "thing" we can place alongside DNA, cells, organs, and limbs.

Yes, in an abstract sense the bare DNA sequence (the sequence of nitrogenous bases) in a frog embryo, in a tadpole, and in an adult frog is, generally speaking, the same. If we begin by applying the widespread notion that genes consist of portions of that sequence, then if the sequence stays the same, genes must stay the same. They are the stable and unchanging physical basis of the organism, while all other things may be different in the different life phases of the frog.

But if the genes are the "same" in embryo, tadpole, and adult frog, then can it be the genes that make these phases of life different from one another? This is worth pondering.

The conventional response would be: well, there are different genes that are acting at different times during development. So there's no problem; it's just that we don't know yet the total activation sequence of the ever-present DNA over time. But there is a problem, and it's hidden in the expression "genes acting." How do genes act? By being woven into the activity of the rest of the organism. There is a highly complex and variable series of interactions that occur when a gene "acts." (See Steve Talbott's article in this issue of *In Context* and the much more detailed consideration in Talbott 2015.) DNA is chemically modified (for example, via DNA methylation), brought into movement, repaired, re-arranged and more during the developmental process. To say that "DNA stays the same" is to say that certain sequential features can be found to be stably produced and reproduced over time. That is basically the same as saying: over generations the wood frog stays a wood frog. When we say in biology something "stays the same" we actually mean it continually *becomes* the same out of activity; it is not an unchanging thing.

There are about 20,000–25,000 protein-coding DNA sequences, or genes, in the human genome, as geneticists typically count them. But many more proteins are synthesized than this static view of genes might suggest. Over one million distinct proteins are thought to be formed in the human body. The synthesis of these proteins does require specific DNA sequences, but the relevant sequences are not simply lined up, waiting to be utilized. Their final specification occurs within the context of development and through the activity of the organism under changing inner and outer conditions. It has become clear, as stated in an article by biologists on "How to Understand the Gene in the Twenty-First Century?", that genes need to be "conceived as emerging as processes at the level of the systems through which DNA sequences are interpreted, involving both the cellular and the supracellular environment. Thus, genes are not found in DNA itself, but built by the cell at a higher systemic level" (Meyer et al. 2013).

At whatever level you consider—whether molecules (DNA, proteins, etc.), cells, tissues, or organs—you find interrelated activity. Surely the doings will always be connected to "things," but the "things" don't explain the doings. DNA acts "because" proteins interact with them and act on them; proteins exist "because" DNA enables their synthesis. Every "actor" in the biological drama is also always an "acted upon." All the mind-boggling interactions molecular biologists discover *make sense* within the context of the healthy organism. They are part of the performance of the organism, to use Kurt Goldstein's phrase (Goldstein 1995, p. 282). All the genes that "come into action" while the tail of a tadpole is being reabsorbed, or in the formation of the new type of hemoglobin in the nascent frog, are part of the unfolding story of the frog's coming into appearance.

The Organism: Being-at-Work-Staying-Itself

Inasmuch as we become aware of this formative, activity-nature of life, we also move beyond strictly spatial conceptions. We are looking not only for mechanisms ("this" causes "that"). Rather we seek to understand how each "this" and "that" is connected within the coherent life of the organism, a life that expresses itself in every form, substance, and activity, from eating a fly to producing a digestive enzyme.

Trying to adequately express the activity-nature of organisms in one word, Aristotle coined the term *entelechia*. This Greek word is usually transliterated into "entelechy" in the English language. It is often interpreted as indicating a kind of essence or life force that affects the material workings of the organism as if from the outside. But this is clearly not what I've been talking about and it is also not what Aristotle intended. In recent translations and commentaries on Aristotle's works, Joe Sachs creates unique English phrasings that he believes are more true to Aristotle's dynamic view of nature and creative use of the Greek language. Sachs translates *entelechia* as "being-at-work-staying-itself"(Aristotle 1999). Every organism is being-at-work-staying-itself. This phrasing points to the fact that the organism is an active agency. It indicates that we don't have two things—a being that is also active—but rather a single "being-at-work." It *is,* only inasmuch as it is *active*. And this being-at-work is also coherence; it is continually "staying-itself" as frog, wolf, or poppy amid ever-changing circumstances. As awkward as Sachs' expression is, to my mind it accurately suggests the reality we encounter in organisms. Moreover, through its awkwardness we are challenged to actually think about what we are saying, and becoming active in thinking brings us closer to what we are actually trying to apprehend—the active nature of the organism.

In the end it should not be so important what term we use. In fact, it may be best to use different expressions, depending on the specific context, in order to suggest our meaning—organism-as-activity, agency, being-at-work-staying-itself or, simply, being. So, yes, a science of beings is possible. But it demands moving beyond certain habits of thought and a different way of looking at life than is typical today.

Gaining a sense of the activity-nature of organisms is a first step or a first opening into a science of beings. Many pathways can then be taken. I want to suggest one here. Wolves, frogs, and poppies are very different kinds of organisms. Each is its own "being-at-work-staying itself." But what is the wolf's particular way of being itself at work, what is the frog's, what is the poppy's? In other words, can I engage in the specific way-of-being of a particular species or group of organisms so that the living world in its manifoldness and varied and unique expressions can show itself? What follows is such an attempt.

Portraying a Frog

A tadpole lives fish-like, immersed in and bound to a watery environment for the duration of its life before metamorphosis. During metamorphosis a whole new body form is created. As lung-breathing, four-legged animals, most frogs seek the land. Some stay in close proximity to their watery origin, others return to water only in the mating season.

Figure 1. A green frog (*Rana clamitans*). (Photo: C. Holdrege)

With their moist, permeable skin, frogs are never fully at home in a land environment with dry air and strong sunlight. They prefer humid conditions, and most are nocturnally active. Although the skin is a physical boundary, it is porous with respect to water. As a result, the water content of the frog's body can fluctuate strongly depending on outer conditions. A frog can lose over a third of its body mass through evaporation and still survive as long as it can replenish the lost fluid. Interestingly, frogs cannot drink through their mouths. Rather, they drink through their skin, especially their belly skin. A frog that is dehydrated can simply lie in a puddle and drink through its skin; or it can bury itself under leaves or in the soil and slowly draw moisture into itself. Desert frogs spend most of their lives in self-dug burrows (up to 90 cm deep—almost a yard) and slowly draw water out of the soil. Frogs can store large amounts of fluid in their bladders and distribute it as needed.

Frogs are dependent on warmth from their environment to maintain their body heat, so that body temperature fluctuates with changes in ambient temperature. They are generally sluggish in cool weather, and some frogs can survive for a period of time in the frozen bottom of a pond. They become active in warmer weather, but you generally do not find amphibians basking in the sun like thick- and dry-skinned reptiles (think of lizards and snakes) in order to warm up. They avoid direct evaporation-causing sunlight.

So we see how the frog is very open to its environment. Through its skin it is giving up fluid to the air and drawing fluid in from the surroundings. Even though it has lungs, a frog still inhales around 40 percent of its oxygen and exhales more than two-thirds of its carbon dioxide through the skin. And the frog's body temperature oscillates with the warming and cooling of its environment. In these ways it lives in intimate connection, behaviorally and physiologically, with the changing conditions. Or we could also say the frog participates in these changing conditions and is part of them. There is no clear boundary that indicates here the "frog" ends and there the "environment" begins. While we can say that the frog is a center of formative activity, this activity is wholly embedded within and dependent upon the larger fabric of interactions and substances that we call its environment. We can as little separate the frog from its environment as we can the center of a circle from its circumference.

As the name amphibian implies, frogs are beings between water and land. They are not wholly at home in water (as are fish) and are not fully at home on dry land (as are many reptiles). But they are not "homeless"; they are at home in the in-between. They are aquatic for periods of time and, when on land, retain an affinity to moisture. They are in this sense "moist-earth" beings. This is even true of brightly colored tropical frogs that live high up in tree canopies (following a tendency of many tropical plants and animals to raise their "ground" into the crowns of trees). These frogs lay their eggs in little pools created in crevices or depressions of a tree or in rosettes of epiphytes such as bromeliads, where the eggs stay moist and largely hidden from direct sunlight.

The frog's skin is moist and rich in glands. Some of the most potent animal poisons are produced in the skin of colorful tropical frogs. Poisons in reptiles or insects are usually created in glands within the organism. In frogs the external organ of the skin maintains some characteristics of an internal organ—breathing, drinking, and secreting.

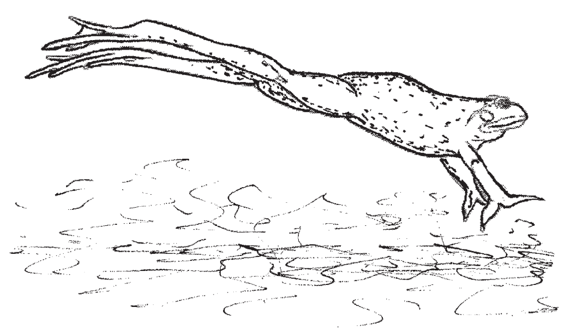
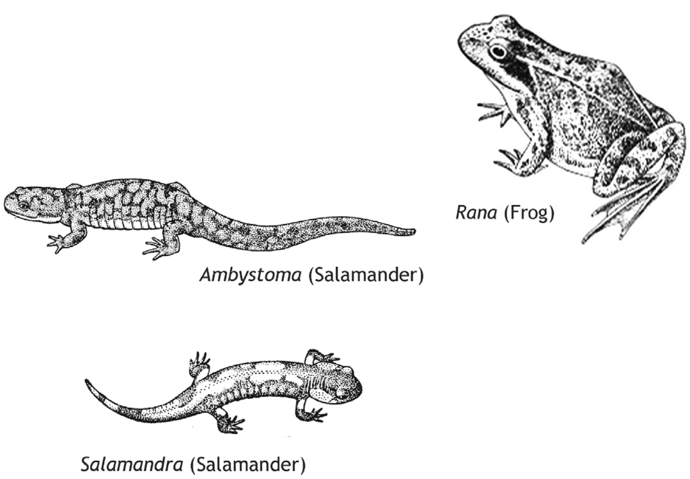


Figure 2. A leaping frog about to land (*Rana esculenta*). (Altered, after Zisweiler 1976, p. 230.)

From this perspective we can see how the so-called external environment of the frog in a sense belongs to or is part of the frog. This attunement is something you can sense almost viscerally in the early spring in the northeastern United States, when the temperature rises and the first rains fall. As part of this change, the enchanting and atmosphere-filling chorus of spring peepers and wood frogs resounds.

Much of what I've discussed so far is true not only for frogs but for the other two groups of amphibians as well: salamanders and the little-known caecilians. What clearly sets frogs apart from these other amphibians is their form and the specific ways of behaving that are intimately connected with their unique bodily configuration.

While a tadpole is reabsorbing its tail, it is also developing its long and powerful rear legs. The long intestine of the tadpole shortens dramatically, and the compact body takes shape as the head and body flatten and widen. The muscular rear legs are longer than the body, as the drawing of a leaping frog vividly illustrates (see Figure 2). A frog has a morphology and manner of movement that is wholly different from that of its amphibian relatives—salamanders and caecilians.



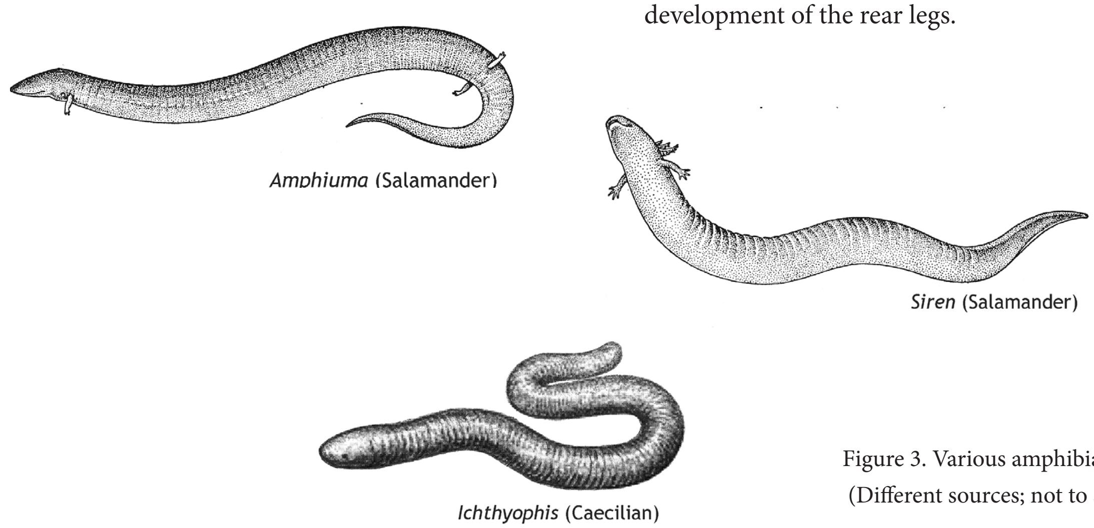


Figure 3. Various amphibians; see text. (Different sources; not to scale.)

Figure 3 shows a selection of different amphibians. Salamanders have a long body with relatively short legs. In some species the body elongates dramatically while the legs become shorter and, in some cases, the rear legs do not develop at all. The caecilians, which are tropical burrowing, worm-like amphibians, have no limbs and a very long body. In contrast to salamanders, they have no tails. Morphologically, amphibians form a spectrum, with rich variation between the short-bodied, limb-dominated frogs at one pole, and the long-bodied, limbless caecilians at the other. And while the dominant sense in frogs is sight, the caecilians are fully or almost blind.

The skeleton reveals in telling detail salient features of frogs. Frogs have the least vertebrae of any vertebrate, and the vertebral column (spine) is very short. Like all other amphibians, frogs have only one short neck vertebra, so that the head attaches almost without separation to the body. But the frog has only eight other vertebra (some species have fewer) in its spine (including one sacral bone), while salamanders generally have 15 to 20 (63 in the long-bodied siren). The skeleton of caecilians consists mostly of vertebrae—between 95 and 285, depending on the species—and they have no tail.

Interestingly, while externally a frog has no tail, it does have one bone—the urostyle (or coccyx)—that corresponds to a tail in salamanders. This long bone develops out of three to four vertebrae that fuse together. It does not extend, however, beyond the pelvis; rather, it is drawn up into the pelvis and is a functional part of it (see Figure 4). Qualitatively this is a revealing characteristic: what would be part of the tail extending behind the body in salamanders or other animals is in the frog one long bone that is incorporated into the pelvis and helps to support and anchor the powerful rear legs. This detail expresses the overall contracted morphology of the frog's body—a contraction correlated with the remarkable expansive development of the rear legs.

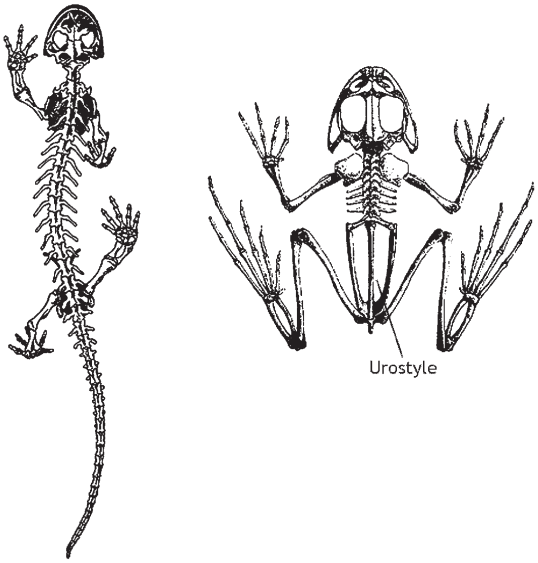


Figure 4. Skeleton of a salamander (*Salamandra*) and a frog *(Rana)*.

Now think of the way a frog moves. Sitting with its legs folded close to its body, the frog suddenly and spring-like extends its legs, propelling itself through the air. It cushions its landing with its forelegs and then the rear legs contract again at the sides of the body. Frog leaping is a radical kind of expansion and contraction, morphologically mirrored in the compact body and the long, strong rear legs. Rapid, projectile-like movement also occurs in feeding when frogs use their "well-developed tongues [that] they are able to catapult from their mouths in order to pick up prey" (Duellman and Treub 1994, p. 365).

And when frogs croak, the body wall around the air-filled lungs contracts and forces air through the larynx, which suddenly relaxes and opens. The air streams over the vocal cords and into the mouth, filling the air sack, the skin of which vibrates. The surrounding environment fills with sound. The active animal expands out into the larger world. The chorus of many voices resounds in the spring landscape.

Portrayal

> Any attempt to directly express the being of a thing is fruitless. What we perceive are its effects, and a complete narrative of these effects would encompass its being. We labor in vain to describe a person's character; however, when we draw together his actions, his deeds, a picture of his character will emerge. (Goethe, 1995, p. 158)

Since every organism is a being-at-work, its being as a wolf or frog is not given as a thing. You can't place the "frogness" of the frog next to its liver, brain, heart, and stomach to examine it. You cannot describe it directly; it is not a spatial entity. In this sense Goethe can say that it is "fruitless" to try to express the being of a thing. But that does not mean it does not exist, and it does not mean we must resign ourselves to compiling facts.

The frog as being-at-work is at work in the formation of all its organs, in the shape and proportions of its legs, in the way it feeds. It is present in all its activities and in the relations it engages in. It is in all of these, not as a thing to be found but as effective agency. So how do I come to perceive and present this "no thing" that is certainly not nothing? While there are no simple "steps" in this process, there are different facets that can be understood as a scientific methodology for a "science of beings."

Engaging: As a researcher I carefully study the organism and work to gain an ever better sense of its specific way-of-being. I try to notice and observe: The frog leaping into the pond when I come close; the frog floating with only its big bulging eyes and wide mouth breaking the water's surface; the varied colors of individual wood frogs; the way tadpoles swim. So I attend to the frog. And I do not rely only on my own observations. I also read extensively in the scientific literature about frogs. Many people have dedicated their professional lives to studying myriad aspects of frog life and I draw from their findings and insights.

Freeing: Because much research is dedicated to discovering causes ("mechanisms") and to embedding findings in over-arching theories (for example, evolution through "natural selection") there is a good deal of thought-work involved in trying to discern how findings are influenced by frameworks. I work to free myself from the biases and interpretations that constrict a more open-ended consideration of the phenomena. I do not want to place the facts in the context of a theoretical framework but discover how they place themselves within the organism itself.

Picturing: By going into so many details I can also increasingly lose any sense of the organism's way-of-being and its wholeness. I may lose the forest for the trees. So it takes constant effort to make conscious the connections and relations through which the organism reveals itself. To this end I try to picture what I'm observing or the findings I'm reading about as vividly as possible. I'm not focusing in a narrow way on "why" the frog has this or that or does this or that. I'm not trying to "explain" the frog. It was through vividly picturing the development of a tadpole into the adult frog that I first realized that in a very essential sense it is not correct to say that the adult form develops "out of" a tadpole. Rather, this form is the result of creative activity that wholly re-configures what was tadpole into adult frog.

By staying close to the observed phenomena and connecting the separate observations into a unity that reflects the unity that is at work in the organism, I get a glimpse in thought of its way-of-being. The thought energy others put into theorizing, I put into picturing.

Comparing: The particular way-of-being of an organism stands out all the more when we compare its characteristics with those of other organisms. What it means to be a frog becomes clearer when we let it be illumined by other amphibians (salamanders and caecilians) and then by "neighboring" vertebrates such as bony fishes and reptiles. We cannot understand the frog in isolation; it speaks its reality through its relations to others. We let the different kinds of beings and their characteristics illuminate each other.

Intuiting: When I was in college and dissected a frog, I learned that it had a urostyle. At the time this bone made no big impression on me; unfortunately, it was simply one more part to memorize. In my recent study of the frog the urostyle suddenly lit up. I no longer saw it as an anatomical part but as a crucial member of this organism. I saw through it a quality of the frog: what is in other animals the extensive tail becomes in the tailless frog an internal bony structure that supports the strong leaping legs. This is a form of perceiving meaning in the organism—how the "parts" are truly revelatory of the whole organism. This kind of intuiting is not something you can make happen, as little as you can make a frog appear in a pond. But you can prepare for such insights through all the work described above, so that you are moving in the territory in which connections can show themselves.

Portraying: In a visual portrait, the character of a person shines through the whole presentation and composition—through the way the parts are composed by the artist. He or she has glimpsed this character and seeks to give it artful expression. A scientific portrayal of an organism requires something similar. In portraying, I attempt to depict specific qualities, activities, and relations in such a way that the being-at-work of the frog can show itself to the reader. I can only suggest. As Owen Barfield points out, "meaning itself can never be *conveyed* from one person to another; words are not bottles; every individual must intuit meaning for himself " (Barfield 1973, p. 133; his emphasis). Since meaning is concerned with relations, it can only speak between the lines in the active mind of the reader. Of course, much depends upon the felicity of expression and composition. If I succeed in describing the characteristics of an organism as vividly as possible, and if readers vividly picture what they read, then an understanding of the organism as a being can arise.

When I've completed a portrayal, I am not done and my engagement with the frog is not something that I leave behind. What I have noticed is that after the intense process of working with a particular animal or plant, when I go out and see it in the wild again, my perception is different. A green frog swimming in the pond is much more of a presence than it was before. The forceful and yet graceful kick of the legs, the shimmering green of its head, its bulging eyes—these details speak more strongly. My interest grows and also a kind of elemental joy in moments when I am able to participate in another being's way-of-being. I am more present, and the frog can present itself more fully.

I then experience the truth of Emerson's statement: "It seems as if the day was not wholly profane, in which we have given heed to some natural object" (1983, p. 542). The "natural object" loses its profanity when it becomes a presence—when we have been touched by another being.

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