Gould S. J. (1977) Ontogeny and phylogeny. Belknap Press, Cambridge.
Gould S. J. (1997) The exaptive excellence of spandrels as a term and prototype. Proceedings of the National Academy of Sciences 94(20): 10750–10755.
Gould S. J. (2002) The structure of evolutionary theory. Harvard University Press, Cambridge MA.
Gould S. J. & Vrba E. S. (1982) Exaptation: A missing term in the science of form. Paleobiology 8(1): 4–15.
Mayr E. (1961) Cause and effect in biology. Science 134: 1501–1506.
Pigliucci M. (2008) The proper role of population genetics in modern evolutionary theory. Biological Theory 3(4): 316–324
Pigliucci M. & Müller G. (eds.) (2010) Evolution, the extended synthesis. MIT Press, Cambridge MA.
Vargas A. O., Botelho J. F. & Mpodozis J. (2020) The evolutionary consequences of epigenesis and neutral change: A conceptual approach at the organismal level. Journal of Experimental Zoology Part B: Molecular and Developmental Evolution.
► https://cepa.info/7885

Alexander Vargas is an evolutionary biologist whose main contributions are about the origin and early evolution of birds, especially regarding their developmental evolution. He also revived interest in the neo-Lamarckian experimentalist Paul Kammerer (1880–1926), after pointing out specific resemblances between his experiments and modern experiments in transgenerational epigenetic inheritance. Since 2008, Vargas has run the laboratory of Ontogeny and Phylogeny at the Department of Biology, Faculty of Science, University of Chile. Since 2013, he has directed the Red Paleontológica U. Chile (Paleontological Network of U. Chile), whose members have described several fossil vertebrates new to science, including the transitional ankylosaur *Stegouros elengassen.*

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Darwinian and Autopoietic Views of the Organism

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> Abstract • Our goal is to illustrate that Darwinian and autopoietic views of the organism are not as squarely opposed to each other as is often assumed. Indeed, we will argue that there is much common ground between them and that they can usefully supplement each other.

« 1 » In his target article, Jorge Mpodozis defends an interesting alternative way of viewing the processes of development and evolutionary change that challenges the more traditional gene-centred perspective associated with Darwinian theorizing. However, we do not think that the mode of presentation, as a stark dichotomy between his view and the standard picture, is necessary or indeed helpful. Instead, we argue that both perspectives provide something useful for understanding evolution, and there is more common ground between them than he allows.

« 2 » In particular, we doubt that there are many contemporary defenders of the strong genetic determinism that he pits his view against. For example, the view that "envisages the process of development as the deployment of a set of instructions encoded in the DNA of some of the initial cellular components of a living being" (§17) seems like a straw man, one that any modern biologist is unlikely to endorse without acknowledgement of the range of other structures and processes that influence development. Even if biologists often idealize non-genetic processes away, that is not evidence, in itself, for a stronger metaphysical commitment to genetic determinism. Contemporary biologists such as Eva Jablonka and Marion Lamb (2020) recognize a variety of influences on ontogeny, phenotype, and inheritance, such as epigenetics and differential gene expression – even if they might disagree about how important they think these processes are. When Mpodozis states that "characters are not inherited, but recreated by the process of systemic reproduction" (§23), this does not appear at odds with mainstream thinking, since no one thinks that traits are somehow inherited whole, but rather that genetic inheritance provides a rough "blueprint" or, better, "scaffold" from which they are reconstructed in feedback-loops with the environment (Veit 2022a). It is thus hardly surprising that the specific outcome is highly sensitive to particular environmental conditions, gene expression, and other epigenetic factors. While the older metaphors are still persisting, the mainstream views of biologists have already shifted substantially in the last decades. Admittedly, Mpodozis's account is based on Maturana and Varela's theories in the 1980s when the mere mention of epigenetics was scorned and evolutionary developmental biology had not been developed yet into a thriving field. Nevertheless, things have changed and these changes are more congruent with his work than Mpodozis seems to think.

« 3 » Unfortunately, Mpodozis sets up his position as an absolute that stands in contrast with constructivist discourse:

> "Reproduction is a systemic process of conservation of a particular organism–medium relation, or way of living, and *not a genetic process* […] A lineage arises in the systemic reproductive conservation of a way of living and *not in the conservation of a particular genotype.*" (§1, italics added for emphasis)

« 4 » We would like to suggest a more fruitful middle ground that can take into account features of both views. For instance, while we agree with Mpodozis that "it is not possible to claim that any features that arise in the life history of an organism are [exclusively] genetically determined" (§1), neither is it the case that they are completely independent of genetic conditions. He admits that the genotype is something like a gatekeeper, constraining the space of possible structure and action, and it is here that we see the most common ground – the difference between the views starts to seem more like one of degree rather than kind. The degree to which these constraints, rather than developmental or epigenetic conditions,

influence the organism's phenotype and actions will differ in different contexts, but it is obvious that both sets of influences play a role. The answer lies neither in one extreme nor the other.

« 5 » Many of the claims in the target article can be viewed through a more traditional lens, illustrating the level of overlap. In his description of the Neo-Darwinian picture, for instance, Mpodozis states that for a living being to "know" the environment is to "form an internal representation of the objects in that environment through some special mechanism that captures the relevant characteristics of those objects" (§10). However, while he claims that this picture is completely mistaken, genes can, in a non-trivial sense, be taken to be a representation of the past environments a lineage has encountered, and the traits that benefited the organism's survival and reproduction. While he may object to the term "representation" as something involving richer associations, we doubt that he would deny that we can learn anything about the past environments of organisms from their genome. Similarly, when he says that "the structural present of a living being (molecular autopoietic system) is the historical result of the flow of actions that this living being has carried out during its life" (§14), we take it to also be a result of the actions that ancestral organisms have carried out, and the consequences of those actions, as *represented* by the genome (and epigenome), even if he wants to rest that kind of language. When Mpodozis claims that "[e]nvironmental factors do not drive, nor do they select changes in the pool of total genotypes, but only allow them to occur" (§29), this does not appear so different from a traditional evolutionary picture – what else would it mean for an environment to "allow" or "disallow" a trait or genotype, if not to select for or against them? Those traits that an environment does not "allow" would be those that go on to disappear from a population, without necessarily implying intentional selection.

« 6 » In the end, our question is what role Mpodozis wants his view to play. We see two options –

Option A: The provision of a new lens through which to view the processes of development and evolution, foregrounding different factors from those more traditional gene-focussed views attend to. This is then consistent with both views having a place, each theory providing a useful perspective within different contexts. Which we should adopt in any given situation will then depend to a large extent on the goals of enquiry and what type of explanation is sought. We could see each view as compatible, as explanations with a different emphasis on what it is that is meant to be explained. Rather than constituting rivals, this would make Darwinian and autopoietic theories of organisms complementary theoretical frameworks to explain different natural and possibly overlapping phenomena. Take, for example, string theory and the theory of general relativity in physics, which have (at least so far) not been reduced to each other. What we would want to see then, is the explicit rationale for preferring this view – what are its theoretical virtues, which phenomena does it capture better than the alternatives?

Option B: The different theories are presented as empirical and explanatory competitors, i.e., they are both taken to cover, in some sense, *all* the empirical data such that they cannot both claim to be "correct." Here, what we would like to see is a set of testable predictions arising from each theory to differentiate them empirically: Which phenomena, were they to be observed, would provide support for or refutation of this theory (or the alternative)? We suspect that such tests cannot be provided because both theories have different aims and deliberately emphasize different aspects of biological phenomena. Not only is it hard, if not impossible, to test alternative theories that aim to simultaneously cover *all* empirical data, philosophers of science have also argued that emphasizing different features is necessary for understanding particular features of organisms (Massimi 2012; Veit & Browning 2020). Rather than treating scientific theories in a strongly representationalist sense as attempts to offer "true descriptions of reality," they are more akin to useful tools or frameworks that offer partial insights into the complexity of biological phenomena.

« 7 » From the arguments we presented above, it should have become clear that we prefer Option A, the pluralistic approach, in line with constructivist philosophy, according to which different theories are not considered competitors of which only one can be "true" whereas all others must be "false." As argued in Veit (2020), science often advances by expanding our set of possible models that are applicable to different situations, rather than by determining a single all-encompassing model applicable to all situations. Instead of necessarily seeing them as competitors, we can thus recognize that Darwinian and autopoietic views of the organism both play an important role in advancing biological science.

« 8 » Finally, we do not just want to make the point that a more moderate position is to be preferred. We are also concerned that Mpodozis actively harms his own case for an organism-centric view of biological evolution by misrepresenting contemporary biological thought without providing sufficient evidence for what amounts to strong assertions that many biologists would dispute. Indeed, we argue that this is a larger problem in some of the literature in the autopoietic tradition, which has sometimes suffered from being framed in ways very antagonistic to mainstream Darwinian thinking, which has progressed significantly in the last decades. For instance, those inspired by the autopoietic tradition continue to deride modern evolutionary biologists for being externalists and ignoring the internal features of the organism. However, this is no longer an accurate description of even the most ardent Neo-Darwinians, who have come to accept the significant feedback between organism and its environment, and to conceive of "adaptations" as something produced by natural selection, rather than treating them in terms of an externalist sense of environmental "fittedness" into a pre-defined niche akin to two puzzle-pieces sticking together (Veit 2022b). This failure to recognize significant shifts within the discipline has made it hard to bring many of the important insights of Maturana & Varela (1987) into mainstream biology. We hope to have made a case here for a more conciliatory approach that may have more success in integrating autopoietic ideas into the modern Darwinian revolution. Such an approach would clearly emphasize the importance of Mpodozis's alternative account.

References

Jablonka E. & Lamb M. J. (2020) Inheritance systems and the extended evolutionary synthesis. Cambridge University Press, Cambridge.

Massimi M. (2012) Scientific perspectivism and its foes. Philosophica 84(1): 25–52.

Maturana H. R. & Varela F. J. (1987) The tree of knowledge. Shambhala, Boston.

Veit W. (2020) Model pluralism. Philosophy of the Social Sciences 50(2): 91–114.

Veit W. (2022a) Scaffolding natural selection. Biological Theory 17: 163–180.

Veit W. (2022b) The origins of consciousness or the war of the five dimensions. Biological Theory: Online first. https://doi.org/10.1007/s13752-022-00408-y

Veit W. & Browning H. (2020) Perspectival pluralism for animal welfare. European Journal for Philosophy of Science 11: 9. https://doi.org/10.1007/s13194-020-00322-9

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Revisioning Planetary EmergencE/Y Through the Lens of Natural Drift

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> Abstract • I explore how considering planetary emergencE/Y in terms of natural drift can reframe "what" the environmental crisis "is" while engendering new possibilities for ethical engagement. Intelligent response thus entails participation not only at the level of technical intervention but also in/as the ability to perceive along the cusp of (in)sensibility and dance with ambiguity.

« 1 » Humberto Maturana (2005: 58) claimed that "as an observer makes a distinction, the entity distinguished arises implying the domain or matrix of operational coherences in which it exists as it arises in the distinction." One cannot help but be reminded of these words when reading philosopher of science Isabelle Stengers's (2015: 43) essay *The Intrusion of Gaia,* where she begins with the claim that "to name is not to say what is true, but to confer on what is named the power to make us feel and think in the mode that the name calls for." Gaia is for Stengers neither Earth "in the concrete," nor a benevolent mother figure who provokes a sense of belonging. Gaia is rather the "one that intrudes" in a manner that is effectively blind or indifferent to human affairs. Stengers further points out that Gaia's articulation forces us to recognize that –

- the "stable backdrop" upon which history plays out is the result of a dynamic co-evolutionary process, and that
- the planet can now be recognized as having its own regime of response-ability that is sensitive to perturbation.

« 2 » The "individual" organism in Gaia is taken up by/as the collective that (re)produces itself without recourse to a transcendent sovereign or purposive telos.[1] In terms of natural drift, as pointed out by Jorge Mpodozis in his target article, it proceeds as a "step-by-step process that has no other direction than the one that arises from the flow of actions itself" (§14). To consider Gaia such a collective of non-telic emergence is to identify a new way of thinking-*with* (as opposed to merely thinking *about*) planetary emergencE/Y[2] – a task that, for Stengers (2015: 50), requires learning to compose with "the voices of many peoples, knowledges, and earthly practices."

« 3 » Natural drift is one such system of knowledge that may aid us in rethinking planetary emergencE/Y and our role therein. If, indeed, reproduction "is a systemic process of conservation of a particular organism–medium relation, or way of living" (§1b), the "environmental crisis" can no longer be conceptualized solely as a set of problems occurring in/as an objective environment that, given enough time and ingenuity, will be "solved." Such categorical determinations tend to obscure the particular organism–medium relations that have given rise to (and maintain) the symptoms of the environmental crisis. It is, after all, not "humans" (i.e., as a universal category) that have caused the environmental crisis, but rather particular modes of activity of particular humans. And while there is a limited sense in which certain environmental problems can (and indeed should!) be solved through positivistic identification and technical intervention, relying *only* on these kinds of determinations tends to obscure the non-linear complexities of Gaia and consequently its capacity for creative emergence. Put in Maturanian terms, "a system is brought forth in the observer's domain of existence by the operation of distinction that he or she performs" (Maturana 2008: 268) – an operation that moreover reveals certain regularities in our living while obscuring others. Natural drift is one such distinction that enables us to think of environmental problems beyond their reduction to a set of

1| Critical theorist Donna Haraway (2016: 60) thus prefers indicating the organismic "individual" using the term *holobiont* to denote symbiotic assemblages that are "more like knots of diverse intra-active relatings in dynamic complex systems, than like the entities of a biology made up of preexisting bounded units."

2| The "environmental crisis" is both an emergence and emergency. There is danger, but also opportunity for radical transformation. From Latin *emergere*: bring forth, bring to light.