Diversity and Biocultural Invention

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Abstract:

In non-modern biocultures, contextual human technicity has played a key role in shaping the behaviors and the morphology of non-human species, which in return has simultaneously modulated human morphology and behavior: *behavior affords behavior*. Studies intersecting anthropology and ecology have framed this process as a biological feedback in which species co-evolve through the constitution of biocultural diversification, thus producing negative entropy through technical activities.

Keywords:

Evolution, Plasticity, Bioculture, Invention, Techniques, Fractals

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Evolution is things changing when they must. - Kinji Imanishi[1]

1. Beyond the NBIC Paradigm

While change is an unavoidable characteristic among living things, the convergence of the fields of Nanotechnology, Biotechnology, Information technology and Cognitive science (NBIC), constrain our modes of human enaction by naturalizing consumer logics. The change produced within this framework is mainly directed towards capitalist accumulation, standardizing all sorts of variables through an accelerated production of entropy which diminishes the diversity of the biocultural fabric. Invention within the NBIC paradigm approaches issues from the decontextualized point of view of calculation and statistics; aimed to be deployed massively, it avoids, or even disables the invention of localized solutions to overcome urgent contemporary issues.

The expression of technology inherent to the NBIC paradigm standardizes –and thus stabilizes– the behavior of the human population at large, while homogenizing landscape management through monocultural food production and massive resource extraction. Although most humans are apparently docile regarding normative top-down regulations, the rest of the biotic and abiotic members of the planetary ecology, as well as those humans existing outside of hegemonic paradigms, are producing ever increasing unforeseeable events in shorter iterations, as a reaction to the constraints and enablements installed by the modern human world. Random variation plays a key role in biological evolution, but selection canalizes it. In the balance between randomness and non-randomness the possibility for navigation emerges.

According to Stengers and Prigogine, the emergence of modern science happened with the discovery of a specific form of communication with nature–that is, the conviction that nature responds to an experimental interrogation, which presupposes a systematic interaction between theoretical concepts and observation.[2] Modern technology is erected on top of modern scientific endeavors while simultaneously constraining them for its benefit, therefore they are part of the same process: *modern technoscience*. This process has an inherent entropic tendency towards biological and ontological standardization that not only affects humans, but all biotic and abiotic members of the biosphere.
By creating ruptures in the metabolic fabric of specific localities through the imposition of one-size-fits-all approaches which modulate the current social and cultural order, modern technoscience decontextualizes subjects from their direct concrete realities, rendering a particular human ontology as

1 Kinji Imanishi, "A Proposal for Shizengaku: The Conclusion to My Study of Evolutionary Theory," *Journal of Social and Biological Systems* 7, no. 4 (October 1984): 363.
2 Ilya Prigogine and Isabelle Stengers, *Order out of Chaos: Man's New Dialogue with Nature* (Toronto: New York, N.Y: Bantam Books, 1984), 5.

a universal standard. Stengers and Prigogine further consider that according to modern technoscience, nature is nothing more than a submissive automaton, to the point that it can be described as "constituted against nature, since it denies complexity and evolution, alleging an eternal and knowable world governed by a small number of simple and immutable laws."[3]

But even if the modern technoscientific enterprise and mass culture attempt to present an image of scientific progress as a linear and univocal way of understanding and acting within the world, when rigorously delving into scientific research, it is impossible to not notice that pluralism has always existed. The illusion of science as a monotheistic realm is only a matter of which are the scientific activities that get the most funding for both research and marketing strategies.

2. Shizengaku: Towards an Intersubjective Biology

As Giuseppe Longo and his colleagues have clarified, the attempt to create a priori mathematical models for the possible trajectories of biological evolution is not only incoherent, but has also hindered the progress of biological research. The impossibility to apply the mathematical models (which are so abundant in physics) comes from the fact that biological species modify —and are modified by— their ecological niches, constituting a positive feedback between organisms and their ecological niche.[4] As a biological species whose evolutionary trajectory is correlated with those of the multiple species that constitute our niches, randomness is constantly emerging, meaning that unforeseeably events are modifying both our lifelines as individuals and our evolutionary paths as a species.

Kinji Imanishi argues that we can only interpret and express the world in our own human terms and thus a biology "that lacks an intuitive knowledge of resemblances [which] can provide only an impoverished, mechanistic view of the living world."[5] We read this as a call to acknowledge our human position on the planet from an intersubjective understanding and to actively perform ourselves as co-constituents of ecosystems. But to arrive at a more intuitive understanding of evolutionary trajectories, we first need to scrutinize the modern synthesis, also known as Neo-Darwinism.

Lynn Margulis argued that the practitioners of this hegemonic view of life "widely believe and teach–explicitly and by inference–that life is a mechanical system fully describable by physics and chemistry."[6]

3 Ilya Prigogine and Isabelle Stengers, *La nueva alianza: metamorfosis de la ciencia* (Madrid: Alianza, 1997), 47.
4 Giuseppe Longo et al., "In Search of Principles for a Theory of Organisms," *Journal of Biosciences* 40, no. 5 (December 2015): 955-68.
5 Kinji Imanishi, *A Japanese View of Nature: The World of Living Things*, trans. Pamela J. Asquith. Japan Anthropology Workshop Series (London; New York, NY: Routledge, 2002), 62.
6 Lynn Margulis, "Big Trouble in Biology," in Lynn Margulis and Dorion Sagan, *Slanted Truths: essays on Gaia, symbiosis, and evolution* (New York: Springer, 1997), 266.

While Neo-Darwinists proffer formal mathematical explanations for the ways in which organisms evolve, Margulis argues that biologists who "live among and observe metabolizing animals, plants, and microbes have difficulty measuring the quantities or even understanding general concepts labelled and taken as directly observable."[7]

Prigogine and Stengers consider that the kind of scientific invention that emerges from these contexts denotes a driving force which stubbornly applies to nature the same homogeneous techniques and concepts, and always ends up encountering an equally stubborn resistance from nature.[8] They describe this way of relating as violent, and thus, it is no wonder that such mechanistic understandings of life has played a key role in enabling the multi-directional violence that characterizes modern human society. Inventors arrange cultural controls (e.g. technological devices, experimental situations) to consciously interpret nature, objectifying a culture which enables a way of "using," "experiencing," or "inventing" nature; and the outcomes of these cultural controls are used again and again to re-create an experience of nature.[9] What is then the experience of nature created through the perspective of the modern synthesis? How does it affect our daily lives?

By conducting processes of artificial selection in the search to enhance or perpetuate desired traits in other biological species, unforeseeable characteristics also emerge. The *domestication syndrome* refers to the processes in which a biological species loses or acquires new characteristics as a result of the processes of artificial selection. For example, in the monocultural production of agave in Mexico used for distilled beverages, the domestication syndrome becomes observable as the gigantism which emerges in different parts of the plant, and a lack of stability in the leaves, among others.[10] This modern agriculture of agaves happens in deforested areas, contrary to the mesoamerican agroforestry systems in which agaves used to thrive in correlation to other biological species; in the latter, each agave plant may present variable and particular features depending on its specific environmental pressures. In the former, the whole population of plants is managed statistically.

Imanishi considers that statistics, which are central to the western mode of thinking, report on things as static and species as unchanging: "if we interpret it statistically, the variation expressed by most individuals, or something like the average variation, may be considered the equivalent of not changing at all."[11] Absolute stasis is not possible for living organisms; creativity is at our core, and this is noticeable in our most basic behaviors. When walking through a seemingly straight path I encounter objects of different scales that may require a drastic modification of my whole trajectory or of a single

7 Margulis, "Big Trouble in Biology," 271.
8 Prigogine and Stengers, *Order out of Chaos: Man's New Dialogue with Nature*, 308.
9 Roy Wagner, *The Invention of Culture* (Chicago: London: University of Chicago Press, 1975), 100.
10 Alejandro Casas et. al., "In Situ Management and Domestication of Plants in Mesoamerica," *Annals of Botany* 100, no. 5 (July 2007): 1101–15.
11 Imanishi, *A Japanese View of Nature: The World of Living Things*, 134.

step. Ignoring these objects could result in falling and hurting myself.

Living is creating, and thus, creativity plays a role of utmost importance within evolutionary trajectories. Imanishi argued that "evolution is creation and that creativity is an attribute of living organisms."[12] But, on the other hand, the illusion of creativity inherent to modern technoscience has had such a catastrophic impact on the planet's environment. How to constitute modes of creative enactment, between change and stasis, that not only possesses evolutionary potential, but is also situated from diverse and specific contexts? If humans are positioned within multiple and simultaneous evolutionary processes, our psychological, physical, and social structures become both the stage and the performers. Living things cannot exist in separation from the environment. Therefore when thinking about concrete forms of existence we always refer to the organism-environment relation; but the environment is constituted by biotic and abiotic members that according to Imanishi have grown and developed from one single thing;[13] To look at each living thing in its own right actually means making our recognition of them, and hence of their affinities, more accurate. Imanishi called for a new science of the living things, –*shizengaku*–, which is based on the apprehension of this intuitive understanding of similarity.[14] The central hypothesis of shizengaku is that the heterogeneity of the constantly changing elements that constitute our ecosystems develop from a single unit that diversified through habitat segregation, meaning that specific traits and behaviors emerge during the distribution of a species throughout different habitats which results in a diversification of affordances.[15] We thus consider that Imanishi's arguments can be read from the Mayan-Tseltal concept of *ch'ulel*, as described by Juan López Intzín:

> Contrary to positivist Western thought, which has classified existence into animate beings and inanimate things, in indigenous Maya thought, everything has life, source, matrix, heart, veins, bones, flesh, feelings, thoughts, language, and *ch'ulel*.[16]

In the Mayan languages, such as the Tseltal, the category of "object" does not exist[17] and therefore there

12 Imanishi, *A Japanese View of Nature: The World of Living Things,* 123.
13 Imanishi, *A Japanese View of Nature: The World of Living Thing*s, 80.
14 Imanishi, *A Japanese View of Nature: The World of Living Things*, 62.
15 In Augustin Berque, "The Perception of Space or a Perceptive Milieu?" *L'Espace géographique* 45, no. 2 (2016): 174: Berque mentions that what the animal encounters is the 'as' by which it perceives things: as food, as obstacles, as shelter, as housing, etc. "In other words, in a functional circle, this 'as' is the medial handle that an object offers the animal." In James Gibson, *The Ecological Approach to Visual Perception: Classic Edition* (New York; London: Psychology Press, Taylor & Francis Group, 2015), 129: These "as if's" were described by James Gibson as affordances, "An affordance cuts across the dichotomy of subjective-objective and helps us to understand its inadequacy. It is equally a fact of the environment and a fact of behavior. It is both physical and psychical, yet neither. An affordance points both ways, to the environment and to the observer."
16 Juan López Intzín, "The Ch'ulel-Multiverse and Intersubjectivity in the Maya Tseltal Stalel,"in *Resistant Strategies*, Taylor, Diana and Marcos Steuernagel, eds. Resistant Strategies. Digital Book. Durham: Duke University Press and Hemi Press. (Forthcoming).
17 Margara Millán, "En otras palabras, otros mundos: la modernidad occidental puesta en cuestión," in *Lengua, cosmovisión, intersubjetividad. Aproximaciones a la obra de Carlos Lenkersdorf*, ed. Márgara Millán and Daniel Inclán (México: Universidad Nacional Autónoma, 2015), 50.

is no asymmetrical relationship in the construction of knowledge between "subjects" and "objects." López Intzín further explains that:*"ch'ulel* turns everything in existence into a subject and allows us to interact with one another, subject to subject."[18] We thus realize the intersubjective character of the metabolic and trophic relations happening within and between all of the biotic and abiotic members that constitute an ecosystem. If evolutionary trajectories are creative fluctuations in constant intertwining, can we understand shizengaku as the blueprint for an intersubjective biology?

3. The Multiplicity of Individuality

Animals cannot be considered anatomical or physiological individuals because a diverse multiplicity of symbionts both inhabit and function within them, completing metabolic pathways and serving other physiological functions.[19] Thus, the notion of individuality has been constitutively redefined as 1) a *niche* inhabited by others or 2) a composite and *heterogeneous whole*. Elena Gagliasso mentions that "apparatuses, cells and even our eukaryotic DNA include a huge prokaryotic world (bacteria) inhabiting them, which modulates their chemistry, and governs their metabolism."[20] The ambiguity brought forth by all of the micro-alterity that an "individual" is dependent on, is further amplified when we notice that throughout its lifetime, an individual drastically exchanges microorganisms with the ecosystems that it inhabits, to the extent that these "external" ecological fluxes become constitutive of itself.
While natural selection excludes traits or phenotypes that are not compatible with a given context, it is not an optimization process towards the generation of the 'fittest.' Fitness as a category is not absolute since it varies depending on environmental influences, and furthermore, the fitness of a phenotype can only be judged a posteriori. If the individual has such porous boundaries, which is then the unit of selection? On what level does natural selection act?

> From the side of "hosted" entities (symbionts) bacterial strains are selected by internal habitat changes (e.g. the interference of antibiotics), so that the major body is the context (milieu) where plural micro-diversity evolves. In this case the individual is replaced by nested systems of various different entities, a micro-ecology where what matters are the boundaries between parties, membranes, trophic exchanges (i.e. "microbiota"). From the major organism's perspective (holobiont/hologenome), instead, the "dividual" is selected as a cohesive unit.[21]

The holobiont concept emerges in the tension between the *individual as a multiplicity* and the *dividual as*

18 López Intzín, "The Ch'ulel-Multiverse and Intersubjectivity in the Maya Tseltal Stalel," 18.
19 Scott F. Gilbert, Jan Sapp, and Alfred I. Tauber, "A Symbiotic View of Life: We Have Never Been Individuals," *The Quarterly Review of Biology* 87, no. 4 (December 2012): 325.
20 Elena Gagliasso, "Individuals as Ecosystems: An Essential Tension," *PARADIGMI*, no. 2 (August 2015): 87.
21 Elena Gagliasso, "Individuals as Ecosystems: An Essential Tension," 93.

a unit virtually separated from the whole; as a cohesive unit constituted from a multiplicity of organisms, it can do things that none of its parts could while maintaining a degree of independence from the biosphere. There is no sharp distinction between the subject and the environment. Without such dynamic coupling, neither the organism nor its adaptation would be possible. While at the same time, if the coupling is extremely tight, the organism might lose its identity.[22]

The holobiont is a dynamic entity in which certain microorganisms multiply and others decrease in number: "microbial amplification is a powerful mechanism for adapting to changing conditions."[23] The subject is like a warp and weft fabric in which a multiplicity of fluctuations of different scales and orders spiral through each other, bringing forth our perceptual experience and determining our understanding of nature and our attitude towards it. Shizengaku—which literally translates as nature-ology (*shizen* means 'nature' and *-gaku* means "study of")—postulates a three level structure for understanding nature: *specion*, *specia*, and *holospecia*.

Specion refers to an individual organism (or holobiont). *Specia* refers to all the individuals of a species understood as an "existent entity with an autonomous nature;"[24] where each of the members contributes to the perpetuation of the specia to which it belongs. And finally, the *holospecia* is understood as a "unit composed of all the extant specia on the Earth."[25] Even if living organisms have developmentally diverged in myriad forms from a single unit, all of them are interwoven by an immanent force: the *ch'ulel*.[26] Imanishi considers that all structures are the result of gradual development, and thus, if we want to speak about living organisms we always need to consider them as alive: they are continuously changing in relation to the other biotic and abiotic subjects that co-constitute their ecosystem. As a call for an intersubjective life science, it inter-relates the myriad of living things which are continuously turned against each other by western technoscience.

Oyama argues that the belief in genetic determination seems to be rooted in our desire to derive from science the answers to very old questions about what we are meant to be and what we can be,[27] but which ultimately remain unresolved, and further confused in the rationale of abstract mathematical formulas. If modern science cannot solve such questions, what could solve them? When thinking about ontogeny, meaning the development of an organism during its lifespan, Oyama mentions that the developmental information itself has a developmental history, which "neither preexists its operations nor arises from

22 Susan Oyama, *The Ontogeny of Information: Developmental Systems and Evolution*, (Cambridge: New York: Cambridge University Press, 1985), 182.
23 Ilana Zilber-Rosenberg and Eugene Rosenberg, "Role of Microorganisms in the Evolution of Animals and Plants: The Hologenome Theory of Evolution," *FEMS Microbiology Reviews* 32, no. 5 (August 2008): 723.
24 Imanishi, "A Proposal for Shizengaku: The Conclusion to My Study of Evolutionary Theory," 361.
25 Imanishi, "A Proposal for Shizengaku: The Conclusion to My Study of Evolutionary Theory," 361.
26 López Intzín, "The Ch'ulel-Multiverse and Intersubjectivity in the Maya Tseltal Stalel," 13, 18.
27 Oyama, *The Ontogeny of Information: Developmental Systems and Evolution,* 8.

random disorder."[28] Developmental information is then constructed as an organism constructs its own evolutionary path; but not as a function of pure chance. Random variation is crucial to its formation and its functioning, where intentionality and adaptation are involved too.

4. Cascade of Symmetry Changes

Prigogine and Stengers consider that modern technoscience was axiomatized by a homogeneous and isotropic space as conceptualized by Euclid, contrary to the Aristotelian space, "for which one source of inspiration was the organization and solidarity of biological functions."[29] In their theory of dissipative structures, which relies on the latter, fluctuations are able to cause instabilities in which symmetry breaks emerge.[30] A dissipative structure is an open system operating out of, and often far from, equilibrium. Differently from close-to-equilibrium situations, in far-from-equilibrium systems behaviors become highly specific. When far from equilibrium, universal laws are no longer valid to deduce the overall behavior of a system.[31] In each particular system, qualitatively different behaviors may emerge. Thus, the trajectory of the diverse systems continuously bifurcate, as cascades of symmetry change define particular structures and functions that may appear as completely dissimilar from the once homogeneous single unit which Imanishi considers as the basis of the fundamental relationship between every biotic and abiotic subject.[32]

Bifurcation points are the critical moments from which a new state becomes possible: "The points of instability around which an infinitesimal perturbation is sufficient to determine the macroscopic operating regime of a system."[33] Far from equilibrium, new structures and functions become possible, destabilizing the system from which they emerged, developing a succession of amplified instabilities and fluctuations.[34] Unlike physical systems which can be analyzed through their instantaneous flows, understanding a biological organization requires a historical analysis too. Evolutionary history is thus an ever growing fractal of phylogenetic and ontogenetic trajectories in which cascades of symmetry change generate anatomical and functional variability.[35]

Longo and his colleagues propose a Theory of Organisms with two founding principles: (1) the default state of cells as proliferation with variation and motility, and (2) non-identical iterations of a morphogenetic process as the framing principle. The first one refers to variation as a symmetry

28 Oyama, *The Ontogeny of Information: Developmental Systems and Evolution*, 3.
29 Prigogine and Stengers, *Order out of Chaos: Man's New Dialogue with Nature*, 171.
30 Prigogine and Stengers, *Order out of Chaos: Man's New Dialogue with Nature*, 171.
31 Prigogine and Stengers, *Order out of Chaos: Man's New Dialogue with Nature*, 145.
32 Imanishi, *A Japanese View of Nature: The World of Living Things*, 2.
33 Prigogine and Stengers, *Order out of Chaos: Man's New Dialogue with Nature*, 186.
34 Prigogine and Stengers, *Order out of Chaos: Man's New Dialogue with Nature*, 186.
35 Longo et al., "In Search of Principles for a Theory of Organisms," 955–68.

change happening through reproduction, a "descent with modification," which is driven by motility: the capacity of an organism to move independently using forces and flows of energy and matter. The second refers to life phenomena as non-identical iterations of a morphogenetic process through which organization is iterated and maintained.[36] Can this Theory of Organisms be intermixed with the theory of lateral gene transfer? In recent years, the idea of *reticulate evolution* has been conceptualized as a way to conceive biological evolution in a web-like pattern instead of a tree. In addition to the descent with modification and the non-identical iterations of morphogenetic processes, which could be described as the vertical threads of our evolutionary fabric, lateral gene transfers can be understood as the horizontal threads which interweave evolutionary processes as a web of life.

The theory of lateral gene transfer has posited that apart from the vertical gene transfer that happens in a species' reproductive cycle, an individual may exchange genes with other living organisms and with other viral genetic agents which are traditionally conceived as non-living beings. Natalie Gontier argues that the acquisition of foreign DNA through lateral gene transfer allows us to think about evolution beyond the rigidity of common descent with modification. And thus, gene exchange can occur between organisms that are commonly rendered as distant by the image of the tree of life.[37]

Contrary to Neo-Darwinian thought, genes do not merely "move" out of selfish "needs" for propagation, several mutualistic benefits can be identified which result from horizontal gene transfer, including DNA repair, genome growth, and acquisition of novel functions. Reticulate evolution enables us to render a weblike image of life in which plural mechanisms, patterns and processes are constantly changing the symmetries of biocultural systems. For Oyama, a "view of the biological world that reduces cause to discrete genetic and environmental forces reduces living beings to infinitely thin membranes resonating to signals from within or without but lacking the substance to generate signals of their own."[38]

5. Negentropy and Antidomestication

In the experience of life as rendered through NBIC technoscience, the domestication syndrome is becoming an almost generalized characteristic for several members of the biocultural world. Thus, the production of diversity –as a negentropic process– becomes a necessity if we ever want to experience life outside of modernity's monoculture. Modern progress is a linear movement that progressively closes its trajectory towards decline; and in this process, human invention is only enacted towards

36 Longo et al., "In Search of Principles for a Theory of Organisms," 955–68.
37 Nathalie Gontier, "Historical and Epistemological Perspectives on What Horizontal Gene Transfer Mechanisms Contribute to Our Understanding of Evolution," in *Reticulate Evolution: Symbiogenesis, Lateral Gene Transfer, Hybridization and Infectious Heredity,* ed. Nathalie Gontier (Cham: Springer International Publishing, 2015), 161.
38 Oyama, *The Ontogeny of Information: Developmental Systems and Evolution*, 162.

conventionalization to maintain the constraints which render the ways of modernity as unconditional. The experience of life, as run through NBIC technologies, produces biocultural entropy and therefore diminishes diversity.

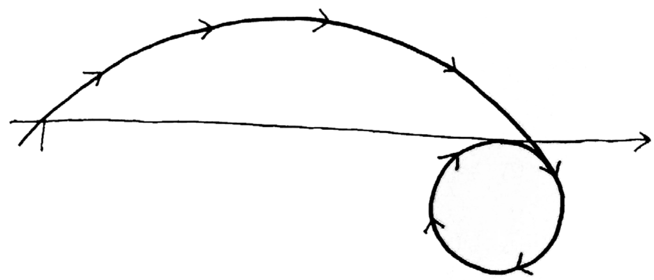

Figure 1. *The self-closure of a bioculture.* (Drawn by Diego García).

Experiencing the rise of mass biological and ontological homogenization imposed by modern human activity, is it possible that human technical activities can produce biological diversity? While modern human enaction imposes its entropic tendency to whatever it touches, in several non-modern biocultures the production of biological diversity is inherent to technical activities. Manuela Carneiro da Cunha describes people in the Amazon –specifically women agriculturalists– as *producers of biodiversity*:

> Women will attentively observe the new-comers [seedlings]. They will separate spots for them and they will be experimented upon for at least two or three years. Their first year tubers–one single conical tuber per individual–will be unique and distinct from subsequent years' tubers. Only when they are replanted from stem cuttings will they show their true colors, qualities, or specificities.... Different varieties will be ripe at different moments. The earlier ones can be harvested after just six months. This is no doubt a practical reason for planting different varieties in a single garden. But it can hardly explain the excess that certain women indulge in, of cultivating up to 40 varieties in their gardens.[39]

Carneiro Da Cunha mentions that the people she worked with in the Rio Negro basin, maintain a minimum of three gardens at once, each in a different stage; they understand the new seedlings "as both coming from and belonging to 'the old folks' (*os antigos*) and paradoxically (since they are result of sexual reproduction) as orphans."[40] Can we also aim to become producers of biocultural diversity, not only through conducting technical activities such as agriculture and fermentation upon other

39 Manuela Carneiro Da Cunha, "Traditional People, Collectors of Diversity," in *The Anthropology of Sustainability*, ed Marc Brightman and Jerome Lewis (New York: Palgrave Macmillan US, 2017), 263.
40 Carneiro Da Cunha, "Traditional People, Collectors of Diversity," 263.

biological species, but also by catalyzing divergence in our own selves, through the transformation of our microbiome, for example?

According to Nicholas Georgescu-Roegen the three basic elements needed for life are: "first, matter (such as natural resources); second, energy; [and] the third and more mysteriously is diversity, also known as low or negative entropy."[41] Entropy is low when internal diversity is high, and it grows as diversity decreases. The concept of entropy introduced the idea of irreversibility to the reversible physicist's world.[42]

Structure and function develop as two spirals that revolve around each other through the arrow of change that is time. And this interplay of emergence is intersected by the technical activities of organisms, which generate constraints on evolutionary trajectories and at times create cascades of symmetry change. Prigogine and Stengers argue that entropy, as the dissipation of energy and matter, is generally associated with the concepts of loss and evolution towards disorder, but far from equilibrium it can turn into a source of order.[43] Just like the forest after the slash-and-burn process of agroforestry, an almost desertified biological and ontological landscape could allow the possibility of a reforestation in which diversity flourishes.

Cultivating the seeds that remain from the human premodern biocultures, the futures we want to harvest are more similar to the premodern modes of enaction—the *ancestral futures* as Ailton Krenak conceptualizes—than to the technocratic fantasies of the NBIC paradigm.[44] Can localized biocultural invention enable biological and ontological diversification processes that take us beyond the contemporary state of things? Can the processes of bio-ontological homogenization be stopped before the world-landscape is completely desertified?

Carneiro da Cunha has referred to the agroforestry activities enacted by the Jamamadi people of the Amazon with the concept of *antidomestication*. These people oscillate freely between forms of living; through their practice of swidden agriculture, they resist the so-called progress, the supposedly universal "evolution" assumed to be irreversible from foraging to domesticated life.[45] As much as former nomads can become gardeners, agriculturalists are able to morph into foragers. This is possible through the constitution of synanthropic regenerative biocultural niches.

The interaction between Amazonian people and the tropical forest "implies that both are part of a

41 Carneiro Da Cunha, "Traditional People, Collectors of Diversity," 257.
42 Carneiro Da Cunha, "Traditional People, Collectors of Diversity," 258.
43 Prigogine and Stengers, *Order out of Chaos: Man's New Dialogue with Nature*, 143.
44 See Ailton Krenak. *Futuro ancestral*. (São Paulo: Companhia Das Letras, 2022).
45 Manuela Carneiro Da Cunha, "Antidomestication in the Amazon: Swidden and Its Foes," *HAU: Journal of Ethnographic Theory* 9, no. 1 (March 2019): 185.

social-ecological system, formed by mutually dependent feedbacks."[46] The Amazon tropical forests are composed of a multiplicity of other beings, and the Jamamani particularly understand that there is no such thing as wild plants, since everything is cultivated by some "other" cultivator.[47] Positive feedback within an agroforestry system such as the Amazon can then be understood as a multispecies interaction in which every member is participant in the axiomatization of the rest of the members; this amplifies food availability at large scales. In this contextual and local management of the tropical landscapes, the selection, cultivation and dispersing of plants intersects the ecological processes that shape the composition of the forest. A main quality of this positive feedback, is that when local people and their techniques are excluded from the system, landscape's composition changes too, since several non-human populations are dependent on human interaction.

Each ecological equilibrium is only temporary since all organisms are continuously constituting and modifying niches through their conscious and unconscious activities. The metabolic functions, which entail the acquisition of energy from food and beverages, can be more widely understood as the physical and chemical mode in which the environment is incorporated into the subject. Imanishi argues that "the digestive tract might be considered as a part through which the outside world penetrates our body and as such is an extension of the environment entering the body."[48] So even if a living organism is a self-contained system, its body assimilates food and thus continuously incorporates elements from the environment into itself. The metabolic coherence of behavior seems to be developmentally given for all species in the biosphere, except for modern humans who are continuously branching out from it. The possibility for organisms to change the symmetry of an evolutionary trajectory is conceptualized by Prigogine and Stengers as:

> Autocatalysis (the presence of X accelerates its own synthesis), autoinhibition (the presence of X blocks a catalysis needed to synthesize it), and crosscatalysis (two products belonging to two different reaction chains activate each other's synthesis).[49]

The development of the organisms' behavioral schemes happens in the same manner as the web-like image that reticulate evolution has brought forth to the development of biological species. Behaviors are also transferred vertically from generation to generation as descent with modification emerging in non-identical iterations, and also shared horizontally in intraspecies and interspecies transfers. Imanishi argued that species must be something which creates itself, meaning that its origin and transformation must be in the species itself;[50] In this view, the processes of autocatalysis, autoinhibition

46 Bernardo M. Flores and Carolina Levis, "Human-Food Feedback in Tropical Forests," *Science* 372, no. 6547 (11 June 2021): 1146.
47 Carneiro Da Cunha, "Antidomestication in the Amazon: Swidden and Its Foes," 172.
48 Imanishi, *A Japanese View of Nature: The World of Living Things*, 26.
49 Prigogine and Stengers, *Order out of Chaos: Man's New Dialogue with Nature*, 153.
50 Imanishi, *A Japanese View of Nature: The World of Living Things*, 62.

and crosscatalysis are enacted by its members. If these processes can be initiated by any member or group, this means that there can be wide degree of variation between the members of a species:

> this range of change among individuals does not indicate the absolute limit of mutability. Living things with the potential for random variation always have a limit relative to the environment. Yet there may be times when mutants go beyond this limit.[51]

According to Imanishi, a species suppresses extreme forms of mutation by modulating variability to maintain a state of equilibrium; this can be understood as the tendency to preserve the status quo, or to prevent the emergence of a weak line of development. The modulation of mutations concentrates variations to make as many individuals as possible maintain a middle path of change: this can also be thought of as the strengthening of the species itself, which is probably one expression of its autonomy.[52] In the contemporary world, unpredictable conditions are constantly emerging, and thus, environmental pressures are reaching a level of almost complete randomness.

While decontextualized top-down solutions are being imposed upon the whole planetary population, it is evident that the one-size-fits-all approaches have not only failed to work efficiently, but have also played a key role in the enablement of contemporary climate change. Inhabiting a planet in which environmental pressures are changing relatively fast, organisms need to adapt to emerging conditions in order to survive. How can processes of autocatalysis, autoinhibition and crosscatalysis be initiated by techniques developed through biocultural inventions?

Invention stands as the sign of differentiation, and the processes of differentiation are bounded in an interplay with processes of conventionalization. Differentiating symbolization delineates radical distinctions upon the flow of construction which are later assimilated by the processes of convention. Meanwhile, conventional symbolization reintegrates differentiations by bestowing order and rational constructions.[53] The collective viewpoint or orientation of a culture—meaning the way in which its members learn to experience the world—is created through the alternation between acts of differentiation and conventionalization.

This oscillation between differentiation and conventionalization is parallel to Imanishi's thought when he mentions that "in the body of a living thing certain characteristics actively change in a certain direction, but there are other characteristics that are conservative and offset the active change."[54] In shinzegaku, change is structural and morphological as much as functional and behavioral, asserting a

51 Imanishi, *A Japanese View of Nature: The World of Living Things*, 148.
52 Imanishi, *A Japanese View of Nature: The World of Living Things*, 79.
53 Roy Wagner, *The Invention of Culture*, 39.
54 Imanishi, *A Japanese View of Nature: The World of Living Things*, 80.

continuity between the psychic and the physical realms:

> the origin of the species is a problem of how did these kinds of cultural characteristics diverge and develop to the point where they became a defining feature of the species.[55]

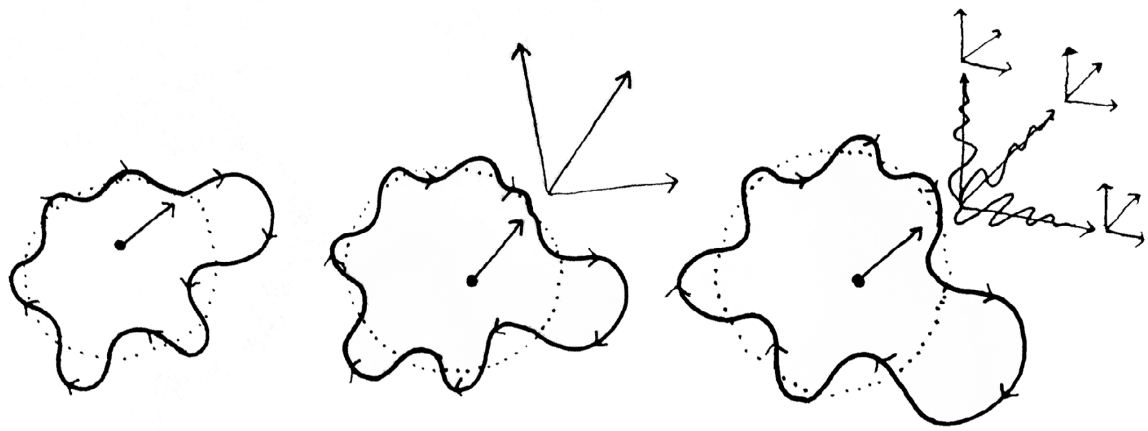

Figure 2. *Differentiation and conventionalization.* (Drawn by Diego García). When a difference emerges, it is amplified until becoming a figuration that is then conventionalized. In the moment in which a difference is conventionalized, it axiomatizes subsequent processes of differentiation.

Oyama mentions that a single genotype may be developmentally mapped onto many phenotypes, which do not necessarily emerge in continuous variation. Evolution is an interactive process whose constraints and causes emerge as it functions.[56] As contemporary climate change exponentially escalates, biological species must find their way of survival within contingent environmental pressures that are continuously emerging. But, as it is described by the developmental theory of evolution, environmental pressures have constantly changed since the first organisms emerged. While some variations might only stay during the lifespan of an individual or a community when they encounter emergent environmental pressures, if "the aberrant life cycle becomes the typical one... the conditions for the new character will be present for each new generation."[57]

Phenotypic variation is not just different ways of *appearing*, it is different ways of *being*.[58] If variation is expressed in the human species through specific physical and behavioral characteristics, why does the vast and diverse human population tend towards homogenization? Modern technoscience, as an entropic force, has a tendency towards normative homogenization; its inventive processes are enacted within the NBIC framework, and its main goal is capitalist accumulation. The emergence and proper functioning of modern technoscience happens through the installment of a moral of compatibility as a source of normativity, which imposes a fundamental, a priori image that modulates the role of the

55 Imanishi, *A Japanese View of Nature: The World of Living Things*, 82.
56 Oyama, *The Ontogeny of Information: Developmental Systems and Evolution*, 45.
57 Imanishi, *A Japanese View of Nature: The World of Living Things*, 175.
58 Imanishi, *A Japanese View of Nature: The World of Living Things,* 169.

person[59] to inherently allow the extractivism-pollution-exploitation of nature as a standing-reserve.[60] Stengers and Prigogine ask:

> What would happen if, as a result of certain uncontrollable events (e.g. mutations, technical innovations), constituents of a new type [of fluctuations] were introduced that could take part in the system processes and multiply with their help?[61]

New constituents introduced in small quantities bring a new set of reactions between the components of the system, which then begin to compete against the preexistent ones. When a system is structurally stable, the new mode of functioning won't be able to establish itself, and the "inventors" won't survive. But if these "inventors" are multiplied fast enough to invade the system instead of being destroyed, the whole system will adopt a new mode of functioning and its activity will be governed by a new 'syntax.'[62] A population's nonlinear interactions determine the possibility of appearance for particular modes of evolution (snowball effects, epidemic spreads, differentiation by amplification of small differences).[63] How to unchain such fluctuations?

Simondon considers that the most simple invention relies on the operational models that are already functioning within a system: "the operational models with their motor content constitute by themselves the most elementary of the axiomatics that do not need to be constructed since they are delivered by the organism itself."[64] That is to say that this mode of invention relies on the metabolic coherence of the biocultural axiomatics that bring forth a heterarchical organization between subjects. Such simple inventions inherently possess symbiotic characteristics, and thus, when enacted by humans, they cannot be differentiated from the technical activities of other species. The symbiotic invention of biocultural techniques takes advantage of ecological plasticity to reconfigure ecosystems.

Through a localized axiomatization, symbiotic inventions are individually and collectively applied to multiple scales: to an ecosystem as a whole in the process of niche constitution, to a community of individuals from another biological species, and to the body of oneself understood as an ecosystem. Symbiotic inventions can enable processes of autocatalysis, autoinhibition and crosscatalysis.

59 Gilbert Simondon, *Imaginación e Invención*, (Buenos Aires: Cactus, 2015), 181–182.
60 Martin Heidegger, "The Question Concerning Technology," in *The Question Concerning Technology and Other Essays*, trans. William Lovitt (New York and London: Garland Publishing, 1977), 23.
61 Prigogine and Stengers, *La nueva alianza: metamorfosis de la ciencia*, 200.
62 Prigogine and Stengers, *Order out of Chaos: Man's New Dialogue with Nature*, 190.
63 Prigogine and Stengers, *La nueva alianza: metamorfosis de la ciencia*, 209.
64 Simondon, *Imaginación e invención*, 170.

6. The Fractal of Evolutionary Warps and Wefts

Since an ecosystem is composed of a multiplicity of organisms interacting with one another, the behavior of one species has an influence on the axiomatization of another species' behavior, and thus: *behavior affords behavior*.[65] Relying on multi-species interaction, symbiotic invention happens as a subtle process through time and space, and given the necessary conditions for its amplification, it can unchain fluctuations that can destabilize, stabilize and reconfigure whole ecosystems. Evolutionary dynamics often involve causal interactions between entities from distinct levels of biological organization, or operating at different time scales, who are responsible not only for the destabilization of pre-existing entities, but also for the emergence and stabilization of novel entities.[66]

A main quality of imagination is "the capacity of the prediction of qualities that are not practical in certain objects, that are neither directly sensorial nor entirely geometric, that relate neither to pure matter nor to pure form, but are at this intermediate level of schemas."[67] How can we radicalize our imagination to predict and enable emergent qualities in our ecosystems, other species, and our own bodies, functionally, structurally and even aesthetically? We are interested in exploring the possibility of a system's destabilization and reconstitution through the modulation of the plasticity of biotic and abiotic subjects and of whole environments.

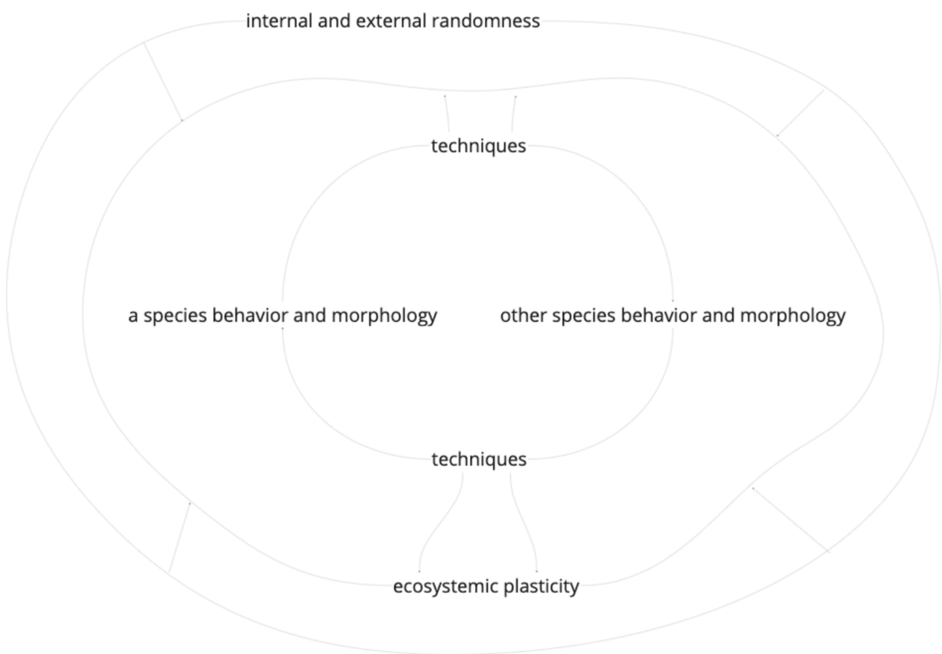

Figure 3. *Behavior affords behavior.*

65 James Gibson, *The Ecological Approach to Visual Perception: Classic Edit*ion (New York: London: Psychology Press, Taylor & Francis Group, 2015), 121
66 Eric Bapteste and John Dupré, "Towards a Processual Microbial Ontology," *Biology & Philosophy* 28, no. 2, 379.
67 Gilbert Simondon, *On the Mode of Existence of Technical Objects* (Minnesota: Univocal, 2016), 74.

The word plasticity unfolds its meaning "between sculptural molding and deflagration, which is to say explosion,"[68] and this precisely characterizes the relation that a subject maintains with events of different orders. Longo and colleagues consider that…

> evolution is both the result of random events at all levels of organization of life and of constraints that canalize it, in particular by excluding, by selection, incompatible paths — where selection is due both to the interaction with the ecosystem and the maintenance of a possibly re-newed internal coherent structure of the organism, constructed through its history.[69]

Organisms are in a state of permanent transition in which random events arising from both their internal and external ecosystems generate the necessity for adaptability. Mary Jane West-Eberhard mentions that environmentally induced variations are heritable insofar as the ability to respond by producing them is heritable, meaning: genetically variable. The responsiveness of organisms to the influence of the environment involves mechanisms that normally are genetically complex and therefore subject to genetic variation.[70] While environmental factors can affect numerous individuals simultaneously, mutation may initially affect only one.

Plastic modulation refers to the modification of the interactions between the biotic and abiotic constituents of an organism/ecosystem. Modification can be applied to characteristics such as rhythm, frequency or degree of intimacy of the parts. This might allow the transformation of the size of a population or the efficacy of a function and a structure. Plastic modulation can be reparative to the extent that lost interactions can be re-established while undesirable interactions can be diminished. While we cannot define a standard set of rules to determine the efficient functioning of an ecosystem, the detailed observation of the localized metabolic dynamics should be the main indicator to understand the health of its trophic interactions. But instead of approaching our role as producers of diversity through the tools provided by the NBIC paradigm, can we conduct these technical endeavors through our intuition?

Antidomestication, as an approach for modulating the plasticity of organisms/ecosystems, can enable differentiating fluctuations that cause a state of instability to encourage environmental heterogeneity through the creation of ecological patches, mosaics, and edges. This mode of inhabiting a landscape avoids turning human interests into hegemony and unchains processes of ecological feedback towards humans.

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68 Catherine Malabou, *What Should We Do with Our Brain?*, trans. Sebastian Rand (Fordham University Press, 2008), 70.

69 Longo et al., "In Search of Principles for a Theory of Organisms," 955–68.

70 Mary Jane West-Eberhard, "Developmental Plasticity and the Origin of Species Differences," *Proceedings of the National Academy of Sciences* 102, no suppl_1 (May 2005): 6547.

Stengers and Prigogine consider that the absolute character of scientific statements used to be considered a sign of universal rationality, meaning that universality should entail the negation and overcoming of all cultural particularities. From their perspective there is a need to construct a way of conducting scientific endeavors where there is no longer a denial of the concerns and questions of the societies in which it develops, maintaining a dialogue with humans from all cultures, and learning to respect their particular questions.[71] Perhaps what Viveiros de Castro has referred to as *multinaturalism* can lead such an endeavor. The idea of multinaturalism affirms the multiplicity *in* cultures, bringing forth the naturalness of variation or, more precisely, championing that we need to apprehend variation *as* nature.[72]

Different organisms evolve at different time scales, and thus evolution operates in fragmentary multinatural relationality. Imanishi considers that to live is to act and to create, and in that sense, all the daily life of living things is part of evolution.[73] Is it possible then to diversify the imposed homogeneity of the current global order through differentiating fluctuations which start from local contexts? How to develop new structures and functions through contextual techniques?

Stengers and Prigogine assure us that "close to equilibrium, the laws of fluctuation are *universal*, while far from equilibrium, […] the relative value of dispersion *no longer obeys* the general formula,"[74] and thus, the trajectory of each fluctuation becomes highly specific. Fluctuations emerging from the instability of a bifurcation point might be correlated, to the point that macroscopically distant regions will stay in relation, and thus local events might affect the totality of the system. The production of biodiversity (negative entropy) is an *immeasurability*,[75] and rather than conducting our life processes with the sole aim to produce biodiversity, the beings which maintain a metabolic coherence with the ecosystem are inherent producers of biodiversity. What is the role of intentionality then?

The discovery or introduction of a new technique can generate the axioms to overcome social, technological, economic or ecological orders through their radiation. The amplification of such innovations might need a ground in which they can flourish, but simultaneously establish never before seen conditions to propel their own multiplication. According to Oyama there are three kinds of radiation: (1) ontogenetic (differentiation), (2) phenotypic (variation among individuals with the same genotype, norm of reaction) and (3) evolutionary (phylogenetic divergence). All three of them share the qualities of constancy, change, and variability.[76] Dissipative structures irradiate fluctuations in multiple

71 Prigogine and Stengers, *La nueva alianza: metamorfosis de la ciencia*, 44.
72 Eduardo Viveiros De Castro, *Cannibal Metaphysic* (University of Minnesota Press, 2014), 65–75.
73 Imanishi, *A Japanese View of Nature: The World of Living Things*, 68.
74 Prigogine and Stengers, *La nueva alianza: metamorfosis de la ciencia*, 202.
75 Édouard Glissant, *Poetics of Relation*, trans. Betsy Wing (Ann Arbor: University of Michigan Press, 1997), 61.
76 Oyama, *The Ontogeny of Information: Developmental Systems and Evolution*, 52.

non-linear trajectories, and thus we can conceive evolution as fractalizing cascades of symmetry change. Danièle Dehouve contrasts natural fractals as the result of self-organization, with cultural fractals that proceed from human voluntary organization.[77] But what happens when we understand evolution as an interrelated fragmentary history with no barrier between nature and culture? Is there an actual difference between biological self-organization and human voluntary organization when speaking about biocultural fractals? Perhaps a more precise image of evolution would come as a multiplicity of interweaving spiral warp and weft fabrics –of variable scales, dimensions, and orders– in which each single fluctuation can further fractalize.

77 Danièle Dehouve, “El fractal: ¿una noción útil para la antropología americanista?” *Desacatos* 53, (Jan–April 2017), 136.

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