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# Introduction.
# Environment: Trajectories of a plural concept


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Within public discourse, 'environment' is typically invoked as a singular, unified entity. Although this abstractive move can be traced back to the 19th Century[1], its current use reflects mainly the historical turn initiated roughly fifty years ago by the Club of Rome's alert about the dangers of anthropogenic changes of the environment, grounded in the first major computer simulation conducted at the global scale. Overshadowing its descriptive, neutral meaning of «a multiplicity of environments in the plural», the term in the singular became laden with «deontic» overtones. Functioning as a proxy for an entire political agenda, it carried a strong «normative charge and a call to action»[2], shattering the long-standing extractivist stance that the environmental consequences of human activity could be relegated to mere externalities. It promoted a new public imagery of the environment as an endangered global common good, that must be protected and safeguarded proactively, through a radical innovation of the extant system of ethical, political, economic and social norms. More concretely, at the political, institutional, and scientific levels, it has also fostered the development of an 'integrated expertise' to deal with the environmental crisis at the planetary level[3].

This praiseworthy effort was effective in eliciting a global shift in public imaginaries and in moving research from a generic awareness of the 'limits of development' toward a more precise analytical assessment of ecological 'boundaries' at the planetary scale – many of which are already being transgressed[4]. However, it stands at odds with the contemporary drive in the life sciences toward the pluralization – indeed an almost *mise en abyme* – of the notion of environment.

In *ecology*, this trend takes on different forms. It may be driven by the vindication of the irreducible specificity of particular environments and their mode of action on organism and population. This is the case of the marine environment, whose scientific understanding has been long impaired by the dominance of terrestrial models and concepts[5].

The joint influence of landscape ecology, hierarchical theory, and nonequilibrium ecology has shattered early views of ecosystems as spatially and temporally homogeneous functional systems, prompting their decomposition into a dynamic mosaic of heterogeneous, interacting patches. The emphasis has shifted to their spatial and temporal differentiation, which fosters asynchronous

[1] A. Etxeberria, *'Environment' as Interdependent Surroundings*, this issue.

[2] G. Toepfer, *Historisches Wörterbuch der Biologie: Geschichte und Theorie der biologischen Grundbegriffe*, J. B. Metzer, Bd. 3, p. 580.

[3] P. Warde, L. Robin, S. Sörlin, *The Environment: History of the Idea*, John Hopkins University Press, 2018.

[4] M. Bartels, *Humans Have Crossed 6 of 9 'Planetary Boundaries'*, in «Scientific American», September 13, 2023.

[5] J. H. Steele, *A Comparison of Terrestrial and Marine Ecological Systems*, in «Nature», 313, 1985, pp. 355-358. Daniele Iudicone's talk at the Naples Symposium, *The Oceans as a World Apart*, explored this topic in a wide-ranging and evocative manner.

and diverse functional responses to perturbations, thereby increasing the resilience of the global meta-ecosystem[6].

The very reliability of the notion of *planetary boundaries* has been called into question. Donohue et al. argue that ecological stability and disturbances are multidimensional and cannot be adequately understood or managed with *one-dimensional* metrics. In fact, indicators that work at one scale (e.g., local ecosystems, short-term dynamics) may not capture processes at another (e.g., global systems, long-term resilience). Without clear multiscale grounding, such measures risk misleading political decisions[7].

The burgeoning field of *socio-ecology*, which focuses on the coupling between social and ecological systems, is bringing to light the extant diversity of the ways these different dimensions of environment are coupled in different societies and cultures[8]. In particular, the merging of the socio-ecological approach with postcolonial ethnoscience and anthropology, focuses on those cultures that were most marginalized by the homogenizing march of western colonization. This emerging interdisciplinary approach both enriches our scientific understanding of human-environment interactions and challenges our political imagery to exploring viable alternatives to the dominant extractive mode of development[9].

However, it is mostly at the more fundamental level of «*the ontology of life and living systems*»[10] that the drive to the pluralization of the notion of environment has become compelling. A new conceptual framework has marginalized the view entrenched in Modern Evolutionary Synthesis, of the environment as the supreme court judging on the adaptedness of the full-grown organism. This 'externalistic' tenet, whereby «the environment acts, and the organism responds»[11] has been challenged by many trends in post-genomic biology. New findings and both conceptual and technological advancements have brought to the fore an inherently relational notion of environment, that is deeply embedded in the tradition of systems thinking. As open systems, organisms are constitutively entangled with their environment: their very capacity for self-organization depends on the continuous exchange of energy and matter with their surroundings and is directed toward modulating and internalizing control

[6] J. Wu, O.L. Loucks, *From Balance of Nature to Hierarchical Patch Dynamics: A Paradigm Shift in Ecology*, in «The Quarterly Review of Biology», 1995, 70, 4, pp. 439-466).

[7] I. Donohue *et al.*, *Navigating the Complexity of Ecological Stability*, in «Ecology Letters, 2016, 19, pp. 1172-1185.

[8] C. Folke, *Resilience: The Emergence of a Perspective for Social-Ecological Systems Analyses*, in «Global Environmental Change», 2006, 3, pp. 253-267.

[9] D. Mount, S. O'Brien, *Postcolonialism and the Environment*, in G. Huggan (ed.), *The Oxford Handbook of Postcolonial Studies*, Oxford University Press, 2013, pp. 521-539; E. de Hoopet *et al.* (eds), *Historicising Entanglements: Science, Technology and Socio-Ecological Change in the Postcolonial Anthropocene*, in «Global Environment», 2022, 15, 2, pp. 194-208.

[10] Etxeberria, *'Environment' as Interdependent Surroundings*, cit.

[11] *Ibidem*.

over these exchanges. Thus, within this expanding 'interactionist consensus'[12], the environment conveys better than nature a fundamental relational stance[13] and rather challenges the entrenched dichotomy between nature and nurture.

At the crossroad between *evolutionary developmental biology*, in its latest instantiation as eco-evo-devo, and *biomedicine*, a deeper understanding of the mechanisms of phenotypic plasticity has uncovered formerly undetected modes of 'instructive' environmental action on the making of the phenotype.

Findings indicate that subtle environmental cues – for example, signals of a specific predator – may elicit in the developing organism a *predictive adaptive response* that induces one of the potential morphs encoded in its norm of reaction[14]. This veritable 'bet' on the conditions of life it will encounter as an adult may also be lost if the environment it will find proves to be different from its prediction.

These findings have a direct impact in conservation biology, as the study of the factors influencing the plasticity of organisms is substantial for predicting their resilience to environmental changes and devising strategies to enhance it.

But these mechanisms have gained importance in *biomedicine* as well[15]. The evidence that most genetic variation associated with complex diseases resides in noncoding regions of the genome – where regulatory elements orchestrating gene expression are prone to environmentally induced epigenetic modifications – has redirected the focus of medical research toward the environment. In fact, the mismatch between the predicted and the actual environment is as well a cause of human pathology, as in the well-known case of the progeny of the women which were pregnant during the Dutch famine in 1944[16]. Now a brand-new branch of medicine is specifically devoted to the study of the 'developmental origins of health and disease' (DOHaD)[17].

The new term coined in 2005, the *exposome*, circumscribes the environment as the complete set of exposures that are causally effective in shaping the organismal phenotype 'from womb to tomb'[18]. Exposome research is reshaping epidemiology through large-scale epigenetic screening, now at the forefront of

[12] P.E. Griffiths, *The Philosophy of Molecular and Developmental Biology*, in P.K. Machamer, M. Silberstein (eds), The *Blackwell's Guide to the Philosophy of Science,* Blackwell, 2002, pp. 252-271.

[13] E. Casetta, *Filosofia dell'ambiente*, Il Mulino, 2022.

[14] S.F. Gilbert, D. Epel, *Ecological Developmental Biology*, II ed., Sinauer Associates, 2015.

[15] P.D. Gluckman, M.A. Hanson, F.M. Low, *Evolutionary and Developmental Mismatches Are Consequences of Adaptive Developmental Plasticity in Humans and Have Implications for Later Disease Risk*, in «Philosophical Transactions of the Royal Society B», 374, 20180109. <http://dx.doi.org/10.1098/rstb.2018.010>.

[16] Prenatal malnutrition during the Dutch Hunger Winter (1944-1945) caused lasting epigenetic changes – especially in DNA methylation – that have been linked to higher risks of metabolic, cardiovascular, and psychiatric disorders in adulthood.

[17] T. Kubota, H. Fukoka (eds), *Developmental Origins of Health and Disease* (DOHaD), Springer, 2018.

[18] C.P. Wild, *Complementing the Genome with an 'Exposome': the Outstanding Challenge of Environmental Exposure Measurement in Molecular Epidemiology*, in «Cancer Epidemiology, Biomarkers & Prevention», 2005, 14(8), pp. 1847-1850. <https:/doi.org.10.1158/1055-9965.epi-05-0456>.

the field. It wields unprecedented heuristic force, for its unprecedented capacity to reveal societal stressors, uncover unseen environmental causes of disease – and even establish their time of action – and may provide new therapies specifically targeting epigenetic biomarkers[19]. Yet, precisely because of the unprecedented visibility on the individuals' life history it enables, the growing impact of exposomics is not only clinical but also profoundly social and political, thereby becoming the object of mounting public concern[20].

Furthermore, this fine-grained view of the intertwinement of organism and environment at the short time scale of development and physiology is also integrating and sometimes contradicting the Modern Synthesis gradualist approach to evolutionary change. In fact, phenotypic plasticity often relies on epigenetic changes that do not alter DNA sequences yet can sometimes be transmitted across multiple generations. A rich array of environmental factors beyond the genome – including chemical pollutants, diet, social hardship, low socio-economic status, lifestyles, and patterns of parental care – can therefore influence the very trajectory of evolutionary change, particularly when epigenetic inheritance becomes stabilized through mechanisms such as genetic assimilation or genetic accommodation[21].

Environmental signals that funnel down to the level of gene transcription, and that are precisely represented within the internal milieu through molecular and cellular systems of perception, make it increasingly difficult to regard the skin as a definitive border between the inside and the outside of the organism.

The discovery of the manyfold functions that the gut microbiota plays in normal development as well as in health and disease is further overturning the dichotomy between internal and external milieu. This internal exposome is in fact, to paraphrase Peter Handke, rather «the innerworld of the outerworld of the innerworld»[22] – a highly complex biotic environment which is furthermore also epigenetically inherited, as integral part of the maternally transmitted niche. The transgenerational stability of symbiotic relationships in all multicellular organisms has led to the proposal of replacing the notion of individual with that of holobiont, a collective entity in which major developmental and physiological functions are distributed across hosts and their symbionts[23].

Furthermore, we are increasingly taking cognizance of the extent to which inheritance may be mediated by the environment, which in turn stores the memory of the modifications induced by the activity of living systems. The foremost example is *niche construction*, the process by which the activities of or-

[19] S. Caianiello, *Personalized Epigenetics: Prospects and Challenges*, in C. Beneduce, M. Bertolaso (eds), *Personalized Medicine in the Making*, 2022, Springer, pp. 227-248.

[20] H. Landecker, A. Panofsky, *From Social Structure to Gene Regulation, and Back: A critical Introduction to Environmental Epigenetics for Sociology*, in «Annual Review of Sociology», 2013, 39, pp. 333-357; T. Bonnin, S. Canali, *Exposome Research in the Perspective of* Longue Durée *Political Epistemology*, this issue.

[21] M.-J. West-Eberhard, *Developmental Plasticity and Evolution*, Oxford University Press, 2003.

[22] P. Handke, *Die Innenwelt der Außenwelt der Innenwelt*, Suhrkamp, 1969.

[23] S.F. Gilbert, J. Sapp, A.I. Tauber, *A Symbiotic Wiew of Life: We Have Never Been Individuals*, in «The Quarterly Review of Biology», 2012, 87, 4, pp. 325-341.

ganisms modify the selective pressures experienced by subsequent generations – both of the same species and of others – thereby providing an ecological form of inheritance; an insight anticipated by Darwin's account of earthworms as ecosystem engineers that created the conditions supporting the explosive diversification of life[24].

The realization that the genome is not a fixed blueprint of the phenotype, but rather a resource deployed differently depending on context[25], has rendered the notion of the organism's *internal environment* increasingly stratified and plural.

In the last decades, the relationship between cells and their microenvironment is increasingly conceived in terms of 'dynamic reciprocity'[26]. Mounting evidence of the active role played by the cell's microenvironment in regulating gene expression and maintaining the stability of cellular and tissue differentiation has opened new avenues in cancer research, challenging earlier approaches that foregrounded the genetic determination of this pathology[27]. At the same time, the increasing recognition of the sophisticated capacities of cells, tissues, and even organs to sense diverse environmental signals at their own scale and to flexibly modulate their behavior in pursuit of context-dependent, homeostatic outcomes has considerably expanded the realm of biological agency below the organismal level. These layered sub-organismal systems operate, according to Levin, as competent goal-directed agents – 'agents with agendas' embedded in recursive loops of shaping and being shaped, both by local microenvironmental cues and by long-range signals stemming from 'environments' at higher scales[28].

These few examples may provide insight into the multidimensional extension of the notion of environment across different temporal and spatial scales, as well as into the polysemy of its various acceptations and the «distinct philosophical commitments» they entail[29].

Faced with this striking polysemy, it is indeed legitimate to ask, with Huneman[30], whether a common conceptual core can ever be discerned across these diverse usages. However, the organizers of the 2024 Naples Symposium 'Envi-

[24] F.J. Odling-Smee, K.N. Laland, M.W. Feldman, *Niche Construction: The Neglected Process in Evolution*, Princeton University Press, 2003. Cfr. C. Darwin, *The Formation of Vegetable Moulds through the Action of Worms, with Observations on their Habits*, John Murray, 1881 – Darwin's last book.

[25] D. Noble, *The Music of Life: Biology beyond Genes*, Oxford University Press, 1992.

[26] C.M. Nelson, M. Bissell, *Modeling Dynamic Reciprocity: Engineering Three-Dimensional Culture Models of Breast Architecture, Function, and Neoplastic Transformation*, in «Seminars in Cancer Biology», 2005, 15, 5, pp. 342-352.

[27] M. Bertolaso, *Philosophy of Cancer. A Dynamic and Relational View*, Springer, 2016.

[28] M. Levin, *The Multiscale Wisdom of the Body: Collective Intelligence as a Tractable Interface for Next-Generation Biomedicine*, in «BioEssays», 2024, 0:e202400196.

[29] Etxeberria, *'Environment' as Interdependent Surroundings*, cit.

[30] P. Huneman, *What It Is Like To Be an Environment? A Semantic and Epistemological Inquiry*, in «Biological Theory», 2022, 17, pp. 94-112.

ronments. Trajectories of a concept' (Elena Casetta, Elena Gagliasso, Alessandra Passariello and me) privileged a different, more exploratory approach to this polysemy. Soliciting reflections on the current use and role of environment across different areas of the history and philosophy of the life and mind sciences, we were rather interested in phenomenologically investigating how conceptualizations of the environment have contributed to opening new epistemic spaces – granting visibility and scientific citizenship to phenomena and processes that were previously invisible or liminal. This Special Issue documents a large portion of the contributions presented at the Symposium.

*A glance at the contributions*

Arantza Etxeberria (*'Environment' as Interdependent Surroundings*) – keynote speaker at the Naples Symposium – frames the pathway to the relational view of environment as the overcoming of two opposite asymmetries, the already mentioned *externalist* view supported by the Modern Synthesis and the *internalist* view that, from cybernetics to the theory of autopoiesis, emphasized the operational closure of organisms as the hallmark of their autonomy. She shows how the joint action of epigenetics, exposomics and holobiosis has fostered a more markedly relational view of organismal autonomy, in which «organism and environment co-emerge through interaction».

However, there is a broader dimension of «ecological entanglement» that must be taken into account, that which «does not end with the organism». The notion of 'interdependent surroundings' conveys the view of «a living network of mutual influences, where the space around any organism is continually transformed by the actions of others». It is precisely at this juncture that the insufficiency of the internalistic approach emerges most clearly, and the conceptual instruments of niche construction theory demonstrate their unparalleled strength. The interdependency of surroundings provides in fact a framework for understanding how contemporary «human-induced evolution» reshapes selective pressures across species, altering their developmental trajectories and turning the world into a vast anthropogenic niche[31], the accelerated tempo of which is «outpacing the adaptive capacities of many species», including, ultimately, our own.

Andrea Gentili (*The Transcendental Biology of Jakob von Uexküll: Environment, Subjectivation, and Relationality*) provides a first-hand insight into Jacob von Uexküll's writings about *Umwelt*, one of the main sources of the current relational understanding of environment. Starting from a synoptic overview of the former history of the notion of environment in different European languages, he reconstructs the genesis of Uexküll's semantic innovation. *Umwelt* conveys the new meaning of the organism's species-specific, self-centered world, constituted through the functional circle linking perception (*Merkwelt*) and action

[31] A. Meneganzin, T. Pievani, S. Caserini, *Anthropogenic Climate Change as a Monumental Niche Construction Process*, in «Biology & Philosophy», 2020, 35(38). <https://doi.org/10.1007/s10539-020-09754-2>.

(*Wirkwelt*). The organism-environment system is the all-encompassing «self-enclosed unit», structurally constrained by the organism's active selection and interpretation of physiologically *meaningful* cues (*Bedeutungsfaktoren*).

This relational view is reinforced by Gentili's argument against a relativistic interpretation of Uexküll's *Umwelt*, which is grounded on the misleading assumption of a primacy of the subject over an objective «manifold awaiting to be ordered». The coupling between organism and environment is genuinely dynamical, «a continuous becoming-environment of the organism that coincides with a becoming-organism of the environment». Nonetheless, relationality for Gentili is not the ultimate foundation of Uexküll's theoretical biology. Uexküll's enterprise is better framed as a «transcendental theory of subjectivation», which rests on the «non relational principle» of universal *Planmässigkeit*, or unity of life. «Entirely immanent in its regulative *a priori* function», it articulates the very condition of possibility of plural world-making practices. Positing «no sharp divide between humans and other animals», the lesson Uexküll has still to teach to contemporary environmentalism is that of an ethology of multiple modes of existence of situated organisms, irreducible to the «single operational framework» of «a global ecosystem».

The evidence that, as emphasized by Etxeberria, organisms and environments are dynamically involved in mutual «cycles of transformation» has profoundly shaped post-cognitivist approaches in the philosophy of mind. On this view, the environment is not a pre-given domain of stimuli eliciting organismal adaptation, but a dynamic field of relations constituted through the ongoing mutual engagement of organisms and milieu. Organisms selectively enact and stabilize meaningful environmental features through their sensorimotor and metabolic organization, while environmental structures simultaneously constrain and enable those very organizations. Cognition thus emerges not as an internal computational process but as a temporally extended, distributed process unfolding across the organism-environment system, grounding enactive and ecological accounts of sense-making.

Morabito and Pacifici (*The Material, Cultural, and Relational Environment in the New Cognitive Sciences*), bring to light how the environment is inherently involved in the «dynamic process of world-making» within the contemporary, post-cognitivist approach of the 4E cognition paradigm. After reconstructing the complex genealogy of this approach, spanning from Claude Bernard to Uexküll, from the *Gestaltpsychologie* to the Soviet school of cultural-historical psychology, from Gibson's ecological psychology to the Santiago school of Cognition, they analytically sort out the contribution of each of the 4E (embodied, embedded, enacted, extended) to a renewed understanding of the constitutive role of the environment in the post-cognitive framework. A particular emphasis is laid on the articulation of the 4E tenets in Malafouris' Material Engagement Theory. This theory expands the entangled web of reciprocal co-constitution to include human artefacts, conceptualizing them as material agents endowed with an inherently social form of agency, constitutive of hu-

man world-making both in its distinctive social ontogeny and cumulative cultural evolution.

The 4E cognition framework inaugurated a new conceptual trajectory, rejecting classical GOFAI computationalism[32] and reconceiving cognition as distributed across brain, body, and environment. More recently, this perspective has been elaborated into what is termed the biogenic approach to cognition[33]. This evolutionarily *bottom-up* approach to the emergence of intelligence has significantly undermined residual forms of cerebrocentrism. Enabled by the unprecedented high-resolution sensitivity of new technologies, it is expanding the range of cognitive beings *all the way down* through successive levels of biological organization[34]. This 'cognitive lens', applied to unicellular organisms, to cells and cell collectives as well as to aneural organisms (i.e. lacking a nervous system or specialized nerve cells), has effectively disclosed new epistemic spaces, significantly expanding the understanding of the causal efficacy of salient environmental signals as well as the range of possible forms of biological agency. The biogenic approach has also played a pivotal role in ushering in the recent 'plant neurobiology revolution'[35].

This «bio-ecological» approach to cognition is currently enabling an accurate understanding of the unique way in which plant communities interweave their vital functions with their environment. The dynamic association of plants with their underground biotic microenvironment can be seen as an exemplary case of *extended* cognition, involving most of plants cognitive performances: «perception, memory, and signal transmission of environmental information in response to various stimuli and stressors». Bianchi (*The Multifunctionality of the Environment in Plant Interactions: Rethinking the Concept of 'Environment' and the Extended Cognition Hypothesis*) frames the 'Extended Plant Cognition Hypothesis' in the wider framework of the 4E paradigm's relational redefinition of environment. However, rather than simply subscribing to the framework of holobiosis – that, as Etxeberria reminds «dissolves any residual boundary between organism and environment»[36] – Bianchi explores in depth whether a distinctive form of agency might be conceived for plants beyond the framework of individuality. Besides the pragmatic and heuristic advantages of maintaining «epistemic boundaries between organisms and environments»[37], Bianchi underscores the risk of perpetuating the misconception of «a deficiency or lack relative to the

[32] GOFAI is the acronym introduced by J. Haugeland, *Artificial Intelligence: The Very Idea*, MIT Press, 1985 for 'good old fashioned artificial intelligence', i.e. the classical symbolic approach to AI.

[33] P. Lyon, *The Biogenic Approach to Cognition*, in «Cognitive Processing», 2006, 7, pp. 11-29.

[34] M. Levin, D. Dennett, *Cognition All the Way Down*, in «Aeon», Oct. 13, 2020. <https://aeon.co/essays/how-to-understand-cells-tissues-and-organisms-as-agents-with-agendas>.

[35] P.V. Minorsky, *The 'Plant Neurobiology' Revolution*, in «Plant Signaling & Behavior», 2024, 19, 1, e2345413-2.

[36] Etxeberria, *'Environment' as Interdependent Surroundings*, cit.

[37] J. Baedke, A. Fábregas-Tejeda, G.I. Prieto, *Unknotting Reciprocal Causation between Organism and Environment*, in «Biology & Philosophy», 2021, pp. 36, 48.

animal paradigm», a significant obstacle to the compelling task of unveiling the unexpected breadth of plants' 'unconventional intelligence'[38].

Interestingly, Bianchi's insight into plants' extended cognition brings further than the mere acknowledgment of the «dynamic and transformative relation» enclosing organism and environment in species-specific functional circles, and rather converges with the direction suggested by Etxeberria's notion of 'interdependent surroundings'.

Evidence of ecological signals «potentially endowed with a 'transversal value', chemically 'understandable' by very different organisms» discloses the possibility of «interspecific and even interkingdom» forms of communication across a shared environment. In this light, the *multifunctionality* of the environment appears to be more than the sum of affordances eliciting meaningful interactions for different organisms: it also functions as a structured reference frame for potentially indirect interspecific interactions.

To remain attuned to Uexküll's metaphor – recalled by Gentili – of individual scores within an overarching global melody, this perspective resonates with findings from soundscape ecology. Species typically occupy distinct acoustic niches, yet they retain sensory access to a broader acoustic background than the subset of signals used for conspecific communication. Accordingly, they may detect and respond to acoustic signals not specifically 'addressed' to them, as is clearly the case with low-frequency noises generated by abiotic processes such as thunderstorms or fires.

If the environment, in its relational coupling with organismal active sensemaking, comes to be seen as «a structured field» of potential significance for diverse biological agents, then its distinction from the notion of information begins to blurs. As N. Katherine Hayles reminds us, information requires embodiment – a principle successfully operationalized in science and engineering through systems that rely on physical rather than symbolic computation. Examples include supramolecular chemistry, which exploits material interactions as computational processes[39], and, more explicitly, embodied robotics and morphological computation[40]. While these developments attest to the practical translatability of the post-cognitive framework, they fall short of dislodging entrenched conceptions of information. These extend from GOFAI back to its original root in Wiener's cybernetic dictum 'information is information, not matter or energy', the generative premise from which symbolic AI inherited its disembodied conception of information. Against this backdrop, the notion of the environment as *structured information* (Della Rocca, *Environment as Information*), developed in the wake of Vittorio Somenzi's materialist theory of information, resists relativist interpretations of merely subjective *Umwelten*. For Della Rocca, information «is physically there whether or not any organism currently exploits

[38] Levin, *The Multiscale Wisdom of the Body*, cit.

[39] E. Fox Keller, *Towards a Science of Informed Matter*, in «Studies in History and Philosophy of Biological and Biomedical Sciences», 2011, 42, pp. 174-179.

[40] R. Pfeifer *et al.*, *On the Information-Theoretic Implications of Embodiment – Principles and Methods*, in M. Lungarella *et al.* (eds), *50 Years Artificial Intelligence*, Springer, 2007, pp. 76-86.

it». Della Rocca's materialist approach proves particularly significant in the analysis of digital virtual environments, as it highlights the risk of perpetuating, as in Floridi's infosphere, a hierarchical order in which a semantic-epistemic layer remains superposed upon its physical, material infrastructure. Moreover, the emphasis on the fact that digital environments are shaped by affordances – « cues, invitations, obstacles, or resources for behavior» that nonetheless delimit the range of possible actions and experiences – underscores the importance of «concealment»: all that the environment withholds or renders unavailable as information. In the case of digital environments, concealment is poised to become politicized, since the structure of affordances arises less from co-evolution or cultural niche inheritance than from human design – and, mostly, from «a corporate intelligence, evolving within the arid, airless ecology of neoliberal capitalism»[41].

It is, however, the last three contributions that address more explicitly the values, and the cultural and political commitments associated with different notions of environment.

Furia (*The Substances of Landscape*) argues that bringing a relational view of the environment into aesthetic experience demands overcoming the rupture of dichotomous thinking. The extant rupture is discerned between the landscape aesthetic experience – constrained and mediated by culturally laden «representational codes» – and the environment, as the substantive ensemble of processes unfolding within ecosystems. The current drift toward a «global aestheticization of space, operating through standardizing both taste and the landscapes themselves» can be opposed by an environmental aesthetics that reinstates a 'substantive' conception of landscape. Aesthetics is emancipated from the prevailing representationalist paradigm and restored to its etymological perceptual root as a «dynamic, embedded, embodied interpretation» of space – emphasizing the situated dimension of human experience. A restored aesthetic experience of landscape necessarily relates to the environment as an «in re potential» of aesthetic qualities, diversely enacted across living species. Such a «pan-perceptual» understanding of landscape fosters a holistic de-anthropocentrificaton of aesthetic experience, together with the humility of recognizing how much of this aesthetic potential remains «inappropriable as such». Against the background of restored pan-perceptuality, the 'substance' of landscape remains distinctly plural.

Bonnin and Canali (*Exposome Research in the Perspective of* longue durée *Political Epistemology*) apply an 'integrated history and philosophy of science'[42] approach to exposomics to better illuminate the epistemic situatedness of contemporary approaches to the role of environment in pathogenesis. Although exposomics is often portrayed as a radical innovation of post-genomic medicine, the role of the environment in health has been central to medical thought ever since Hippocratic medicine, with its emphasis on place and climate,

[41] J. Bridle, *Ways of Being*, Penguin, 2022.

[42] E. Herring *et al.* (eds), *The Past, Present, and Future of Integrated History and Philosophy of Science*, Routledge, 2019.

through early modern neo-Hippocratism, and into social medicine and social epidemiology. In all these instantiations, the conception of environment was imbued with political undertones and commitments; the medical notion of environment is thus a preeminent object of study for political epistemology.

Against this backdop, they analyze the current split within exposomic research, which has generated two distinct political epistemologies. The mainstream internalistic approach concentrates on *internal* exposures, privileging molecular traces of environmental effects. Under this view, socioeconomic factors are considered only insofar as they can be quantitatively assessed at the individual level, in line with the tenets of 'evidence-based' medicine. This orientation risks medicalizing *socially* determined exposures as individual traits, thereby enacting preventive or therapeutic interventions that narrowly target those traits.

Acknowledging the limits of this model has led to the development of a more holistic, integrative approach, one that seeks to combine high-resolution measurements across diverse types of exposure. In practice, however, such an ambitious project, which demands intensive data infrastructures, has thus far been implemented primarily in affluent urban environments. Inherent limits in its feasibility have thus ended up perpetrating well-known socio-spatial inequalities in health policy. To overcome this impasse, the authors encourage a more reflexive approach to epistemic and methodological choices, one which acknowledges that dealing with the complexity of environment-health relations requires strategies of pragmatic simplification that take stock of their political consequences. For this reason, when considering different future directions for exposomics, they emphasize that, in the trade-off required to achieve more effective and equitable policy outcomes, the «maximalist explanatory ambitions» of the holistic approach may need to be relinquished.

Framed from the perspective of the decolonization of knowledge – a central and evolving focus of decolonial studies[43] – the deontic, politically-charged category of environment in the singular appears irremediably overloaded by centuries of colonial extractivist practices imposed under the banner of an anthropocentric and Eurocentric ontology. Far from retaining the relational meaning that has fostered its pluralization in diverse scientific fields, the concept of environment is but the carrier of a «naturalized managerial stance», relegating other-than-human subjects to «mere resources» and nature «to an external field to be governed». Quizhpe Parra (*Beyond the Conventional Notion of the Environment: Care and Management of Nature through* Sumak Kawsay *in Ecuador*) targets the ambiguities of Western environmentalism that perpetrates forms of «developmental reason»: governmental practice which under the banner of a «greener modernity», still dissect the 'living collective' of human and other-than-human-entities reducing them to variables in a calculus aimed at optimizing ecosystem services.

[43] G. Ascione, *Concept Formation in Global Studies: Post-Western Approaches to Critical Human Knowledge*, Rowman & Littlefield, 2024.

The biocentric perspective heralded by the *buen vivir* philosophy seeks to overcome this conventional notion of the environment and its ontological underpinnings by advancing a genuinely relational perspective of 'territory life' (*territorios de vida*[44]): «a relational world in which human and other-than-human beings co-constitute obligations, values, and institutions», a lasting legacy of Latin American indigenous ontologies. In tune with post-development theory, the focus on *territorios de vida* fosters the institutionalization of a distributed conception of agency as well as of rights. This shift was formally recognized in 2008, when the Ecuadorian Constitution incorporated the *buen vivir* philosophy together with the principle that natural entities are subjects of rights – veritable voices inspiring «obligation and reciprocity». Quizhpe Parra takes stance on the harsh debate surrounding the distortion of *buen vivir* following its constitutionalization[45], as it has been appropriated both locally and internationally by «green governmentalities», highly suspect of reproducing «colonial patterns of land control, knowledge extractivism, and sacrifice zones» under the banner of progress and development.

Nonetheless, a subtle thread can be perhaps retraced between this contribution and others in this issue concerning the rejection «of the modern image of one world with many cultural perspectives upon a single nature» in favor of the irreducibly individual, performative enactment of the contextual web of relationships that make out the pluriverse of world-making practices – a 'patchy' view which resonates with other contemporary socio-ecological critical perspectives[46].

If, as I have suggested, the increasing pluralization of the notion of environment has been driven by the breakthrough of its relational interpretation, the exploration of the diversity of its trajectories endorsed by the Naples Symposium may corroborate the view that *relationality* is, by itself, insufficient to legitimize environment as a singular concept. Rather, its «pluralism challenges any effort to reduce environmental thinking into a single narrative or conceptual framework»[47].

There is, however, another – perhaps more important – function that the relational notion of environment appears to have served: namely, that of a heuristic concept, effective in opening up new observational and epistemic spaces, in identifying new forms of agency, cognition, and experience, and even in revealing the diverse epistemic as well as political commitments entailed in its use.

[44] Cfr. A. Escobar, *Territories of Difference: Place, Movements, Life, Redes*, Duke University Press, 2008.

[45] A. Acosta, *Retos, logros y limitaciones del Buen Vivir. Una propuesta con muchas potencialidades*, in «Wirapuru», 2024, 5, 9. <https://www.wirapuru.cl/images/pdf/2024/9/02dossier.pdf>.

[46] A.L. Tsing *et al.*, *Field Guide to the Patchy Anthropocene: The New Nature*, Stanford University Press, 2024.

[47] Etxeberria, *'Environment' as Interdependent Surroundings*, cit.

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## – Introduction. Environment: Trajectories of a Plural Concept

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ABSTRACT
In public discourse, the notion of *environment* is often invoked in the singular, underscoring the call for an integrated approach to anthropogenic environmental change. In the life sciences, however, its usage has become increasingly plural. After illustrating the scope of this pluralization through a series of examples, the text surveys the diverse meanings of *environment* explored in the contributions to the proceedings of the Naples 2024 Symposium *Environment(s). Trajectories of a Concept* (2024). On this basis, it underscores the heuristic value of the current relational understanding of this notion, fostering new trajectories of inquiry and opening fresh observational and epistemic horizons.

KEYWORDS
Environment; Life Sciences; Relationality

SOMMARIO
Nel discorso pubblico, il concetto di *ambiente* è spesso utilizzato al singolare, a sottolineare l'esigenza di un approccio integrato ai cambiamenti ambientali di origine antropica. Nelle scienze della vita, tuttavia, il suo uso è divenuto sempre più plurale. Dopo aver illustrato l'ampiezza di questa pluralizzazione attraverso una serie di esempi, il testo esamina i diversi significati di *ambiente* esplorati nei contributi agli atti del Simposio di Napoli *Environment(s). Trajectories of a Concept* (2024). A patire da questa esplorazione, mette in rilievo il valore euristico della attuale accezione relazionale del concetto di ambiente, e la sua fecondità nell'aprire nuove traiettorie di ricerca e inediti orizzonti osservativi ed epistemici.

PAROLE CHIAVE
Ambiente; Scienze della vita; Relazionalità