

Political ecology of adaptation: claiming a critical biomimicry for the Anthropocene

Nicolás Jiménez¹

Omar Ramírez

Universidad Nacional Abierta y a Distancia, Colombia

Universidad de la Costa, Colombia

Abstract

In this article, the authors appropriate the concept of *adaptation* within the framework of *political ecology*, in order to critically rethink the principle of biomimicry as a strategy capable of contributing to the construction of a sustainable society, in an era plagued by deleterious effects generated by the socioeconomic system. The article uses the concept of «sustainability» as an emancipatory practice not only intricate with environmental issues but mostly with political matters. A *political ecology of adaptation* should allow, then, to understand adaptation in terms of the political commitments involved and the social interests at stake. The authors propose an adaptation criterion that allows *redesigning* the technosphere to harmonize the biophysical processes and social development. These criteria are not only intended to provide solutions to the *design problem*, but also to contribute to overcome unequal geographical development and the cynicism that supports it.

Keywords: Technological adaptation; technosphere; vulnerability; sustainable innovation; political sustainability

Resumé

Dans cet article, les auteurs s'approprient le concept d'*adaptation* dans le cadre de l'*écologie politique* afin de repenser de manière critique le principe du biomimétisme en tant que stratégie susceptible de contribuer à la construction d'une société durable, à une époque marquée par les effets délétères générés par la système socio-économique. Ce manuscrit utilise le concept de «durabilité» comme une pratique émancipatrice non seulement liée aux questions environnementales, mais surtout à des questions politiques. Une *écologie politique de l'adaptation* devrait ainsi nous laisser place à comprendre l'adaptation en termes d'engagements politiques en jeu et d'intérêts sociaux en jeu. Les auteurs proposent donc un critère d'adaptation permettant de *redessiner* la technosphère afin d'harmoniser les processus biophysiques et le développement social. Ces critères ont non seulement pour but de fournir des solutions au *problème de design*, mais également de contribuer à surmonter un développement géographique inégal, ainsi que le cynisme qui le sous-tend.

Mots-clés: Adaptation technologique; technosphère; vulnérabilité; innovation durable; durabilité politique

Resumen

En este artículo los autores se apropian del concepto de *adaptación* en el marco de la *ecología política*, con el propósito de repensar críticamente el principio de biomimesis como una estrategia capaz de contribuir a la construcción de una sociedad sustentable, en una época plagada de efectos adversos generados por el sistema socioeconómico. Se utiliza el concepto de «sostenibilidad» como una práctica emancipatoria, no solo en lo que atañe a problemas medioambientales sino, principalmente, a asuntos políticos. Una *ecología política de la*

¹ Nicolás Jiménez, PhD student in Models and Research Areas in the Social Sciences, University of the Basque Country/Euskal Herria Unibertsitatea. Member of the RI+3 Biomimicry Network and the International Centre of Thought in Environmental Epistemology (NIPEA). Professor at the School of Agricultural, Livestock and Environmental Sciences, UNAD, Tv 31 #12-38 sur, Bogota, Colombia. Email: [nicolas.jimenez "at" unad.edu.co](mailto:nicolas.jimenez@unad.edu.co). Dr. Omar Ramírez, Industrial and Environmental Science and Technology, Professor at the Department of Civil and Environmental, Universidad de la Costa, Calle 58 #55-66, 080002 Barranquilla, Colombia. Email: [omarjrh "at" yahoo.com](mailto:omarjrh@yahoo.com). Thankyou to referees and editors.

adaptación debería permitir, entonces, comprender la adaptación en términos de los compromisos políticos involucrados y los intereses sociales en juego. Así, los autores proponen un criterio de adaptación que permita *rediseñar* la tecnosfera para armonizar los procesos biofísicos con el desarrollo social. Estos criterios no solo están orientados a proporcionar soluciones al *problema del diseño*, sino también deben contribuir a superar el desarrollo geográfico desigual y el cinismo que lo sustenta.

Palabras clave: Adaptación tecnológica; tecnósfera; vulnerabilidad; innovación sustentable; sustentabilidad política

1. Introduction

The predominant social response to global phenomena such as climate change (at an institutional, corporate and state level) tends to reproduce socioeconomic concepts and methodologies that, paradoxically, have originated and encouraged these problems. Modern society has rampantly transited along unknown paths under the guidance of a developmentalist discourse which has meant that our relationship with the environment must be mediated through a mechanistic perspective. This has imprinted deep scars on territories and created the conditions of what is now known as the *Anthropocene*.

The Anthropocene, beyond encouraging entertaining and interesting academic discussions, is a concept that alerts us to the way in which we are intervening, transforming, occupying, and shaping territories. The adverse ecological, economic and health effects that we are currently facing cannot be attributed to metaphysical forces nor can they be justified by religious explanations, since they are directly associated with anthropogenic causes. Therefore, those in the political, social and economic spheres must recognize their responsibility both as originators of contemporary problems and as agents of their solution. This does not mean that the alternatives must arise from hegemonic political and economic actors and institutions. On the contrary, it indicates that the definition of the route to follow requires broad political debates, including adjustments to the current economic model.

Climate change, like so many other large-scale environmental concerns, requires critical self-reflection about the state of society and the roads traveled as a civilization. This entails, inevitably, implementing actions to reduce and control the imminent, catastrophic, and sometimes irreversible, scenarios of the Anthropocene. Nowadays, these actions are grouped by the broad term, *adaptation*. This concept recognizes the existence of biophysical changes associated with deep social and ecological impacts to which society must adapt in order to reduce their levels of vulnerability. This process of adaptation does not refer to simple technological adjustments. It involves process of learning from the mistakes made, which entails moving away from short-term economic perspectives and rejecting those cosmetic solutions that, under simplistic views, elude the complexity of reality. Therefore, it is not surprising that the adaptation strategies that have received greater political and economic incentives in recent years, are limited to promoting exclusively technological interventions.

In this article we appropriate the concept of *adaptation* within the framework of *political ecology*. This is in order to critically rethink the principle of biomimicry as a strategy capable of contributing to the construction of a sustainable society, in an era plagued by deleterious effects generated by the socioeconomic system. Sustainability, in this case, is understood as an emancipatory practice that includes ecological, economic, technological, energetic, cultural and, most notably, political systems. Thus, the denomination *political ecology of adaptation* allows for an understanding of adaptation processes in terms of the political commitments that promote them and the social interests that guide their planning, organization and legitimacy in development projects.

From a different perspective to that of *genomic adaptation* (Leff 2014), *elitist adaptation* (Cano 2017) and *technocratic or business adaptation* (Taylor 2015), the authors propose adaptation criteria that allow *redesigning* the technosphere to harmonize the biophysical processes and social development. These criteria are not only intended to provide solutions to the *design problem* (i.e. the mismatch of the social metabolism), but also to contribute to overcoming unequal geographical development and the cynicism with which the Anthropocene is being viewed.

This article questions the interests of the dominant processes of adaptation, denouncing the instrumental and corporate logic of capitalism that stimulates a social metabolism that permanently ignores ecological limits. This means recognizing the historical responsibility of anthropogenic interventions, which does not mean delegating this responsibility to the totality of the human species. At the conclusion of the article, some ideas are presented to illustrate an alternative approach to biomimicry within the framework of the political ecology of adaptation. To conclude, we highlight the relevance of reorienting adaptive actions to minimize environmental degradation and redesigning the technosphere based on principles of social and ecological justice.

2. Anthropocene: what is at stake

At the beginning of the 21st century, Paul Crutzen (Dutch climatologist and winner of the Nobel Prize in Chemistry) introduced, in a discussion of the Scientific Committee of the International Geosphere-Biosphere Programme (IGBP), a term to define our era: the Anthropocene.² The concept emerged with the purpose of explaining the biophysical transformations that the planet has been experiencing through anthropogenic activities. Although its scientific status as a geological epoch is under debate, the Anthropocene has functioned as a catalyst for discussions on the scope and scale of the impacts generated by the human species on Earth (Brondizio and Syvitski 2016; Crutzen and Stoermer 2000).

The Anthropocene states that "human activities were affecting the environment at the global scale" (Steffen *et al.* 2007: 616). According to this definition, human beings have become such a powerful force on the planet that we are generating very profound alterations, even at the geological level. Steffen *et al.* (2007) warn, in this sense, that we are being pushed into a kind of *terra incognita*. Environmental risks are increasing, which implies greater ecosystem vulnerability and, consequently, the proliferation of disasters. We have deeply altered our vital spaces and, if we do not change our strategy, then human survival, as well as that of other species, will be seriously compromised.

The IGBP published a report on *Global change and the Earth system* in 2004 (Steffen *et al.* 2004). The report describes the planet as a self-regulated system, composed of subsystems, where the biosphere³ fulfills primordial functions. This systemic perspective (Odum 1953; von Bertalanffy 1969) has generated significant changes in the way we analyze our interactions with the non-human world and has highlighted a central idea: we live on a living planet of which we are a part. This was acknowledged long ago by several ancestral peoples who named the planet *Pacha Mama* (Valencia 1999) and *Mother Earth* (Wermus 2002). Authors such as Capra (1996) and Lovelock (2007) have proposed similar concepts such as *The Web of Life* and *The Gaia hypothesis*, respectively.

Although the biosphere has great resilience, even when the loss of biodiversity is significantly high, anthropogenic impacts are gravely threatening its stability (Zalasiewicz *et al.* 2015). The predominance of a mechanistic view of the world, which theoretically reduced the complexity of the planet, is partly to blame. Whitehead (1978) identified the triumph of this vision in the conceptual separation between a *physical world* and a *living world*. From this perspective, nature and all its organisms become *available objects*. In the words of Horkheimer and Adorno (2002: 2), "What human beings seek to learn from nature is how to use it to dominate wholly both it and human beings". Thus, knowledge becomes a mechanism of power and social control that mediates the exchange processes between humans and nature.

One of the adverse results of the predominance of a mechanistic view is the expansion (spatial dimension) and the intensification (temporal dimension) of the ecological alterations. These surpass the capacity of recovery of the biosphere, as Latour affirms (2017: Kindle version):

² This term was previously used in the 20th century by Soviet geologist Aleksei Petrovich Pavlov in 1922, and by American marine biologist Eugene Stoermer in 1980 (Angus 2016). Nonetheless, the concept was strongly positioned only with Crutzen. To date, books, articles, novels and even musical pieces about the Anthropocene have been published.

³ Vladimir Vernadsky (1998) used this term to refer to the surface of the Earth where life is produced. This includes the lithosphere, hydrosphere and troposphere.

It doesn't stop; every morning it begins all over again. One day, it's rising water levels; the next, it's soil erosion; by evening, it's the glaciers melting faster and faster; on the 8 p.m. news, between two reports on war crimes, we learn that thousands of species are about to disappear before they have even been properly identified. Every month, the measurements of carbon dioxide in the atmosphere are even worse than the unemployment statistics. Every year, we are told that it is the hottest since the first weather recording stations were set up; sea levels keep on rising; the coastline is increasingly threatened by spring storms; as for the ocean, every new study finds it more acidic than before.

To explain these events, which are a set of exchanges between the human species and nature, we use the concept of *metabolism*. It refers to the social appropriation of matter and energy that is subsequently deposited as waste in natural spaces (Toledo 2013). This is an exchange circuit that has its own rhythms, intensities and particular contents depending on the time and space in which it is developed. This exchange, now known as *social metabolism*, is determined by the levels of spatial transformation, human needs, social relations of production and the ways in which nature is *produced* (Toledo 2013).

In this way, the current ecological footprint of the human being is not an invariable indicator, let alone a process reduced to a natural stimulus. It is, according to Moore (2014), the result of a particular way of *producing* nature and *producing* ourselves as a species. Thus, the process of appropriation of matter and energy of nature (input) and its subsequent deposition in natural spaces in the form of waste (output) is determined, according to Toledo (2013: 51), by "institutions, forms of knowledge, worldviews, rules and agreements, technological knowledge, modes of communication and governments, and forms of ownership" (our translation). This appropriation can occur in three ways: a) without producing substantial changes in ecosystems, b) "disarticulating" or "disrupting" ecosystems, and c) conserving ecosystems to protect several species and natural patterns or processes (Toledo 2013: 55-56). The second form of appropriation is the one that defines most of our contemporary society. The socio-economic systems we have designed have never before been as disjointed from the biosphere as they are today. Riechmann (2006) observed this problem and formulated it in terms of a *poorly designed technosphere*.

At this time, it is pertinent to present a clarification: when we mention the society/nature dichotomy to problematize the current ecological situation, we are not affirming that the human species is *outside* of nature. On the contrary, we are active agents *embedded* in a system or web of life. The concept of metabolism is related to this perspective, since it is a biological concept that refers to the internal processes of a living organism (Fischer-Kowalski and Haberl 2000). Therefore, it is important to consider the implications of pretending to separate the human species from the Earth system. In the book entitled, *Foundations of the critique of political economy (Grundrisse)*, Marx (1973: 489) identified this problem in the following way,

It is not the *unity* of the living and active humanity with the natural, inorganic conditions of their metabolic exchange with nature, and hence their appropriation of nature, which requires explanation or is the result of a historic process, but rather the *separation* between these inorganic conditions of human existence and this active existence, a separation which is completely posited only in the relation of wage labour and capital.

We went from a relatively organic metabolism to a techno-industrial metabolism in a very short time, generating notorious and relevant impacts on the biosphere (Hamilton and Grinevald 2015). This type of metabolism is based on the techno-scientific paradigm and imposes important challenges for the sustainability of society (Riechmann 2006). As McKenzie Wark states, the Anthropocene is not only a particular form of metabolism, but a set of *metabolic rifts*, "where one molecule after another is extracted by labor and technique to make things for humans, but the waste products don't return so that the cycle can renew itself" (Wark 2015: Kindle version).

This is precisely how we need to think about the Anthropocene: *rift* process generated by the social metabolism that we have adopted and that advances violently against the ecological frontiers. This forces us to

build strategies to adapt to the ecological dynamics, in order to reinsert our systems *into* them. But also *adjust* those ecological frontiers to *our interests* as constitutive elements of the biosphere (Jiménez and Ramírez 2016). The human species must not only adapt to its environment, the latter also fits us in the process of life⁴.

What is at stake is not our ability to "alter nature", as suggested by concepts such as *Gaia* and *Web of life*. What really demands our attention are the *social interests* that promote, sustain and perpetuate the contemporary metabolism, as well as its materialization in the construction of the technosphere. Bruno Latour exposes this problem in a simple way: "every organism intentionally manipulates what surrounds it «in its own interest» – the whole problem, of course, lies in defining that interest" (Latour 2017: Kindle version). Ecosystems are also produced by the organisms that inhabit them and, in this order of ideas, there is no transcendent ecological structure that imposes an absolute criterion of adaptation, especially when dealing with human systems.

If the Anthropocene is a result of the systems we have designed and the interests that inspire them, how should a technosphere to slow down metabolic rift in favor of a sustainable social metabolism be redesigned? What theory is the most appropriate in order to carry out this goal? What type of *epistemological rift* should we promote to counteract the proliferation of harmful metabolic rifts for the support of life on the planet? What principles guide the way we socially appropriate nature? These questions are what give meaning to a *political ecology of adaptation*. As we stated in another article, "addressing the problem of adaptation from political ecology is crucial because it introduces a contingency factor, according to which levels of environmental degradation can be accentuated or minimized in relation to the social interests that guide adaptation strategies" (Jiménez and Ramírez 2017: 58, our translation).

This contingency factor not only highlights the *historical characteristic* of environmental degradation, it also reveals the *power relations* that produce it. Those of us who are committed to political ecology cannot accept, as the Anthropocene suggests, that the responsibility for this crisis falls on the totality of the human species. As indicated by Carril *et al.* (2017: 4): "behind the ontological revelation of the Anthropocene concept [of *all* being responsible] there seems to be a deception, an intentional tissue in language that constructs a reality adapted through the transformation of a concept into a discourse" (our translation).

Following this argument, and before addressing the question of the technosphere in light of the political ecology of adaptation and the concept of biomimicry, we want to make a brief comment on the validity of what the German philosopher Ernst Bloch called the *principle of hope*. Today it is essential to believe once more in the possibility of building a social order that claims social and ecological justice. In other words, it is necessary to recover the hope that it is possible to build diverse collective projects, capable of modifying the current social metabolism in a concrete way.

3. Cynicism or hope?

Corruptio optimi pessima: fraudulent hope is one of the greatest malefactors, even enervators, of the human race, concretely genuine hope its most dedicated benefactor.
Ernst Bloch, *The principle of hope* (1995)

In the dystopian novel *1984*, George Orwell describes a society characterized by a form of *conscious deception* that consists of thinking, at the same time, about two contradictory opinions. This form of self-deception, unlike the *false conscience* where the subject acts *without knowing* what it is doing, proceeds in the opposite way, since the subject denies "the existence of objective reality and all the while to take account of the reality which one denies" (Orwell 1961: Kindle version). In his *Critique of cynical reason*, Sloterdijk (2013) discusses a similar process. According to the German philosopher, *ideology* does not have the form of false consciousness, but of a cynical reaction where the subject is fully aware of being falsifying reality. As Žižek

⁴ The concept of "nature" usually refers to that which is contrary to "culture" or "human." This definition is common in the conservationist and preservationist environmentalist circles of the early twentieth century.

points out, "one knows the falsehood very well, one is well aware of a particular interest hidden behind an ideological universality, but still one does not renounce it" (2008: 26).

ExxonMobil is an example of this cynicism. Being one of the largest and most powerful oil companies in the world, it has spent more than twenty-eight years financing think tanks with the purpose of refuting and delegitimizing climate change. If this company did not know that climate change is a reality, it would not allocate so much time and resources to deny it. Lenny Bernstein, who worked for the company for thirty years, stated that "Exxon knew, years earlier [1981], that climate change was a reality; that it accepted the reality, instead of denying the reality as they have done publicly" (Johnston 2015).

There are also those who take cynicism even further. It is not a coincidence that the most powerful economic sectors in the world, which previously rejected environmental problems, are today the main promoters of *sustainable development*. For the World Bank, for example, climate change may have been an uncomfortable burden, but today it is a *development opportunity*. The moments of financial, social and environmental crisis become opportunities to promote innovative processes of economic growth (Smith 2007; The World Bank 2013).

In *The shock doctrine: the rise of disaster capitalism*, Naomi Klein uses the following observation by Milton Friedman to explain how the dominant sectors of the world economy take advantage of moments of crisis to impose their ideology: "only a crisis—actual or perceived", Friedman observes, "produces real change [in order to] develop alternatives to existing policies, to keep them alive and available until the politically impossible becomes politically inevitable" (Klein 2007: 6). The shock, or the crisis, produces *malleable moments* that capitalism uses to impose its ideas on "a clean sheet of paper" in which the world can be reconstructed in its image and likeness. "It is in these malleable moments", Klein points out, "that these artists of the real plunge in their hands and begin their work of remaking the world" (Klein 2007: 21). Thus, the *production* of nature is determined by these mechanisms.

We are living in a naïve era of *perilous optimism* where there seems to be no physical limitations for economic growth insofar as the only problem of scarcity that we have to face is that of *human intelligence*. Although optimism has no factual validity, neither today nor fifty years ago, it is the ideological paradigm that has been imposed on political and economic decisions for decades (Partridge 2001).

There is no alternative is a neoliberal mantra that saturates social reality. It is permanently updated to keep alive the myth of economic growth and to hinder the construction of models different from that of capitalism. If this myth did not have a real impact on the social metabolism, we would not have to worry about it. Will we let cynicism and a false naïve optimism continue to define the destiny of the planet? Do we not have the responsibility to maintain the hope of another possible future and affirm that there are alternatives?

4. Political ecology: redesigning the technosphere

We have the challenge of confronting denialism and what Leff (2014) called *genomic adaptationism*. This is with the purpose of opening the field to other social agreements about the way that we want to live. Unfortunately, and despite the scientific evidence showing the biophysical limits of the planet, the premise of "unlimited" economic growth continues to guide the rhythm of social metabolism in our time. The current economic model operates *without knowing* that it is a subsystem of the finite natural system. Despite the advances made in the natural sciences during the last sixty years, what we know about nature is still limited. We have used nature to exploit, dominate and destroy, but also to justify selfishness and to build unjust and unequal societies (Singer 2000). Feyerabend (1987), in his book *Farewell to reason*, points out that the task of knowledge today has to be a function of the survival of living beings, and of peace among human beings and between them and the whole of nature. This imposes the challenge of disputing both a project of society that allows us to restructure our metabolic relationships, as the same concept of sustainability, which should act as a guide for our interventions.

In this sense, political ecology (as a multidimensional field of social action) understands the theoretical and practical importance of the concrete experiences of social movements and individuals in the search to transform reality. David Harvey uses the figure of the *insurgent architect* to explain the subject of that transformation. According to the English geographer and anthropologist,

...the architect struggles to open spaces for new possibilities, for future forms of social life... [in] a world full of contradictions, of multiple positionalities, of necessary flights of the imagination translated into diverse fields of action, of uneven geographical developments, and of highly contested meanings and aspirations. (Harvey 2000: 200, 233)

Thus, social leaders like Mariátegui, Chico Mendes and Berta Cáceres (just a few examples from Latin America) are architects in that precise sense. Their lives were the result of very unjust concrete circumstances, against which they responded with a critical and transforming vocation. The *Inca Ayllu*, the need to guide progress without destruction and the call to build societies capable of coexisting in a just and dignified way, can be interpreted as architectural efforts to *redesign poorly designed technologies*.

These concrete experiences are the reason why some authors affirm that political ecology is characterized more by assumed commitments, than by its object of study or by the socio-spatial criteria with which it operates. According to Perreault *et al.* (2015: 7-8) there are three such commitments that characterize political ecology:

- a) A *theoretical commitment* to social critical theory and post-positivist theory, from which diverse ways of apprehending and constructing nature are approached using different schemes of knowledge and social organization.
- b) A *methodological commitment* to qualitative research, direct observation and participatory action research, without neglecting quantitative methods and document analysis.
- c) A *political commitment* to socio-environmental justice and structural political transformation. Political ecology has an explicit normative character that tries to understand socio-environmental and ecological-distributive conflicts, and the struggles of marginalized and excluded people.

In this sense, paraphrasing Marx, political ecology not only seeks to understand the world, but to transform it.

5. Towards a political ecology of biomimicry

One of the four laws of ecology proposed by Commoner (2014) is that *nature knows how to do things better*. Under this conceptual referent, a field of knowledge has been strongly positioned in recent years, that intends to incorporate teachings "extracted" from nature in different fields of design. This *science*⁵ is known by the name of biomimicry.

Biomimicry seeks, in general terms, to study the models of nature, to imitate them and apply them in social contexts to solve human problems (Benyus 1997). In the nineties, biomimicry was associated with robotics, contributing significantly to the construction of devices and machines responsible for developing specific functions. Over time, interest in this discipline was extended to different fields of applied science such as the improvement of materials (Tatman *et al.* 2015), mobility from the optimization of motion kinetics and energy efficiency (Lurie 2014), architectural design (Zari 2010), marine hydrodynamics (Chu 2016), and tissue engineering (Fernandez-Yague *et al.* 2015), among others.

Authors such as Benyus (1997), Commoner (1990) and Riechmann (2006) have insisted on the importance of learning from nature to incorporate principles that lead to a more efficient and sustainable adaptation of human systems. The interpretation of nature as a *model* is the starting point. From this idea, useful information is obtained which can be applied to *human designs*, with the purpose of problem-solving. Our approach in this article is that not all designs that apply the principle of biomimicry are necessarily sustainable or lead to transformative practices of the current metabolism. This is explained by the fact that some biomimetic

⁵ Janine Benyus (1997) refers to biomimicry as a science. However, it is a very debatable claim, and we prefer to understand it as a *field*, a *strategy* or a *principle of action*.

designs are oriented towards economic efficiency and, therefore, operate under the logic of the market economy, without questioning the interests that support the unsustainability of the Anthropocene era.

6. *Terra incognita or terra economica?*

How is nature built *from* biomimicry? The book *Biomimicry is innovation inspired by nature*, by Janine Benyus, is a representative work in the biomimicry field. In this book, Benyus (1997) questions the instrumental logic of nature and proposes that, instead of thinking about what we can *extract* from it, let us think about what we can *learn* from it. Some consider that it is a revolutionary book, since it "fires the imagination with the exciting possibility of taking the best designs from nature's storehouse of invention and applying them to the challenge of building a sustainable and creative future" (Cited in Benyus 1997: Kindle edition).

This means understanding nature as a *model*, a *measure* and a *mentor*. We can extract practical knowledge of ecosystems and living organisms that allow us to solve human problems. This is a practice that has always accompanied humanity in one way or another. What Benyus proposes, however, is the conscious appropriation of this principle in order to *turn the economy green*: "In effect, [biomimicry] could give Adam Smith's invisible hand of capitalism a green thumb" (Benyus 1997: Kindle edition).

This perspective coincides with the projections that international cooperation agencies make in relation to new technologies. The Green Growth Strategy of the Organization for Economic Co-operation and Development (OECD), for example, incorporates biomimicry and biotechnology as useful instruments to debug environmental degradation processes derived from economic growth (OECD 2001). They argue that a *change of technological and productive paradigm*, inspired by natural processes, is necessary. According to the OECD, biomimicry is "the name coined for this approach in which industrial production systems imitate nature" (OECD 2001: 10). From this viewpoint, biomimicry seeks to build a green industry to obtain benefits from nature, without destroying it (Goldstein and Johnson 2015).

Like the bioeconomy, biomimicry is optimistic about the solutions that the market economy offers to environmental problems. Since the 1990s, biomimicry has positioned itself as an instrument of green innovation that responds to the need to produce new sources of economic wealth, while promoting environmental awareness. The levels of productivity achieved with biomimicry, in various sectors of industry, are remarkable. The organization led by Benyus, *Biomimicry 3.8*, is an example of the profitability that can be achieved by imitating nature.⁶ In the framework of a market economy, where business competitiveness and property rights over nature prevail, this organization is responsible for identifying biological processes that serve as inspiration for their profitable projects. Thus, biomimicry is part of the logic of economic productivity.

From this perspective, nature provides us with new knowledge and materials, in such a way that innovative inputs emerge, and new designs are obtained. However, in a commercial logic and an accelerated social metabolism, these events recreate the processes of location of nature, giving rise to new instrumentalization techniques. In this way, environmental sustainability is subordinated to the designs of economic development (OECD 2001). Bennett and Smith (2015), consultants in strategic design, point out that biomimicry offers a strategic advantage in the design, research and development of sustainable products. That is to say, biomimicry is impacting a multitude of industries and is expanding markets around the world.

In this case, we could say that *biomimicry is a strategy of capital accumulation*. According to Neil Smith (2007: 26):

The market has now retaken and recolonized environmental practices. Bitter mutual antagonism [nature/capital] is replaced by financial partnership: "what's kind to nature" is also "kind to profits" ... the commodification and financialization of nature "all the way down" marks the new phase of the production of nature.

⁶ <https://biomimicry.net/>

We could also say that biomimicry subordinates all processes of research and production of knowledge to a business logic, taking nature as a source of immaterial and unlimited inspiration. Access to nature, understood as the appropriation of a set of knowledge that can potentially be transformed into capital, depends on the success of its process of intellectual privatization. Goldstein and Johnson (2015: 76) warn that any "promise that biomimetic production will constitute more 'symbiotic relationships, much more mutualism, [and] much more cooperation' seem unlikely as biomimetic processes and products are enclosed and deployed as private property" (Goldstein and Johnson 2015: 76).

The biomimetic industry is becoming a factor of economic change when combining biological knowledge with commercial engineering. In 2010, the San Diego Zoo Global published a report in which they pointed out that, starting in 2025, the field of biomimicry could make up around US\$300 billion per year of the United States' GDP (San Diego Zoo Global 2010).

Corporate biomimicry, therefore, is part of the assumption that economic growth and environmental sustainability are not contradictory. From this point of view, biomimicry is part of the techno-industrial metabolism to which we referred earlier. Instead of introducing principles that reduce the material and immaterial metabolism of our societies, biomimicry deepens it by creating "new natures" susceptible of being exploited and privatized through *novel, innovative* and *creative* forms.

Biomimicry seeks to increase profitability and, paradoxically, help improve the environment. However, what is truly paradoxical is that the opposition between economic growth and sustainability seems to have been diluted. *Human naivety* works very well, either to deny or affirm human problems. Nowadays, environmental concerns are not a problem for the establishment. On the contrary, they represent a factor of growth and profitable accumulation of capital. Capitalism adapts to the crises that it produces, that is why the so-called environmental crisis represents a new domain of economic investment.

Thus, Goldstein (2012) argues that the *nature produced* by biomimicry is configured as a *terra economica* always available to be used as a commodity. Perhaps the *terra incognita* towards which human activities drive us is not so unknown after all. We have spent more than five centuries under the logic of the *economization of the world* (Leff 2005), from which we have not yet liberated ourselves, but we know it very well.

7. As a corollary: biomimicry as an adaptation strategy

There is an unquestionable contradiction between the application of biomimicry that we discussed earlier and the idea of environmental sustainability. As Jesse Goldstein and Elizabeth Johnson affirm, "In practice, biomimicry conscripts a more-than-human world into the business of economic and social development, making life's continuation entangled with capital's expansion" (Goldstein and Johnson 2015: 76). While biomimicry works under the prevailing economic logic, it cannot contribute significantly to the construction of a sustainable technosphere.

Learning from nature to do business does not contribute, in any way, to producing a sustainable social metabolism. Nonetheless, there are other perspectives from which we can apply this principle. Indeed, Lewis Mumford (1955) and Barry Commoner (1990), and more recently, Jorge Riechmann (2006) and Jesse Goldstein (2012), have suggested another interpretation. These biologists, sociologists, ecologists and philosophers, mostly influenced by Marxist theory, have pointed out the importance of *imitating* nature when it comes to rebuilding human systems. The *life-centered economy* proposed by Mumford (1955) is a clear example of this.

Given the emergence of the Anthropocene as a new geological period, not yet confirmed, but for now a very suggestive sociological concept, it is necessary to rethink the criteria from which we are *making* the world. Political ecology can guide us in the task of channeling biomimicry as a strategy to *(re)make* the world under a criterion of sustainability that understands and reconciles the ecological functioning of the planet.

The binomial *bio-mimicry* refers to life or nature, *bios*, and to the action of imitating, *mimicry*. What should be noted is that both concepts are determined historically and socially. With this we are not suggesting that nature is a social construct lacking objective reality. What we are pointing out is that society, being immersed *in* nature, interacts permanently in it, physically and conceptually altering the other elements that comprise it. Thus, for us as a human species, "nature" does not always mean the same thing. Its meaning depends

on the social context, power relations, the dominant scientific paradigm, and the social relations of production, among other aspects.

In light of this, it is relevant to problematize the concept of "nature" constructed from corporate biomimicry, since it permits the questioning of the ideological, epistemological and political matrix that gives it meaning. "Nature", as a *terra economica* or *bank of ideas*, is subject to certain logics "whose fertile potential ends up being materialized in a procedural system of design and innovation to be introduced, later, within the competitive logic of the market" (Sierra and Kuiru 2014: 92, our translation). The *design* of the technosphere is subordinated to the ways in which nature is constructed and systematized and to the power relations that sustain and promote them. The dominant explanations about the relationship between society and nature have a political character that is almost always hidden beneath a supposed "neutrality."

The so-called environmental crisis is the symptom of political contradictions that cannot be easily observed and, for that reason, are frequently ignored. The possibility of effectively overcoming the contemporary environmental crisis depends on how we identify and question the *powers* that lie behind the supposed "consensus" that we have reached as a society. Therefore, the principle of biomimicry can play an important role, no longer in terms of the processes of capital accumulation, but in the construction of a truly sustainable economy. The *alternative rationality* of Mariátegui (Quijano 1994), for example, invites us to claim more organic economies that serve as a model to build human systems adapted to ecological conditions and existing social, political and ethical challenges.

On the other hand, it is necessary to rethink the methodology from which corporate biomimicry operates, focused on extracting knowledge from nature to make it functional to the interests of the chrematistic economy. Orienting the results of biomimicry to a collective social objective depends on the methods with which reality is addressed and the purposes that guide the research. Without a methodological commitment to understand the complexity of the symbiotic relationships between society and nature, identifying their tensions, contradictions and contingencies, our perspective will continue to be inscribed in mere economic instrumentalization (Jiménez and Ramírez 2016; 2019).

Corporate biomimicry does not lead to new political practices. On the contrary, it intensifies the violence of the existing ones. Sustainability requires a renewal of the political practices that allow us to dispute other sustainability projects based on an understanding of metabolism and a characterization of reality that takes into account its complexity. It must be recognized that environmental deterioration is the cause and effect of political conflicts. But they also inspire interpretative frameworks of nature and orient structural designs that drive metabolic processes with the potential to produce qualitative changes in nature.

This places us in the definition that Riechmann (2006: 201) gives of biomimicry as "a strategy of *reintegration of human systems within natural systems*" (our translation), to adjust the former to the conditions of the Earth system and thus ecologically reconstruct the economy. This assumes a deep reflection on what kind of actions we have to carry out to generate this process of adjustment and reinsertion.

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