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Synthetic Biology - Cultural and Anthropological Perspectives

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Abstract: This article aims to make an analysis of the cultural and anthropological issues raised by synthetic biology. The novelty of the field makes it relatively difficult to compose a comprehensive analysis, even for philosophers with experience, but who are not familiar with the specifics of the field. The article will follow the synthesis of the models of ethical decision applicable in the field of ethical evaluation of technologies from a cultural and anthropological perspective, their critical analysis and will highlight the limitations of each model, as well as a possible synthesis of a model of ethical evaluation of technologies. Afterwords, it can be decided whether a particular technology - such as those involved in synthetic biology - poses risks to the environment, to those involved in research, to future generations (including humans, but not only), to humanity as a whole or to present or future ecosystems.

Keywords: *synthetic biology, cultural perspective, anthropological perspective.*

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Introduction

The emergence of synthetic biology gives humanity a demiurgic role due to its ability to probe into, but also to change the deep structures of life - or the " biobricks", as they are called. The creation of life is a unique moment of "self-empowerment" of humanity over nature and as such, a new anthropology will gradually take its place, starting from the symbolic deification of the researcher who, like the magician, operates - apparently at will - with the deep structures of nature, subjecting it to his will. The "magic" substance in this situation is knowledge - but not the theoretical knowledge itself, in the sense of an ancient episteme, but especially the practical knowledge, that is, the techne, as this knowledge was called by the ancient Greeks.

The cultural perspective on synthetic biology can be reduced to the idea of a philosophy of a culture of the unnatural. We are not talking about a culture of the artificial or the artifact in the postmodern sense of the terms, but rather the artifact of nature, by intervening on its constituent elements, not only in the sense of their transformation, but also of their appropriation as a noetic and cultural product.

The idea of nature as a cultural product, where by culture we mean technology, is a radical change in the philosophy of culture, due to the dissolution of the border between natural and cultural. Nature becomes culture in the truest sense and, as such, its very constituent elements, genes, become the objects of intellectual property.

I. The anthropological perspective on synthetic biology

I.1. Synthetic biology as a spiritual marker of the Anthropocene

The term Anthropocene (Wodak, 2020) is used in the current philosophical literature (Stanford Encyclopedia of Philosophy, 2018) with reference to the current geological age, seen as the period in which human activity was the dominant influence on climate and the environment. By analogy, synthetic biology is considered by us as a marker of the Anthropocene, because it extends the dominant influence of humans on the biological in its deepest sense, to the level of the constituent elements of living things - cells and genes - that it reconstructs in shapes and varieties designed by the researchers who make them (Eisenhaber et al., 2022). Their need and continuity with existing biodiversity is questionable - both ontologically and ethically.

Synthetic biology can pose a direct threat to ecosystems, to the point of extinction that could result in the genetic superiority of synthetic

biological entities over natural ones, with which it then competes for survival and resources, once synthetic entities are introduced into the natural environment. This structural threat to nature is not, in our opinion, more serious than that of other anthropocene markers, such as pollution, destruction of the natural habitats of various species, nuclear technology etc.

However, the other markers mentioned above are ultimately controllable by a benevolent humanity, and it is up to the species and human intelligence to create environmental policies that preserve biodiversity, limit the use of polluting technologies and replace them with clean technologies, limiting the risks of nuclear catastrophes etc. Of course, current trends in environmental destruction / pollution are still a negative balance between environmental conservation and pollution reduction, but these measures are - at least in part - under human control, even if they have far exceeded the capacity for a natural regeneration of biodiversity.

In the case of syn-biotic entities, they act directly at the level of ecosystems and, even if in the initial phase they are programmed with certain biological characteristics – a certain resistance level, service life etc. -, they can undergo genetic mutations in their natural development, becoming a species distinct from the synthetic one that was created, possibly stronger than their natural competitors, which they will displace from the ecosystem. The natural balance can thus be disturbed, in an uncontrollable and undesirable way.

The ethical and legal concern that arises both within states and also in socially responsible and conscious corporations is to ensure that the application of a new technology - such as those associated with biological materials - does not turn products into biological hazards. There are a number of studies (Cullet, 2006) looking at the impact of introducing genetically modified plants and animals into the environment as well as the potential dangers of human consumption of genetically modified foods (Saukshmya & Chugh, 2010). Saukshmya and Chugh point out that the reasons why ethical and legal reflection should focus on regulations and guidelines governing the work of this industry are the potential for such organisms to become biological hazards, as control over their behavior and functions ceases after their release into the environment. These organisms can exploit their innate ability to actively interact with pre-existing wildlife in the wild once they are introduced into the environment (Saukshmya & Chugh, 2010). This mixing, known as 'accidental presence', generally refers to the unintentional presence of genes, traits or seeds in a crop or other consumable materials (Nordlee et al., 1996).

Given previous experiences with genetically modified organisms that were subsequently released into the wild and that transmitted parts of their genome to natural organisms in that environment through hybridization processes, concerns about organisms and biological systems developed by synthetic biology become obvious. These artificially created organisms are new and substantially different from those that exist in nature, but they still retain their ability to self-replicate and evolve, being subjected to environmental as well as genetic pressure. As such, even if these organisms did not occur naturally through evolution, thus partially evading this law and the environmental adaptations required by it, their evasion of the requirements of the law of natural evolution ceases with their release into the environment and the evolutionary benefits will continue to spead for future generations. Of course, these reflections on the evasion of the law of natural evolution (Sandu, 2020) may also be valid in the case of genetic editing of human beings, when such processes create improved human beings, by changing natural evolutionary relationships and introducing the risk of bioenhancement to future generations.

I.2. Syn-biotic organisms and the issue of regulating their existence

Although the research undertaken by Craig Venter (Venter, 2022) and his team aimed to create living systems from non-living biological materials and their parts / components, syn-biotic organisms do not always have to be built from scratch, and genetic fragments can be used in their construction. They can be designed by combining genetic elements and assembled from nucleic acids or separate genomic components that together form a new living strain.

This raises a new dilemma, because such organisms could express properties arising from complex interactions between constitutive genes and which, because they do not exist in nature, could not be previously studied and as such are not known. Consequently, the risks associated with the accidental or deliberate release of such organisms into the environment are extremely difficult to assess, including their possible spread in new ecological niches leading to the evolution of new potentially harmful characteristics (Central Intelligence Agency, 2003).

Other concerns that have been raised and that require ethical and legal regulation are bioterrorism or the malicious use of such products - either through synthetic biology or through genetic engineering itself. For example, in 2020, there were rumors that the Covid-19 virus was in fact such a product of genetic engineering or synthetic biology, whether intentionally or unintentionally permitted to escape from the genetic laboratories in

Wuhan, where indeed samples of the most virulent known pathogens are kept and whose biosecurity conditions have cast doubt. Such allegations concerning the voluntary spread of the virus or at least negligence in its handling, followed by a deliberate failure to communicate to the international community the risks and extent of the pandemic, lead to the fact that accusations were formulated against China by the U.S. and the international community since 2020 (Sands et al., 2020).

Despite concerns by the international community about limiting possible misuse, including in the field of bioterrorism, of products obtained from synthetic biology, the level of awareness of these risks and the existing social responsibility among researchers working in this field is low - or at least, not at the level at which this particular scientific community is expected to be. A lack of reflection and awareness of the social acceptability of such technologies in the general public is also highlighted by researchers in studies on public perceptions of synthetic biology (Pauwels, 2013).

I.3. Between techno-optimism and techno-pessimism in the anthropology of synthetic biology

Josh Wodak criticizes the opinion of techno-optimists - as is the case with E. O. Wilson (Wilson, 2003), who believes that there is currently competition between technologies that adversely affect the environment and those that restore biodiversity, with synthetic biology being among those that can sustainably promote biodiversity. Wodak points out that a number of technologies, such as synthetic biology, act not only on the environment but also on the evolutionary mechanisms themselves (Wodak, 2020). The author is upset about the positive effects that human intervention, aimed at conserving endangered species, has on nature at a time when it has entered into an era of mass extinction of species (man-induced), based on genetic interventions and other forms of active intervention in the evolutionary processes, for the conservation of species whose genetic background and natural habitats are degraded to the point of lack of viability by human intervention in the ecosystems in which these species exist.

Basically, attempts to conserve some species by innovative biological pathways - such as genetic engineering, synthetic biology etc. -, we question not only the viability of those species but also of the whole ecosystem, which thus becomes anthropodependent. Processes such as desertification, accelerated deforestation of large areas, with major bioclimatic effects, the expansion of some species in space - we do not refer here only to the human species but also to bacterial species that may accidentally or intentionally reach outer space - particularly when using synthetic biology in the processes

of colonization and terraforming of other celestial bodies, it practically launches evolutionary processes within a controlled biodiversity. In this situation, the competence of today's humanity in initiating such demiurgic processes of initiation of new worlds is questionable, and at the same time the viability of the evolutionary processes initiated in these conditions, as well as their finality for the human species, is questionable.

Josh Wodak considers human intervention on biodiversity in this late Anthropocene period to be, paradoxically, absolutely necessary but also irrelevant, from the perspective of the temporal conjunctures in which humanity and natural ecosystems find themselves. Of course, we are talking here about an extension of the ethical problematics from the ethics of synthetic biology and the use of artificially created organisms to a broader ethic of the synthetic embedding of nature, of the programmatic anthropocene - in the sense that human influence on nature is not a secondary result, but a directed process of modifying the natural itself by coexisting with the synthetic.

The coexistence of the natural with the synthetic can be expressed as a result of the creation of entities that no longer conform to the dichotomy between living and non-living, being the existence of quasi-biological processes, including protein synthesis that occur in such entities but have no life or viability on their own. We are talking, for example, about the processes of enzyme synthesis that occur at the interface between human cells and the mRNA nucleotides that exist in state-of-the-art vaccines. This juxtaposition between living and non-living in quasi-biological processes will later be involved in the construction of nanotechnologies carrying a localized biological message in the form of drugs that reach the target tissues or, why not, smart weapons targeting certain genomic markers of characteristics such as ethnicity, race etc.

I.4. The artifact and transforming nature into an artifact

The living world is becoming a field of economic interest, not only in the sense of its exploitation, as before, but also of the transformation of the biological in the sense of the expressed human interest. When organisms - unicellular for the time being, but possibly multicellular in the future - are used as biofactories, we are talking about a humanization of the natural context. This has been happening since the dawn of the development of human communities, with the discovery of the possibility of using yeasts for the production of fermented beverages or bakery products. Synthetic biology allows the creation of biological organisms whose purpose is to

produce substances necessary in various technological, therapeutic processes etc.

The difference between the two approaches to the technologization of nature is between the use of nature and its manufacture. Of course, we may wonder if there is any ontological difference between yeast used for fermenting beer - which pre-existed in nature when humans discovered fermentation processes - and organisms created synthetically for the purpose of exploiting them in technological processes. Of course, from the perspective of viability, the latter, being genetically reconstructed, possess unique qualities, non-existent in nature. But this does not make them less alive or viable - but it can make them much more effective in fulfilling the purposes for which they are used.

It is still up to normative ethics to build models for the use of these technologies so that the risks of using them reluctantly are minimized. On the other hand, these biological entities, in the absence of self-destructive genetic programming, compete with living things, securing a place in the food chain - when they become part of evolutionary processes based at least in part on chance and therefore have an unpredictable behavior. As such, these entities are partially out of the control of the researchers who created them, and therefore such a technology requires a forward-looking ethic that aims at accepting the hazard of synthetic biology for each of its applications. It is impossible to predict the evolution of syn-biotic systems and especially post-syn-biotic systems, but it is imperative to draw guidelines to address the limits of acceptability of these technologies.

In drawing these boundaries, the views of ethicists, biologists and bioinformatics, evolutionary biologists and those directly involved in working with synthetic living systems - should be confronted with the views of the general public. This democratized approach to ethical acceptability has the merit of socially legitimizing these technologies, but it brings with it a drastic limitation of technological development that may be due to the cultural and social context in which the ethical acceptability of a technology is questioned.

Josh Wodak (2020) points out that in the ethical analysis of any technology, synthetic biology in particular, social imagery cannot be overlooked - that is, those cultural projections that create an emotional response of the individual to technology. "At the basis of such dreams of salvation is the cultural imaginary in which nature is more than humanized, when coupled with technoscience. Whether or not it was born out of a pure need or born out of the fierce urgency of the climate crisis, if this dream is to avoid becoming another nightmare, then there is much to reveal about

the very culture that wants the dream to become a reality. Proving this dream takes time, as it is now a promise without any demonstrable means of fulfillment or without a guarantee, put in the context of recent historical failures to fulfill previous promises for rescue through biofuels, bioplastics, bioremediation or other technologies based on biosciences" (Wodak, 2020). The synthetic era, as a culmination of the Anthropocene, brings with it the desire to recover some extinct species, without invoking an evolutionary purpose or at least one of anthropic importance, but simply due to the demiurgic desire to overcome the limits of nature and control nature in its most intimate resorts.

As eco-philosopher Christopher Preston argues in his 2018 volume *The Synthetic Era*: *Overcoming Evolution, Resurrecting Species, and Redesigning Our World*: "The changes we face are far more significant than the familiar litany of human impact, such as climate change, species extinction and toxic pollution. The earth is entering a period in which some of its most fundamental processes are being co-opted and redesigned by engineers. Synthetic biologists, climate engineers and nanotechnologies go deep enough into the workings of nature to alter the very metabolism of the planet we inhabit. In doing so, they promise to create a whole new, synthetic world" (Preston, 2018).

In this context, philosophers such as Julien Săvulescu (Douglas & Savulescu, 2010) raise the problem of blurring the distinction between biological and non-biological, between living and technological - undermining the distinction between living being and machinery - raising the question of whether this new ontology of synthetic living and the risks it brings have an ethical approach, and if so, we ask ourselves whether current ethics can be sufficient in the ethical exploration of this technology or whether other foundations of ethics are needed, different from principled, deontological, utilitarian, or their various syntheses.

The arguments for a predictive ethic - even if it is not called as such - brought by Julien Săvulescu and his collaborators aim at the construction of hypothetical cases, such as that of a syn-biotic computational structure, which is based on human neural tissue and which claims civil rights. Of course, this situation is not a current one, because synthetic biology has only so far intervened on viral structures or living tissues of low complexity. The fact that this technology is not currently applicable to complex biological structures should not prevent ethical reflection on the questioning of the moral status of these frontier sciences - now and in the future.

A model of ethics of new technologies applied in the field of synthetic biology is the one formulated by Rebecca Mackelprang et al.(2021). The proposed principles are:

I. to create products or processes that benefit people, society or the environment;

II. to consider beneficial research in relation to potential damage;

III. to include fairness and justice in the selection and implementation of education, research, development, policy and marketing in engineering biology;

IV. to be open to the dissemination of incipient research and development results;

V. to protect the rights of persons associated with biological engineering, including the freedom of investigation of researchers and the free and informed consent of participants in research;

VI. to encourage open communication between biological engineering researchers and stakeholders who may be affected by the research, development and implementation of new technologies.

All these principles are welcomed to guide the work of bioengineers and researchers in the field but, because of the way they are expressed, these general principles are an adaptation of some general principles of bioethics and technoethics, without taking into consideration an anthropological and ontological depth necessary for the ethical drawing of the Late Anthropocene and the Synthetic Era. Most systems based on principiism, due to their preponderance for the pragmatic, want to create rules of good practice for those who work in the field, without taking into account the collective trends in the field and the onto-gnoseological mutations that it brings and that affect not only the direct biological systems involved in the research (Terec-Vlad, 2016) but also future ones, the existence or non-existence of which can only be assumed (Sandu, 2016).

Synthetic biology systems would have one or more of these attributes, of which at least two are considered mandatory:

- the products obtained by synthetic biology will be raw materials, being built from basic elements - oligonucleotides - synthetic or purified in the laboratory and which were not part of a natural cellular process;

- there is no natural correspondent of these synthetic elements, there is no identical copy in the natural cells; it will be possible to create the artificial genomic structures with various levels of complexity, without reaching the complexity of the natural genome, thus maintaining the synthetic structure as simple as possible, within the limits of a minimum viability;

- the structures thus created will be programmable, there are elements of synthetic regulation and the networks designed in the cells could be controlled by external stimulus in a deterministic way;

- a key goal of synthetic biology is obtaining a complete synthetic genome;

- the existence of a clear distinction between syn-biotic constructions (organisms produced by synthetic biology) and trans-genetic ones (which are based on artificially induced mutations in the genome of a natural biological entity, i.e. a living organism) (Saukshmya & Chugh, 2010).

We cannot at this time formulate a definitive answer as to the moral status of these frontier sciences, as in the case of synthetic biology, which has the potential to change the ontological status of mankind, nor is it easy to keep up with the technological developments, but we appreciate that an anthropocene ethic could consider an extended principiism, correlated with a prospective ethic that focuses the discourse on the ethical priority of beneficience, non-maleficience and the respect for the autonomy of conscious beings. The indifferent species will belong either be biological or non-biological entities and, therefore, the equity in access to the resources necessary for natural development without creating subjective dichotomies between people who do not have access to technological enhancement will become paramount (Sandu & Caras, 2013).

In our opinion, an ethic of new technologies that includes their acceptability should start from the abovementioned principles, after recovering from the ethics of Immanuel Kant the idea of moral conscience that governs action.

II. The cultural perspective on synthetic biology

II.1. Synthetic nature and intellectual property

With the widespread creation of synthetic biological entities - if this ever happens - we will be able to speak of the "emergence of a synthetic nature", i.e. a nature that coexists with the natural, enriched by various technologies, including synthetic ones. If this synthetic nature is already valid as a form of the Anthropocene - the historical period described in the previous section - the synthetic nature is a particular way of syn-biotic existence, in which human intervention on the biological will be a common action.

Each such intervention will be patentable, and nature in its enhanced form will become the intellectual property of companies in the field of biotechnology, pharmaceutical research, computer science or virtual reality.

Thom van Dooren explores a number of inequities that arise from the way in which intellectual property has been applied to the genetic resources of agricultural plants, focusing primarily on patents. In particular, the author was concerned about the importance of what is considered "natural" in the distinction between something "invented" and something that is only "discovered" - a distinction that is at the heart of patent. Authentic inventions are considered human products and therefore eligible for patent protection, while discoveries cannot be patented, because they are part of the heritage of natural biodiversity - as such being goods that belong to the whole world. The author seeks ways to implement equity in protecting the heritage invented by humans that are related to biodiversity and that targets new plant varieties with genetically modified components (van Dooren, 2008).

Patent protection of plant varieties and, in the future, of artificially created genomes, is a source of inequity that will extend, within the pharmaceutical industry, to products such as vaccines or, in the future, biological nanobots or biotransporters, making whole populations disadvantaged by the lack of access to protected technological products. This inequity has already occurred, with access to vaccines - including those with messenger RNA - being limited to those countries and territories that could cover the costs required by manufacturing companies.

As new plant varieties displace existing crops, forming a market, producers who are unable to adapt to technology will suffer impoverishment processes, with entire communities becoming excluded from access to a "patented" nature.

The problem becomes more severe when it comes to the medical applications of synthetic biology, where the high legal and moral issues regarding intellectual property and patenting are not yet clarified, especially when it comes to medical applications that may result, on short and medium term, from synthetic biology (Van den Belt, 2013). There are debates about the types of discoveries or inventions that are (or should be) patentable, and the economic and political pressure on companies and research institutes to either adopt strong patenting strategies or alternative policies, aimed at open access for such technologies.

Another direction in the approach to patenting in the field of synthetic biology is the need for an ethical analysis that takes into account the fact that we live in a globalized and interconnected world. Van den Belt argues that ethics policies regarding synthetic biology should go beyond the typical interests and concerns of a single nation-state, so that the normative goal of global justice is a key element in reforming the international

intellectual property system (Van den Belt, 2013). We remember, from the ideas expressed by Van den Belt, the principle of the technological neutrality of patents - in the sense of not patenting the technologies themselves, but only the resulting products, thus paving the way for technological co-construction in the field of frontier sciences.

Artificially synthesized organisms may, in the future, be programmed or taught to perform a number of applications, such as the production of certain biomedicines - which we discussed earlier - but also to create personalized metabolic pathways. Therefore, this technology has the potential to transform human life both directly and indirectly. The patenting of the products of these technologies aims to ensure their profitability, beyond the simple recovery of the initial investment in research and technological development.

II.2. Synthetic Biology - A New Copernican Revolution?

T. Saukshmya și A. Chugh (2010) offer an insight into the extraordinary economic value of synthetic biology in various fields. It is noteworthy that tools and organisms derived from synthetic biology can be used to save, create or destroy life; therefore, increased attention should be paid to the socio-ethical implications of this rapidly advancing field of biology and to the role of the intellectual property regime in the marketing of synthetic biology products.

Again, we observe a prescriptive-universalizing approach, which refers to a series of values, such as those of technological progress, which are prioritized over individual or corporate values related to profit. The ability of these technologies to radically change nature and society is understood without, however, being portrayed as a Copernican revolution in terms of human ontology, but also of contemporary epistemology. Despite the huge potential of these technologies, the ethical approach remains dependent on a paradigm of a dualistic ethic - profit versus equitable distribution of resources and benefits - without drawing the social-phenomenological component of new human behaviors in the face of these technologies, their risks and of their perceived benefits.

Biohazard and biosecurity are quantified as components of moral hazard, being approached in a reductionist way, in the paradigm of an ethic of equity, while the attention paid to the phenomenological dimension of the issue could highlight the repositioning of the human ego as opposed to a de-humanized and de-natured nature.

The marketing of synthetic biology products, at least when it comes to phenomena associated with humanized technologies, will emphasize the

objectification of nature - not only in the sense of commercial property on an external nature, but also intellectual property on a "synto-nature". Such possibilities, opened by synthetic biology, reposition humanity at the extreme limit of the biological with the noetic (Sandu, 2020). It is somewhat anecdotal that the first widespread application of synthetic biology, mRNA, was used to create vaccines to combat a global threat to public health and the quality of life posed by a virus whose global impact has been created by the globalizing effects of recent technologies that enable human mobility.

The technology thus helps to reduce the potentially catastrophic effects of other technologies, creating, in turn, future threats - real or just perceived (Sandu, 2020). The imposition of instrumentalizing values on nature de-naturalizes it, making it a fragmentary part of a noetic universe, which is becoming more and more distant from nature, paradoxically looking for remedies for nature conservation.

Nature, as an artifact or as a collection of manufactured objects, is transformed from an anthropological reference of the human condition, into a simple object of possession, thus being completely instrumentalized.

II.3. Synthetic biology as an open science

The protection of information and technology used in synthetic biology under intellectual property law is increasingly in conflict with the open source paradigm on the development of software and open science - open biology. The Massachusetts Institute of Technology has developed the Registry of Standard Biological Parts, also known as the BioBricks Foundation. It promotes open access to both the standard biological parts developed and the software used to implement this technology (Saukshmya & Chugh, 2010). The open source innovation system denounces the protection of copyright on genetic components - these being passed under creative commons licenses, which allow the scientific community to create derivatives specific to an open approach.

At the moment, products derived from synthetic biology are not the subject of protected copyright, genomic research being part of open science. Free access to such technologies creates the preconditions for potential equity in the derivation of certain products and technologies, but also creates risks associated with free access to technologies aimed at genetic editing and which can ultimately lead to the creation of unacceptable "biological products", potentially destructive in nature - biological weapons or viruses, pathogens and, why not, illegal genetic editing of human beings.

II.4. Techno-optimism and techno-pessimism as cultural approaches to synthetic biology

Regarding the attitude towards synthetic biology, its benefits but also its risks, there are two ethical perspectives as analysis frameworks - each justified by a series of arguments: the proactive, techno-optimistic one, which proposes synthetic biology as a technological practice, not only acceptable, but also welcomed for the science and technology of the future and, respectively, the conservative, cautious one. Understanding the ethical frameworks of analysis allows us to assess the limits of disagreements regarding possible physical or non-physical risks and, hence, to establish the actions and rules that will be formulated in response to each of these assessed risks.

A proactive attitude generally corresponds to ethical minimalism and a preference for minimal self-regulatory governance. This way of constructing science and research ethics policies, especially involving members of the scientific community in the field, is justified by the fact that only they can, in the end, understand the benefits and risks and formulate a risk – benefits balance, thus proposing, with professional and human integrity, the best regulations to avoid any risks. Regulations such as the existence of an ethics commissions and their opinion on research, implementation of principles such as beneficience, non-maleficience, equitable access to resources, professional and scientific responsibility, social responsibility of academic and research institutions etc. are discussed.

Stephen Maurer and Laurie Zoloth argue that self-regulation of research policies is the only practical way to control the security risks involved in synthetic biology. The authors point out that "initiatives developed by the synthetic biology community may be more effective than government regulations, precisely because they are more likely to be respected and taken seriously. And politically, building a non-governmental body to implement biosecurity policy seems like a good investment" (Maurer & Zoloth, 2007). Finally, the authors conclude, the protection against the risks of synthetic biology depends directly on the will, capacity and commitment of the scientific community in the field to self-regulate both the operation of basic research and its derivatives.

Involving the general public, who do not have serious skills in the field, in the ethical debates regarding the regulation of research in synthetic biology, would only introduce an additional emotional factor, diminishing the epistemic and axiological neutrality necessary for such research. Proponents of self-regulation point out that as long as ethical guidelines are prioritized by specialists, they will maintain the scientific objectivity and

minimalism needed in such a professional community, which has the epistemic value of systematic doubt and acceptance of any opinion only after the demonstration of irrefutable arguments.

On the other hand, techno-pessimists argue that professional visions, when transferred to ethics, can be vitiated precisely by values that belong to the scientific framework of reference - such as epistemic neutrality - and that make such people involved in ethical reflection strictly be unilateral and not to take into account cultural, social or religious sensibilities. Even if a technology does not involve immediately observable material risks, the cultural and mental changes and the civilizational changes that it brings, respectively, make this technology subjectively risky, and these risks are much more difficult to assess by people without broad philosophical competence. For example, the civilizational task of transferring responsibility for the artificial selection of species to humanity requires an eco-sensitivity that professionals do not have, through their strictly professional training.

Applied philosophy should make its views known in debates on the regulation of potentially disruptive areas of research, precisely because of the phenomenological sensitivity that philosophical ethicists have more or less developed through vocational education.

Historical experience shows that some technological products - or even technologies - although correctly assessed in terms of occupational risks and immediate risks, have generated adverse side effects, which are difficult to remedy on a global scale, especially if whole sectors of production are based on that technology. We refer here to the technologies for the production of energy from fossil fuels, which have made possible the globalization of goods in terms of mobility, but which later proved to have extremely harmful effects on the environment, by polluting the extraction areas, but also the large industrial cities. We also think of antibiotics, which made it possible to eradicate incurable or fatal diseases before the advent of antibiotics and which, through excessive consumption, led to the development of a population resistance to antibiotics, which may lead in the close future to the elimination of antibiotics from the panoply of medicines, with the risk of returning to the actuality of those diseases that seemed to be eradicated.

The discussion on vaccines - including mRNA-based vaccines - shows how a technology becomes a threat to at least a part of society, whether it is a real threat or one that is subjectively perceived as strong enough to generate significant social movements.

Conclusions

A major ethical objection to the development of synthetic biology can be built around the insufficient problematization of human responsibility for the creation of new technologies that interfere with the processes of natural selection and the evolution of species.

Such interventions, when not sufficiently well understood, can lead to imbalances within the ecological systems and uncontrollable genetic mutations in the genetic material that is hybridized with synthetic genetic material. It is impossible to predict the evolution of synthetic biological systems, an evolution beyond any mathematical modeling, to estimate the biological risks posed by the emergence of partially or totally synthetic new species, and especially their spread in ecosystems.

Ethics approaches this new science in a technicalized way, partially able to provide guidance to researchers and even respond to the momentary social fear mentioned above, but we believe that this technology - especially the identified ontological implications - requires a philosophical approach that emphasizes the radicalism of these scientific research topics, that can address the need for moral guidance, when most of the values of traditional ethics are questioned.

A conservative approach to biotechnology leaves society unprepared for the future, while an overly liberalized approach paves the way for abuses, including those of an ethical nature, abuses that can have incalculable consequences, as long as we talk about an ethic of the species, and improving humanity through enhancement - including its moral side.

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