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BIOETHICS AND COMPLEXITY. AN APPRAISAL OF THEIR RELATIONSHIPS TO OTHER SCIENCES

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Abstract: By and large, bioethics is concerned with life, i.e. understanding and explaining the living beings both as-they-are and as-they-could-be. The hard core here is global bioethics, which is a wider and richer domain than clinical bioethics. Global bioethics, it is claimed, stands very much along the way of the sciences of complexity – as an understanding of increasingly complex systems and behaviors. This paper explores the relationship between bioethics and complexity science. Thanks to such an appraisal a landscape appears additionally about the relationship with other sciences and disciplines. The hardcore for such interplay is the concern about life, i.e. the living beings. This paper argues that thanks to the interplay between bioethics and complexity theory, science and technology in general can harness from bioethics, and provides arguments about it. Firstly, it is shown that a right understanding of bioethics entails a distance with clinical bioethics. According to its very origins, bioethics is to be viewed as a sincere concern with life in general. Therefore, the developments from bioethics as a bridge on to global bioethics, and even to deep bioethics are shown and highlighted. This understanding impedes any reductionism of bioethics – which can be named here as "normal bioethics". On this ground, complexity science is depicted in general terms, and a panorama of links and relations among bioethics and other

sciences and disciplines is sketched. The main argument then goes that a solid even though basic understanding of life is needed in order to cope with the challenges and opportunities around us all. This, we claim, is both an ethical and an epistemological demand.

Keywords: *Global Bioethics, Life, STEM Sciences, Technology, Sciences of Complexity*

1. INTRODUCTION

E. Schrödinger discovered a fantastic research program, never ever formulated before. Since then probably the most compelling and crucial problem has been brought to the fore, namely understanding what life is, and therefore striving to make it as possible as imaginable. Consequently, a number of fields have emerged devoted to the understanding and explanation of life, i.e. the living beings, ranging from the life sciences to the health sciences, bioethics, bioeconomics, a certain approach to biopolitics, not to mention also bioeducation, for instance. Biology has experienced a revolution thanks to the discovery of symbiogenesis and systems biology, and the human and social sciences have been enriched by enlarging a scope that originally was centered exclusively on the human beings. Ethology and ecology, the very discovery of exoplanets, the development of the information and computing sciences as well as, more recently, the launching of the Global Bacteriome Project (2007-2013) and the Global Virome Project (2018-2022) – all jointly shed brand new lights on to the understanding of the complexity of life at large. As a consequence the heuristics can be stated as understanding life-as-it-is very much as life-as-it-could-be.

This paper takes as leading thread bioethics and argues that the transition from clinical or normal bioethics to global bioethics corresponds to learning about life not just in terms of a human concern, but also and mainly as a bio-centric or eco-centric concern. In such tenure, it is claimed here, any conception or interpretation about the value of the human being is not to be suppressed at all, but quite on the contrary, it is integrated in a larger and broader scope that encompasses it and makes it possible, namely the framework of life in general. Four arguments support this claim. First, a re-appraisal of bioethics is compulsory that shows how and why a shift from mere clinical concerns leads further to the interplay

between human beings and nature at large. The second argument brings together bioethics and complexity science. After all, it is argued here, the sciences of complexity can be adequately seen as sciences of life since life or the living beings are by far the most complex systems and phenomena imaginable. This second argument defines the hard core of this paper. On this basis, the third argument consists in depicting a map of relations regarding the ongoing panorama of sciences and disciplines directly concerned with understanding and explaining life. A most thoughtful view emerges hereafter. The final argument assesses that bioethics can and will have a real impact on the arena of science and technology at large, bearing in mind the previous arguments jointly. A most suggestive conclusion can be withdrawn that sets bioethics on a quite new and different foot. At the end some conclusions are drawn.

2. A RE-APPRAISAL OF BIOETHICS

North American oncologist professor Van Rensselaer Potter (1911-2001) will go down in history as the "theoretical" father of bioethics. However, the works by bioethics historian, Warren Thomas Reich (Reich 1994, 1995), make us rethink such paternity. Reich thinks that both Potter and André Hellegers (1926-1979), founder of "The Joseph and Rose Kennedy Institute for the Study of Human Reproduction and Bioethics", well known as the Kennedy Institute at Georgetown University, used the word "bioethics" independently of each other in 1971. But it was believed that the credit for coining the expression and using it for the first time came from the biochemist Potter, with his article published in the fall of 1970 in the journal *Perspectives in Biology and Medicine* (Potter 1970).

A couple of years ago from now, the neologism "bioethics" was discovered not to be a Potter creation, but an invention by the Protestant theologian Fritz Jahr (from Halle an der Saale), who gave such a title to a 1927 article: "Bio-Ethics: A Review of the Ethical Relationships of Humans to Animals and Plants", published in the magazine *Kosmos. Handweiser für Naturfreund* (Jahr 1927).

Jahr's contribution was to focus his attention particularly on what he called "the bioethical imperative" (Garzón 2009). Paraphrasing Kant, Jahr suggests considering each living being as an end in itself and treating it as such as far as possible. The formulation was not final until a few

years after the first article from 1927. Hence its importance in the field of biological research using animals. Anticipating many publications that would soon reveal the need for ethical training in dealing with the experiments on animals, Jahr considers the importance of reflection, deliberation and analysis of intentions and convictions by the researchers "*Gesinnungsunterricht*[1]" (Lolas 2012). For Hans-Martin Sass (Sass 2008), Jahr's contribution consists in giving a new dimension to the term "bioethics". It is true, indeed, that Fritz Jahr's theological and philosophical background and his 1927 vision and concept of bioethics adds a third dimension: the concern for ethics and morality in times of new technologies and changing cultures (Jahr 1926, 1927, 1928; Goldim 2009; Muzur and Rinčić 2011; Engels 2011). Instead of shedding a shadow onto the works of Potter and Hellegers, Jahr's contributions represent the wealth and constant evolution of the new discipline called "bioethics".

However, Jahr's work was forgotten, and it was Potter who outlined a work agenda that goes from the intuition of creating this new knowledge to raising the possibility of looking at bioethics as a systemic or deep discipline around the year 1998. The complete plan for his work was the following (Garzón 2003):

- 1970-1971. Potter coined the term bioethics in two writings: firstly in the article *Bioethics, science of survival* (Potter 1970) and then also in the book entitled *Bioethics: Bridge to the Future*. (Potter 1971).
- 1988-1996. Potter once again gives bioethics a new vision by writing a book called *Global Bioethics, building on the Leopold Legacy* (Potter 1988), where he insists on taking up Leopold's legacy of creating a planetary ethics (Potter 1993, 1994, 1994a, 1995, 1996).
- 1998-2000. Potter publishes his last article while alive, *Bridge Bioethics, Global Bioethics and Deep Bioethics* (Potter 1998), where he presents a new challenge, namely thinking about bioethics in systemic terms.

Towards 1970, Potter understood the so-called "bioethics" neologism as a "bridge between biological science and ethics". His intuition was to

[1] Literally: "Education in good taste". It was the traditional way in which ethics and medicine were taught. A shift was produced thereafter to the techniques in genetics.

think that the survival of much of the human species, in a decent and sustainable civilization, depended on the development and maintenance of an ethical system. What interested Potter at the time was the questioning of progress and where all the materialistic advances of science and technology were taking western culture. Potter gave bioethics the following mission: an attempt to answer the question facing humanity: what kind of future do we have ahead? And do we have another choice? Consequently, bioethics was transformed into a vision that required a discipline to guide humanity along the "bridge to the future" (Potter 1962, 1971, 1975).

Shortly after the publication of his book, Potter argues that a well-funded institute for the study of human reproduction is needed – beating the words "and bioethics" added to its title. This promptly shifted the focus of research interest in bioethics. That Institute was created later in 1971, at Georgetown University, apparently unaware of his previous publications. In the following decade, bioethics was taken over by committees operating in bioethics centers in the clinical area, which dealt with life and death problems that are still highly controversial (Potter 2001).

Henceforth, bioethics developed amid clinical concerns, more specifically in the work of intensivists working in ICUs in hospitals and clinics. Consequently, bioethics set out to speak of, and be based on, "principles", which refer mainly to the discovery of the "patient" as a new social, cultural and historical realm. Such an origin of bioethics can be seen in the works of Tom Beauchamp and James Childress (Beauchamp and Childress 2009; Gracia 2008). This development took place within the framework of the transformation of medicine into biomedicine thanks to the achievements in basic research and the pharmaceutical world. This whole situation defined what can be properly called "normal bioethics", that is, the ethical study of the patient vis-à-vis the ongoing developments in medicine and the health sciences.

Years later, in 1988, Potter expanded bioethics to other disciplines, not only bioethics as a bridge between biology and ethics, but also on to a global ethics. Indeed, Potter created and defined the term "bioethics" in 1970, to describe a new philosophy that sought to integrate biology, ecology, medicine, and human values. "Bioethics is often linked to environmental ethics and stands up in sharp contrast to biomedical ethics." (Potter 1988). Because of the confusion (and appropriation of the term in medicine), Potter chose to use the term "global bioethics" in 1988. Potter's definition of bioethics from *Global Bioethics* is, "biology combined with diverse humanistic knowledge forging a science that sets a

system of medical and environmental priorities for acceptable survival" (Potter 1988, p. 153; Potter and Whitehouse 1998, p. 9).

From this book onwards, global bioethics was formulated that aimed at spreading ethical concerns about life by not only focusing on humans but also integrating any other type of life on earth. The historical and cultural framework for such a change at that time is clear. Table No. 1 synthesizes the most recent about global bioethics, 2018-2020:

The list of subjects and subtopics can be brought together in a set of main concerns, thus: theories, legal and educational aspects, moral and ethical positions, public health, religion, nature and environmental change, African bioethics, geographic and regional dimensions.

Furthermore, traditional or clinical considerations, generally focused on the principles of bioethics, are completely excluded from the panorama exposed by the documents gathered in Table No. 1. Instead, according to current trends and subjects in our contemporary world, the current approach to bioethics must focus on social, political and cultural aspects. Bioethics must face, and be able to respond to, some of the most important challenges that our world encounters today, not to mention the ability to maintain a dialogue with regional and even continental demands, especially Latin American, African and Indian (Sunita, et al. 2018; Bandewar, et al. 2018) concerns.

Finally, starting in 1998, Potter raises the concept of *deep bioethics*, (Potter 1998) first discussed by Professor Peter Whitehouse of the University of Cleveland, Ohio. (Whitehouse 2001, 2002, 2003). Whitehouse took the idea of advances in evolutionary biology, especially the idea of complex and systemic thinking that supports biological systems (Potter and Whitehouse 1998). "Deep bioethics" aims at understanding the planet as greatly intertwined and interdependent biological systems, where the center no longer corresponds to man as in previous times, but to life itself (Potter 1999). Man is only a small strand within the entire plot of life, paraphrasing Fritjof Capra (Capra 2009).

Potter's legacy can be summed up as follows: The concept of *bridging bioethics* was the first stage in bioethical thinking. The second stage was the idea of *global bioethics* as an expanding morality that would result from building a bridge between medical ethics and environmental ethics (Potter 1999, 1999a). Recognition in the 1990s of a series of ethical dilemmas led to the recognition that a bridge between medical ethics and environmental ethics is not enough. All ethical specialities need to be expanded from their short-term problems to their long-term obligations

Table No. 1. Global bioethics, subjects and issues

Global bioethics papers 2018-2020	Subjects and Issues
2019	Feminist Bioethics
	Historical and theoretical approach
	Bioethics and/as common morality
	Environment and climate change in Africa
2018	Health and inequality
	African bioethics
	Multiculturalism
	Global education
	Virtues, embodiment and faith
	Medical education
	Ethics and Law
	Argument and logic
	Bioethics curricula
	Disaster research ethics
	Moral distress in nursing
	Public health disasters
	Nature as legal subject
	Privacy and confidentiality
	Culture and solidarity
	Common morality
	Regional approach: Bengal
	War veterans and refugees as survivors
	Theoretical approach
	Global education
	Bioethics and human rights
	African perspectives
	Hospitality, dignity and vulnerability

Source: own elaboration

(we need, as it happens, *deep bioethics*). Bioethics should thus be seen as a *cybernetic approach* to the continuous search for wisdom, "what, says Potter, I have defined as knowledge about how to use knowledge for human survival and to improve the human condition" (Potter 1995, 1996, 1998).

Openly stated, bioethics has ceased to be just an applied ethics and has become a deep reflection and concern on fundamental questions both in science and in humanity. Once a principle-based bioethics is no longer dominant, other new bioethics have emerged: African bioethics (Barugahare 2018; Gillum 2008; Tangwa 2010, 2019; Andoh 2011; Behrens 2013; Sam-Agudu et al. 2016; Coleman 2017; Tosam 2018); Latin American bioethics (Tealdi 2008; León 2008; Vidal 2012; Feitosa and Nascimento 2015; Oliveira and Osman 2017; Miles and Laarn 2018); or global bioethics (Turner 2003; Marshall and Koenig 2004; Schroeder 2005; Borry, at al. 2006; Engelhardt 2006; Holm and Williams-Jones 2006; Widdows 2007; Finkler 2008; Fox and Swazey 2008; Zieler 2009; Verkerk and Lindemann 2011; Ten Have and Gordijn 2014; Gracia 2014; Rheeder 2018; Simpson 2018; Stanton-Jean 2018; Afolabi 2018; Ten Have 2018; Toumi 2018; Zanella 2019; Sganzerla and Pessini 2019), among others. In general, bioethics has become a fundamental concern about life. Not ultimately in the literature the intertwining between bioethics and human rights, bioethics and politics, bioethics and computing, bioethics and the fourth industrial revolution can be found, to name just a few of the recently developed areas.

3. BIOETHICS AND COMPLEXITY SCIENCE

The sciences of complexity have been said to be sciences of life since life, i.e. the living beings, are by and large the most complex system possible in the universe (Maldonado 2019a). Originally coined as such at the Santa Fe Institute in New Mexico, the sciences of complexity are an array of conceptual tools aimed at studying increasingly complex systems characterized by nonlinearity, self-organizations and emergence, among many other features (Bar-Yam 1992; Scott 2007; Mitchell 2009).

A close intertwining can be traced between bioethics and the sciences of complexity, something that has not been openly done so far. The common ground for such a link is a basic understanding of life, the most thrilling phenomenon ever. It is almost impossible to turn one's head and

not see life around. The two extremes go from the extremophiles to the ongoing developments about robotics, artificial life and artificial intelligence passing through biology and ecology in the widest sense of the word. Life pervades the entire panorama of the visible universe, and yet, we have not come to a final decision about how to fully understand and explain life, i.e. the living beings.

A twofold philosophical perspective serves as rationale here, namely the understanding and explanation of life-as-it-is, and life-as-it-could-be-possible. Our take here is that life is not so much a stuff – or a *hylé*, but a process: we know life by what it does. To be sure, there are three ways that clearly help explain this. Life consists in metabolizing – let us remember the claim: metabolism first, as the most solid hypothesis about the origins of life; life is a process of information processing; and life computes. These three expressions are ultimately one and the same; the differences lie in the scope considered, thus: biology and medicine, firstly; physics, secondly; and computing science, thirdly.

In other words, life is a process by which abiotic elements are transformed into biotic stances and processes. Such transformation can be adequately grasped as metabolization, information processing, and computing. Counterintuitively, the sciences of complexity show that: a) life emerges already complex, not as an additive process (Kauffman 1993; 1995), and b) life generates the very conditions for its appearance and sustainability (Dartnell 2019; Hands 2017; Canfield 2014).

Indeed, the very essence of life at large consists in a variety of synthesis, not analysis. Some very basic and good examples are: synthesis of proteins, synthesis of bio-polymers, synthesis of ions, perceptions as synthesis, sexual reproduction as synthesis, synthesis of imagination, among others. A biochemical translation of such synthesis consists in catalytic and auto-catalytic loops or sets. Chemistry teaches about, and is largely grounded on, synthesis, not just on analysis. In fact, the chemical forces and chemical reactions are unceasing processes of synthesis – whether natural or artificial.

Moreover, there are no material differences between life and non-life. The differences can be expressed only in terms of qualities, degrees of organization, and gradients. The entire alphabet of the known universe has already been unveiled. It consists in 118 characters organized in the Periodic Table of Elements. The entire universe is written with the combinatorics of those 118 characters. The differences can be said to be in forms of organization, which in terms of chemistry is said as simple,

double, covalent, van der Waals links, and others. Chemistry teaches us all to think in terms of sets – i.e. set theory, not just in terms of aggregations. Chemistry is after all about sets of sets – a most wonderful language and logic – not just elements and interactions among them, as it is the case in particle physics, for instance.

Recent important cross-disciplinary research projects are having a fundamental impact on the very scope and horizons of bioethics, such as the Global Bacteriome Project (GBP) (2007-2016), and the Global Virome Project (GVP) (2018-2028). As a result, the image of and about the human beings is been radically changed. Human beings are holobiontic in that for each living cell in the human body there are at least ten bacteria; all in all human beings are made up in 90% of bacteria (GBP); only 10% are human cells. With the development of the GVP the ratio of "human" stuff will most certainly decrease. Deep philosophical and biological questions emerge hereafter.

Exactly along this same research line, epigenetics sheds new lights on to the issue, namely the recognition that there are clearly not two dimensions any longer – nature and culture (or also culture and nurture), but only one. The close interplay between nature and culture has come to be identified as the outcome of methylation processes in the DNA thanks to the histones and the chromatin such that there is a genetic expression without altering the DNA. Epigenetics has been observed in human beings, but also in animals and plants. In other words, the expression of the genes affects the phenotype without altering the genotype. Epigenetics is about how genetic factors are altered by the cell environment. Consequently, the classical division between nature and culture is completely vanished. Epigenetics has been said to be one of the sciences of complexity (Maldonado 2020).

In other words, epigenetics brings to the fore the fact that nature and culture are one and the same thing, which is to have serious consequences for a bioethical understanding of the world and the human beings. As it happens, we inherit not only genes but also experiences, we also transmit them (Jablonka and Lamb 2005). At the current state of research, epigenetics has been proved in human beings, animals, and plants. The inheritance and transmission of genes and experiences has been demonstrated to up to three generations. Further advances will surely widen up that time span to, say, five to eight generations.

As it can be clearly seen, the traditional division between ethics and science appears retrospectively as a blurred view, and hence principled

bioethics becomes a small if not a tiny part of larger and deeper take, namely global bioethics or deep bioethics, precisely.

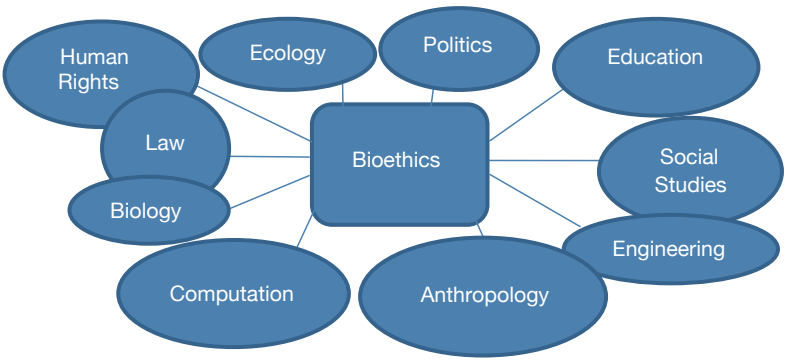
As can be seen, it is the interplay between complexity science and global bioethics which completely modifies the very status of bioethics as – a sheer – applied ethics, concerned mainly with clinical or medical case studies. Straightforwardly said, the sciences of complexity help enlarge and enrich bioethics in exactly the way in which global bioethics was envisioned by van Potter – as global bioethics. However, in mainstream bioethics global bioethics seems to be still an eccentric topic. Mainstream bioethics is willing to reduce bioethics as an ethics of control of basic science – for instance, control of research on mother cells, most notoriously, control and rejection of bio-engineering, genetic engineering, and bio-inspired engineering, among other spearhead fields.

We claim that the relationship between bioethics and the sciences of complexity greatly benefits bioethics along the way that openly leads to global bioethics. This very same claim is *a fortiori* true when relating complex human and social sciences to bioethics – which makes that bioethicists become concerned with subjects such as human rights, animal ethics, political and social critical movements or with the critique of the free-market society and the market system – some of the ongoing signs of malaise in our times and countries, almost all around the Globe.

4. BUILDING A MAP OF RELATIONS

As it happens, bioethics is being affected by the ongoing course of research in spearhead science and technology, as well as by the most sensitive current social, political and economic processes around the Globe. Furthermore, bioethics, i.e. global bioethics has been having an increasing impact on different sciences and disciplines. Graphic No. 1 shows the array of relations so far:

As it happens, bioethics comes closer to a variety of concerns ranging from what a human being is and can be (anthropology), to the impact of engineering in the very development of human life (posthumanism, transhumanism, cloning, working with artificial cells, etc.), to legal issues (law), to human rights (justice, injustice, inequality), to social issues (multiculturalism, local and regional issues), to education (education of bioethics, bioethics in education), to biology (the definition of life), to ecology (natural resources, public health and sustainability).



Source: Own Elaboration

Graphic No. 1. A Map of Relations between Bioethics and Science At Large.

The map depicted in Graphic No. 1 does not pretend to be exhaustive, for new links and bridges are being continuously developed. One of them is the relationship between bioethics and philosophy (principled versus non-principled bioethics).

When observing foreground science, cross-disciplinary approaches seem to become the rule. However, the truth is that in academic life disciplinary explanations are still the dominant practice. Interdisciplinarity remains wishful thinking, to-date – even if a well-intended one. A more optimistic take can be to assess that cross-disciplinary approaches are truly new.

Be it as it may, numerous and increasing relations are being set up among bioethics and different other sciences and disciplines. The rationale for such links lies in the search for concepts and means able to cope with increasingly complex challenges – both theoretical and practical. Indeed, largely said, bioethics can set the ground for the main avenue, so to speak, for the encountering between the human and social sciences. Bioethics is being searched as a means for helping, supporting or fostering life in an increasingly complex world. This, we argue, is an epistemic as well as an ethical issue, both parallel and closely intertwined. What is at stake, indeed, is the care for life, its meaning and its quality – in the deepest and largest sense of the word.

Scholars and researchers are to provide insights, understanding and explanation when required to help people and society cope with continuously changing environments. Not ultimately, the Covid-19 crisis set out such a complex landscape.

The pace of science and research is certainly rapid; yet, science at large –science and philosophy, of course – must help enlarge the windows through which reality and the world are seen and understood. Undoubtedly one single science and discipline is at odds with complex times and phenomena, whence the need for cross-disciplinary approaches. Both global bioethics and the sciences of complexity fulfill more than adequately the call for cross-disciplinary explanations. The ground, it appears, is more than mature for bridging up different languages, methods, explanations, understandings and instruments. Clinical and mainstream bioethics seems to know very little about these ongoing processes.

In any case, however, it is also true that increasing links are being built between bioethics and the natural science and engineering, at large. Thus, for example there is an open acknowledgement about a hybridation of values when facing biotechnology and the information and computing sciences (Valderdú 2009). At the same time, the awareness of environmental issues – most notably the global warming — raises serious concerns among bioethicists as well as among scholars who do not properly work on bioethics but are sensitive to it. The most recent research about CRISPR in genetics does nos go taken for granted, certainly among some of the most rigorous bioethics scholars (Cribbs, and Perera 2017), for instance.

All in all, an array of relations is being built that bridges bioethics with different sciences and disciplines. It is not unimaginable that the links and bridges will increase and strengthen in the upcoming future. After all, this is science at its best whilst it is being developed.

5. IMPACT OF BIOETHICS ON SCIENCE AND TECHNOLOGY AT LARGE

Even though in its very origins bioethics was set within the framework of applied ethics, it has witnessed a wonderful enlargement and enrichment. The advancement of science and the developments of technology have been exponential in recent years and have been transforming life in many senses. Artificial blood has been produced, the workings in genetics and systems biology is surprising and have brought brand new realms and concerns, the web has changed from the current web 3.0 on to the upcoming web 4.0; even the web 5.0 already has a name: the emotional web (Benito-Osorio *et al.*, 2013; web pages). Some people argue for and

against trans-humanism and post-humanism as a consequence of the ongoing technological changes; the life expectancy and life hope have been largely extended over the last decades; new human beings are being created such as hybrid human beings, the transgenic humans, transgenomic humans, bionic humans, mainly (Maldonado, 2015). All these are the outcome of scientific and technological advances, not only cultural processes. This list could be easily enlarged and exemplified.

A summary of the spearhead technologies presents them as the NBIC+S, thus: nano-technology, bio-technology, the information technologies, the technologies of cognition, and the social dimension of technology. These have been called as convergent technologies. The outcome is the emergence of the ongoing fourth industrial revolution (Schwab, 2016).

As for science, the first scientific revolution, namely the emergence of science in the modern age, from Descartes and Galileo to Einstein, passing through Pasteur, Koch, and Newton, among many others, has shifted, more radically, into the second and the third scientific revolutions. The second scientific revolution consists in quantum science, which ranges from Planck and Einstein to-date. It comprises fields and behaviors such as quantum entanglement and teleportation. Quantum physics has seen how quantum chemistry, quantum biology, and even the quantum social sciences (Haven and Khrennikov 2013; Maldonado 2019c) have emerged providing a most compelling and complex arena. The third scientific revolution is information science, which starts with Shannon and Weaver and extends to our days encompassing domains such as cryptography, and quantum information processing. Bioethics cannot be blind to these developments, and indeed it is not.

Whereas the first scientific revolution took centuries to be carried out, the second scientific revolution can be counted in terms of decades; finally, the third scientific revolution can be observed in the lapse of just some years. This clearly shows the pace and speed of knowledge and discovery. It is within the scene of the second and the third scientific revolutions, we claim, that bioethics emerged and is being developed. Thus, in terms of its *Zeitgeist*[2], bioethics has very little to do with classical science, i.e. modern science – and very much with quantum and information sciences. Yet, it appears not very much has been said about it in the literature. This paper aims to fill in a gap, even if only partially.

[2] In other words, of its own epoch, age or period.

There are two main ways in which bioethics has been largely interpreted and worked out. On the one side, as applied ethics, it is the means of control of science and research. Principled bioethics is about cautioning, warning and restricting actions that may impeach life in any expression. European and Anglo-Saxon bioethics can be said to belong to this first understanding (Beauchamp and Childress 2009; Gracia 2008). On the other side, bioethics can be seen as a way of fostering science and research aiming at making life as much as possible. One reasonable motto here would be: everything that is technically possible to enhance and make life possible is ethically imperative and compulsory. In this second sense, life is the limit, namely life-as-it is very much as life-as-it-could-be.

The distinction between both kinds of approaching life, i.e. the living beings, was originally set out by Ch. Langton, the father of artificial life (Langton 1997). Bioethics and artificial life share one and the same philosophical spirit, indeed. As it is well known, artificial life emerged as a research program aimed at explaining one of science main puzzles namely, understanding the origins of life. However, at the same time, artificial life was originally conceived and stated as the program via computational techniques for explaining the very logics of time. This story has been told several times (Adami 1998; Bedau et al. 2000).

In other words, artificial life consists in building life as a way to understand how natural life once emerged on Earth, nearly 3.8 billion years ago. Computing science is to be viewed here as a cultural instrument that complements microscopic and macroscopic techniques via modeling and simulation. To be sure, spearhead science is impossible without taking into account and knowing how to work and how it is structured – modeling and simulation. When van Potter first thought about the shift toward global bioethics, working on simulation was at its best a mere dream.

6. CONCLUSIONS

Even though there seems to be clear enough hints as to the history and development of bioethics, the literature regarding the interplay between bioethics and complexity science is scarce. This paper aims at filling up the gap. In order to do so, a twofold way has sketched, namely: on the one hand, the very reappraisal of bioethics as a sincere concern with life in general, and not just with clinical medicine (intensivists, and the like). Often forgotten, the understanding of bioethics as a bridge, firstly,

as a global interplay among sciences and disciplines, secondly, and lastly also as "deep bioethics" allows bring to the fore the concern about life in general (*überhaupt*).

On this ground, the second way shows how the sciences of complexity can adequately be grasped as the concern for life as-we-know-it, as well as for life as-it-could-be-possible. In other terms, it is both an ethical and epistemological must to have a solid even if basic understanding of life, i.e. the living beings. An array of fields become then compulsory, among them epigenetics, systems biology, artificial life, and the NBIC+S were mentioned here, along with a few more. By and large, life is the most compelling, thrilling and fascinating phenomenon ever. Caring for life entails, therefore, surpassing a sheer anthropological concern and opening it up further to a bio-centric or eco-centric understanding. There, we claim, is exactly where both bioethics and complexity theory anchor, and become intertwined. The outcome of such interplay results in a better understanding of life – certainly the highest demand of all, if possible.

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