

DARWINIZE IT TWO TIMES: ON THE POSSIBILITIES OF EXTENDING EVOLUTIONARY MEDICINE THROUGH NEW DEVELOPMENTS IN EVOLUTIONARY THEORY

Abstract: In this paper, I will briefly summarize the history and current accounts of Evolutionary Medicine (EM). I will show that EM, in its current forms, is using an evolutionary understanding that carries the explanatory framework, as well as explanatory limits, of the Modern Synthesis (MS). I will then point out some essential elements that need to be seen as limiting factors within EM and analyze the limitations that are brought about by the MS understanding of it. On this basis, I will argue that if the latest developments in evolutionary theory are considered – in particular, those pertaining to the inheritance mechanisms highlighted by the Extended Evolutionary Synthesis (EES), and the newly introduced evolutionary entities – EM will have a much broader explanatory scope and increased explanatory power in addition to greater relevance, which will enable its application in medical explanations.

* * *

1. *What is Evolutionary Medicine?*

This paper does not aim to define Evolutionary Medicine (EM) by trying to read through the existing frameworks and combine or group perspectives that claim to be “evolutionary medicine”, while excluding certain other evolutionary perspectives, but aims at illustrating the broad landscape of evolutionary medicines. One principal challenge to start with is defining what is “evolutionary” in the very first place. In this section, I will start by covering some key perspectives in this sense. However, I won’t try to give an exhaustive account of what “evolutionary” means, as its usages vary greatly amongst different disciplines.

Since the 70s, boundary debates on what is evolutionary and what is not became very common within the community of evolutionary biologists, fa-

mously ignited by the *Spandrels of San Marco*¹ paper by Stephen J. Gould and Richard C. Lewontin. Moreover, within evolutionary biology, the adjective “evolutionary” is very often used as a contrasting element, juxtaposed for example with “developmental”. Furthermore, within many fields of evolutionary biology, “evolutionary” – albeit in a vague way – is still used to contrast durable versus short-term changes, life history versus within-the-lifespan of the individual, inherited versus non-inherited. Therefore, defining evolution as such has been an exceedingly challenging task for many. This is particularly relevant in light of a very pluralistic conception of “evolution” in use among different evolutionary biologists and which is evident in the literature². This means that scientific communities understand very different things by “evolution” in their respective fields, in order to achieve different narrative aims. In this sense, evolution can vary from the strict population genetic definition of «any change in the frequency of alleles within a population from one generation to the next»³, to the more narrative ecological one of Douglas Futuyama: «[biological evolution] is change in the properties of groups of organisms over the course of generations (...) it embraces everything from slight changes in the proportions of different forms of a gene within a population to the alterations that led from the earliest organism to dinosaurs, bees, oaks, and humans»⁴. The complexity of defining evolution within one single theory is noted and the acknowledgment of evolution as a network of ideas by the scientists working in the field is also reported⁵. Discussing EM, which is constitutively characterized by the usage of evolutionary thinking, methods, tools, or domains in medicine, therefore carries the difficulties mentioned above, which will be the focus of discussion in the forthcoming sections. These issues will prove to be even more

¹ S. J. Gould – R.C. Lewontin, *The Spandrels of San Marco and the Panglossian Paradigm: A Critique of the Adaptationist Programme*, «Proceedings of the Royal Society of London. Series B, Biological Sciences», CCV (1979), 1161, pp. 581-598.

² As regards explanatory pluralism, see K. Sterelny, *Explanatory Pluralism in Evolutionary Biology*, «Biology and Philosophy», XI (1996), 2, pp. 193-214.

³ D. L. Hull – M. Ruse, *The Cambridge Companion to the Philosophy of Biology*, Cambridge (UK), Cambridge University Press, 2007, p. 26.

⁴ D. J. Futuyama, *Evolution*, Sunderland, Sinauer Associates, 2005, p. 2. One forgotten aspect here is that, instead of “defining” evolution, these disciplines “depict” evolution from their own perspectives. This is a function of different theories, tools and reasons. Therefore, it is necessary to accept a pluralistic approach to different definitions arising from different disciplines.

⁵ J. C. Ahouse, *The Tragedy of A Priori Selectionism: Dennett and Gould on Adaptationism*, «Biology & Philosophy», XIII (1998), 3, pp. 359-391.

pressing in the context of EM, due to the accumulation of the abovementioned difficulties.

The application of evolutionary ideas, principles, or approaches to medicine naturally traces back to pre-Darwinian accounts of evolution. Erasmus Darwin, the grandfather of Charles Darwin, was a medical doctor and engaged with the evolutionary ideas of his time. He was quite a forerunner of the blended study of evolutionary and medical approaches, with both perspectives informing each other. Zampieri (2009) divides the influential eras of evolutionary approaches to medicine (be they medical research, medical explanation, or medical research programmes) into two distinct time frames: Medical Darwinism and Darwinian Medicine⁶. His quantitative analysis is based on the frequency of publication of evolutionary research in the most influential medical journals, that is, *The British Medical Journal* and the *Journal of the American Medical Association*. Medical Darwinism refers to the research era between 1880 and 1940, while Darwinian medicine to the one starting in the 1990s. The gap is to a considerable extent due to the well-deserved bad name given to many terrible approaches using Darwinian understandings (or, in this case, misunderstandings) in medicine. After World War II, there has been a long pause in the application of evolutionary or Darwinian approaches to issues outside the evolutionary biology domain⁷. This first period identified by Zampieri was even before the establishment of MS, which will become the standard approach in evolutionary biology until the end of the century. Méthot (2011), on the other hand, looks at the kinds of explanations within research traditions of evolutionary explanations in medicine to make the distinction between two distinct tendencies: «forward-looking explanations» and «backward-looking explanations»⁸. Forward-looking explanations mark explanations that are aimed at possible developments in the future, while backward-looking explanations are about evolutionary histories. In Méthot's distinction, the more recent advancements in evolutionary medicine starting around the 90s lay more emphasis

⁶ F. Zampieri, *Medicine, Evolution, and Natural Selection: An Historical Overview*, «The Quarterly Review of Biology», LXXXIV (2009), 4, pp. 333-355.

⁷ Zampieri (*Medicine, Evolution, and Natural Selection*) also notes that the old Darwinian Medicine was more of a British phenomenon, while contemporary evolutionary medicine is stronger in the US.

⁸ P. O. Méthot, *Research Traditions and Evolutionary Explanations in Medicine*, «Theoretical Medicine and Bioethics», XXXII (2011), 1, pp. 75-90. Such backwards-looking explanations, although not pursued deep within his research, seem to create the basis for adaptationist explanations.

on forward-looking explanations, if compared to those of Medical Darwinism. Méthot's distinction cuts through the distinction already made by Zampieri. In Zampieri's distinction, the second trend that started as Darwinian Medicine was coined by two very influential figures working in the field of evolution: the famous evolutionary biologist George C. Williams and the physician and clinical psychiatrist Randolph M. Nesse, authors of the influential book, *The Dawn of Darwinian Medicine*. The second tradition, which started in the 90s, draws to considerable extent from the research tradition of these influential figures⁹.

1.1. *Difficult Disciplines, More Difficult Disciplinary Boundaries*

The main problem with the application of evolutionary medical research to its clinical results can be summarized by the question: "What can a book do?". It should be noted that it is mostly evolutionary biologists or scholars who are already working within evolutionary biology that are trying to create connections to the field of medicine, and this is provenly difficult to achieve since these scholars are not very often institutionally connected to medicine¹⁰. When the canonization problem is acknowledged, the limits of evolutionary research – where it begins and where it ends – are up for debate. Moreover, we should be able to ask which part of the medical research is "truly" inspired by evolution, and if so, which conception of evolution is used within the research. In addition to the above-mentioned difficulty of addressing a singular discipline as "evolutionary medicine", disciplinary distinctions are rather difficult to make. This adds to the general considerations of historical divergence. Moreover, the body of evolutionary biology is constantly increasing and becoming integrated. The increase is also due to the usage of *ad hoc* and lower-level explanations within the subdisciplines of evolutionary biology or other disciplines within biology, where evolutionary perspec-

⁹ Of course, there have been also other figures who were working in evolutionary biology which had health-related implications. However, Darwinian Medicine started a canonical programme which was aimed to be integrated directly into medical curricula, and to be made central for other scholars from other fields. The main goal was to integrate evolutionary thinking into the medical research, thinking and explanation.

¹⁰ One field, which is easier to connect – psychiatry – is no wonder influential in this regard. Psychiatry is also Randolph Nesse's main field, probably the most central figure to the whole research programme of Evolutionary Medicine since the 90s, also writing one of the most influential books in evolutionary medicine: *Good Reasons for Bad Feelings* (London, Penguin, 2018).

tives have been applied only in relatively recent times¹¹. Following this logic, from a practical perspective, as I will argue later, such explanations mark an ultimate/proximate distinction that is not as strong as it was supposed to be in the Mayrian view on the boundaries of evolution and non-evolutionary biology¹². Moreover, a further problem concerns where integrations come from, given that there are many sub branches of evolutionary biology which are not so slightly connected. The problems mentioned here are of course not limited to these concerns, and they refer back to the canonization problem, starting with the diverse fields of evolution¹³. On top of that, there is the dilemma of integration: the more integrated evolutionary understandings, methods, or hypotheses are to medicine – particularly to clinical practice – the more powerful aspects of explanation are already out of the toolkit of evolutionary medicine, and embedded in the medical profession due to the asymmetry of the practical aspects of these fields. After all, the antibiotics crisis is now mostly handled by medical researchers, and not evolutionary biologists. The integration of evolutionary perspectives to medical teaching and reasoning has been one of the fundamental goals of EM. This is an exceedingly difficult deadlock. In a sense, it testifies the eagerness of medicine to integrate evolutionary insights. However, without a well-established discipline of evolutionary medicine, their success becomes difficult to measure, and at best can be reconstructed with vague boundaries in hindsight.

As regards the success of EM, perhaps we should focus not on the practical side, but on the impact on the public and scholarly communities. The main starting point of Darwinian Medicine as a self-standing book, *Why We Get Sick* (1994), written by Williams and Nesse, has been translated to many languages. It was on the cover of *Bild* in Germany and was targeted at an ex-

¹¹ By these categorizations, I refer mainly to Nancy Cartwright's account of higher and lower-level laws in her *How the Laws of Physics Lie* (Oxford, Oxford University Press, 1984).

¹² The classical landmark of proximate – ultimate causation in biology draws on E. Mayr, *Cause and Effect in Biology*, «Science», CXXXIV (1961), 3489, pp. 1501-1506. The critique of this distinction can be found here: K. N. Laland – K. Sterelny – J. Odling-Smee *et alii*, *Cause and Effect in Biology Revisited: Is Mayr's Proximate-Ultimate Dichotomy Still Useful?*, «Science», CCCXXXIV (2011), 6062, pp. 1512-1516.

¹³ The canonization problems I mention here can also be traced to boundaries problems that are explained by large in the following work: T. F. Gieryn, *Boundary-Work and the Demarcation of Science from Non-science: Strains and Interests in Professional Ideologies of Scientists*, «American Sociological Review», XLVIII (1983), 6, pp. 781-795. However, due to integration and interdisciplinary transfer being very crucial to explain and perceive EM, I do not think that it explains all the concerns I have, and the difficulties EM has. I am grateful to Prof. Matthew Sample for suggesting this perspective.

tremely broad audience (Zampieri, 2006). The authors have been also highly active in the organization of the communities around it. The above-mentioned difficulty of canonization of evolutionary medicine was also recognized by experts working on the understanding of evolutionary medicine. Therefore, in 2018, a panel of 56 scholars has gathered to develop a unifying understanding and a framework that can reflect the shared expectations from the kinds of explanations involved in the field¹⁴. They were provided with structured and guided perspectives on the suggested principles of evolutionary medicine, and read each other's work and arguments in this direction¹⁵.

As a measure of success of this developing field, a good criterion is to also look at the journals currently working in this direction. Today there are many journals such as *Evolution, Medicine and Public Health*, which are quite influential within the domain of evolutionary biology, and by their very nature, combine different perspectives from different disciplines, as well as increasing the collaboration of these disciplines via supplying a common platform. However, the gap between medical research and evolutionary research is still a big one and the current attempts seem not to have solved it so far. In the following sections, while keeping the reservations of developing such an independent field in mind, I will use the Delphi Study of 2018 as the main agreement marker of EM.

1.2. *EM's historical account: Distinguishing Evolutionary Medicine and Darwinian Medicine*

After putting the above-mentioned difficulties of framing aside, from here on I will focus on the core of the research tradition that was started around

¹⁴ The study and the general principles can be found here: D. Z. Grunspan – R. M. Nesse *et alii*, *Core Principles of Evolutionary Medicine: A Delphi Study*, «Evolution, Medicine, and Public Health», I (2018), pp. 13-23. In addition to that, even if we consider Darwinian Medicine as the main surrogate of evolutionary medicine, starting in 90s, it is quite natural that the scholar who wanted to implement the central ideas from accounts of Darwinian Medicine diversified the frequency of the explanations coming from different fields. And since their particular discipline's perspectives need to be adjust to the central ideas of their fields, it is natural to expect more “evolutionary medicines”. I do not wish to go into detail about the reasons of such “scattering” of the central ideas, but I would take it as a given.

¹⁵ As my colleague Matthew Sample suggested, Delphi study have been used as a cold war method to make participants read each other's work until they reached a decision. The methodology is also very much embedded in an elimination way, rather than a method to provide consensus by making the participants explain and defend their positions.

Darwinian Medicine as the surrogate of EM. This was the main driving force behind the Delphi Study of 2018¹⁶. One issue worth discussing here is the research traditions and the connections between them. The question is the following: what are the research activities of EM and, more importantly for my purpose, what are the main principles of EM that we can make use of in medicine? The results of the Delphi study of 2018 are various. The importance of different principles in EM was weighted differently, and the ones which passed the agreement threshold can be organized in various ways. I believe that fundamental questions about what to expect from the understanding of disease is, in the very first place, very different for the medical practitioner and the evolutionary biologist. The clinician asks whether she can intervene on the token of a given disease; the evolutionary biologist, on the other hand, tries to “explain” the given disease as a general structure and category without intervening on it. For any evolutionary “explanation” to gain its place within the literature, the evolutionary biologist should either explain a new phenomenon (such as a disease kind) within the existing theory or use new phenomena to provide a new theoretical addition to the existing body of theory. There is a bias towards the second one, and only the activities of this second case are really going in the direction which can be called “evolutionary medicine”, while the first practice is purely evolutionary biology. I would call this the “explanatory bias problem” for evolutionary biology.

1.3. *The Dilemma of the Starting Point: The Question of the Evolutionary Biologist*

Evolutionary biologists, particularly those who adopt an adaptationist approach, often ask the question: “Why does (a particular or in general) disease exist in the very first place?”. Or, more specifically: “Why haven’t we gotten rid of all the disease conditions that still haunt us?”. To be fair, this question is not asked by the very adaptationist side only but is deeply embedded in the tradition of MS. In what follows, I will discuss the main answers provided to these questions: the first is in terms of trade-offs, the second of mismatch.

¹⁶ Of course, this does not mean that other evolutionary approaches should not be used, or cannot be seen as legit evolutionary medical approaches. On the contrary, I believe that there is much more within evolutionary understandings, thinking, approaches, and methods to be applied to or integrated with medicine. However, my purpose here is to find a general intellectual core about the growth of such perspective.

a) The trade-off answer:

The trade-off answer is a frequent answer given by many established biologists. It allows them to draw on their understanding of MS and apply it to a particular problem. The answer provided does not take the environment as an external causal element in the explanation. Thus, this answer gives evolutionary biologists within a more adaptationist tradition the possibility of thinking about the emergence of disease in the very first place. The usual trade-offs in this kind of explanations are between different traits of the organism, such as the ability to run fast and be robust. In such a hypothetical scenario, since the more robust an animal is, the more often the heavier it gets, there seems to be a trade-off in the organism between these two traits. Another example is the immune system: the more comprehensive it is, the higher the “upkeep costs”. Therefore, the main idea is that, in order to get “immune” to a certain kind of harm, the organism would need, in certain cases, to increase the vulnerability on other fronts, due to the cost of fitness maximization.

b) The mismatch answer:

The mismatch answer is more general than the trade-off answer. In this case, the question of optimization is answered by a plain “yes”: there has been optimization for the given environment where evolutionary processes took place¹⁷. It is argued that however, sudden changes cannot be accommodated by temporally limited changes, since evolutionary adaptation and its inheritance take a long time. This issue becomes particularly tangible in human evolutionary histories and projections, where the concept of *diseases of civilization* is frequently used. The question for the evolutionary biologist would be as follows: how can a trait that was beneficial and selected for at a certain time be maladaptive and harmful under new circumstances? This is what is meant by the so-called diseases of civilization. More specifically, these are used in EM to explain diseases that occurred due to a mismatch between the Pleistocene epoch (2.8 Ma-11.7 kya), when the majority of the human body’s adaptations allegedly took shape, and modern environments. When traced to its origins, this understanding of an “original environment” can be found in psychologist John Bowlby’s 1969 work¹⁸, where he framed the period as Environment of Evolutionary Adaptedness (EEA). I do believe that this is the most central element of EM when scientists explain disease

¹⁷ The trade-off explanation is also about matching differing optimization parameters. However, these are seen within the organism for that.

¹⁸ J. Bowlby, *Attachment and Loss*, New York, Basic Books, 1969.

situations in many cases. From a higher level of abstraction, this explanation enables us to reconstruct the organism-environment relationship question at a more abstract level¹⁹. I will not go much into what to make of EM outside of its capacity of providing explanations here, but I do believe that it is a very important aspect against the medical model of disease, which is also criticized by feminist epistemologies and scholars in disability studies²⁰. In short, medical model assumes the organism to function under the given circumstance without its historical/evolutionary background, and the organism is modelled under an ideal structure. The variation amongst individuals on different metrics, in this model, are also seen ahistorical, purely as medical phenomena.

The limitations of MS are now widely discussed, and the objections towards the established framework are increasing²¹. On one hand, the main question is: what does MS explain? The answer, at first sight, looks rather simple: MS explains evolutionary phenomena. However, MS, like any other research programme, has its own limitations and explanation agenda. The most interesting and limiting aspect in this regard is how MS is committed to explaining the evolutionary relevant phenomena through a heavy reliance on population genetics. MS is prevalent in explanations of EEA because the central assumption of MS is that gradual changes in the allele frequency are the main forces of evolutionary change. In this manner, mismatch situations are seen within the slow work of selection on given inheritance mechanisms.

1.4. *Objections*

When EM is constructed in the way that MS is prevalent in the structuring EEA – *i.e.*, the assumed conditions of tens of thousands of years ago – the human body's relationship to the changing environment is explained by

¹⁹ R. M. Nesse, *Good Reasons for Bad Feelings: Insights from the Frontier of Evolutionary psychiatry*, London, Penguin, 2019. Provides this level of abstraction already in his book on evolutionary psychiatry, however, is mostly thinking still within the framework of MS.

²⁰ In principle my position is more or less in the same line with the approach towards disability studies in that regard, but pointing towards that direction is not within the scope of this paper.

²¹ The objections are many, but for simplicity, I would like to point out to the following discussions: K. Laland – T. Uller *et alii*, *Does Evolutionary Theory Need a Rethink?*, «Nature News», DXIV (2014), 7521, p. 161. And J. Baedke – A. Fábregas-Tejeda – F. Vergara-Silva, *Does the Extended Evolutionary Synthesis Entail Extended Explanatory Power?*, «Biology & Philosophy», XXV (2020), 1, pp. 1-22.

“ultimate” or evolutionary explanations. This distinction is made by Mayr²² (1961) on the basis of “proximate” and “ultimate” explanations. EM indeed relies on the distinction between ultimate and proximate explanations, as Cournoyea points out²³.

The argument from that objection is straightforward: ultimate explanations are not helpful at all at the clinic²⁴. In order to address that issue, the underlying element that makes that objection possible should be addressed. This issue is the proximate-ultimate distinction. Now I will turn to develop an account of EM beyond the proximate-ultimate distinction.

2. *Darwinize Again! Not One Stable EEA but Multiple EEAs*

The traditional EEA is constructed around inheritance mechanisms. Amongst various kinds of inheritance mechanisms, it becomes crucial to define “the EEA” against expected “plastic” or developmental conditions of environment which are easier to be subjected to change. The central idea of EM, based on a singular EEA is straightforward: evolution operates at a slow pace to optimize different traits of the organism, whereas the environment changes too fast with respect to the adapted traits. So, there are problems that arise from this temporal mismatch that the organism must face. In a way, what evolutionary thinking changed about essentialist thinking was the introduction of a certain kind of gradient within the essences, and very fluid, temporary entities about inheritance. According to this understanding, certain aspects of the organism (traits, behaviour, mechanisms of cellular, organismal, or systemic kind, depending on the question that is asked) were shaped through the evolutionary history of the species. Unlike certain mechanisms which remain stable amongst generations, some were prone to change at an awfully slow pace. This means, to a certain extent,

²² E. Mayr, *Cause and effect in Biology*, «Science», CXXXIV (1961), 3489, pp. 1501-1506.

²³ For such criticism: M. Cournoyea, *Medical Explanations in Evolutionary Medicine, Network Medicine, and Medically Unexplained Physical Symptoms* (Doctoral Dissertation), Chapter 4, 2018, and M. Cournoyea – A. G. Kennedy, *Causal Explanatory Pluralism and Medically Unexplained Physical Symptoms*, «Journal of Evaluation in Clinical Practice», XX (2014), 6, pp. 928-933.

²⁴ I do take this objection rather seriously, although I believe that even an orthodox account can be helpful in many other ways out of explanation. For that account (O. A. Altinok, Springer, 2022, forthcoming). There are other objections as well, but I think this one is the most prevalent in the main debate, and at any case a very categorical objection for EM, therefore, I prefer to reply to that.

writing evolutionary histories of hugely different entities, or parts of entities in different ways due to the differing speed of evolution. The evolutionary history of an organ can be different from the evolutionary history of a molecular mechanism. Moreover, these evolutionary histories, although almost necessarily in a relationship, do not need to be in a positive feedback relationship (in the sense of being selected together), and their effect on each other can also vary (from complicated to none) through the evolutionary history of the species. The important question for EM then becomes “what kind of stabilizing history has been there for any entity/mechanism, and to what extent it is meaningful”.

In what follows, I will start with accepting Evolutionary Medicine’s understanding of EEA as central to the structure of EM, and take it to another context. More specifically, I will keep the main idea of EEA intact and try to address the main perspectives that make EEA possible. That is, I will focus on how historically consolidated selected mechanisms are inherited and what kind of consequences we can expect from this kind of research programme. The common assumption in both these explanations is the mainstream and established environment-inheritance system or evolutionary – non-evolutionary dichotomy.

The question is whether there are enough inherited mechanisms which would provide us with a large enough and explanatory enough understanding that can help us to construct new models of EEA (or, more likely, multiple EEAs). I think this is an open question, and it can be determined empirically only. However, I think that recent developments in evolutionary biology (particularly epigenetics), provide us with enough reason to pursue this goal²⁵. I draw a general explanatory structure based on EEA that can be helpful in providing a base for further research in this sense, also including research that is done under the umbrella of inherited epigenetics within evolutionary med-

²⁵ The discussions regarding the limits of epigenetics in inheritance are still issues of debate at the moment. Here I am following the conceptual framework of Jablonka and Lamb (2005). See E. Jablonka – M. J. Lamb, *Evolution in Four Dimensions: Genetic, Epigenetic, Behavioral, and Symbolic Variation in the History of Life*, Cambridge (MA), MIT Press, 2005. And the more recent empirical cases: E. Jablonka – M. Lamb, *Inheritance Systems and the Extended Synthesis*, Cambridge (UK), Cambridge University Press, 2020. For the analysis of different epigenetic research traditions about inheritance and development; I can suggest my consideration of epigenetics in this context of course falls into inherited epigenetics perspectives: see J. Baedke, *Above the Gene, Beyond Biology: Toward a Philosophy of Epigenetics*, Pittsburgh (PA), University of Pittsburgh Press, 2018. In his introduction, Baedke particularly points out the growth of epigenetics as a field that is not only growing more in size but becoming ever more relevant for explanations in biology.

icine. Unfortunately, I do not have the space to elaborate on empirical studies of “non-traditional inheritance” or directed evolution of such traits. I will take the second step to make sense of such studies within the framework of EM instead²⁶. The question then goes towards whether environmental conditions are stable enough to give an account of inherited but stable structures.

In this regard, I propose two distinct approaches. The first points at certain social groups which, due to different reasons (such as slavery, racialized society or religious practices or geo-social barriers) have been living in certain environmental conditions that are different enough to make a difference to the mechanics of inheritance in their own making²⁷. The second is about smaller groups, such as individuals and families, who also have been going through certain inherited mechanisms. However, due to their smaller size, short-term inheritable mechanisms are much more important in such explanations. Of course, it is also possible to have varying degrees of inheritance between single to two generational inherited traits and longer-lasting, racialized or divided social inheritance situations²⁸.

What to make of these scenarios? One conclusion is acknowledging the complexity of bodily responses and working towards a conceptual framework aimed at generalizing the concept of environment. My suggestion is that, instead of looking for or looking at specific environmental conditions having certain effects, we should keep the research open for having pathways, structures, mechanisms of the organism that are in relation to, or at least relatable with various kinds of environments. These can have a similar effect or similar series of effects. I do believe that given today’s understanding of epigenetic inheritance mechanisms, the creation of such research programmes is possible. In short, this perspective is similar to the classical understanding of EM, where there is a match and mismatch for certain characteristics that can be influenced by different events in the life history of a certain group and the mechanisms that are calibrated can be resulting in different situations, sometimes radically different from the initial cause of

²⁶ For case studies Dutch Hunger Syndrome, or in general, any landmark epigenetic study can be a good start to look at.

²⁷ Such “2set environments” for a couple of generations can work on multiple mechanisms of inheritance, fortifying the explanatory power of the explanation further. For a study of such a situation at a large scale, see J. Degruy-Leary, *Post-traumatic Slave Syndrome: America’s Legacy of Enduring Injury*, Portland (OR), Joy DeGruy Publications Inc, 2017.

²⁸ Here racialization refers to two distinct phenomena. One, due to racialization, people live in certain kinds of environments, such as in the case of slavery, where the environments are fixed, or at least restricted and channelled. Second, I refer to the embodied and clustered racialization of the biologies of the people in question.

segregation of a given population, however the populations are subdivided and the environments tailored differently²⁹. Of course groups in nature are never completely static, but in cases of regulated socialization and localization that took place in the relatively recent history of human social groups, I think we can still talk about those as a causal factors.

When it comes to the usage of other evolutionary entities such as “hologenomes” or “holobiomes” as evolutionary units of selection³⁰, the potential of the field becomes even more obvious. Even when it comes to dealing with the current pandemic, and the studies of epidemiology, the rapid evolution of microorganisms in nature are shown to be outweighing other ethical concerns of research³¹. These entities are not categorically dismissed in the current accounts of EM, but more emphasis on them can be helpful to reconstruct different and interrelated evolutionary histories of different evolutionary entities, which can make them more clinically relevant.

3. Conclusion

In this paper, my starting question was simple in its generality but dense in its scope: what to make of EM if nontraditional inheritance mechanisms are recognized as common? I do not claim to have given a full account of that, and I do not even think that answering such a question in a conclusive way is possible. I took the main objection as the main counterargument – that is, ultimate explanations coming from evolutionary biology not being relevant to clinic. One general answer to this question comes from an approach that sees evolutionary explanations as ultimate explanations (following Mayr) and is represented in the recent discussions in Cournoyea’s account. This perspective is evaluating any body of knowledge (evolution, in this case) with the aim of providing an interventive structure directly at the clinic (Cournoyea, following the first claim). I do not agree with this perspective.

²⁹ Segregation practices as well, being a part of the environment, have effects in the biology of the life history of the group. The extent, and the concrete examples of these however, are open to further study.

³⁰ J. Suárez, *The Importance of Symbiosis in Philosophy of Biology: An Analysis of the Current Debate on Biological Individuality and its Historical Roots*, «Symbiosis», LXXVI (2018), 2, pp. 77-96.

³¹ N. S. Gati – O. A. Altinok *et alii*, *Integrating Evolutionary Aspects into Dual-use Discussion: The Cases of Influenza Virus and Enterohemorrhagic Escherichia Coli*, «Evolution, Medicine, and Public Health», IX (2021), 1, pp. 383-392.

So far, my claim is that the existing forms of EM are helpful within research programmes. However, evolutionary reasoning, theories and frameworks are being helpful in medical thinking, research and practice in ways that are not traditionally categorized under evolutionary medicine. On the other hand, the main principle of evolutionary medicine, EEAs, when seen as central to explaining medically relevant phenomena, can still be useful. This is especially relevant if we consider the recently emphasized importance of non-genetic (or, at least, not directly genetic) inheritance mechanisms and their relationship to the environment. Defending the potentials of evolutionary perspectives in medicine is different from acritically integrating evolutionary explanations to medicine. While the current EM accounts are still to be implemented in medicine, in many different ways, new possibilities coming from the renewal of evolutionary accounts are to come. I believe that when evolution is seen as a larger and richer domain, including different inheritance mechanisms and evolutionary entities, EM can have an even larger potential.

* * *

I would like to thank Andra Meneganzin for her helpful editorial perspectives.

I would like to thank DFG for funding RTG 2220 EvoPAD for giving me the opportunity to work in close contact with evolutionary biologists.

OZAN ALTAN ALTINOK
Center for Ethics and Law in Life Sciences,
Leibniz University of Hannover, Germany
ozan-altinok@cells.uni-hannover.de