Academy of Romanian Scientists *Volume 9, No. 2, 2020, pp. 5 - 25*
Annals Series on Biological Sciences ISSN 2285 – 4177
 ORIGINAL PAPERS

The Human Evolution – Past, Present and the Future

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Abstract
Just as the title itself suggests, the present article represents a synthesis of the information pertaining to the origins of the modern human being, the history of his becoming, his departure from Africa (the cradle from where he emerged) and his conquest of Earth, his transition from nomadic behaviour and the hunter-gatherer occupation (which spanned most of his existence) to the shepherd-farmer one, as well as the consequences of this so-called revolution on the evolution, of his social relationships and on the gradual progress made in all spheres of his activity over the past 10,000 years. The question is whether or not man evolved after his emergence about 200,000 years ago and migration from Africa. One chapter of this paper is dedicated to this aspect, bringing a series of arguments to attest that man has continued to evolve biologically and that, depending on the specific conditions of environment and life, diseases faced over centuries and millennia etc, he has undergone not only spiritual and cultural ones but also some genetic changes. Some obvious questions arise as to whether the evolution of man as a species has ended or he will still evolve in the future, the perspective of this process in view of the conditions of huge progress in various technologies, medicine, biology and molecular genetics, genetic engineering (intervention tool in its very genetic structure) as well as regarding the fulfilment of perhaps its most daring dream - that of conquering other planets. The last chapter of the paper tries to offer solutions to these challenges.

Keywords: origin of man, species of Homo, human evolution, man of the future

DOI https://doi.org/10.56082/annalsarscibio.2020.2.5

Introduction

What do we actually mean by evolution as a biological phenomenon? It is the gradual process through which variations in characteristics determined by changes in the genetic material of a species place the affected organism in a more favourable situation under certain environmental conditions, and, as a result of the intervention of natural selection, these variations are perpetuated and become common over time within a group of individuals that deviate from the initial type. If we refer to man, the fact that he is the end of his evolutionary line may induce the idea that, in his case, evolution has ceased. This way of seeing things is also fuelled by an irrefutable reality, namely that in the modern age man has somehow escaped from the pressure of natural selection, that he is able to create artificial conditions that no longer make him dependent on a certain lifestyle, that he can save himself and his offspring who would normally not survive, due to the undeniable advances of modern medicine. Nowadays, man is present everywhere on Earth, regardless of living conditions and, since not so long ago, in outer space. The unparalleled conquests in all fields of knowledge, recorded in the last century by human society, and the abundance of information that accompanied them induced new perspectives upon the potential future evolution of man. In connection with this subject, various ideas circulate, such as the one that the man of the future will have a much larger head and, implicitly, a larger brain to match it, a higher forehead and superior intelligence, or, on the contrary, that his physical evolution is over and that we can only expect a cultural human evolution. Anthropological observations on ancient human fossils have shown that the vision of the future growth of cranial mass in humans is false, the size of the cranial box being about the same after thousands of successive human generations [56] and, according to other information, the human brain may have actually shrunk in size. Current DNA investigation techniques allow us to take a comparative look at the human genome now and in the distant past and discover that, over time, our species has undergone significant changes in physiology, behaviour, etc [56]. But before we decide on whether man has evolved in any way from his appearance until today and how things will be in the future, we may briefly dwell on his becoming and on some information about the ancestors of *Homo sapiens*.

1. The origin of the modern human (Where do we humans come from?)

In a previous paper we showed that *Homo sapiens* is part of the order *Primates*, the suborder *Anthropoidea*, the infraorder *Catharina*, the superfamily *Anthropomorpha*, the family *Hominidae* [13]. There are rather fanciful opinions that try to get our species out of the animal kingdom and that propose that man be classified in a separate kingdom called *Crania* or *Symbolia* and even in a separate domain - *Demiurgia*, due to its cultural performance and ability to transform any element and create new elements on Earth, having adaptive radiation throughout the biosphere due to its reproduction strategy [2]. In our previously mentioned paper, we indicate that primate representatives have the following basic characters: prehensile forelimbs, fingernails instead of claws, frontal eye sockets, neural skull developed relative to the facial one, superior brain volume relative to size the body, the visual, auditory, tactile and kinaesthetic senses more developed compared with the olfactory one, dentition adapted to an omnivorous food regime; some references were also made to the most distant ancestors of man, but also to arguments that attest the kinship of man with anthropomorphic monkeys.

According to paleontological discoveries in the Miocene, there was a great diversity of monkeys on the African, Asian and European continents. DNA analyses on great apes have shown that man, on the one hand, and the chimpanzee and bonobo, on the other, have a common ancestor, from which they descended about 6 million years ago (6 Mya), [41, 17]. In fact, the closest genetic relatives to the modern man are: the chimpanzee among the living, and the Neanderthal among the extinct (whose common ancestor with the modern man lived 600 thousand years ago - 600 Kya), (K. Pollard, quoted by Norris, 2010) [39]. Actually, the human and chimpanzee genomes are amazingly similar: the DNA sequences in the genome that can be compared to the two species have an identity of around 99%, and, if we were to consider the DNA insertions and deletions, this identity of the two genomes is still 96% (4). The Hominin category includes species more closely related to the modern man than to the chimpanzee. Hominins are characterized by erect posture, bipedal locomotion, relatively large and complex brain, smaller teeth, ability to make complicated tools (things), sophisticated social behaviour and language [18, 40]. The first (typically human) characteristics analysed in ancestral hominid fossils include bipedal walking and smaller, blunt canines.

Regarding the origin of modern man, based on some arguments existing in his time, more than 150 years ago, Charles Darwin considered that man's ancestors came from Africa [33]. Currently, in this respect, there are two hypotheses regarding the origin of modern man: the "out of Africa" and the "multiregional" models. Most authors believe that modern man came from Africa (the "out of Africa" hypothesis), where he emerged about 200 Kya ago and then migrated and colonized the rest of the world, replacing Neanderthal man and other archaic people, without crossing (mixing) with them, a hypothesis that would be supported by most genetic evidence [26, 23, 24, 48, and others]. This model therefore supports the idea of a single and relatively recent transition from archaic hominins to modern humans in Africa [33]. The other hypothesis claims that modern man appeared simultaneously in several places on Earth and that he had a multi-regional appearance [55]. This model was first proposed by Weidenreich in 1946 (quoted by Lopez et al., 2015) [33]. According to this hypothesis, modern man descended from local archaic humans (evidence of some physical characteristics common to them), as a result of which all fossil forms of humans from the last over 2 Mya could be attributed to a unique, polytypic species.

In this regard, S. H. Lee (quoted by Martinon-Tores, 2018) [35] believes that hominid fossils discovered in Dmanisi (Georgia) are as old as those identified in Africa, that *Homo erectus* originated in Asia and migrated later to Africa to generate later *Homo* species, and Denisovans would be “Asian Neanderthals” [35]. There is also a so-called “*candelabra model*”, sometimes confused with the multiregional model. According to this model proposed by Coon in 1962, the ancestors of man migrated from Africa to other continents about 1 Mya ago and during this whole period of time, modern humans derived from these autonomously, at several points in time and in different locations around the world [33]. .

Hawks (2012) considers that human evolution can be divided into 3 stages: the first took place 7-4 million years ago (Ma), when hominin lineage appears, with bipedal locomotion; the second, between 4-1.8 Mya, was the age of australopithecines, hominine bound bipeds, with a stable set of adaptations, some similar to early humans, but with a low brain volume (about 450 cm^3); the third stage began about 1.8 Mya ago, when the genus *Homo* appeared, [21]. Other authors believe that the genus Homo appeared in Africa 2.5 Mya ago (and with it the first stone tools), then spread in Eurasia about 2 Mya ago, generating more species of this genus [17].

The earliest ancestors of man on Earth were *Sahelanthropus tchadensis* (identified in Chad) which seems to have been the first known hominin, about 7 million years old (Ma), *Orrorin tugensis* (identified in Kenya) with an age of 5.7-6 Mya and *Ardipithecus ramidus* (identified in Ethiopia) with an age of about 4.4 Mya [29, 10, 18, 41, 49]. *A. ramidus* seems to be the first hominid, having about 1.2 m height, erect posture, optional bipedal gait, smaller canines [42], some of his characters suggesting that he spent most of his time in trees. His brain was about the size of a chimpanzee, about 300-350 cm^3 [10, 41]. *Ardipithecus* may be the common ancestor of chimpanzees and human ancestors and, at the same time, australopithecines may have descended directly from it [10].

A successful hominin was *Australopithecus* ("southern monkey", as Harari calls it, 2017) [17], which had a brain of about 390-515 cm^3, presented an accentuated sexual dimorphism (females of about 30 kg, males of about 40 kg), and whose food consisted chiefly of plants. *Australopithecus* survived about three million years and, within this kingdom, several species succeeded in eastern and southern Africa, including: *A. anamensis* (4.2-3.9 Mya ago), *A. afarensis* (3.9-2.9 Mya ago), *A. bahrelghazali* (3.5–3.3 Ma ago), *A. africanus* (2.8–2.3 Mya ago), *A. robustus*, and *A. boisei* (2.5–1.5 Mya ago), [21, 41]. Among the australopithecines, it was Lucy who became famous, a female specimen of *A. afarensis*, whose skeleton was discovered in 1974 in the Afar region of Ethiopia. Lucy lived about 3.2 Mya ago, had a height of about 1.00 - 1.4 m, a weight of about 29 kg, a small brain (about 450 cm^3), and the bones of the pelvis and legs showed an upright posture and bipedal movement ability [21].

The oldest fossils of the genus Homo - *H. habilis* (2.3-1.4 Mya) have been identified in East Africa. Unlike australopithecines, they had a brain of about 510 cm^3, arms and legs more similar to humans, were small in stature, had smaller teeth (due to changing diet), used stone weapons [42]. Their daily diet consisted not only of plants, but also of food richer in energy – meat and bone marrow from animal bones (obtained by crushing them with stone tools). *H. habilis* was followed by *H. erectus* ("upright man"), a successful species, able to adapt to various environmental conditions, which survived about 1.5 Mya, migrated from Africa to other continents, including Europe and Asia, being the first of the primates to use firearms and hunting weapons [42, 57]. Representatives of this species had a higher cognitive capacity than before, due to the obvious increase in brain mass (about 1200 cm^3) and lost the adaptation of limbs for climbing; their daily diet probably consisted of softer food, richer in energy, as the size of the molars was smaller etc. [41].

From *H. erectus*, about 700 Kya ago (perhaps even earlier), descended *H. heidelbergensis*, a species considered as an "archaic" *H. sapiens*, given the proportions of the body, cognitive capacity, type of dentition, active hunter qualities, the ability to make useful tools and even to control fire – apparently discovered more than 400 Kya ago and used daily for the last about 300 Kya [17]. The Neanderthal (*H. neanderthaliensis*) is said to have descended from European populations of *H. heidelbergensis* about 250 Kya ago, while the modern man (*Homo sapiens*) supposedly emerged from the *H. heidelbergensis* of East Africa about 200 Kya ago [41]. Neanderthals were more massive and muscular than modern humans, better adapted to the cold climate of the glacial period of Europe and Western Asia [17]. There is still controversy among paleoanthropologists, some considering Neanderthal and Cro-Magnon humans to be separate species, others viewing them as subspecies within *Homo sapiens*, namely *H. sapiens neanderthalensis* and *H. sapiens sapiens*, respectively. No wonder there are discussions in this regard, if we consider that between Neanderthals and modern man the differences in DNA are quite small, but they have a larger brain (about 1600 cm^3) than ours (about 1350 cm^3), [42].

By consulting the literature on the origin and evolution of man, we discover other species of archaic people attributed to the genus *Homo*, depending on certain characteristics and the place where their fossil remains were identified. Among these we mention: *H. rudolfensis* – which lived in the early Pleistocene in the area of Lake Turkana in Kenya and which seems to be rather an australopithecine or a subspecies of *H. erectus*; in eastern and southern Africa lived about the same time (1.9-1.4 Mya) *H. ergaster*, also considered to be a subspecies of *H. erectus*; in the same situation would be *H. soloensis* – another subspecies of *H. erectus*, which lived on the island of Jawa, being adapted to life in the tropics; *H. floresiensis* – is the archaic dwarf man (with a maximum height of 1m and a weight of 25 kg) who lived on the island of Flores (Indonesia) before the arrival of modern man, about 50 Kya ago; a mysterious hominin is the *Denisova Man*, who allegedly coexisted with the modern man, being considered by Lee (quoted by Martinon-Tores, 2018) as an "Asian Neanderthal". The Neanderthal is said to have a more recent mitochondrial common ancestor with the modern man than with the Denisova man: 466 Kya in the case of the first and 1.04 Mya for the latter [24]. For Harari

(2017), things seem settled: *"The truth is that, starting from about two million years ago and until about 10,000 years ago, the world was at the same time the home of several human species*" [17].

It is possible that, as more detailed molecular investigations are being carried, in particular in the case of the analysis of mtDNA and the Y chromosome *("furrowed by all the scars of evolution"*, as Mukherjee put it, 2018) [38], and with the use of bioinformatics, the analysis of hominid fossils discovered up to present, but also of the fossils that are expected to be unearthed, will bring to light new information that will help us outline even more precisely the “route” that we followed up to the status of “sapiens”.

Regarding the place and time of the emergence of modern man, there do not seem to be important differences of opinion between specialists, in the sense that its origin is considered Africa, where it appeared about 200 Kya ago [42, 44, 46, 52, 56, 58 etc]. In a paper published back in 1987, Cann et al. (quoted by Haskett, 2014 and other authors) showed that comparative analyses of mtDNA of 147 people in five different geographical regions of the globe suggested that they came from a common ancestor who lived 200 Kya ago in Africa. The group of individuals from Africa presented the largest variations in mtDNA, followed by the group from Asia. In all of the analysed groups, most mutations occurred in the D-loop region of mtDNA. According to the resulting data, the authors estimated that the modern man left Africa about 90-180 Kya ago, colonizing Australia 40 Kya now, New Guinea 30 Kya now and New World about 12 Kya now. Ingman (2001) showed that DNA studies suggest that the modern man came from Africa, emerged as a founding population about 170 Kya ago, from where he migrated to other parts of the world, replacing other hominids [26].

The most recent common ancestor of the modern man appeared about 200 Kya ago, which makes us descendants of the so-called *"Mitochondrial Eve"* (an expression now used by many specialists), a woman who lived in those days in Africa and whose mtDNA we inherit, [61]. The genes of the modern man are said to descend from a single population of about 10,000 individuals [16], who lived in sub-Saharan Africa about 150 Kya ago, [7]. Pikrell et al., (quoted by Lopez et al., 2015) [33] highlights an old link between populations in southern and eastern Africa and believes that both areas could be places where the modern man emerged. An extensive genealogical project, conducted by Spencer Wells, started in 2005 over several years, which included more than 100,000 DNA samples taken from indigenous individuals around the world, followed the process of human migration from Africa and its spread to other parts of the world, but also how some factors such as culture have influenced *"patterns of genetic diversity"*. It was found, among other things, that mtDNA analyses show that the group of Khoisan individuals (indigenous to South Africa), separated genetically from other Africans about 150-90 Kya [28, 43 46].

Disputes between specialists arise regarding the migration of modern man from Africa to other parts of the world, the geographical routes followed, the timing of his departure from Africa, the reasons that caused this event, whether it occurred once or multiple times etc. In a synthesis article, Beyn (2011) shows that three models have emerged regarding the departure of the modern man from Africa: a model (that of *"African Eve"*) claims that, after his emergence on African soil, the modern man migrated about 100 Kya ago in other parts of the world, replacing the archaic people *"without any genetic admixture"*; another considers that modern man appeared only in a limited area of Africa, from where he then migrated and replaced the archaic people in their path; there is also the model of a multiple dispersion of early modern man in other geographical areas [7]. The original exodus from Africa (”the Great Expansion”) allegedly included between 1000 and 50,000 [16], or approximately 2,500 individuals [22]. "*We know that this migration occurred because the genomes of all humans outside Africa belong to a subgroup of the genome ensemble which is found exclusively in Africa*", specifies Kenneally (2019) [28]. According to DNA studies on mtDNA and the Y chromosome, a small population formed a group that escaped from the African continent and found a new home, grew in size, after which a subgroup (of "founders") broke away from it and went in search of another inhabitable area and this process continued until the modern man gradually conquered all continents [61]. Based on the data available, Henn et al (2012) considered that the migration of the modern humans started from the south of Africa to other regions of this continent, then a small number of people from Northeastern Africa continued their expansion to Eurasia, Oceania and probably Americas [22].

Two possible routes out of Africa have been advanced: a northern one - through Egypt and Sinai, and a southern one - through Ethiopia, the Bab el Mandeb Strait and the Arabian Peninsula [16]. Genetic studies of Y chromosome haplogroup distributions in populations in Africa and the Middle East, but also the results of genome sequencing of individuals in Egypt and Ethiopian ethnic groups, seem to support the hypothesis that the northern route was the one through which the modern man migrated from Africa. However, there is also information based on the mtDNA study that supports the hypothesis of the modern man leaving Africa on the southern route, after which he travelled to various areas of Southeast Asia and Oceania [33]. In his paper, Beyn (2015) shows that there is consensus on the routes (northern and southern) of modern human migration from Africa, but not on the timing of this event and the populations that were the source of human colonization of Eurasia in Upper Pleistocene [7].

Regarding the time of the emergence of modern man and his departure from Africa, there are other opinions in the literature, such as the one according to which he appeared about 141 Kya ago and migrated from Africa approximately 45 to 60 Kya ago [22], or even about 70 Kya ago [17, 58]. Harari estimates that the human cognitive revolution started 70 Kya ago, representing the beginning of human history. Blaxland and Dorey (2018) show that, based on genetic and material evidence, most experts believe that the mass exodus of the modern man from Africa took place in the last 60 Kya, with the exception of the Levant region, which was occupied by him about 120-100 Kya ago [8]. The moment when the modern man left Africa is described by Stix (2008) as follows: *"Fifty or sixty years ago a small band of Africans - a few hundred or even several thousand - crossed the strait in tiny boats, never to return... Those first trekkers out of Africa brought with them the physical and behavioural traits - the large brains and the capacity for language - that characterize fully modern humans"* [46]. At the same time, the genetic variation observed in today's human populations would have developed 50-70Kya ago, mainly due to the genetic drift resulting from the confrontation of small migratory populations around the world with various environmental conditions [47].

Based on the study of the distribution of mtDNA haplogroups, Rito et al., 2013 (quoted by Lopez et al., 2015) consider that *"the most recent common ancestor of modern mtDNA"* arose in Central Africa. It later split into South African groups (such as Khoe-San) and Central East African groups. 70 Kya ago, a large eruption of the Mount Toba volcano in Sumatra was followed by an ice age that lasted about 1000 years, putting great pressure on *H. sapiens*, forcing individuals to cooperate, to associate in groups of families and tribes [57]. Some consider that we, today's humans, would be descendants of the survivors of that cataclysm [28]. Information obtained from investigations by the means of molecular techniques, especially through the study of mtDNA and the Y chromosome (*"while mitochondria tell the female story, Y-chromosomes tell the male story"*, states Hodgson and Disotell, 2010) suggests that modern man lived for the longest period of time in Africa and that his expansion into Eurasia took place more recently. At the same time, the study of genomic diversity in different human populations shows that African populations have a greater genetic diversity than non-African ones [24]. The presence of the modern man in Europe is certain starting with about 30-40 Kya ago (Dodge, quoted by Paixao-Cortes et al., 2012). His first fossils were discovered in south-eastern France, and their age was estimated at 23-27 Kya. This is the Cro-Magnon man. Unlike Neanderthals, Cro-Magnons were taller, had less massive skeletons and muscles, a more rounded skull box, a higher forehead, a smaller face, and a more developed brain, [58].

Up to around 35 Kya ago, after his departure from Africa, the modern man had already conquered much of the Old World: 80-60 Kya ago he had conquered Asia, 45 Kya ago he had reached Indonesia, Papua New Guinea and Australia, about 40 Kya he had gotten to Europe, 35-30 Kya ago he had arrived in North-eastern Siberia, and about 15 Kya ago he had travelled from Asia to North

America (through the Bering Strait) and from there to South America [16, 28, 58]. The departure of the modern man from Africa caused the 6th mass extinction of some animals, the destruction of plains and forests for agricultural purposes, climate change etc. Human migrations have led (due to game) to the extinction of a large number of large mammals (mammoths, mastodons, giant sloths, woolly rhinos, Irish elk) in Eurasia, many marsupial species (giant kangaroos, wombats) in Australia, the biggest part of the flightless birds in New Zealand, large mammals (horses, camels, giant armadillos, mammoths, ground sloths) in North America. Probably the very disappearance of these large animals was a factor that determined the transition of man from the occupation of hunter-gatherer to that of farmer [31, 32].

The Neanderthal disappeared 30 Kya ago [15, 17, 21, 28], being contemporary with the Cro-Magnon man for a period of about 5,000 years [38] or even more, circa 12,000 years [23]. The populations of the two species came in contact and it is believed that they sometimes even mated. In some papers, this possibility is not excluded, but it is considered a rare event, supported by the absence of hybrid characters in the Neanderthal and Cro-Magnon skeletons analysed, [58]. Comparing the genome of the Neanderthal man with the genome of modern humans in different parts of the world, Green et al. (2010) show that "*Neanderthals shared more genetic variants with present-day humans in Eurasia than with present-day humans in sub-Saharan Africa, suggesting that gene flow from Neanderthals into the ancestors of non-Africans occurred before the divergence of Eurasian groups from each other*" [15]. At the same time, the authors highlighted 212 regions of the Neanderthal genome that in modern humans have undergone adaptive evolution after the separation of the two species, including genes involved in skeletal development. The investigations of some authors (Krause et al., quoted by Hodgson and Disotell, 2010) revealed in Neanderthal remains an identical form of the FOXP2 gene with that of humans. As this gene is involved in modern human language, the authors believe that Neanderthals possessed language similar to ours and that the FOXP2 gene was attached to the two species before their divergence. Hodgson and Disotell (2008) find the discovery interesting, but suggest that *"it is premature to conclude from this that Neanderthals shared our language ability"* [23]. Some profile information [15, 23, 28, Reich et al., cited by Paixao-Cortes et al., 2012] shows that current non-African human populations have 1-4% nuclear DNA of Neanderthal origin, and the current Melanesians of Papua New Guinea and Bougainville Islands possibly inherit 4-6% of the genes from the archaic Denisova population. According to other information, this interbreeding probably occurred 37-85 Kya ago, when the DNA from the Neanderthal is found in a proportion of about 1.5-2.1% in the genome of modern man outside Africa, that 9 genes (including those associated with type 2 diabetes, lupus and Crohn's disease) come from the Neanderthal man, that a DNA sequence - associated with the concentration of haemoglobin at high altitudes in the Tibetan genome, could come from Denisova man etc [57].

Commenting on the data from the literature on this topic, Hodgson & Disotell (2008) conclude: *„It seems unlikely that Neanderthals contributed any substantial fraction of modern variation and it remains to be seen whether any adaptive alleles crossed the human-Neanderthal species boundary”* [23]. A similar conclusion has been reached by Green et al. (2010): *”The analysis of the Neanderthal genome shows that they are likely to have had a role in the genetic ancestry of present-day humans outside of Africa, although this role was relatively minor given that only a few percent of the genomes of present-day people outside Africa are derived from Neanderthals”* [15]. It is certain, however, that the populations of the two species intersected in some parts of Eurasia and that they probably competed for environmental resources. In fact, Mukherjee (2018) considers that *"Neanderthals were our neighbours and rivals"* and that we probably contributed to their extinction [38]. The last close relative of *Homo sapiens*, which has disappeared about 13 Kya ago, was *Homo floresiensis* [17].

2. Are humans still evolving?

Each of us has probably wondered if the modern man has evolved ever since his appearance, whether we are now the same as our ancestors in the beginning or those who lived, say, 10-15 Kya ago or even more recently. It may seem surprising to some, but the answer provided by most specialists is categorical: Yes, we have evolved, we are no longer the same, although as a species we are the same – *Homo sapiens sapiens*. However, there is information in specialized literature according to which the biological (genetic) evolution of man has stopped and that now his evolution would take place only in terms of ideas, memes [S. Jones, 2002 - quoted by 52 and 56]. However, other information shows that, on the contrary, the rate of human evolution has accelerated continuously since the last glaciation [58]. Out of Africa and gradually spread all over the world, the modern man has been faced with new living conditions, new selective pressures, the most radical being determined by the transition to domestication and growth of plants and animals [20]. From hunter and fisherman, gatherer of fruits and seeds for food, man becomes a farmer, which forces him to move from nomadic life (in families and groups) in search of new sources of food, to stable human settlements. The agricultural revolution, along with wars and slavery, paved the way for man to civilization [21]. There are observations and information that over 7% of human genes have undergone evolution in the last about 5,000 years, many of these changes being adaptations to particular environmental conditions, or that over 300 regions of the human genome have undergone changes that have led to improvements in survival and reproduction [52, 55].

The beginning of the agricultural revolution coincides with the end of the most recent glaciation, the Younger Dryas, about 11,500 to 11,700 years ago, when the Earth suddenly warmed and many areas became suitable for agriculture [32]. Over the last around 7000 years (Anthropocene Age) the climate of Earth stabilized, which allowed his development and the production of a surplus of food that facilitated not only population growth and the emergence of ever-increasing permanent human settlements, but also the specialization of individuals for other tasks, created the conditions for innovation and cultural development [14, 47,]. The wave of domestication of plants and animals ended broadly around 3500 BC. Interesting and suggestive is Harari's (2017) interpretation of this major event, showing that a handful of plant species *"domesticated Homo sapiens rather than vice versa"* [17]. It is certain that around 8500 BC there were already permanent settlements in the Middle East, such as Jericho, where people cultivated some of the domesticated plants. The new occupation of man created important food resources, which ensured the growth of the population at a much faster pace and also led to the change of some eating habits, of his diet up to that point. Before man became a farmer, the Earth was inhabited by around 5-8 million nomadic hunter-gatherers, with their number being reduced to about 1-2 million in the first century AD, while those who practiced agriculture (on only 2% of the Earth's surface) amassed to around 250 million.

Pre-industrial human societies in Western Europe and North America were characterized by high fertility and mortality rates. The intense industrialization of the last two centuries produced obvious changes in lifespan and family size, determining an increase in longevity, lower fertility and a reduction of the pressure exerted by selection on the characters associated with mortality [21].

Due to the natural phenomenon of mutation, but also to that of genetic recombination, together with the numerical growth of human populations, their genetic diversity has also increased. Over the last 40 Kya, the selection rate of new adaptive mutations / alleles has been strongly accelerated [20]. Man's life in growing communities has led to the diversification of his concerns, the social division of labour, changes in habits, diet, etc., the modern man faced new challenges, such as, for example, the contracting and easier spread of contagious diseases. The transition of the modern man from nomadic to farmer life increased mortality caused by some epidemic diseases such as smallpox, malaria, typhus, yellow fever, cholera, measles, influenza etc [58, McNeill, quoted by 20]. It has also been considered that genes that have undergone recent evolution in humans are associated with immunity to pathogens, skin pigmentation, brain development, reproduction, etc [60]. Pathogens have been an important factor in recent human evolution. Just for malaria resistance selection has promoted over 20 alleles in various human populations, there were also gene variants for the MHC system (*Major Histocompatibility Complex*) etc [21]. The last 10 Kya are said to have brought rapid evolutionary changes of the human skeleton and dentition, the emergence of new adaptations to diet and disease. Under conditions of a more refined human diet, changes in jaw size and dentition have occurred [47]. Some pathogens considered to have been transmitted to humans from domestic animals were apparently present in foragers long before the agricultural revolution [4]. Another element also intervenes in the bacterial infection in humans, capsase-12, whose presence causes a weaker response to such infections. The gene for this enzyme has been gradually inactivated in human populations. It is not known why our ancestors had this gene active, but it has been found that individuals with both inactive copies of the gene are much more likely to withstand a severe bacterial infection and survive. Mothers carrying HLA-B genes have also been shown to be more likely to survive HIV infection, [60]. Some mutant genes that cause disease in humans have been preserved in the human gene pool because they give it advantages in certain environmental conditions. This is the case of sickle cell anaemia (sickle cell disease), a disease in which the erythrocytes take the form of a sickle, caused by a mutation that causes the replacement of glutamic acid with valine in the 6th position of the β-globin chain. In the homozygous state, the gene is lethal, but in the heterozygous state it allows the survival of those affected, which creates health problems, but also ensures their resistance to malaria in the areas affected by this scourge [12, 44].

The human diet has become predominantly vegetarian, largely dependent on a number of grains [58]. The food provided by cereals ensured the earlier weaning of children and allowed women to give birth at shorter intervals [35]. An interesting adaptation, which appeared in the last 5-10 Kya in some human populations, was lactose tolerance in milk. As it is well known, the intestinal production of lactase, the enzyme that metabolizes lactose, ceases after weaning. For this reason, in many parts of the world (especially in Southeast Asia) adults cannot consume milk, which causes a number of disorders such as bloating, abdominal cramps, flatulence, diarrhoea, vomiting etc. In contrast, approximately 80% of the adults in north-western Europe can consume milk [25], which shows a change in the region of DNA that controls the expression of the lactase gene, so that the gene remains active even after weaning. This genetic change is considered to have occurred with the domestication of animals, especially cows in Europe, and was selected because it benefited humans: the consumption of milk provided, on the one hand, a necessary intake of vitamin D (lower exposure to the sun), and on the other hand saved him from starvation during critical periods for crops, [60]. It is also estimated that changes in diet will cause changes in our microbiome, microorganisms that live in our gut and help us maintain our health [45].

Skin pigmentation is another example of a characteristic that has undergone changes after man left Africa [21, 44]. Given that man comes from the tropics of Africa, where the intensity of sunlight is very high and extends throughout the year, it is assumed that, initially, man had a dark skin colour (as people living in area), given the large amount of eumelanin in the skin, a pigment that provides protection from solar radiation. The production of pigment in the skin is determined by several genes. Human migration to areas with higher latitudes of the globe, where the sun's rays fall obliquely and their intensity is lower, a high level of melanin in the skin makes it difficult to synthesize vitamin D in the body and maintain bone health, so that over time under the action of natural selection it reached skin tones adapted to the specific conditions of the living area, darker in the equator area and more open towards the poles [44, 45].

Human populations living at high altitudes, such as the Tibetan plateau, the South American Andes, the high Ethiopian plateau (where air is sparse and oxygen levels lower) have acquired specific adaptations [11, 25]. In high-lying areas, ordinary people experience increases in haematocrit and erythrocyte counts (polycythaemia), which is not the case of those who have lived in these conditions for thousands of years. On the Tibetan plateau, located at an altitude of over 4000 m, the oxygen level is 40% lower. Tibetans possess in their genome versions of the *EGLN1* and *EPAS1* genes [34, 44], which through their products regulate some blood parameters. Mutations in these genes or impairment of their activity would be associated with anaemia and polycythaemia. Variations in EGLN1 provide protection against polyctenid, and SNPs at the EPAS1 locus regulate haemoglobin levels [34]. Finding that a segment of the EPAS1 gene in Tibetans and some Han Chinese is identical to that of the Denisovans, Nielsen et al. (quoted by Solomon, 2018) considers that this gene comes from their ancestors, who probably inherited it after mating with Denisovans.

A study by Mathieson et al. (2015) on DNA samples from 230 western Eurasian [36], who lived between 6500 - 300 years BC, indicates that the allelic frequencies of today's Europeans are outside the specific range of ancient human populations so, in many respects, Europeans 4,000 years ago were phenotypically different from Europeans today. It is estimated that natural selection affects only about 8% of our genome and that some genes evolve faster than others. In this latter situation would be HAR1 (human accelerated region 1), involved in brain development. It seems that this phenomenon is due to "*increases in G and C at DNA's regular repair sites*" and that about 1/5 of rapidly evolving human genes are affected by this process [25].

From Darwin onwards, we know that the main factors of evolution are genetic variability, heredity and natural selection. The "engine" of evolution is natural selection, the "*survival of the fittest*" according to the great biologist. Natural selection acts on phenotypes and implicitly favours or eliminates certain genotypes from the population. The advantaged ones will give more offspring and will spread within the population, so that with time there will be a genetic change in that species. On the other hand, man is a species with a long lifespan and low reproduction, so it is difficult to observe "*intergenerational genetic changes*" [47]. The question arises as to whether natural selection also acts in the case of modern man, taking into account the progress made in the field of medicine. Obviously, its action cannot be neutralized, although some authors (Baldi, quoted by 3) consider that "*the force of natural selection became minimized and that we are somehow at the 'end-point' of our evolution*" [3]. An example of its action is the fact that genes for white skin and blue eyes have become much more widespread in the last approximately 2000 years within the population of Great Britain (Tayag, 2016). Another would be the recent positive selection of the FOXI1 gene in the Yoruba population of the Saharan desert of West Africa, an adaptation to water retention in the arid climate specific to the area, promoted in the last 10-20 Kya, the gene having multiple functions, including kidney-mediated water-electrolyte homeostasis [37].

Modern medicine has progressed enormously, becoming a kind of mechanism of artificial selection, as it ensures the survival and even the generation of offspring by individuals who 1-2 centuries ago would have had no chance due to severe infectious diseases or genetic abnormalities [11]. Some observations show that, in the UK, in Darwin's time, when medicine was less developed and natural selection operated somewhat unhindered, only 50% of children survived until the age of 21 [53]. It is a well-known fact that the disappearance of individuals before generating offspring is an effective filter for a gene pool [54]. At present, things are somewhat different, leading some experts to say that "*We are helping genes that would have dropped out of the gene pool*" [52] or "*humans now exert a pressure on the evolutionary process that is independent, at least in part, from natural pressures*" [50] or even *"our advanced medical capabilities have, in effect, blunted natural selection"* [54]. There are also more categorical opinions on the role of modern medicine in the prevention and treatment of diseases in children, according to which its intervention creates a false evolution, that in this way we "select" "sick" genes that are transmitted to future generations, we basically help them "survive", an action that would contribute to the very slowdown of our own evolution [51].

3. The evolution of man - where to?

The huge advances made over more than 50 years in the field of technology in general, information technology in particular, robotics, molecular biology, biotechnology, genetic engineering, etc., have given free rein to the imagination and have given rise to scenarios and speculations concerning the human evolution in the future. Despite the abundance of knowledge and scientific information accumulated in recent decades, no one can predict what the man of the future will look like. And yet, some experts have also made assumptions in this case, advancing a number of possible scenarios for changes in humans in the future. Whether or not they will be confirmed remains to be seen. Such predictions were presented by Ramanchandran (2018): the reduction of human muscle mass due to the sedentary lifestyle and the takeover by machines of many physical activities; decreased visual acuity (increasing myopia and decreasing hyperopia) because today's and tomorrow's man no longer faces the problems of his ancestors in the living environment; reduction of natural immunity as a result of continuous advances in medicine; shrinking of the teeth and toes, due to the ingestion of soft cooked food, respectively the renunciation of barefoot walking; enlargement of the skull, as a result of increased intellectual activity and implicitly an increase in brain size (a questionable prediction we consider, given that in modern man, unlike Neanderthals, the brain decreased slightly in size but became more efficiently functional); “racial” uniformity, the blurring of physical differences between different populations and ethnic groups as a result of human migration, there are now modern and fast means of transport and communication that spread across the planet [42].

The growing industrialization of the last two centuries has caused a large part of the human population from villages to migrate to cities. There have also been massive human migrations from one geographical area to another in the world, from the poorest to the richest areas, due to poor living conditions, climate change, wars, famine, man's desire to live better etc., so that the mixing of human populations took place, a process that will continue in the future. According to a UN report, in 2017 there was a 49 percent increase in the number of people living in a country other than where they were born, and by 2050 another 140 million people will migrate to other areas of the globe than those of origin. In the next four decades, multiracial human populations will increase by about 174 percent, so we will see a significant flow of genes, new combinations of characters [44, 45]. Even if Ward (2009) is of a different opinion, the trend will certainly continue in the future, marriages between individuals from distant geographical areas, skin colour, ethnicity and different cultures will be more frequent, because the present reticence on the matter especially about belonging to a certain ethnicity or religion will disappear. Gene combinations will thus be increasingly diverse, with beneficial phenotypic effects on their carriers. Will it eventually lead to a relative genetic uniformity of the human population, as it probably was in the beginning, but obviously at a completely different level than about 150-200 Kya ago?! Hard to anticipate.

For some time now, we have been putting high hopes in genetic engineering for solving the problems that man faces or dreams for himself: correcting or removing "sick" genes (gene therapy), prolonging life, acquiring useful characters through transgenesis, intensification of some characteristics etc. At the moment, not all the conditions for genetic manipulation in humans have been "baked", but in the more or less near future they could become routine operations. If such operations have succeeded in other organisms, why would they not succeed in humans as well?! Gene therapies, which appeared in the late 1990s and considered by Mukherjee (2018) *"the rebirth of positive eugenics"* [38]., may aim to correct deficient human genes in non-reproductive (somatic) cells and in the genome of reproductive (germinal) cells. When we talk about gene therapy, we must remember an unfortunate experiment, which took place in September 1999, which put an end to this type of operation for some time. At the University of Pennsylvania, an 18-year-old patient suffering from a deficiency in the enzyme ornithine transcarbamylase (OTC), an enzyme involved in the breakdown of proteins in the liver, underwent gene therapy by injecting a healthy gene attached to an adenovirus. Enzyme deficiency was linked to a single gene, in theory, ideal for such operations. Unfortunately, the experiment was insufficiently prepared, conducted in a hurry, poorly monitored and led to a lamentable failure, the patient dying 4 days after the injection, illustrating, although not appropriate, how "*a superb theory can be killed by an ugly experiment*". S. Mukherjee describes in a chapter of his book "*The gene: An Intimate History*" published in 2016 (translated in Romania in 2018) this sad episode of the history of medicine, but concludes in an optimistic note, stating that "*Gene therapy will one day become therapy*" [38], a conclusion that is certainly embraced not only by specialists in the field, but also by all those tormented by genetic diseases. Probably for human monogenic diseases the day when they intervene in their correction through gene therapy is near. But many human genetic diseases are polygenic and, in this case, things are much more complicated, it is difficult to predict when and if they can also be corrected. But science does not stand still, so we must remain optimistic.

With the help of CRISPR ("clustered regularly interspaced short palindromic repeats") technology, *"a remarkable genome-editing tool"*, also presented by Mukherjee in the above-mentioned book, specific DNA sequences can be recognized and targeted portions of genetic material through the intervention of endonuclease Cas9 (Beck, 2017) or other enzymes such as Cpf1, CasX and CasY [30]. The human CCR5 or CD95 protein is involved in the immune system, being a receptor for chemokines located on the surface of white blood cells. The CCR-Δ32 mutation consists of deletion of a portion of the CCR5 gene. In the homozygous state, the mutant gene confers resistance to HIV-carrying individuals. In 2018, in China, CRISPR technology was used to delight the CCR-Δ32 mutant gene in two twin baby girls, an action considered to protect them from the risk of HIV transmission from their HIV-positive father. However, the father's HIV infection was kept under control, the titter of the virus being so low that the risk of transmitting the infection to his daughters was negligible. It was an action criticized by specialists and considered "*a case of human enhancement intervention rather than therapy"* [3]. In such operations, it must be taken into account that some genes, such as this mutant gene, have a pleiotropic effect and other characteristics of the body are affected by their deletion. Some believe that the very insertion of this mutation in the genome of those at risk of contracting HIV could be considered [1], an opinion that currently seems risky, but who knows if tomorrow it will not become a feasible operation. CRISPR technology has been used by some Chinese researchers (Kang et al., quoted by 6) and to "cure" human embryos of beta-thalassemia and G6PD-deficiency, with a success rate that varied significantly depending on the experiment, which indicates that optimizations of the technique are still needed. There are hopes for its use in treating cancer, in enhancing the capacity of immune cells, in increasing the level of expression of some characteristics. The terrible potential of CRISPR technology has made some people dream, ask bold questions such as if it could be used *"to create super-humans, to implant kill-switches into human cells, to prolong lives of those than can pay for it"* [6].

Through genetic engineering techniques, it is possible to intervene not only on somatic cells, but also on germline, a situation in which things get complicated, corrected or acquired traits become hereditary, they are passed on to offspring, which requires maximum caution. Some authors consider that *"intervening in the germline is likely to have an impact on the evolutionary processes of the human species"* and *"the use of large-scale genetic engineering might exponentially increase the force of 'niche construction' in human evolution"* [3]. But be aware that: *"genomic engineering based on CRISPR / Cas9 allows us to add information to the genome: a gene can be modified in an intentional way, and the new genetic code can be inscribed in the human genome"*! [38]. Prudent in the face of these challenges and possible errors regarding the hazardous use of CRISPR/ Cas9 technology, the US National Institute of Health has banned research on human embryonic cell stem (ECS) that aims to either implant these genetically modified cells in animals/ humans for the development of living embryos, or the transmission of these genomic changes to the germ line (sperm or eggs, in other words), [38]. To temper our enthusiasm, Mukherjee warns us, however, that *"It is a typical modern illusion to imagine that the ultimate solution to a particular disease is to change nature, that is, genes, when the environment is often more malleable"* [38].

In other words, the time will probably come when our planet becomes "too small", and its food, energy, economic resources, etc - insufficient, which will cause man to leave it in search of another to host him. The greatest hopes and dreams are currently related to the planet Mars (which has a number of similarities with Earth), but other destinations should not be ruled out. Man's migration to other planets involves preparing him for long journeys of many millions of kilometres, which would mean, among other things, increasing his lifespan or, as Ward says, finding solutions to hibernate him during the journey (without consequences on the brain and nervous system). Mars (or the red planet) has a rarefied atmosphere, being strongly bathed by solar radiation, including some harmful (such as UVB rays), gravity is much lower (only 38% of that of Earth), the temperature ranges between -140℃ and + 20℃ and so on. Through genetic engineering, man could acquire properties that allow him to survive in conditions hostile to life, such as radiation resistance in outer space, in the case of inter-planetary travel or colonization of other planets.

Although the conditions on Mars seem unfit for human life, some authors do not give up and believe that human evolution on Mars could promote a mutation that would make it, according to Ella Alderson, less dependent on vitamin D, or, according to the opinion of Solomon, on Mars the rate of mutation would be accelerated and so after a few hundred generations another type of man could appear, or even more categorically, *"If we get off to the stars, yes, we will have speciation"* Peter Ward says. A similar opinion is being embraced by Warmflash (2017), which considers that a long-term isolation (thousands or even hundreds of thousands of years) of human colonies on other planets would interrupt the gene flow with terrestrial peers and would lead to reproductive isolation from them or with those with whom they colonized this other planet. These groups could become over time if not a species, at least a different subspecies. In another paper, the author believes that the richer radiation environment on Mars could have a selective effect on humans, in the sense that it would induce sterility in many individuals, which would exert an obvious selective pressure on reproductive cells [54]. These assertions are of course based on the past history of man, on his becoming as sapiens among his close relatives of the genus Homo. Well, if these scenarios work and man will one day be able to live on other planets, another type of man could develop, one adapted to new living conditions, with some characteristics different from the ones of the terrestrial man, but it becoming another species of human, reproductively isolated from the terrestrial man is, we believe, less plausible. It is probable that man will register an evolution similar to the one observed at the exit of the modern man from Africa, but perhaps more accentuated.

At the same time, the correction of some genes or the acquisition by man of some useful characteristics through genetic engineering, the implantation of some mechanisms that increase certain abilities, etc. cannot change his nature and cannot isolate him reproductively from peers not subject to such operations. Humans will remain humans as a species, even if some appreciate that "smart technology" will migrate on the surface and even inside the human body, will accelerate its evolution, *“the result being that humans will be viewed more as a* *technological being than biological"* and that technological advances *"directed towards enhancing the body could lead to a future merger between humans and technology"*, [5]. Of course, the qualities acquired by man through the use of "smart technology" products will not be inherited, but will help him to be more performing, more efficient in all of his projects. In the case of colonization of other planets, man will certainly find ingenious solutions to counteract the effect of unfavourable factors, and many of the activities that could endanger his life will be performed by robots, which will also become more efficient. It will no longer be important whether the human who escaped to other planets will be, or not, in the distant future able to mate with the terrestrial one, but the presence on those planets of the essential elements of life for them to continue their existence.

In the face of the many reservations about the use of genetic engineering in humans, including ethics, of the many questions that trouble us today and have no plausible answer, solutions will certainly be found tomorrow, because - as Harari said at the end of his book *"*Sapiens: A Brief History of Humankind*"*,… *"it is naive to imagine that we could simply put the brakes on and stop scientific projects that upgrade Homo sapiens into a different type of being"* [17].

I think, in fact, that it is premature to decide in which direction man will evolve in the future, because everything is in a perpetual motion, nothing stands still. Science and the human society are evolving at an accelerated pace, so that what we cannot achieve today or what we are not allowed to do today may be possible tomorrow. Why not accept the idea that, one day, man will be able to direct his own evolution! Now, this idea may seem bizarre or absurd, but tomorrow, who knows!?

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