Who we are and how we got here

Ancient DNA and the new science of the human past

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The book is a report on a recent revolution in genetic archaeology made possible as a spin-off of the human genome project, the biological equivalent of the Moon landing. The genome project was launched because it was expected to have spectacular medical applications, but as far as I know few if any have so far been forthcoming. This was also the basis of wide-spread criticism both at the time of its launching and during its operation, claiming that the medical benefits would not justify the great expense. Be that as it is, the non-medical consequences are interesting enough catering to the curiosities of people of the right temperament, to which the book is addressed, enabling them now to enjoy the fruits without having to have taken the initial responsibility for them. The genome project, which is science on the big industrial scale, is apparently too big to fail, and is thus still being financed by the medical establishment, whose financial resources far outstrip those for the so called curiosity-driven. Basic science hence gets a more or less a free ride, for which we should be grateful.

The idea of biological determinism in the form of inheritance is very old and cannot be traced back to its origins lost as it is in the mist of pre-history. That off-springs resemble their parents, not only at the level of species, but also as to individual traits, must have been observed since time immemorial, and may also be the reasons that bonds, or at least the recognition of such, exist between parents and offspring beyond the immediate period of rearing[1]. It has been observed by anthropologists that aboriginal people keep track of

[1] At least when it comes to mammals, the mother is instinctively attached to the progeny for a period which can vary considerable, from a week or so to a couple of years, as with the big cats. This attachment between mother and offspring is manifested by the biological process of lactation, from which the father is excluded. This specific bond does not exist among birds, where either both parents may be involved in the feeding, or only the father or the mother (but the chicks are not expected to feed for themselves). Such extended rearing is, as far as I know, absent outside warm-blooded animals, so one may speculate as to the habits of the dinosaurs. As to the extended cultural bonds, they seem in general to be absent for most species, the mother normally rejecting her off-springs once she is ready for a new set. We have two poodles, a mother and a son, and it is far from clear that there exists still that special bond between them, in fact as a precautionary measure the son has been castrated. On the other hand chimpanzees which have been reared in human homes, until they reach puberty and become intractable in furnished rooms, seem to have strong sentimental attachments to their erstwhile foster-parents even after being taken away to confinement. Konrad Lorenz (of imprinting fame) seems to have had lifelong relations to his adopted progeny. The interesting question is whether this cultural bond can also be observed among the great Apes as well as among the Elephants. Personally I believe so, but my reasons for such beliefs are mostly sentimental.

their vertical ancestry as well as their horizontal relations in a very elaborate way going far back. This practice may to some extent, as suggested by Levi-Strauss, have the purpose of avoiding incest, but I suspect that it is mainly for the great value they put on knowing how they fit into the group and really want to know who they are and how they got there[2]. In Swedish there is a binary system of identifying your ancestors and you always make a distinction between 'farfar' (paternal grandfather) and 'morfar' (maternal) and similarly for grandmothers, there is no word for 'grandfather' or 'grandmother' and it becomes a bit awkward to refer to grandparents [3]. I know of no other language adhering to this convention, not even the dialectal variants of Norwegian and Danish have it. It may be a linguistic fossil from earlier times.

The incipient idea of biological inheritance is encapsulated in the idea of 'blood', as in Royal blue blood, and the saying that blood is thicker than water. It also underpins the idea of succession in monarchical lines, although that has to be complemented by some ad hoc additions, such as primature, to work. And the idea of transmitting something inestimable from your family to your off-springs, be it variations of artistic ability or intellectual brilliance to be seen in your family only, is very much pervasive to this day, and can be seen as an instinctive form of racism, and as such maybe even biologically determined, or at least prejudiced.

The inheritability of traits is something exploited by breeders for a very long time, in principle ever since the domestication of wild animals and plants. Although the process may not have been initially consciously intentional it certainly had become so in more modern times. In husbandry you intentionally select traits to be transmitted to the next generations and you try to purify them. In the case of canines it seems to work beautifully giving rise to the great diversity of phenotypes we observe, and which does not seem to have any counterparts in other domestic species[4]. Darwin took human engineered breeding as a point of departure in his initial speculation about unintentional natural selection which he for years tried to boost by incontestable arguments. Modern genetics started as we all

[2] Modern Western people do not seem to share that need to the same extent, maybe because of the variety of distractions available to them. How many people can name (all) their great grandparents? It presumes the existence of an oral tradition.

[3] This was very important for me as a very young child because it made me aware of the mathematical composition of functions, as one may go from the words 'father' and 'mother' designing individuals to the abstractions of being functions, i.e. each individual having a father and mother. As to 'brother' and 'sister' they are not necessarily functions, as they may designate many individuals, or no individuals at all. The ancestral system of designation is also complemented by a more horizontal, in Swedish you distinguish between 'farbror' and 'morbror' and cannot speak about uncle in the more generic sense. However, Swedes do not distinguish between cousins on the maternal and the paternal side, although in principle individuals can be designated, such as 'farbrorson' it is never done! In fact this is the first time in my life I wrote down the 'word' 'farbrorson' and it is not to be found in the official list (SAOB) of Swedish words.

[4] Cats are also bred, but the diversity, at least to the eye, is not as striking as in dogs. There have been attempts to breed humans as well, but those have never taken off ground, maybe because never consistently pursued for a variety of reasons, one of them being the substantial time intervals between generations. The greatest genetic and consequently phenogentic differences between humans are to be found in Africa, as exemplified by the tall dinkas and the pygmies.

know by Mendel with his seminal paper in 1865 when he manifested the discrete nature of inheritance where he was able to associate traits with units (genes) inherited in pairs, and hence brought to the attention dominant and recessive ones. His discoveries were not brought to the scientific establishment until almost forty years later when the field of genetics took off. With Mendel genetics became a subject of biology that cried out for a mathematical treatment and hence attracted many mathematicians who may have been too seduced by the elegance of their own subject to really appreciate the ad hoc and messy nature inherent in biological phenomena[5]. It was a quintessentially top-down approach. The second genetic revolution occurred with Crick-Watson and the elucidation of the 3-dimensional chemical structure of DNA, namely that of the double helix. As such it may not be too helpful, but should be seen in the light of the burgeoning science of bio-chemistry which started in the early Postwar years[6]. It made for a major change of paradigm, as one now could write down the structure of molecules which defined life, and hence in principle give the basis for a thorough materialistic science of life in which life could be created in the laboratory on first principles. It made the way for the discovery of the so called genetic code, which describes life as basically a story of information and its implementation. The DNA molecules consist of strings of bases referred to as A,C,G,T[7] sequences of which produce various proteins and which we may refer to as genes. Now, although there are many genes, there are even more traits. While genes may be seen as more or less well-defined physical entities which we can point at, traits exist on many different layers of abstractions and are linguistic concepts. There are more traits than genes, so they are usually determined by a combination of genes, which make the story of selection so much more complicated than what is usually presented. Traits such as eye-color are exceptional, but have for obvious reasons received disproportionate attention, as science as most human activities tends to be rather pragmatic. Most DNA seems to be junk, meaning that it does not produce any proteins and hence does not contribute to the building of the phenotype[8].

Although we know in principle which atoms make up the DNA strands and how they fit together, you cannot do chemistry by building up molecules atom by atom as

[5] It has been suggested that Mendel's statistical tables were doctored, that he might have had a hunch of what was going on, and then adjusted his data for a better fit. In fact a fit too fit to ideal statistical expectations. But let no shadow fall upon him, like all true scientists he understood that expectations come before data, the latter can only be used to reject theories not to confirm them let alone determine them, as taught by Popper.

[6] Of course biochemistry goes much further back with the killing of the vitalist theory by German early 19th century chemists, who had been able to synthesize organic molecules.

[7] referring to **a**denine, **c**ytosine, **g**uanine and **t**hymine To be precise there is a difference between DNA and RNA, where in the latter the T-base of DNA is replaced by the U-base (**u**racil).

[8] There are many explanations for the presence of so much junk, in fact sometimes junk is so prevalent that some rather primitive organisms have genomes larger than that of humans. My own explanation is that the DNA sequences are not edited unless there are compelling reasons of natural selection to do so. When I program in Postscript I often take old code and inactivate large parts of it rather than carefully editing it because for that I have no patience. If this process is repeated a lot of times, the junk part can totally dominate.

if they were the kind of stick models chemists used to work with, you have to work on available material. Furthermore in spite of this knowledge modern genetics is still very much a top-down approach, even if you know what proteins are manufactured you do not at all understand the complex embryological process in which those proteins take part and which results in the final phenotypes. And from a philosophical perspective one may even wonder whether we can ever understand it, being too complicated for human cognition. The real great revolution of what we initially referred to is the possibility to extract long sequences of DNA from human remains. This involves great ingenuity as well as a long-going technological innovation, which as a mathematician impress me much more than the mere statistical manipulations of the sequences those extractions eventually will provoke and allow. In the first case you need to get your hands dirty, and not only your own, but thousands of others; the second case is much cleaner. In principle 18th century mathematicians could have handled that, save for performing the actual competitions which require modern computer facilities. It is for the first break-through Svanet Pääbo is known, more specifically for his incredible feat of extracting DNA from Neanderthals[9] which revealed that modern humans have interbred with Neanderthals and had descendants, and that they hence with standard definitions were to be considered as in the same species, which had been guessed before, but maybe more on political grounds than scientific.

This story of technically extracting sequences of DNA is far too complicated to relay in a book meant for the layman. Besides it is more of the nature of a hands-on experience to be appreciated than an academic. However when it comes to the DNA sequences, in which all the research is being done, the situation is different. Although the author succeeds well in conveying the taste of the research and what it amounts to, not enough hard details are supplied to allow a mathematicians to reconstruct. This is, in my opinion, the main drawback of the book. But admittedly the book is not written for the intermittent mathematician and most readers would find more technical genetic and statistical detail tedious, and besides the taste of it has anyway been given. However, some of the necessary details would I think be of interest to a wider audience, especially what characterizes a group of interbreeding individuals and how big it must be. This is also essential for the concluding discussion on racism and what constitutes a race. Species is one thing, but

[9] One speaks loosely of ancient animal and plant domains as fossils, although this is not always very accurate. In a fossil the form is preserved but not the content. The original molecules have bee replaced by others much more permanent, thus fossils can survive as such for billions of years. However there is a limit to as the amount of detail which is being replaced, DNA is not, so the information of the base sequences is lost. However, insects trapped in amber are not fossilized in the technical sense, and may harbor snatches of DNA from the blood of dinosaurs they may have sucked. This is the rationale for some recent science-fiction. Now human and proto-human remains only go back at most a million years, and those which are only a couple of hundred thousands years old, may provide fragments of real DNA. One should not forget that copies of DNA is supplied by every cell of the body, and of cells there are very many, so what is missing in one cell may be present in another, so in fact if every cell only supplies stretches long enough to have some individuality one may use them as pieces to fit with others to make up long stretches, not unlike the challenge of a jigsaw puzzle (and in fact the dating method of dentrochronology works on that principle.

races are far more fluid and subject to subjective interpretation[10].

Now in what follows, the DNA sequences themselves are of interests, more or less, as entities on their own, what they signify, in particular how they translate into specific phenotypes, can be more or less ignored. What remains is simply statistical analyses[11]. The conclusions that can be drawn from those are what will be of interest and they have completely revolutionized our understanding of the past, and provide the data, modulo their interpretation, which contradict previously cherished beliefs and speculations. The triumph of science, as the author repeatedly points out.

The most interesting part of the book is of course its middle sections reporting on what the modern techniques has revealed about our past as a species. The story which is being told is still of course tentative and bound to be modified, especially when it comes to the finer details, as more and more data becomes available. The most fine-grained picture is available for the European theater, as most of the research has been done on Europeans and where most of the resources are available. The findings are hard to memorize and summarize, at least after just one single reading, but there are certain highlights that stand out. The most exciting being that non-Africans tend to have, as already noted, a smattering of Neanderthal genes, the figures mentioned are around 2-6 percent. However, this is as far as I understand purely statistical findings, which testify to the fact that Modern Humans and Neanderthals were capable, unlike horses and donkeys, of producing fertile progeny and hence belonging to the same species. They can further be used to estimate when this mixing may have taken place, but I doubt that it is known for what traits they codified, for all we know it might be all junk. The transmission of genetic material is quite different whether it is indifferent junk or is under selective pressures.

Obviously without the ability to extract DNA from Neanderthal remains, such findings would have been impossible, but with this ability one is able to so to speak triangulate the past and get footholds, which in its turn can be used for interpolations. In this way one believes that on may identify ghost populations of the past for which no remains have

[10] We cannot make, what the mathematicians call a partition of all individuals of all organisms in mutually disjoint subsets (species) covering them all, because there is no underlying equivalence relation, as the history of evolution makes clear. But even if we take a time slice it is not true, although the exceptions are rather in the form of curiosities. Apparently there is a species of gulls circling the north pole which can always interbreed with their east neighbors. But when one has circled the pole once, there will be a 'date-line'. An example of biological mondodromy. An attempt of an equivalence relation would be to say that A and B are related if they can produce fertile off spring. This relation is symmetric by definition, but not reflexive as a single individual cannot mate with itself, let alone get fertile off springs. Nor is it transitive, so we make it so by saying that A and B are related if they can be joined by a sequence of fertile mating relations. In this way we get reflexitivity for all fertile individuals, but that might not be enough; on the other hand all fertile individuals will end up being related, at least we are allowed to go back in time, which is far too much for what we bargained. However, given a time slice of the great tree of life, it works most of the time, which makes the problem of species a legitimate scientific one, much more so than race.

[11] This is also the case in the most widely used applications of modern DNA techniques, namely in the forensic field.

been found[12]. This is of course part of the scientific urge to put ladders on ladders, in order to go beyond what mere facts can directly inform us[13]. Furthermore, recent genetic research gives credence to the idea that cultural traits such as farming and Indo-European languages, were actually transmitted physically through migration rather than traveling like waves through a human medium by emulation, an idea I have tended to cherish. Most likely it is a case of both, but the direct way may have predominated. One also learns that there were several migrations to the New World, by different Asian populations, and not all of them may have come over the Bering Strait[14] Perhaps even more intriguingly in the past the racial divisions of humanity may have been rather different from what it is now. When all is said and done what this research actually shows in some detail is the intricate way different populations interact with each others providing a stew out of which steadily new combinations of genetic material are produced. The populations themselves are unstable entities over time, merging and splitting up, not unlike the clouds in the sky. This process has been one of pruning, resulting in a single species[15] but not, which may have been more interesting to observe a speciation. One should of course not totally rule out the possibility in the future but one we will never witness[16].

When it comes to biology and the human mind there is a curious case of idealism that comes into play. Not that I necessarily am out of sympathy by the phenomenon, only that I am somewhat amused by it. Alfred Wallace famously excepted the human mind from having been subjected to evolution, in contrast to Darwin, who had the intellectual courage to include everything in his vision. First we have the maxim that all people are of equal worth, whatever is meant by it. I am always irritated by it, as I see it as an expression of intellectual laziness and moral self-righteousness, the implicit message seeming to be that those who do not agree are inferior as human beings (and thus not of the same worth as I who hold this exalted view). The idealism being that when it comes to intellectual and moral qualities, all genders and races are equal. To claim that men are better at mathematics, if not necessarily by crudely averaging ability but by men being over-represented at say the top 99.9% percentile is met with derision and distaste. But is there an axiom that men and women are cognitively equal, at least when considering the higher mental abilities. The assumption of which is a matter of idealism, a top-down approach, to which all facts have to accommodate, and if not they be damned. It is true that any inquiry has to start with preconceived notions, and unless there will eventually be conflicts with beliefs even deeper held, those need not to be jettisoned, in fact they could be quite useful. The assumption that there is no difference between men and women

[12] A little bit like Mendelev inferring still not discovered basic elements

[13] One is reminded of how large distances are measured in astronomy going well beyond the limits set by direct geometric methods

[14] I may make a mistake in recalling, as I also understand that the colonization of the Pacific Islands were relatively recent. But like many speculative facts this would be hard to falsify.

[15] According to Gould not unlike that of the evolution of horses, from an evolutionary perspective such pruning tend to lead to eventual extinction!

[16] H.G.Wells speculated about such a development given the division between the laboring classes and the leisured ones. But of course such divisions have been present since the emergence of civilization and has had not such consequences.

could be a useful assumption deeply congenial to our ideals and values, but that does not mean that one should shut out for ever the possibility that this might not hold water at some future time. When I started out as a graduate student at Harvard there was a furor about the researches by Herrnstein et al, claiming that Blacks were as a group inferior in mental capabilities. Demonstrations were held and they were booed out and stripped naked. What was the uproar all about? The conclusion? Or the very fact that they presumed to do such research at all? If the conclusion would be foregone anyway, all people being equal (or at least all races), why do it at all, no new knowledge is to be gained? And if the result is otherwise i.e. false, so much the worse[17]. If you are going to measure some quantity, in this case IQ, it is bound to vary between groups. What would be so bad in reporting this? Is not science free? There are of course a variety of arguments against the freedom of science, at least as it applies to society, as such statements are never pure but imbued with hidden agendas. Yet, there is bound to be frustration. Furthermore one may argue convincingly that so called IQ-test are at best very crude and thus spurious, and totally misleading and specious at worst. And even if accurate in a sense, although it is hard to believe that they can fathom all the subtle aspects of mental cognition, to give them undue significance is uncalled for, and reveals sinister agendas[18]. In science there is always the interplay between facts and interpretations (theories). Facts are useless not to say meaningless without interpretations, while interpretations are impossible without facts. In social sciences this distinction inevitably tends to become somewhat blurred which becomes the basis for much discord.

Indeed racial science is considered a murky business, although this was not always the case. The idea of white supremacy, which most people think of when they refer to racism[19], did not really take off ground until the 19th century, when the supremacy of the European civilization became apparent economically, scientifically and militarily. By that time the only serious rival, the Ottoman empire and the Muslim world, had become marginalized. The 19th century was also the century of rampant colonialism. For one thing the British attitude towards India was very different in the 18th century compared to the 19th. The Spanish conquistadors did of course horrible things to the indigenous population in South America, destroying their civilizations, but did not exterminate them as they also failed to do in Africa. But when it comes to ethnic cleansing no colonial adventure was as thorough as the North American when it came to replacing indigenous populations[20].

[17] This argument resembles the one the Arabs levied against secular books. If it is not to be found in the Koran, it is false and has to be rejected, and if it is to be found therein it is superfluous. The Christians also had a similar attitude. And why not recall the famous words of David Hume. If a book does not concern itself with facts or numbers, consign it to fire, because it contains nothing but nonsense, or words to that effect.

[18] Recall the issue of all humans being of equal worth. The book 'The Bell Curve' subtitled 'Intelligence and Class structure in American Life' published in 1994 and co-authored by Charles Murray in which they tried to make their point was heavily criticized, indeed scathingly so, on points just raised.

[19] Of course the abstract concept of racism can be applied to many other cases, but when exercised by weak marginalized groups of people it is seen with a lot of indulgence, which is understandable and provides a hint of what is really the issue

[20] The same thing did of course happen in Australia, but on a smaller scale, but nevertheless even more

Because of the great success of the North American expansion, most of which took place in the 19th century, it is not really considered a colonial abuse, but rather as a case of a rightful seizure of territory from marginal people who did not have the means to fully exploit it. They were simply on the losing side of history and what has been done cannot be undone (unlike the case of decolonization in other regions in the world) there is no way of stopping progress. One should not forget that from a more detached perspective, ethnic cleansing and extermination of people is nothing new in the history of mankind, but rather the rule than the exception, and has made us what we are when it comes to our mixed heritages. But of course we use a different terminology when talking about the history of long duration in the manner of Braudel, employing more innocuous words like 'migrations'. What is new of course is the level of sophistication when it comes to technology, which makes us stand apart from history.

Old racial research had the conclusions given and were merely looking for confirmations, and such according to Popper are always easy to find[21] There were methods which we now consider as risible, such as the measuring of skulls, but from the scientific point of view they were legitimate efforts to look for objective standards, only in retrospect they appear crude and pointless. Modern racial biologists look at DNA sequences instead,ad they are far more exciting an fruitful. However, to many indigenous people, there seems to be little difference, and it is as humiliating to have you DNA taken and studied, as to have you skull measured and your tongue extracted, all for the sake of satisfying the curiosity of the white man. But as the author notes, the opposition to be genetically tested always comes from those who claim to speak for their people, not from individuals. The author is Jewish and by virtue of the focus on the Holocaust, one may suspect that he should be immune against accusations of racist intentions, himself belonging to the victimized group par excellence. However, this may only cut the mustard in Europeans and North American circles, from an Arab perspective, Jews may be the most virulent anti-semitists. The accusation works of course equally well in the opposite direction.

To conclude the discussion the author may have noted that the genetic variation of humans is surprisingly narrow [22] when compared to other mammalian species (as the Ancient Greeks taught us, quantities, unlike numbers, are meaningless unless compared). It is also striking that any non-pathological human child, regardless of race, easily picks up the local idiom perfectly as to diction and accent. There are of course Black and Oriental people who have grown up in Sweden and speak perfect Swedish like any other Native. Vision appeals predominantly to our intellectual nature, while hearing to our social[23] and thus it stands to reason that we should identify with people who talk like us to the point of trumping mere visual stimuli. Thus one may make a case that human genetics supports the idealism of racial equality, maybe even, as some more ardently have suggested, that racial divisions as such are mere human constructs without any real objective basis. The author

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viciously.

[21] yet another instance of the power of falsification over verification.

[22] a standard explanation is the assumed existence of a rather recent bottleneck when humans were on the verge of extinction.

[23] It is claimed that becoming deaf is worse than becoming blind, as the former hampers us socially and make us isolated.

is not of this persuasion. Very similar as we humans may be, viewed from a distant and detached perspective, there are nevertheless differences which provide an endless source of fascination. Our instinctive reaction towards people of other races is not only skin-deep. It is not only skin-color to which we react, in fact our reaction as so called Caucasians to a dark-skinned Indian is very different from that of a dark-skinned Aborigine from say New Guinea or an African from Senegal. Awareness as such of such differences is nothing to be ashamed of, in fact it is something we cannot help. It is what we do with it and how we interpret it which matters. Such considerations makes us peculate as to the possible social status the Neanderthals would have been accorded in Modern Society had they survived to this day (to say nothing about more archaic humans, we know in what regard we hold our cousins the Apes). It has been suggested that the Neanderthals for one thing were anatomically incapable of articulating any requisite variety of speech sounds, and if so would they not have been shunned, although this may not exclude sexual intimacy, which at its most elemental is not social at all[24].

What the findings, which prompted the book, reveal, or try to reveal, is how migration of people have proceeded in the past. As with all forensically motivated paleontology, it is based on fragmentary evidence, and thus liable to be if not overturned at least substantially modified in the light of new facts under the ground unearthed. As to Europe there are two historical events of primary importance. One is the spread of agriculture the other is the spread of Indo-European languages. The former is amenable to classical archaeology abetted with modern dating techniques, the latter by considering the present, or near present, distribution of languages. Now with DNA there should be a third approach to correlate with previous findings. Similar patterns emerge. Waves coming from the south east and then fanning out in the west, north and east. When agriculture is concerned we are talking about 9500 BC to about 4000 BC, when languages presumably a shorter interval going back to 5000 BC (maybe longer). The modern story begins with the Iceman 'Ötzi' found in 1991 in a melting glazier. DNA tasting revealed that he was more closely related to modern Sardinains than to present day Alpine people. It could of course be just a fluke, but than it would not be so interesting a discovery. But similar flukes turned up in a study of ancient hunter-gatherers resident in Sweden. The prevalent theory up to that time was that those hunter-gatherer were descendants of farmers who had returned to an old life-style, and who had no relation to earlier hunter-gatherer populations who had been present there. But DNA testing disproved the theory, in fact the farmers and recent hunter-gatherers were as distinct from each other as Scandinavians and East-Asians are today. And in fact the farmers showed a Sardinian connection. It was then proposed that farmers spread all over Europe without any significant genetic interaction with the indigenous hunter-gatherers. Then of course over time the population of farmers on the continent would genetically evolve over the European continent making up the diversity we see today, while those stranded on Sardinia would become isolated and genetically preserved. But as it would turn out the story was more complicated. There was also another migration of North Eurasians into Northern Europe not earlier than five thousand years ago. To summarize the findings of the author and his team. The basis is the West Eurasian population encompassing Europeans, Middle Easterners and North Africans and

[24] To marry for social reasons tends to be looked down upon, but is nevertheless often done.

Central Asians (hence Turkish people and Afghans) which show a high degree of internal similarity already noted in the 18th century during which they were classified as 'Caucasoid' in contrast to 'Mongloid' (East Asian), 'Negroids' (sub-Sharan) and 'Australoid'. Using standard techniques involving mutations, they are about seven times as similar to each other than they are to East Asians, and does in fact make up a rather homogeneous population. But ten thousand years ago the populations in Western Eurasia were far more differentiated than today, in fact four major populations, the farmers of the Fertile Crescent and those of present day Iran, and then hunter-gatherers of central and western Europe as well those of the eastern Europe, as differentiated from each other as Europeans and East Asians are today. But the racial classification relevant to the time would no longer be so, none of those populations have survived in un-mixed form today. This sharp differentiation had by the time of the Bronze Age broken down. Nowadays we think of typical north western Europeans as blond, light-skinned and blue-eyed, but eight thousand years ago you find dark-skinned and dark-haired people with blue eyes, an unusual combination nowadays.

The first migration wave we consider consisted of hunter-gatherers. Then about nine thousand years ago came the first farmers genetically similar to the Sardinian population who interacted minimally with the resident populations of hunter-gatherers. Then there was a second invasion of farmers some six thousand years ago, which however did to a larger extent mix with the populations they encountered.. They are associated by the archaeologically determined Funnel Beaker culture responsible for all the megaliths[25]. They constituted a new equilibrium, some unmixed remnants of the previous hunter-gatherers persisting in isolated pockets such as the islands off Southern Sweden [26] And then there was the tide from the steppes of the East some five thousand years ago. We are talking about the Yamnaya culture, who are thought to be responsible for the invention of the wheel, or at least exploiting it making them much more mobile[27]. Their arrival in Central Europe put the last missing touches to the European genetic make-up.

How does the spread of Indo-European languages fit into this? It has been decided that the similarities of them puts a common ancestry not much further back in time than six thousand years. I do personally feel rather skeptical about the claims of calibrating language change so accurately, but there are other forms of evidence, namely archaeological dating the invention of the wheel and the fact that the main Indo-European languages share so many words having to do with wheels and wagons. Anyway the upshot is that the Indo-European tongues came with the Yamnaya culture, just as they must have spread to Northern India.

The general picture is very confusing in its complexity, and similar pictures can be obtained from other regions of the world, if not at present with the same amount of details. Much of it is based on provisional theories and half-baked speculation, but the general morale is clear. There are no such things as races, at least not in any way sustained

[25] One may think of the Stonehenge

[26] What is meant by those? Öland and Gotland? Or Bornholm and maybe Rügen? But as to the latter off the southern Baltic coast would be a more appropriate designation.

[27] Once the wheel was invented it was bound to spread rapidly making it very hard if not impossible to pinpoint its geographical origin.

over time. Populations are continually splitting up and recombining, just like clouds in the sky and with as much durability. The most effective anti-dote to racism, the author stresses, is not to deny racial disparity, but to celebrate it for what it is. A constant mixing and unmixing showing up new combinations. One may wonder whether if this globalized world will endure, whether the splitting up of populations will stop and there will be an inexorable flow towards an equilibrium in the form of a homogeneous population.

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