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# BIOGENESIS AND ANTHROPOGENESIS: HOW RECURRENT, HOW UNIQUE?

The fall of the nineteenth century abounded in discoveries of natural laws, that is, strict and unequivocal rules of the development of life. These laws stated for example that ontogeny of individuals repeats, or recapitulates, phylogeny of the species; that big and specialized forms originate in evolution from small and unspecialized ones, while the reverse is not true; that endothermic animals are larger-sized and more compact in cool than in warm climates, and so on. Louis Dollo, a Belgian palaeontologist, proposed the so-called law of irreversibility of evolution which stated that an organic structure lost in evolution cannot reappear with all the peculiarities of its design. This law seems indeed to be true but not particularly original. It was Heraclitus who first observed that one could not enter the same river twice. Dollo's law says essentially the same thing. The flow of evolutionary events combines so many processes in so many ways that past evolutionary events cannot recur exactly. "What is



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done, is done forever". Time itself introduces asymmetry into the evolutionary process.

Paradoxically, however, the law of irreversibility of evolution tells us also that any true natural laws of evolution are simply impossible because each historical event depends on so many and various factors that it cannot be foreseen or repeated. Natural laws, such as those describing the movements of planets, always concern repeatable and predictable phenomena. The laws of evolution, however, can be at best approximate because the phenomena they concern are at most partly recurrent.

The real problem arises while dealing with phenomena which are unique by their very nature, which happen only once in life's history and have not even a remote equivalent. This is exactly the case with two most important events in the four billion years of the history of the biosphere: the origin of life on Earth (biogenesis) and the appearance of man (anthropogenesis). The former introduced life in the inanimate matter, the latter provided it with consciousness. How to deal in science with phenomena which have not had even a loose analogue? Alfred Russell Wallace gave a very radical solution to this problem. He put these two revolutions—along with a third, less evident event, namely the origin of animal sensitivity—outside the natural history of life and attributed them to activities of a "higher mental power". Today, scientists tend to avoid this sort of explanation, and the origins of human intelligence remain largely a mystery. Being unable to explain the causes of these two unique revolutions, we can at least attempt to explain why they were unique. This, too, is quite important.

An answer to the question of why life on Earth had evolved only once was given by Charles Darwin, and it still is considered correct. The idea, as expressed in one of Darwin's letters, is clear: the physical-chemical conditions necessary for the origin of life have always existed but the first biogenesis must have also been the last one because rapid expansion of life into all possible niches must have blocked the possibility of another biogenesis. One cannot therefore claim that life which we know today is the only one that could ever appear on Earth. We should rather say that our remote ancestor simply was the first among its potential

competitors, and it is for this reason that man, a bacteria, a mushroom, and a plant, reveal so much of biochemical commonality.

This idea of Darwin's pond—his symbolic cradle of life—can be further developed today. The primordial life did not only wipe out all other "protobionts" which were soon eaten up by the first heterotrophs, but it also began to change the original natural environment. Owing to the accumulation of free oxygen in the atmosphere and to the appearance of the ozone layer which shields Earth from the ultraviolet radiation, the environment has become so "unnatural" that another biogenesis was impossible also for purely chemical reasons. Darwin's pond does not exist any more simply because the conditions which allowed for the origination of life have disappeared.

Biogenesis is thus unique, though potentially recurrent. Life may exist on many planets in the Universe but it can develop only once on each planet.

What about anthropogenesis? No matter if the factors that led to the transformation of our direct primate ancestor into man worked also in other animal groups and no matter either if an intelligent and creative being could have appeared on Earth earlier than our species did, the actual appearance of man on our planet has totally changed life's environment. Its immediate consequence was the mass extinction of big mammals and birds on all the continents and many islands. The process achieved its climax some 12-10 thousand years ago and stopped—needless to say, not entirely—as abruptly as it had begun. It remained for long unexplained. The extinction coincided with an equally abrupt retreat of the latest Quaternary icesheet from vast territories of Europe, Asia and North America. These two phenomena appeared therefore to be somehow related to each other. And they indeed were interrelated, but the causal link probably involved the first appearance of aggressive human hunters in many previously uninhabited areas.

The idea that the terminal Pleistocene extinction of big mammals and birds had been caused by hunting tribes was proposed as early as the nineteenth century, and Wallace was among its advocates. There was no strong evidence, however, to

support it. It was only in the 1960's that evidence was presented by Paul S. Martin from the University of Arizona. His overkill hypothesis is by now well known. It is based on fairly precise radiocarbon dating of several archaeological sites in North America, and it states that a rapidly shifting front of human hunters passed like a bulldozer through North America between 12 and 10 thousand years ago, killing the majority of big mammals and, to a lesser degree, birds. Essentially the same process took place earlier in Australia and later, on many bigger islands all over the world. Human history, of course, is not restricted to the last ten or twelve thousand years. We exist as a species for at least 100 thousand years, and as bipedal erect creatures for probably over 4 million years. On the one hand, however, hunting was not "our" normal way of life for all that time and, on the other hand, "we" did not appear on all continents simultaneously. Only a million years ago did man leave the African cradle, and only 30 thousand years ago did humans enter Australia and the Americas. The overkill hypothesis refers specifically to the latter three continents.

This great killing comes now to its end. Construction of a highway was suspended to protect a single snail species; prospective oil drillings were interrupted to save dinosaur eggs. The rare rhynchocephalian reptile hatteria is living carefully protected by naturalists; efforts were undertaken to literally recreate the extinct auroch from various living cattle races; the same has been done with more success for the tarpan, a wild horse widespread in Eurasia during the last Ice Age. The European bison was almost completely extinct, but its future now appears to be safe. An army of specialized services takes care of the flightless takahe bird in New Zealand, which was until recently thought to be totally exterminated. All over the world rare plant and animal species are being actively protected in well managed reservations; some of these species are even enabled to find their way back to the wild.

But this is all we can do. We can help to keep them alive but we cannot restart their evolution. And this is why another "anthropogenesis" is by now rendered impossible. The evolution of terrestrial mammals has come to an end. By our act of will they will continue to exist but not to evolve.

The process of overkill—and man-induced extinction in general—cannot be regarded as competitive displacement of some animal species by *Homo sapiens*. Our species has not had any fixed ecological preferences or specialization, it has not occupied any particular niches. It has proven to be extremely versatile and able to transform the environment to suit its own needs. This is why the terminal Pleistocene extinctions by overkill cannot be simply attributed to the presence of our species on Earth but only to a particular stage in history of early humans—the appearance of expansive and aggressive hunting tribes. Martin speculates that the effect of those hunters on big game animals was most profound in the areas where the animals had little time to adapt to their nasty neighbour. This was the case in the New World. The great killing did not last long. It stopped after 200-300 years, perhaps for want of animals to kill. Then, some 12 thousand years ago, the Neolithic revolution began and more and more human tribes switched over to the sedentary mode of life, to growing (instead of picking) plants and raising (instead of hunting) animals. The fauna was given a break, but it was already too late for many species.

Once the killing was over on continents, it began on many islands. The fate of moas and other birds in New Zealand and big lemurs and Aepyornis in Madagascar mirrored the extinction of mammoths, ground sloths and saber cats in North America or Diprotodon and Thylacoleo in Australia. New Zealand and Madagascar were inhabited by very peculiar faunas, mostly birds, quite unlike all continents. Except for bats and some rodents, there were no mammals in New Zealand since they never succeeded in crossing the sea. On the other hand, New Zealand received many birds; several species have subsequently lost the capability of flight and switched to a more mammalian-like way of life. Perhaps the most striking component of this avifauna was moas, gigantic ratites. They had been a dominant element still in the European Middle Ages but the arrival of the Maoris to New Zealand in the fourteenth century dramatically changed their situation. In 200 years the moa was completely extinct, so that Europeans are not to blame for its sorry fate—they simply had no opportunity to exterminate moas, as they would certainly have done if they had only had any chance to do so. Another group of big, flightless birds,

the æpyornis from Madagascar, disappeared in a similar way. It had evolved into the most awesome bird ever (reaching half a ton in weight) and then succumbed on the arrival of the first human tribes; it is now known from the remains of its gigantic bones and eggs. The Europeans, again, arrived in Madagascar too late to be blamed for the massacre.

The Europeans, however, actively contributed to the extinction of the dodo, a huge representative of the pigeon family, in Mauritius, and its two relatives in adjacent islands, the great polar flightless alca, and numerous other species in the islands scattered all over the Pacific, Indian and Atlantic Oceans. The Europeans also carried out the ultimate slaughter of North American bisons (only a handful has been saved, literally at the last moment, out of hundreds of millions of survivors of the terminal Pleistocene killing) and carrier pigeons (the last one died of old age in 1914 in the Cincinati Zoo). The Europeans wiped out the most interesting species of carnivorous marsupials, the famous native wolf of Tasmania (Thylocinus cynocephalus); the last specimen was spotted in 1933. The list of victims of this modern killing is much longer. Since 1680 more than 70 species of birds and several species of mammals, mainly endemic, and thus particularly interesting, insular forms, became extinct.

All this sounds like an indictment, or rather self-incrimination. But should we accuse Nature for what she is? Should we blame her for creating a species for her own destruction? Did man use his powers improperly? Could he really have applied them in a more desirable way?

The answer seems to be no. I deeply regret that I will never see a kind-hearted dodo, look at the face of grandiose æpyornis, admire a huge mammoth. But history was bound to go this way—or we would not be here to discuss it. Had we not scourged Nature so bitterly we could not possibly be what we are today. The moment our ancestors left trees for more open areas meant fatal prospects for many animal species. Their death sentence was pronounced although the execution was delayed until the discovery of sufficiently effective weapons and until expansion of humans into previously unoccupied territories. There was no appeal, the victims could not hope for mercy.

Our early ancestors were omnivorous. They lived in rich tropical forests and the abundant supplies of fruit allowed for almost complete vegetarianism. When they moved into savannahs, however, frugivory was no longer possible, and they had to eat grains (seeds) or meat. Both those resources were probably exploited, but meat certainly was more attractive. At first, competition from predatory cats and dogs delayed the aggressiveness of our ancestors. Along with the appearance of the first tools and weapons, however, with the mastering of the skill of group hunting and with continually increasing populations to feed, big mammals were obviously becoming ever more attractive as a food resource. Of course, our ancestors could initially hunt only the easiest and most profitable—that is, the biggest and most numerous—prey species. Only after these had been exterminated, would our ancestors turn their eyes to more difficult prey. Should we blame our ancestors for not taking enough care to exploit their resources rationally, for not protecting Nature? Every living creature always concentrates on the easiest accessible food resources. One would have to erase four billion years of earlier evolution from our phylogenetic history to change this rule. Why should the early man worry about the fate of other species if none of them ever worried about his?

It was only much later, when big game populations became scarce and the early humans faced hunger, that the problem appeared to them in all its acuity. Consequently, the Neolithic revolution began. Humans became self-sufficient, they produced what they had previously searched for. Human populations were rapidly growing and expanding into new and less accessible areas. Forests were cut down, steppes burnt, marshes dried out. Animals were only rarely directly killed; they were forced out from their habitats, which often—especially on islands—simply meant extermination; their natural ecological environment underwent continual destruction. Wild animals were generally not hunted for food. Carnivorous species, however, were still killed to eliminate competition—even at the beginning of our century quite a substantial sum of money was paid for each marsupial wolf in Tasmania, and even more recently one could get rich hunting the equally rare placental wolf in Europe. Many herbivorous species were killed simply for the pleasure of hunting.

The moment has finally come, perhaps inevitable after four billion years, when all big land vertebrate and even invertebrate species have felt the impact of this unusual bipedal primate. They either fell his direct victim, or were pushed out into the most remote and generally least favorable parts of their habitats. In those areas they can now even expect—as relics of the past—an active care and help from their previous persecutors. Thanks to the existence of these natural, and also artificial, wildlife preserves, the process of species extinction has been essentially halted. Since the early seventeenth century not a single mammalian species has become extinct in Europe. The last victim was the auroch, the last of which, an old female, died in 1627; ironically, it died carefully protected in one of the first wildlife preserves, the royal Jaktorów forests near Warsaw. The auroch's close relative, the European bison, has even been so lucky, that, due to man's great efforts, it could be put again on the list of wild animals.

These successes in wild life protection may sound comforting but, in the biological perspective, they only mean than man has allowed for the existence of those relics and become the guard of their future fate. Their natural history is thus ended. Their population rise is controlled by man and the capacity of habitats is also strictly checked: it no longer depends on the presence of their natural enemies, changes according to their adaptability, reflects their individual differential competitive abilities. Briefly, the fate of species depends on man instead of on natural selection. The history of life is, of course, not yet finished but its very important stage is over.

Let us now reconsider biogenesis. Life evolved only once on Earth not so much because biogenesis was such a difficult and unlikely event as because the first living organisms must have exploited the other protobionts which soon became their prey. The newly developed life thus ensured itself exclusivity on this planet. At first, potential rivals were simply devoured; later, life gradually changed the terrestrial environment in a way that prevented recurrence of biogenesis. The change of the primordial atmosphere from reducing (rich in carbon dioxide, methane and ammonia) to oxidizing (rich in free oxygen) and the appearance of the ozone

screen which shields Earth from ultraviolet radiation have made any repetition of biogenesis very unlikely if not altogether impossible. The appearance of life has ruled out its reappearance.

The impact of man on the biosphere reveals a surprising analogy to that initial stage of the evolution of life on our planet. The overkill by humans resembles the over-devouring by the first living organisms which fed on protobionts. Through the extermination of big land mammals, our direct ancestor paved the way for the full development of his intellectual powers and he also rendered it inaccessible to all other actually or potentially advanced species. Anthropogenesis has ruled out any other event of this sort.

The last 10-12 thousand years, beginning with the Neolithic revolution, is the period of incessant transformation of the entire natural environment and of the weakening of natural selection, at least among big mammals and birds. Consequently, no rival can threaten our uniqueness on Earth because no species capable of evolving in this direction is subject to natural evolution any more. Our closest relatives—the chimpanzee, gorilla and orangoutan—live in isolated, restricted areas and their populations are effectively controlled by man-created conditions rather than by natural selection. Another descent to the savannah is impossible because savannahs have already been, or will soon be, turned into cultivated land, while the competition in tropical forests is no longer sufficiently fierce to enforce such a risky evolutionary step. On the contrary, the tropical rain forest constitutes the last shelter for many wild animals. Yet, as many anthropologists suggest, tropical jungle is the least suitable environment for evolution to turn in the direction chosen by man's ancestors. We are alone on Earth not as much because ours is the only species capable of developing intelligence as because our existence prevented all other species from developing one; perhaps dolphins are the only exception, for their numbers only weakly depend on human activities and their evolution may still go on.

The origin of man is comparable solely to the origin of life. In both these cases a qualitatively new factor has been introduced. Indeed, very few judgments are as unjust as the opinion that *Homo sapiens* is just one animal species among others. The following quote from the distinguished palaeontologist and evolutionary

biologist, Thomas J.M. Schopf is typical: "From an evolutionary perspective, *Homo sapiens* in its niche seems no more remarkable than any other species in its niche..." This position is understandable but, I believe, invalid. The appearance of life and the appearance of man are the two exceptional phenomena which, according to Wallace, should be explained as having a special status among natural phenomena.

We thus come back to the problem posed at the beginning: could life and intelligence develop more than once and, if so, why didn't this happen in the history of the Earth? The answer is paradoxical: both these phenomena are repeatable in theory but their first appearance is also inevitably the last one.

Repeatability refers only to different planets but not to any single one. Life could appear on Earth only once and only once could it give origin to intelligence, and both these possibilities have already been realized. We cannot expect anything more.

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