

# Chance and Finality in Evolution

Fiorenzo Facchini\*

\* Emerith Professor of Anthropology of the University of Bologna  
E-mail: [fiorenzo.facchini@unibo.it](mailto:fiorenzo.facchini@unibo.it)

For a long time, observations of nature have been aimed to research and recognition of regularities and laws governing phenomena of living nature, taken for a static entity, following the Linnaean model of species fixity.

This viewpoint has been challenged by the discovery of fossil evidences in the past and by geological studies that put emphasis on the temporal dimension, and on changes that happened during time in the inorganic world, and in the living one.

In nature's becoming history, time and chance have an intrinsic value, as it was noted by Italo Scardovi (1999), according to whom statistical chance is the factor that breaks the asymmetry of time and gives a direction to the process of change.

The Darwinian vision of evolution attributed a great role to the randomness of spontaneous changes that can be observed in a species and that are selected by the environment, differentiating himself from the Lamarckian transformism, that also admitted an evolution of life, caused instead by a trend intrinsic in nature.

Starting from evolution, as applicable to a few species, in order to get to the evolution of all life forms present on the planet, having as a starting point a few ancestral cells, is the great challenge posed by Charles Darwin, that is at the origin of a lot of researches in the biological field, and of a debate that continues to remain very alive.

## Chance

A preliminary question is in order: does chance exist in nature?

Poincaré wondered if what we call chance should be attributed to our ignorance. A common way of understanding chance, is found in Aristotle and in several modern philosophers, from Spinoza to Bergson and Monod; they view in chance the intersection of two or more independent causal series. In fact, there can be actual situations of indeterminacy in natural events.

Randomness does not imply an absence of laws or causes, but rather unpredictability of some phenomena, or dynamical aspects of physical and biological reality. It is also ascertained that their repetition may imply regularities in the collective order, as Scardovi again points out. It is enough to think of the probabilities of phenotypes that can arise from the hybridization of two heterozygotes.

About the category of chance in biology, there is a vast literature.

Chance of genetic events, i.e. of changes in a broad sense, is corrected and canalized by natural selection in the Darwinian vision, which still plays a leading role. But interactions between genome and environment are far from being easy to define, and that's why the matter is rather complicated.

Monod (1971) proposed chance and necessity, seen as modalities of the evolutionary process, operated by the natural selection acting on genetic variations due to chance. This is the way in which are formed structures that are meaningful in organization and transmission of life.

## The leading role of natural selection in Darwinism

Natural selection gets the role of great demiurge of the evolution not in the sense that it creates the basic factor, mutations, but, as it is pointed out by Ayala (2009), since it represents a creative process by determining the diffusion of favorable mutations to the whole species, during the evolution, and by making possible genetic combinations favouring the development of life.

A statistical insight in the phenomenon of life, with a vision of events that are not determined, but essentially random, is at the basis of Darwin's theory. "In natural selection there is no presence of any capability of choice, neither human, nor divine; it is the result of the meeting between the fortuity of variants and the concurrent pressure of environment" (Scardovi, 1982). The same Author remarks: "Introducing the time and removing the finality, Darwin emancipated natural philosophy from every teleology." According to Neo-Darwinists, the randomness of genetic mutations is the only basis for evolution. Natural selection is the authentic leading factor.

The harmony of nature gives the impression of a program, but actually, Jacob (1971) observes, we have here programs that arise in nature, but are not planned by any mind. "The living being is indeed the execution of a design, but a design that no mind has thought of, provided with a purpose that no free will chose." We are always dealing with products of the natural selection.

Monod and Jacob speak of teleonomy, as the substitute for every teleology.

In the same line Ayala (2004, 2009) makes the distinction between an internal and an external teleology. In the internal teleology the teleological aspects are the result of an exclusively natural process. Events following each other are chained between them (e.g. the development of an embryo from a zygote, due to a genetic program) according to finalities that are brought in existence by the natural selection. Internal, or natural, teleology may have a character of necessity or of contingency, when it is the result of selection among different alternatives. In external teleology a factor is in play, which is different from the factors depending on physical nature (a superior cause, or man) and it guides the direction of the process. According to Ayala, an external teleology due to a factor external to nature (as it is posited in the theory of Intelligent Design) is to be excluded.

What evolution achieves, according to Darwinism, is due to fortuitous causes. Man too is a fortuitous event. There is no external intentionality whatsoever. Finalism is only illusory. After the elimination of a final cause, what remains is the efficient cause, which is identified in the natural selection, working, as we already stated, on the random variations of the species.

### Chance and causality : the picture the causality

Thus randomness is limited by natural selection, but random events can have causes, even if unknown, and produce effects, even if unpredictable. It is in this way that we introduce in the picture the *causality*, a relation between cause and effect, which can be found present in nature at various levels. With causality it comes in play also the concept of finality, or intrinsic finalistic principle, which, without any external intentionality, cannot be denied in biology.

In order to avoid ambiguity, Monod introduces, as we recalled, the concept of teleonomy, which excludes teleology. It is the unity of the living being that requires a chaining of phases and an organization of its elements. It is in this way that a finality intrinsic to the living being can be achieved. Embryology, especially after the studies on genoma, speaks of a program that gets completed with the development of the zygote.

An intrinsic finalistic principle may be admitted. Thus randomness does not exclude causality, and does not deny the possibility of reaching determined effects, even if it cannot be stated that a specific cause exists for that finality. Randomness does not cut out from several natural processes the finalistic principle, also known as teleonomy. One should not speak of teleology. Mayr (1988) remarks, in line with Monod: natural selection provides a satisfactory explanation for the course of organic evolution and makes an invoking of supernatural teleological forces unnecessary (p.248).

A relationship between the rise of mutations and their (positive, negative, neutral) effects is excluded.

In this perspective, randomness of spontaneous variations in species radically removes finalism from evolution of the species.

Finalism, seen as a predetermined orientation of natural changes toward some finality, would imply an external intentionality, and it would this way put itself out of the domain of the scientific research tools.

Man too is to be considered a fortuitous event, and finds out to be alone in the universe (Monod).

But the problem is still wider, going beyond the causes of biological variability and the aspects of randomness in changes that happen with the passing of time. The real gist of it is if there is a sense in evolution, if some finality of general order may be recognized.

### Chance in the history of life on earth

As we said above, chance is not to be related only to our ignorance of causes of phenomena.

It may depend on the unpredictability of the coincidence of chains of independent events.

It may be seen, sometimes, in terms of statistical probability. With reference to the genetic level, mutations, or the greatest part of them, happen by chance, during DNA replication, without a preferred direction, and are thus unpredictable. Moreover, their effects may be different, depending on the environment in which they take place. Congruency with the environment, which is also subject to several factors of influence, cannot be programmed or predicted in advance.

Two populations with a common genic pool can evolve differently, depending on the environment. In population genetics effects of genic drift are well known.

### Direction and finality in evolution

Randomness does not mean and does not imply a lack of causes, as we already stated, and not even a lack of finality, if certain balances, which turn out to be congruent with the environment, are achieved, transmitted and maintained. Non everything is due to chance, and also what is formed in a random way may have some congruency or regularities or intrinsic finality.

Programs may be formed, that include finalistic relationships, are congruent with life, and are maintained in time.

Relationality is the basis of changes happening during the passing of time. And it can be seen, according to Stoeger (2011), "as a key characteristic of nature and the universe" (p.480).

Relationships that come into being may acquire aspects of congruency in a given environment, giving also rise to new structures and forms, and showing some finalistic aspect. Orientations and directionality, seen as intrinsic finalities, are at the basis of complexity in biology, which appears to be as a whole structured, and maintains itself with the passing of time.

This is also what happens in physical reality, when, in given conditions, atoms and molecules unite between them, establish relationships and interactions, that are persistent. In compound molecules, atoms are not randomly distributed, but have a well-defined spatial configuration

(e.g. water; it would not have the physical proprieties it has, if in its molecule the angle between the two hydrogen atoms were very different from 105°).

Monod speaks of the epistemological paradox of invariance in life's transmission at ontogenetic level. This corresponds to the concept of teleonomy, defined as the propriety to transmit the specific contents of reproductive invariance to the following generation. Directionality seems to be intrinsic to the system and does not depend on any direct external intentionality.

In the history of life directionalities can be found: in biogenesis, in phylogenesis, in anthropogenesis.

Regarding the formation of the primeval living beings, directionalities are admitted in super-molecular aggregations, in given environmental conditions.

In paleontology we recognize evolutive directions in some series, due to genetic factors or to environmental conditions. This happens at least starting from the great changes in the Vertebrates after the Cambrian period. Research on fossil record shows also "evolutive trends" in some series, e.g. in Titanotheres of Eocene and Oligocene, who were adorned with a large frontal protuberance, or in saber tooth cats of Pliocene in North America. Such trends cannot be interpreted in a finalistic sense, since they can be related to modifications in time or to genetic restrictions or to environmental conditions that optimize some structures (Chaline, 2006). In the same perspective, other evolutive trends that can be found (in Rodents, in Giraffes, in Proboscideans, etc.) do not have *per se* a finalistic meaning, for they can be connected with genetic factors, and to variations in the environmental conditions. The growth in complexity shows, as a matter of fact, some directionalities in the differentiation of evolutive lines in the main groupings, as well as in the augmented relationships at a structural level, and in the degree of autonomy with respect to the environment, without need to interpret this in a finalistic sense.

Complexity can take different paths, with different results. Sometimes there is a stop, and the definitive structure becomes extinct for various causes. In other cases it survives, maintaining itself with minimal modifications in time, sometimes complexity has kept growing so far.

### Possible explanations of directionality

Darwinian explanation is well known: evolutive directions are shaped by random events, which nobody programmed. An alternative is orthogenesis, or progressive evolution. This was suggested also by Grassé (1979). Evolution would have happened for internal causes (in line with Lamarckism), while in the Darwinian outlook indeterminism rules, so that one has to speak, eventually, of orthoselection, and not of orthogenesis.

Natural selection itself, which plays a guiding role in evolution, must not be seen in a finalistic sense, as if it were pursuing finalities. In this last direction went the opinion of Asa Gray (1868), a contemporary of Darwin, but Darwin refused such teleological interpretation of natural selection.

As already noted, according to Jacob (1970), programs that are in play have not been thought of by any mind.

It remains true that some structures are formed more than once in the course of evolution (e.g. eye's structure, or the appearance of the Hox, or homeotic, genes in different evolutive series, even phyletically very far, and in different periods of time), as it is made clear from paleontology and from research in biology of development (evo-devo).

There are limitations at genetic level that produce canalizations. For example, grown-up scolopendras always have an odd number of pairs of legs. The lengthening of the neck in giraffes happened maintaining the same number of cervical vertebrae (see Minelli, 2011).

We cannot forget evolutive convergences pointed out by Mivart when Darwin was still alive, and more recently by Conway Morris (2003). Such convergences can sometimes be linked to similar environmental conditions. In other situations, when they happen in very different series, very far among them in space and in time, one may be tempted to think that genetic novelties do not happen by sheer chance, so that it becomes possible to suppose the existence of genetic canalizations.

According to Stephen Gould, if it were possible to start again from scratch the evolutive process, the results would be completely different. Others, like Conway Morris (2003), disagree, in the sense that the results would be, according to them, very similar, and the event of man would be unavoidable.

Along this line can be introduced the debate regarding the anthropic principle, which sees in the advent of intelligent observers the meaning and the purpose of the universe. At this point one cannot avoid reaching the philosophical level. From the scientific viewpoint, directions taken can be appreciated *a posteriori*, and most authors do not like the concept of oriented evolution, an expression that may lead one to think of an external intentionality at play. But the question remains: to which causes can be referred the directions that we can detect, even if we would rather avoid speaking of oriented evolution?

As already noted, in the Darwinian vision, everything is tightly linked to the randomness of mutations that are selected by the environment. It is well known the metaphor of the architect who uses for his construction stones made available because of a landslide, due to various factors (weathering of the ground, composition of the rock, etc.). The role of the architect is given to natural selection, that makes use of the available material to produce new living structures.

In the modern synthesis, as proposed by Simpson, Mayr, Dobzhansky, Huxley and later by Monod, Jacob and many others, it is admitted that, due to errors in DNA replications, new structural elements are formed, and are selected by the environment. With the exclusion of whatever teleology, we are left with the teleonomic principle of finalities that are reached through the congruency of novelties that are formed with the environment, without any external intentionality. In general, life's evolution is referred to genetic and environmental factors, interacting between themselves, but it remains difficult, if not impossible, to define the

modalities in which the interaction happens, except for the micro-evolutive level (e.g. in genetic of populations). According to Allmon and Ross (1990) it is to be admitted a wide range of causal factors, biotic and abiotic, the latter further distinguishable in intrinsic and extrinsic. Allmon and Ross define as biotic intrinsic the factors limiting or leading the direction and modalities of the changes, and as abiotic extrinsic factors the physical laws and physical proprieties of the material which is used in the development of the organism.

Nevertheless, an explication of the orientations or directions that take shape requires a coincidence or convergence of all these factors. For example, in order to get to bipedalism, an open environment must have been very important, as Yves Coppens (1984) affirms, for the regions to the East of the Rift, that have seen the evolution of pre-human and human Hominids, but the environment acted upon structures that were emerging at the genetic level.

The debate about the role of chance and finality in evolution was sparked again, both by the recent studies about evo-devo, and by research about epigenetics, i.e. about the influence of external factors on the expression of genes that could be added to the DNA inheritance. The critical position taken by a couple of cognitivist scientists, Piattelli Palmarini and Fodor (2010) regarding new-Darwinism seems to diminish the role of natural selection, as the great demiurge or main and directive factor of evolution according to the Darwinian vision.

### Efficient cause and final cause

Going back to the theme of efficient causality, we cannot help returning on the final cause of evolution. At the level of epistemology, the former brings on the foreground the latter. In the real situation of the formation of new structures, it is necessary to understand how they are linked, always remaining limited to the domain of causes of physical order, thus excluding a direct external intelligent agent.

One has to consider what is at the origin of events, and what may be its meaning.

Looking at the ways in which natural phenomena happen, at times the cause-effect relationship is well determined, while in other situations we are faced with a multiplicity of internal and external factors, and with the formation of new relationships due to a congruency of the various elements that are in play, so that the individuation of a single cause for an event becomes difficult. If we move to the level of finalities, it is the very congruence of a structure with its functions, no matter how it was formed, to suggest, as already mentioned, some finalistic principle. In fact, it is difficult to avoid the recognition of a finalistic principle in the functioning of the system, due to the characteristics of its elements, but this does not imply that we need to posit an external physical agent that is permanently or intermittently directly operating. Such a conclusion would properly belong to the philosophical level, and it raises directly the question about the direction of life's evolution.

As Possenti (2007) remarks, "*finality is linked to causality. There is no causality without internal teleology, nor teleology without causality.*"

As a matter of fact, thus, if one recognizes some finalities inside the biologic processes, the road is open to a general finalistic dimension or connotation of nature, which can be defended with reasons pertaining to the philosophical level. Ayala (2004) speaks of "design without designer".

"If evolution is oriented toward a growing complexity", Possenti (2005) adds, "which metaphysics is the most suitable to offer a foundation and an explanation to this event?" According to the Author, the doctrine of Thomas Aquinas regarding the relationship between matter and form, if well understood, "highlights a metaphysical trend of the prime matter toward different forms, that becomes an evolutive trend, if one adds to it the temporal dimension" (pp. 222-223).

The argument is further bound to broaden to the intentionality of an external cause, on the basis of the natural order, as several philosophers and scientists hold, as a theme at philosophical level. This argument has its own justifiability at the rational level.

Exclusion of finality, perceived as intentionality, may be required by the exclusion of factors external to the system, if one intends to deal with the problem in a frame of knowledge grounded exclusively on the methods of science.

This is an epistemological assumption, a conclusion derived from the limits of the cognitive horizon of empirical science, which in itself cannot exclude causality at the ontological level, since this would be an essentially reductionist *a priori* position, surely not required by science.

Thus, if we are looking for an answer to the question about the possible causes of directionality or orientation of nature, we should look for them at the level of natural causes, at least to begin with, i.e. to those who are considered secondary causes, without the necessity to admit any miraculous external intervention, which cannot be excluded as well, but that would not be in agreement with the general economy of creation, according to which God works through secondary causes. On this ground is based the criticism about the Intelligent Design theory, which postulates direct external interventions leading to the formation of complex structures, thus adopting theological solutions in order to answer to scientific problems (cf. Facchini, 2008, a,b).

One has to search in the recesses of nature for an explanation of phenomena still unknown to us, such as, for example, the existence of laws or rules for the functioning of the living beings. Ultimately, the proprieties themselves of matter beg for an adequate cause.

A harmony like the one existing in the system of nature can't be thought of without having as its source a mind, that willed a reality of a given type (structure of matter, natural forces), endowed with the capabilities for change that have been observed in nature.

## Emergence of man

If we broaden our scope to the whole evolutive frame, and in particular to man, the problem becomes even more complex. The formation, in the course of evolution, of a species like the human one, endowed with the capability for thought, even leaving aside the causes at the physical level that allowed its evolution (especially the cerebral development), asks for attention both to the efficient causes and to the final cause, to what produced man, and to the meaning of his presence in nature. Are we in the presence of a being absolutely fortuitous, like every other species, as in the Darwinian vision, or do we face a peculiar being, different from every other species?

According to darwinian vision, the universe appear without any finality, and man too is a fortuitous event, incidental, like other species, shaped by natural selection. Man cannot thus be seen at the top of, or as the finality of evolution, if his biological structure has been the result of the randomness of genetic events, even if they have been selected by the environment. It is a true dethronement of man, if confronted with the common mentality. Some people see in this a second Copernican revolution.

Darwin (1871) speaks of humble origins: "*Man still bears in his bodily frame the indelible stamp of his lowly origin.*"

The question of human identity regards both his origin and his meaning in the world of living beings.

Human form is believed to have had its roots in the order of Primates, and to have been reached through a chain of morpho-functional transformations having some correlation with the environment, at least regarding bipedalism, a very important step in the path toward today's man.

What did drive or favoured these transformations can only be hypothesized. But there is no doubt that the human evolutive lineage, that can be traced to a branch that diverted about 6-7 million years ago (if not more) from the Great Apes line, starting with bipedal Australopithecines, is characterized by a growth in the brain size, and moreover by a new relation with the environment, due to the acquired bipedalism.

In the process of hominization, the growth of complexity may be measured by cerebralization, that not only consists in a dimensional growth of the brain, but in a differential growth of different areas, resulting in a more complex organization of the brain functions. The 86 billion of neurons and the trillion of synapses in the human encephalon bear witness to this biologic complexity at the brain level.

Several authors acknowledge brain complexification in Hominids as a characteristic index of hominization, which in turn constitutes a privileged direction in the evolution of Primates among the Mammalia (Teilhard de Chardin, Piveteau Dobzhansky). This is a directionality for which a convincing explanation remains to be found.

The emergence of man is marked from one side by a growth in brain size, with respect to the Australopithecine forms and to the other Primates, and from the other side by the purposeful crafting of tools, that reveals, in the behavior, an intelligence capable of abstraction.

No matter at which morphological level we place the apparition of man. What is evident in his evolution - and the evidence continues to grow with time - is his cultural discontinuity with respect to the world of non-human Primates, *Australopithecus* in particular. This is the reason of the evolutive success of man, with respect to the Australopithecine forms, that are now extinct (Coppens, 1988, 1991).

Such a discontinuity, that can be detected at the phenomenological level, suggests, according to some authors, a discontinuity of an ontological order that reveals a spiritual dimension, which, as such, cannot be explained merely as an event determined only by biologic structures, but requires the cooperation of a superior causality (cf. Facchini, 2011).

Cultural behavior in turn shows a growth in complexity at the level of social organization, which, as Teilhard de Chardin (1956) remarks, can be considered an extension of biologic hominization. It is a growth that appears to be limitless, if one thinks of the network of long distance communications possible nowadays.

At this point, we can ask two questions: this complexity at biologic and behavioristic level may represent a finality of life's evolution on Earth, or is to be considered a purely casual event? And then: humankind answers to some finality, if one admits that the achievement of human form required the cooperation of a superior cause?

About the first question, darwinian vision is well known: evolution does not have any finality. But one cannot deny the completely peculiar process of complexification, as revealed in hominization, that can be ascertained at the phenomenological level, even not considering intentionality aspects; in general, one cannot deny as well regularities and canalizations in the evolutive process, that raise the question about possible orientations or rules, present in nature, and favoured by environmental changes.

Even without considering an external intentionality, from an *a posteriori* observation about how things went, it cannot be denied that events that followed each other did *de facto* make possible the advancement of the river of life in a peculiar direction, in which the emergence of a being endowed with self-consciousness ends up giving a meaning to all what comes before him and all what accompanies him.

The second question remains: what may be the finality or the sense of a being that is endowed with self-consciousness, and is able to know, to choose freely and to love?

The finality of his existence cannot simply be existence itself, but he must exist for someone or for something. Here we enter in the field of considerations that are of philosophic or religious type. Moreover at the ethical and cultural level it may be posed the theme of responsibilities of actions that relate to the sphere of relationships between men, and to the relationship of man with the environment, since man is the only species that is able to establish with it an intentional and programmatic relationship.

If one admits that at the origin of the human appearance on the Earth there is a superior intentionality, then the

finality of the human being itself can be linked to that intentionality or purpose.

## Two positions in the contemporary debate

The positions that can be individuated in the current debate about a finalistic meaning of the universe and of the evolution, in particular, can basically be reduced to the following ones.

1. Having in mind the theory of evolution according to the darwinian model, one can get to a purely horizontal and naturalistic vision about life, man and the universe, with the exclusion of every transcendent dimension. No purpose, no finality in the transformation of things. Everything is self-formed, and develops only as driven by chance. This is what several champions of Darwinism do, in a global reading of history of life that goes beyond empirical data. The very formation of the universe should be reduced to purely natural events, after the Big Bang, which also happened by itself (Hawking, 2011).

We can observe that natural selection has nothing to do with this question. We have moved to what properly called is the philosophical level. In this vision an inference is made: from denying finality in the formation of species, to denying every finalism in life and in the universe.

Darwin's vision would make God superfluous. There is no need to believe in God, some scientists declare. A self-organization of nature is posited, excluding every external intelligence, in the line of a reductionism (we can only reason using what science offers us). At the basis of this there is a choice, i.e. to limit the cognitive horizon to observations of the empirical type, that pretend to answer all the question raised by reality around us. It is a choice of an ideological character, or, if we prefer, a postulate from which to start. What derives from this position is a reductionism which is not only methodological, but also ontological. It is the naturalistic position, held by various scientists and philosophers, that belongs properly to a philosophy of nature, and not to science.

In this position we can find different nuances, going from agnosticism (which Darwin admitted being his position) to denial of transcendence, as in Dawkins (2007), that gets to the point of stating that we cannot avoid being atheists, or of Dennett (1997) that so states: "[Universe] creates itself ex nihilo, or at any rate out of something that is well-nigh indistinguishable from nothing at all."

Telmo Pievani (2006) speaks of a creation without God. Orlando Franceschelli (2007) argues in favor of the scientific, philosophic and ethical plausibility of modern naturalism, "getting rid of the working hypothesis of God" and speaks of a "grownup conscience, weaned from the hypothesis of God and from the more or less pascalian wagers in favor of its existence."

In this naturalistic vision, even man is seen in absolute continuity with other living beings.

Denial of every transcendent reference to explain harmony of nature ends up assuming a philosophical flavor (at ontological level), going beyond the scientific side, and seems to depend on a methodological exclusion, thus implying a philosophic character.

Naturalism does not represent a scientific vision of nature, but a particular interpretation of it, and is thus to be placed on a properly philosophical level.

A second position is the one that recognizes the presence both of deterministic and of chance events in the system of nature, in the domain of laws and proprieties of nature, events that can convey a meaning. One can think to causalities that can be found at the deeper level, like e.g. proprieties, laws or rules of nature of which our knowledge is not complete.

We cannot pretend to know everything and to explain everything on the basis of what we already know.

From here the discourse can develop toward the properly philosophical level: what is at the source of proprieties and laws of matter, that becomes ever more complex in certain directions?

It would be out of place to think of factors external to the system that from time to time interfere with it in order to realize complex structures, as proposed by the Intelligent Design theory. One should think instead of intrinsic proprieties of matter that appear with the passing of time in order to bring about ordered structures. This would happen with the concurrence of several causes, including random factors. As we already mentioned, according to Teilhard, evolution advanced almost gropingly.

Some philosophers (Bergson, Blondel) speak of a natural trend, Teilhard de Chardin (1956) of radial energy, and of growth of consciousness from the aggregations at the molecular level to emergence of man, but his interpretation is more a description on the phenomenological level, rather than an explanation.

Maybe it is not necessary to think this way. Even if we still don't know a lot of aspects and laws of nature, from harmony in nature and from its laws, the inference regarding the existence of an creating and ordering mind has its good reasons.

The finalistic principle, that can be found in nature at several levels, is linked to proprieties and laws that suggest a superior mind. This is admitted by several scientists and philosophers (Einstein, Flew, Gamow, Davies, Barrow, Foster, Lennox, Dobzhansky, Collins, Ayala, Polkinghorn, Novak, etc.). The concept of creation emerges, not in the sense of an event far away in time, to which we can make references, but from the radical dependence of the existing universe, with its proprieties, from another Being that make possible its existence as we experience it.

Creation becomes evident with the proprieties that characterize it, including what can be defined as chance events.

Thus, nature's rationality makes one think of an external rationality which is at the origin of the properties of matter. The question may be posed, if this view is compatible with the idea of a project, such as the one proposed by the Christian vision. The answer is affirmative, since the concept of project does not imply that everything in it is determined in advance and develops according to pre-established rules, without any possibility of incongruence or defects in the course of its implementation. In itself, a general project, that proceeds through secondary causes

can tolerate chance events and aspects which are difficult to understand.

To God, who is out of the temporal dimension, everything is present. The project is implemented through secondary causes, i.e. nature's events, following their course. In such a perspective, open to transcendence, it becomes much more plausible the position that recognizes in the appearance of man a discontinuity not only cultural, but also ontological.

A third position is also possible, i.e. to disregard altogether this kind of problems, but the questions remain all the same.

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