

**TEILHARD DE CHARDIN  
AND THE LATIN SCHOOL OF EVOLUTION:  
COMPLEXITY, MOVING TOWARDS  
AND EQUILIBRIUMS OF NATURE**

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INTRODUCTION

*Teilhard de Chardin as a scientist*

Teilhard de Chardin represents the best example of fruitful connections between science and theology of the XX century<sup>1</sup>. Scientist, his fields of research were geology, palaeontology and palaeoanthropology. Man of faith he was a priest and a Jesuit. So far he had also a good training in philosophy and theology.

As a scientist he accomplished his doctoral degree in Paris, under the supervision of Marcellin Boule<sup>2</sup>. Then he taught geology in the Catholic Institute in Paris, just after the end of the first world war.

It is possible to reconstruct, from the very beginning of his doctoral activity, the making of a true which could be compared with that of the so called modern synthesis, organized research program on evolution in English speaking countries in the same years<sup>3</sup>.

Its main point is that evolution (of the universe, of matter and life) is clearly characterized by a *moving towards* complexity and in animal *towards* cerebralization.

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<sup>1</sup> See: L. GALLENÌ, «Teilhard de Chardin's multicentric model in Science and Theology: A Proposal for the Third Millennium», in: J. SALMON and J. FARINA (eds.), *The Legacy of Pierre Teilhard de Chardin*, Paulist Press, New York, 2011, pp. 59-78; L. GALLENÌ, «Teilhard and the Science of the Biosphere», in: K. DUFFY, S.S.J., *Rediscovering Teilhard's fire*, Saint Joseph's University Press, Philadelphia, pp. 197-206; L. GALLENÌ and F. SCALFARI, «Teilhard de Chardin engagement with the relationships between Science and Theology in light of discussion about Environmental Ethics», in: C. DEANE DRUMMOND, *Teilhard de Chardin on people and planet*, Equinox, London, 2006, pp. 160-178.

See also: A. UDIAS, «Teilhard de Chardin and the current dialogue between Science and Religion», in: C. HELLER DEL RIEGO (ed.), *God seen by Science: Anthropic evolution of the Universe*, Universidad Pontificia Comillas, Madrid, 2008, pp. 71-97; I. NÚÑEZ DE CASTRO, «The Bio-Philosophy of Teilhard de Chardin», in: C. HELLER DEL RIEGO (ed.), *God seen by Science: Anthropic evolution of the Universe, op. cit.*, pp. 99-126, and M. G. DONCEL, «Creation in Evolution: Philosophical and Theological Perspective», in: C. HELLER DEL RIEGO (ed.), *God seen by Science: Anthropic evolution of the Universe, op. cit.*, pp. 127-147.

<sup>2</sup> See: L. GALLENÌ and M. C. GROESSENS-VAN DYCK, «Lettres d'un paléontologue. Neuf lettres inédites de Pierre Teilhard de Chardin à Marcellin Boule», *Revue des Questions Scientifiques*, 172 (19), 2001, pp. 5-104.

<sup>3</sup> See: E. MAYR and W. PROVINE (eds.), *The Evolutionary Synthesis*, Harvard University Press, Cambridge Mass., 1998.

This *moving towards* is at the very basis of the central core of a scientific research program, *sensu* Lakatos, and more specifically is its metaphysical part. The *moving towards* was clearly a suggestion from his philosophical and theological insights and it was highly fruitful because his program suggests also the search of new methods in geology, paleontology and evolution<sup>4</sup>.

The central core is not only based on observations and experiments but also by the general «metaphysical» views of the scientist, in this case the necessity of a *moving towards*!

Of course then the scientific research program must pass the control of verification and falsification typical of the method of experimental sciences. In the case of paleontology the discovery of fossil records.

At the very beginning of his investigations, during the first world war, he had an exchange of letters with his colleague geologist Jean Boussac and in these letters emerged clearly the idea of a non reductionistic approach to the study of evolution. Curiously the scientist, Boussac suggested to the priest, Teilhard, to read a mystic, Angela da Foligno to enter deeply into the perspective of the global vision of reality and so far also of evolution<sup>5</sup>.

From this exciting startpoint we developed an analysis of the scientific papers of Teilhard de Chardin. These papers suggest that an holistic or systemic approach gives information about this process of *moving towards*.

Before our analysis, he was generally considered the founder of the modern geology and paleontology of Chinese subcontinent. He was, also, a member of the team working on the so called Peking man. He analyzed the associated fauna in order to have a better temporal placing of the fossil remains and of their ecological characteristics. Finally he worked to analyze the lithic cultural remains describing the Peking man as *homo faber*.

Many papers have been written regarding these parts of his scientific production<sup>6</sup> and this production found his best synthesis in his book: *Man place in Nature*<sup>7</sup>.

Anyway, for a long time, the large part of his technical scientific papers were completely ignored by investigators mainly because they were published before and during the second world war in Chinese journals.

Luckily Nicole and Karl Schmitz-Moormann recovered all the scientific production of Teilhard de Chardin<sup>8</sup> (more than four thousands and five hundreds pages of scientific monographies), and from these pages it was possible to find

<sup>4</sup> Cfr. L. GALLEN, «Pierre Teilhard de Chardin: Scienza e teologia nella prospettiva del terzo millennio», *Revista Portuguesa de Filosofia*, 61, 2005, pp. 159-184.

<sup>5</sup> P. TEILHARD DE CHARDIN and J. BOUSSAC, *Lettres de guerre inédites*, ŒIL, Paris, 1986.

<sup>6</sup> See, f. i., L. BARJON and P. LEROY, *La carrière scientifique de Pierre Teilhard de Chardin*, Editions du Rocher, Monaco, 1964; J. PIVETEAU, *La père Teilhard de Chardin savant*, Fayard, Paris, 1964.

<sup>7</sup> P. TEILHARD DE CHARDIN, *Le place de l'homme dans la Nature*, Albin Michel, Paris, 1996.

<sup>8</sup> P. TEILHARD DE CHARDIN, *L'œuvre scientifique* (N. and K. Schmitz Moormann, eds.), Walter verlag, Olten und Freiburg im Breisgau, 1971.

the proofs that Teilhard developed a true theory about evolution based on the concept of *moving towards*<sup>9</sup>.

The research for the empirical evidences of the *moving towards* starts from the publication of material related to Teilhard's doctoral thesis. In these papers, side by side with his excellent discussions of fossil records, it is clear his main field of theoretical investigations: to look for parallelisms as the experimental proof of the *moving towards*.

#### TEILHARD DE CHARDIN THEORETICAL WORK

##### *Convergence and parallelism*

First of all he had full consciousness of the difference between convergence and parallelism.

He reported the finding in a French fossil deposit of *Plesiadapis*, a genus representing a first adaptive radiation of Primates, developing an anatomical structure in some way similar to that of Rodents<sup>10</sup>. Anyway Teilhard underlined that this was a convergence.

On the contrary describing the Tarsidae, a group of primitive monkeys, he underlined the presence of morphological evolution towards cerebralization and the parallelism with the other evolutive lines of Primates, first of all that bringing to the family *hominidae*<sup>11</sup>.

We wish to underline the importance of the distinction between convergence and parallelisms, a distinction well present to Teilhard mind<sup>12</sup>.

Convergence was mainly due to displacement of similar morphological characteristics in distant groups and are easily explained by the adaptive answer to similar ecological inputs due to the action of natural selection.

On the contrary parallelisms are defined as the origin of similar characters in just separated lines. This implies that when evolution reaches a morphological or genetic step, the following steps are strictly determined and when different lines evolve from a common step, then they develop independently the same characters

<sup>9</sup> We make a synthesis of our researches in: L. GALLENÍ, «Relationships between scientific analysis and the world view of Pierre Teilhard de Chardin», *Zygon*, 27 (2), 1992, pp. 153-166; L. GALLENÍ, «How does the teilhardian vision of evolution compare with contemporary theories?», *Zygon*, 30 (1), 1995, pp. 25-45; L. GALLENÍ and M. C. GROESSENS-VAN DYCK, «A Model of interaction between science and theology based on the scientific papers of Pierre Teilhard de Chardin», in: W. SWEET and R. FEIST (eds.), *Religion and the challenges of Science*, Ashgate, Aldershot, 2007, pp. 55-72.

<sup>10</sup> P. TEILHARD DE CHARDIN, «Les mammifères de l'éocène inférieur Français et leurs gisements», *Annales de Paléontologie*, t. X, 1916-1921, pp. 40-41.

<sup>11</sup> P. TEILHARD DE CHARDIN, «Sur quelques Primates des Phosphorites du Quercy», *Annales de Paléontologie*, t. X, 1916-1921, pp. 19-20.

<sup>12</sup> See: J. ARENDT and D. REZNICK, «Convergence and parallelism reconsidered: what we have learned about genetics of adaptation?», *Trends in Ecology and Evolution*, 23, 2007, pp. 26-32.

in spite of the selective pressure. For these reasons many authors looking for mechanism different from natural selection described many parallelisms both in plants than in animals<sup>13</sup>.

But what is the difference? In natural selection, when a morphological or a genetic step is reached, various new possibilities are explored by mutations and then natural selection makes a choice and the best solution increases its frequency in the population. Because of random evolution clearly explained by Darwin with the architect metaphor<sup>14</sup>, it is less probable that explorations of new possibilities find the same solutions in separated branches. The main characteristic of evolution is divergence, acting natural selection on different possibilities.

Parallelisms, on the contrary, are the proofs that different mechanisms are working. When a step is reached, then there is not an equal probability search thanks to casual mutations, but some evolutive lines are more probable than others. Evolution is so far canalized and the proofs of this canalization are the finding and description of parallelisms.

#### *Teilhard de Chardin and biology as the science of complexity of life*

Still in Paris at the beginning of the twenties of the last century, Teilhard de Chardin had a fruitful encounter with the Russian geochemistry Vladimir Vernadsky. They separately developed the idea of a science of the Biosphere in order to better understanding evolution and together with Le Roy they applied this global vision to humankind with the Noosphere concept.

The Biosphere as a whole was firstly proposed by the Italian geologist Antonio Stoppani at the end of the XIX century. Antonio Stoppani was a roman catholic priest and a follower of Antonio Rosmini. As a geologist he was well aware that the main characteristics of chemical and physical parameters of Biosphere such as atmosphere temperature or sea salinity, were constant in time. His problem was to find a scientific explanation to this stability allowing the survival of life on Earth.

And the answer was the active action of living beings at the planetary level<sup>15</sup>. Stoppani was an exponent of that Italian school of geology strongly commended by Charles Lyell<sup>16</sup> and his work represented a first statement towards a theory of systems applied to Biosphere and a first application of the concept of stability which will be developed in the second half the XX century by Lovelock with his Gaia hypothesis.

<sup>13</sup> See: ST. GEORGE J. MIVART, *On the genesis of species*, MacMillan, London, 1871, pp. 63-96, and N. I. VAVILOV, «The law of homologous series in variations», *Journal of genetics*, 12, 1922, pp. 47-88.

<sup>14</sup> See: L. GALLEN, *Darwin, Teilhard de Chardin y los otros. Les tres teorias de la evolucion*, Editorial Epifania, Buenos Aires, 2010, pp. 51-53.

<sup>15</sup> Ibidem, pp. 89-91.

<sup>16</sup> See: C. LYEEL, *Principles of Geology*, Penguin Books, London, 1997, pp. 16-17.

Teilhard, after the letters with Boussac and the meetings with Vernadskij, had the possibility to work in China and there he developed definitively his ideas about complexity.

He had to confront himself as a scientist with the long times and large spaces of continental evolution studying geology and paleontology of the Chinese subcontinent and as a man of faith with the desert experience and experience of totality, during the Ordos expedition.

After this experience, he wrote a text, which is one of the best example of the mystic of the twenty century: *The mass on the world*<sup>17</sup>.

Just after the Ordos expeditions and the, so peculiar, experience of totality, he developed his ideas of complexity. In some letters to his scientist friends he wrote that different mechanisms must be present in evolution and could be discovered working on larger scale<sup>18</sup>.

Mechanisms described for the population level are not useful or anyway sufficient to explain evolution at a larger scale. And he proposed a *Biology of the Biosphere* as there was a *Chemistry of the Lithosphere*<sup>19</sup>.

And China was the laboratory for continental evolution: continental evolution opened the possibility to investigate the true deep mechanisms of evolution lost at the population levels.

And quickly he found the parallel evolution of Siphnaeidae. The experimental problem was related to the dating of the remains of the Peking man.

Looking for connections among fossils and strata he found the reddish clays, a peculiar geological layer, rich in Rodents. Among them the Siphneidae: the mole rats. He was able to follow the evolution of this well defined group for millions of years and on a continental basis. And the main characteristic was parallel evolution.

From a common basal group originated three different lines and independently the three branches developed the passage towards an increase in size and cerebralization, an inception of continuous growth of the molars and the fusion of the cervical vertebrae<sup>20</sup>.

In this case, evolution followed for long time and in large space was parallel. This finding confirm that that theory of the evolution as a *moving toward* based on the search of parallelisms, was a true scientific research program because the proofs, i.e. the experimental evidences, were found after that the program was organized.

Evolution of Siphnaeidae was one of the experimental proofs of the Teilhard de Chardin scientific research program.

<sup>17</sup> P. TEILHARD DE CHARDIN, *Hymn of the Universe*, Collins, London, 1970, pp. 19-35.

<sup>18</sup> Cfr. L. GALLEN, *Pierre Teilhard de Chardin: Scienza e teologia nella prospettiva del terzo millennio*, op. cit., pp. 159-184.

<sup>19</sup> See: L. GALLEN and M. C. GROESSENS-VAN DYCK, *A Model of interaction between science and theology based on the scientific papers of Pierre Teilhard de Chardin*, op. cit., pp. 62-63.

<sup>20</sup> P. TEILHARD DE CHARDIN, *New Rodents of the Pliocene and Lower Pleistocene of North China*, Institute de Géo-biologie, Pekin, 1942, pp. 33-81.

*Geobiology: the science of Biosphere evolution*

At the end of his Chinese period Teilhard de Chardin wrote a final proposal: after biology as the science of life complexity and the description of examples of parallel evolution thanks to the techniques of continental evolution, he finally proposed Geobiology as the science of the Biosphere.

First of all an Institute devoted to this new science, the Institute of Geobiology was founded in Peking where the material and the library of the Huangho- Paiho Museum were transferred from Tien-Tsin. The Museum was founded in the twenties by Father Emil Licent S.J. and the cooperation with Father Licent opened the gates of China to Teilhard de Chardin.

So far the new institute was ideally connected with the Museum but twenty years were passed over from this first contact with China and now the perspectives are clearly directed toward the study of continental evolution.

The ideas of father Licent were to gathering all the possible data about the natural history of the Huangho basin.

Now after twenty years, in the projects of Father Teilhard de Chardin, the Institute will become the place to study continental evolution<sup>21</sup>.

But after few years, presenting the journal: *Geobiologia*, printed by the institute, the field of research is now opened to all the Biosphere.

Actually there is a dramatic passage from the local level (the Huangho basin) to the continental level (China) and finally to the global vision (the whole Biosphere)!<sup>22</sup>.

The general laws of evolution can be investigated only thank to the description of the links connecting living and non living at the Biosphere levels.

Geobiology is the science taking into consideration Biosphere as a whole evolving object and it includes first of all the study of the organic links of every kind that are recognizable between living beings considered in their totality as a single closed system; and, secondly, the study of the physico-chemical links by which the birth and development of this living envelope are bound up with the history of the planet<sup>23</sup>.

And here complexity of life is better defined: the world of life must be taken as a whole and forms a single system linked to the surface of the Earth. And here the use of the word *system* must be underlined. The elements of a system are not thrown together as sand grains but are organically interdependent. And here side by side to the description of quality and quantity of the components, there is the concept of relationships among the elements.

In order to have a better exposition of these concepts, Teilhard de Chardin wrote a short program of researches peculiar of the Institute.

The institute, in its first period, will devote itself to apply the geobiological method to the Asiatic continent studying the development of the continent and

<sup>21</sup> P. TEILHARD DE CHARDIN, *L'œuvre scientifique, op. cit.*, pp. 3216-3217.

<sup>22</sup> The two issues of the Journal are reported in: P. TEILHARD DE CHARDIN, *L'œuvre scientifique, op. cit.*, pp. 3747-3903 and 4043-4094.

<sup>23</sup> P. TEILHARD DE CHARDIN, *L'œuvre scientifique, op. cit.*, pp. 3757-3760.

of its fauna and flora in order to clarify not only the action of the physical elements of the Biosphere on the living beings, but also the synchronisms and reciprocal influence of these two developments with the awareness that continental evolution is the only way to study evolution at the Biosphere level, on a reduced scale, but without distortions.

Here there is another proof of the great scientific clearness of Teilhard de Chardin. His idea of continental evolution is only apparently a due compromise with the reductionistic method and the global vision. It is a necessary step towards a science of the Biosphere waiting for tools suitable to work on a global approach.

Again links and connections inside a whole i.e. the complexity vision applied to evolution.

The final definition of complexity is reported in the only book he published in life, the just quoted: *Man's place in nature*, where he wrote<sup>24</sup>:

«Life, (...) appears experimentally to science as a material effect of complexity. What then, in this particular case, is the exact, technical, meaning of complexity?».

And then he follows<sup>25</sup>:

«First (...) I shall not, of course, use complexity to mean simple aggregation, i.e. any assembly of non-arranged elements – such as a heap of sand, for example – or even such as stars and planets (...).

Nor I shall use complexity to cannot simple undefined geometric repetition of units (...) such as we find in the astonishing and universal phenomenon of crystallization.

I shall strictly confine my use of the word to the meaning of combination, i. e. that particular higher form of grouping whose property it is to knit together upon themselves a certain fixed number (...) of elements, within a closed whole of determined radius: such as the atom, the molecule, the cell, the metazoan, etc.

A fixed number of elements, a closed whole: this twofold characteristics of complexity must be emphasized, for on it depends the whole course of the thesis developed here».

And now we reach the definition of complexity<sup>26</sup>:

«Combination (...) produces a type of group that is structurally completed around itself at each moment (even though (...) it is indefinitely extensible from within): the corpuscle, a unit truly and doubly “natural” in the sense that while organically limited in its contours so far as its own existence is concerned also, at certain higher levels of internal complexity, manifests strictly *autonomous* phenomena. We find complexity progressively giving rise to a certain “centricity” – not of symmetry, but of action. Out it more briefly and exactly, we might call it “centro-complexity”».

<sup>24</sup> P. TEILHARD DE CHARDIN, *Man's place in nature*, Collins, London, 1973, p. 19.

<sup>25</sup> P. TEILHARD DE CHARDIN, *Man's place in nature*, Collins, London, 1973, pp. 19-20.

<sup>26</sup> P. TEILHARD DE CHARDIN, *Man's place in nature*, Collins, London, 1973, pp. 20-21.

We are able to rewrite this statement in contemporary terms: a complex object is delimited by a boundary (limited in its contours, using Teilhard's words), it is an unitary object and it is capable of increasing only by inside. According to its centricity of action, anyway, it is changing continuously but maintaining its own identity. Clearly this definition could be fully applied to the embryo, but also to an ecosystem and also to the Biosphere. In this way a correlation between embryonic development and Biosphere evolution is in some way proposed<sup>27</sup>.

At this point we are able to summarize Teilhard de Chardin contribution to the theory of evolution: the theoretical part of the central nucleus of its research program, using Lakatos terminology, is that of evolution as a *moving towards*. Consequently Teilhard is looking for parallelisms in animal phyla to demonstrate that evolution was not characterized by dispersion of evolutionary trends, but by parallelisms and among them the *moving towards* cerebralization of different animal branches.

The research for parallelisms need a global approach to evolution, because only with this approach it is possible to observe those peculiar aspects lost at the population level. And here Teilhard proposed his definition of biology as the science of the infinitely complex and he underlined that, changing scale, also the mechanisms must be different: mechanisms described at the population levels are not useful to explain what happens at a larger scale. It is the old distinction between micro and macro evolution, but here related to the problem of complexity of biology.

Complexity is firstly defined during his first years of his stay in China. Then continental evolution was the tool to find different ways of evolution and the consequent discoveries of parallel evolution in mole rats of the Chinese Pleistocene was the experimental proof of his theory.

The last contribution was the proposal of Geobiology as the science of the Biosphere as a whole evolving complex object. With this approach evolution was characterized by parallelisms and threshold effects and by *moving towards* complexity and in livings *towards* cerebralization.

#### TEILHARD DE CHARDIN LEGACY

##### *The regional schools of evolution: the Latin school*

The history of evolution in the XX century is not an uniform movement toward the modern synthesis.

As matter of fact the modern synthesis was mainly the result of the Anglo American school of evolution related to the convergence, at the population level, of the natural selection theory proposed by Darwin e Wallace and the laws of

<sup>27</sup> L. GALLEN, «Prospettive per un approccio multi disciplinare al problema della biosfera che si evolve come un'unica entità complessa», in: P. CERRAI and L. GALLEN (eds.), *Da Pisa a Como e ritorno*, SEU, Pisa, 1996, pp. 17-32.



heredity of Gregor Mendel. In the first stages of the molecular biology researches, starting from the double helix model of Watson and Crick and the theory of mutations as an alteration of the sequence of DNA basis, the modern synthesis found a brilliant confirm.

Side by side to the Anglo American school, other schools developed different views of evolution which can be usefully confronted with that of the modern synthesis.

In the Latin country we find an autonomous school that we called the Latin school of evolution. It was a school composed mainly of paleontologists from Spain, Italy and France and its main exponents were Crusafont in Spain, Leonardi in Italy and Piveteau in France and in different ways they found a mentor in Teilhard de Chardin<sup>28</sup>.

They met often in Sabadell (Catalunia), attending the courses of evolution organized by Crusafont and discussing not only about paleontology and evolution, but also of the philosophical and theological implications of evolution.

The start point was the first meeting on Paleontology and Evolution organized by Jean Piveteau, in Paris in 1947. It was the first attempt to confront ideas and scientists of the Latin school and of the Anglo American school, mainly, on one side Teilhard de Chardin and on the other side G. G. Simpson, one of the author of the modern synthesis and a paleontologist<sup>29</sup>. One of the topic in discussion was the definition of orthogenesis i.e. directionality in evolution.

Teilhard de Chardin reported the example of the Siphneidae and in his opinion orthogenesis was demonstrated by parallel evolution. Parallelisms of phyletic trends proved directionality of evolution and they were its main characteristic when analyzed at the continental level. Parallelisms suggested the presence of different mechanisms than those described at the population level and at different scales of investigation by modern synthesis scientists. On the contrary G. G. Simpson had the opinion that parallelisms were one of the many lateral events of evolution not worthy of peculiar attention and easily explicable in terms of ortho selection<sup>30</sup>.

<sup>28</sup> The idea of a Latin school is derived from a paper of J. Agusti who spoke of «evolucionismo meridional» in: J. AGUSTI, «El evolucionismo meridional de Miquel Crusafont», *Paleontologia i evolució*, 26-27, 1993, pp. 15-23.

Anyway in his paper Agusti after a correct report about the relationships between Crusafont and, on one side, Teilhard de Chardin and, on the other side, Simpson, wrote that Cusafont at the end made his choice in favour of Simpson. In our opinion, on the contrary, while in Crusafont theory there was a correct link with population biology and the modern synthesis, again Teilhard de Chardin remained the final referent for a general theory of evolution as stated in one of the last papers of Crusafont: M. CRUSAFONT I PAIRÒ, «L'evolució i el fenomen humà segons Teilhard de Chardin», in: J. SANCHO I VALLS (ed.), *Darwin a Barcelona*, PPU, Barcelona, 1984, pp. 447-457.

<sup>29</sup> See for the discussion between Teilhard de Chardin and Simpson, the review of Teilhard de Chardin to the book of Simpson: *Rythme et modalité de l'évolution*, reported in: P. TEILHARD DE CARDIN, *L'Oeuvre Scientifique*, op. cit., p. 4287.

<sup>30</sup> Papers and discussions published in: J. PIVETEAU (ed.), *Paléontologie et Transformisme*, CNRS, Paris, 1950.

In the meetings of Sabadell many topics were discussed and among them the possibility of a *moving towards* of evolution. This *moving towards* was not related to a theological finalism, but as the result of the maintenance of natural equilibriums and stability.

The best example is the work published by Crusafont and Trujols about the evolution of teeth in Carnivorous<sup>31</sup>.

The idea is to follow for a long time and in its geographical dispersion (the Geobiological method of Teilhard!) the evolution of those teeth related to the different feedings habits of Carnivorous thanks to the measurement of two angles in two different teeth which are typical of the hypocarnivores, the Ursidae and the hypercarnivores, the Felidae. Of course these angles are the morphological aspects of ecological differentiations.

Angles were measured from the basal group, the species of the genus *Cynodictis* which was a group with high variability. The material of this basal group is mainly derived from the papers published by Teilhard de Chardin from his doctoral thesis!<sup>32</sup>

Means was calculated and it was easy to follow the different specializations according to the evolution of measurements. Anyway the mean remained constant in time, in spite of the differences of teeth related to the different adaptations of the various families. It is very difficult to find a selective reason for this and the hypothesis reported in the text was that<sup>33</sup>:

«(...) the definitive traits of the various families are essentially contained in a potential way in the genotypes of the initial forms (...) According to this view, the evolution of the group in its essential outlines must already have been defined at its beginning through a great richness of pre-specialized types».

In some way the genetical variability of the basal group strongly determined the following stages and the stability of mean.

We can speak clearly of coordinate evolution determined by the genetic and morphological constitution of the basal group. In this case there was not an increase in diversity, but the initial high diversity was canalized to specialized forms thank to an harmonic evolution with the environment.

As stated by Crusafont during a discussion held in Sabadell having the task of a philosophical discussion of finalism, evolution is the results of the maintenance of biological and ecological equilibriums<sup>34</sup>:

<sup>31</sup> M. CRUSAFONT-PAIRÒ and J. TRUYOLS-SANTONJA, «A biometric study of the evolution of Fissiped Carnivores», *Evolution*, 10 (3) 1956, pp. 314-332.

<sup>32</sup> P. TEILHARD DE CHARDIN, «Les Carnassiers des Phosphorites du Querc», *Annales de Paleontologie*, 9, Paris, 1914-1915, pp. 103-192.

<sup>33</sup> M. CRUSAFONT-PAIRÒ and J. TRUYOLS-SANTONJA, *A biometric study of the evolution of Fissiped Carnivores*, *op. cit.*, p. 330.

<sup>34</sup> II Cursillo Internacional de Paleontologia, *Colloquio sobre evolucionismo*, type written report, p. 17, Biblioteca, Institut de paleontologia M. Crusafont, Sabadell. Thanks are due to the librarians of the institut for their kindness in presenting me the material of Sabadell meetings.

«Entonces el que hay de más típico en lo que el Dr. Crusafont acaba de expornarnos, es que al mismo tiempo que se mantiene el equilibrio biológico, el empuje de la evolución no cesa de ascender hacia el hombre y es aquí donde se presenta la noción de finalidad, de manera tan alta que llega a escapársenos frecuentemente».

It is the idea of Teilhard that humans are the final results of the general laws of Biosphere evolution but with the implementation that the general laws of the Biosphere are linked to the equilibriums maintenance.

And here we are at the conclusions of Crusafont y Truyols paper<sup>35</sup>:

«The forms of any biocenosis are distributed around a mean equal to the synthetotypical value; the dispersion of other values is harmonious and is systematically distributed along the graph; and there is a progressive widening of the ecological scope of the group. These facts suggest to the authors that the fissiped carnivores have undergone an evolutionary radiation by *lysis*, similar to that involved in the theories of Vavilov, as regards space, and of Blanc, as regards both space and time».

In a few word the mean of the basal family (the synthetotype) is maintained step by step during the differentiation and specialization of the group.

Harmonic evolution (but we prefer the term of coordinate evolution) is the adequacy and maintenance of nature equilibriums and stability at the ecosystem level and it is due to connections between the ecosystems and the various species in order to maintain these equilibriums. And finalism acquires the meaning of the final results of describable general laws.

Here we find recovered, on one side, the general foundations of the modern science stated by Galileo with the research of the describable general laws of physics together with the contemporary statement of Teilhard de Chardin that biology is characterized by the general laws of complexity and in evolution they must be described as the laws of the evolving Biosphere.

Finally the general references are to the cosmolisis theory of an Italian paleontologist, Alberto Carlo Blanc<sup>36</sup>, who met Teilhard in Rome and published the Italian translation of some of his papers<sup>37</sup>. The cosmolisis theory was an application to evolution of the theory of the center of origin of cultivated plants proposed by the Russian genetist Vavilov, just quoted for his description of parallelisms. And we have recently summarized the relationships between Teilhard de Chardin and the Russian school of evolutionists<sup>38</sup>.

<sup>35</sup> M. CRUSAFONT-PAIRÒ and J. TRUYOLS-SANTONJA, *A biometric study of the evolution of Fissiped Carnivores*, op. cit., p. 332.

<sup>36</sup> A. C. BLANC, «Cosmolisi. Interpretazione genertico-storica delle entità e degli aggruppamenti biologici ed etnologici», *Rivista di Antropologia*, 34, 1942-1943, pp. 179-290.

<sup>37</sup> P. TEILHARD DE CHARDIN, «L'Avvenire dell'Uomo», *Quaderni di sintesi*, 6, 1947.

<sup>38</sup> L. GALLEN, «L'opera di Pierre Teilhard de Chardin come strumento di dialogo», in: A. A. GRIB, L. GALLEN and F. REATI (eds.), *Scienza e fede in dialogo: Pierre Teilhard de Chardin, Pavel Florenskij*, Saint Petersburg University Press, 2007, pp. 243-259. Bilingual edition: Italian and Russian.

And, during the colloquium<sup>39</sup>, Teilhard is called<sup>40</sup>:

«Nuestro querido maestro y excelente amigo».

From Italy also Piero Leonardi, who was among the participants of the Sabadell Colloquium, wrote of the equilibriums of the Biosphere and of a general symbiotic connections established at the Biosphere level<sup>41</sup>.

In 1966 in Madrid was published a book edited by M. Crusafont, B. Menendez and Y. Aguirre: in our opinion the best book on evolution published in the sixty all over the world.

The papers described evolution of the Universe, of matter, of life, discussing the mechanisms both of the modern synthesis of the Anglo American school, but also of different schools and with strong links to Teilhard de Chardin.

Finally, and this was unusual, a careful discussion of the philosophical and theological implications of evolution was presented<sup>42</sup>.

Crusafont recovered the *moving towards* of Teilhard de Chardin, but with a new perspective: the general *moving towards* of life was not only a *moving towards* complexity and consciousness, but also a *moving towards* freedom. A general aspect of evolution is the development of more complex behaviour toward the surrounding environment so far that a Mammal has more possibilities of choosing its behaviour in respect to Bacteria<sup>43</sup>.

Again the *moving towards* is easy to be related to the general project of the universe, that of giving origin to the free thinking and free acting creature.

It is a finalism which is respectful of the methods of science.

### *Teilhard de Chardin hypothesis confirmed: bacterial nanobrain*

In spite of the general statement that Bacteria are a proof of long term evolution without a peculiar directionality towards complexity, at present many different hypothesis are proposed on the basis of recent observations.

<sup>39</sup> G. G. Simpson presented the results of the Colloquium in his journal *Evolution* [see: G. SIMPSON, «Symposium on Evolution held in Spain», *Evolution*, 10 (3), 1956, pp. 333-334]. He considered that the discussion of finalism was of no interest for the Anglo American authors and the discussion on gradualism and saltationism an old fashioned discussion. He looked like an European traveller confronting with primitive tribes! On the contrary the discussion was more rigorous in Sabadell than that made by some exponents of the modern synthesis such as J. Huxley discussing a *moving towards* progress (see: L. GALLEN, «Pierre Teilhard de Chardin e l'evoluzione come "muovere verso" l'essere pensante», in: L. CALABI (ed.), *Il Futuro di Darwin*, UTET, Torino, 2010, pp. 77-98]. The source of Simpson was: *Colloquio sobre evolucionismo*, *Cursillos y Conferencias del Instituto «Lucas Mallada»*, Madrid, 1956, fasc. III, pp. 147-169.

<sup>40</sup> II Cursillo Internacional de Paleontologia, *Colloquio sobre evolucionismo*, type written report, p. 17, Biblioteca, Institut de Paleontologia M. Crusafont, Sabadell.

<sup>41</sup> P. LEONARDI, *L'evoluzione dei viventi*, Brescia, Morcelliana, 1950, pp. 298-299.

<sup>42</sup> M. CRUSAFONT, B. MELÉNDEZ and E. AGUIRRE, *La evolución*, La Editorial Católica, Madrid, 1966.

<sup>43</sup> M. CRUSAFONT PAIRÒ, «Problematica de la evolucion en las ciencias positiva», in: M. CRUSAFONT, B. MELÉNDEZ and E. AGUIRRE, *La evolución*, *op. cit.*, pp. 1-51.

Bacterial behaviour is more complex than expected, both as a group and as a single individual. As a matter of fact they are ageing and their cells are submitted to a cycle of birth and death like the others organisms<sup>44</sup>.

Moreover, and this is a proof of Teilhard de Chardin *moving towards* cerebralization, there is the description of bacterial nanobrain<sup>45</sup>.

Bacterial behaviour is a complex behaviour in spite of their reduced dimensions: bacterial body is like a dot in the environment and it is not able to perceive a positive or negative gradient. To do so it has to move and to make a confrontation between the different concentrations of the substance making the gradient.

If the gradient is positive i.e. it is the gradient of a nutrient (an attractant substance) then bacterium is continuing its forward motion. If it is an unfavourable substance (a repellent substance) than an order starts and the flagellum change its activity and the bacteria change the direction of their movement.

The signal is sent from a group of molecules which are dislocated near the frontal part of the bacterial cell, the pole opposite to that of flagella. They are able to elaborate the gradient and to send a signal ordering to the flagellum what to do.

To receive a signal, to elaborate the signal and to send a behavioural message to motility apparatuses is the typical function of the brain in primitive Metazoa and the same it happens in Bacteria.

The only difference is that in Metazoa the primitive brain is a cellular brain, in Bacteria it is a molecular brain for this reason called nanobrain.

Anyway also in bacteria is described the *moving towards* cerebralization and it is the best confirm of Teilhard de Chardin scientific hypothesis. Of course it could be easily explained in term of selective advantage, but anyway it is a confirm that the *moving towards* is not due to random events, but on the contrary to the general laws of evolution. In these laws, of course, also random has its role.

But it is a new demonstration of the importance of the presence of parallelisms in evolution: both bacteria and the eukaryotes are derived from the same stem group and they are *moving towards* cerebralization.

Teilhard main statements are confirmed.

### *Metamery in animals: a new proof of parallelism.*

Parallelisms gave us many more confirms looking to the more recent discoveries about animal evolution. The start point is the passage from a period of strong cold temperature (the Cryogenian period and the snow ball theory) to the Ediacarian and then the Cambrian period where all the animal phyla are quickly represented.

<sup>44</sup> J. M. GÓMEZ GÓMEZ, «Aging in Bacteria, Immortality or Not – A Critical Review», *Current Aging Science*, 3 (3), 2010, pp. 1-31.

<sup>45</sup> D. J. WEBRE, P. M. WOLANIN and J. B. SOCK, «Bacterial chemotaxis», *Current Biology*, 13 (2), 2003, pp. 47-49; D. Clausnitzer, OLEKSIUK, L. LØVDOK, V. SOURJIK and R. G. ENDRES, «Chemotactic Response and Adaptation Dynamics in Escherichia coli», *PLoS Computational Biology*, 6 (5), 2010, pp. 1-11.

Of course we are making hypothesis about a not yet well consolidated scenario. Anyway some indications could be given. First of all the passage from a period of cold temperature where a freeze ice cap was diffused quite all over the Earth to a more temperate climate is due to a green house effect related to high emissions into the atmosphere of Carbon Dioxide<sup>46</sup>. Quite probably this green house effect favoured the diffusion of the mechanisms of production of organic hydro carbonic macromolecules based on photosynthetic plants and the diffusion of oxygen in the atmosphere.

At least at this point we have a planetary source of energy (the solar radiation) followed by the chlorophyll based carbon compound synthesis and the diffusion of plants. Moreover we have the rise of the atmosphere and hydrosphere as the general oxygen and carbon dioxide planetary reservoirs, i.e. the rise of the present days Biosphere where livings and not livings are related by feedback mechanisms whose task is to maintain Biosphere stability. The control system is given by the planetary reservoir.

What about animals? We like to follow the Garden of Ediacara scenario where a large majority of animals had the capacity of the organization of carbon compounds: i.e. they were based on autotrophic mechanisms but related to chemiosynthesis. In this case the energy was obtained by the oxidation of hydrogen sulphur<sup>47</sup>.

Autotrophies mechanisms related to chemiosynthesis are described, today, in the animal of the hydrothermal vent ecosystems thank to endo symbiotic bacteria<sup>48</sup>. The increasing level of oxygen concentration in the atmosphere and in the hydrosphere quickly deprived animals of their main source of feeding and there was an increase in heterotrophic habits.

An heterotrophic behaviour implies good capacity of moving, an head tail symmetry and a first development of a brain in the head area. And the head tail symmetry is allowed by a group of genes regulating body organization. At this point the *moving towards* an increase of cerebral structure is determined.

And it is of great importance that the startpoint of the animal *moving towards* cerebralization is related to the Biosphere development caused by the diffusion of oxygen in the planetary reservoirs: it is a coordinate evolution!

The first fascinating events of animal with bilateral symmetry (the head tail symmetry) is the division of the phyletic tree in two main branches: protostoma and deuterostoma. The different organization is related to a 180° degree inversion of body polarity during the first stages of embryonic development so that in Protostoma the mouth will be opened at the blastopore level, while in the Deuterostoma on the opposite site. At this level animal evolution shows two

<sup>46</sup> M. A. S. McMENAMIN, «Gaia and Glaciation: Lipalian (Vendian) Environmental Crisis», in: S. H. SCHNEIDER, J. R. MILLER, E. CRIST and P. J. BOSTON, *Scientists Debate Gaia*, The MIT Press, Cambridge (Mass.), 2004, pp. 115-128.

<sup>47</sup> M. A. S. McMENAMIN, *The Garden of Ediacara*, Columbia University Press, 1998.

<sup>48</sup> F. SANTINI and L. GALLEN, «Non-light based Ecosystems and Bioastronomy», *Rivista di Biologia, Biology Forum*, 94, 2001, pp. 427-442.

different organisation patterns exploring different possibilities. Anyway both possibilities are characterized by an increase of cerebral volume and brain capacities.

As in Bacteria the head tail symmetry is the start point for a paralleled evolution towards cerebralization.

Moreover there is another example of parallelisms in animal evolution: the parallelisms of metameric body organization. Metamery is a peculiar body organization based on the repetition of structures along the main body axis. As a matter of fact the body is divided in many segments each of them presenting an head tail polarity and their genetic development is due to the same genes (the so called *hox* genes) in all animals<sup>49</sup>.

The head tail polarity, linked to the evolution of prey predator relationships and on rapid movement is determining the subsequent evolution in animals<sup>50</sup>.

In recent papers based on the molecular phylogeny correlated with the information obtained from palaeontology, bilateral animals are, of course, divided in two main groups, as we have just written, i.e. Protostomia and Deuterostomia<sup>51</sup>.

Moreover Protostomia are divided in two main group, Lophotrochozoa and Ecdysozoa<sup>52</sup>.

The main groups of Lophotrochozoa are Molluscs and Annelids and generally speaking those animals with spiral segmentation i.e. with the first egg cleavages showing a spiral symmetry<sup>53</sup>. Moreover in Annelids there was also a metameric body organization. The main groups of Ecdysozoa are Nematodes and Arthropods, without spiral segmentation but, in Arthropods, with a metameric body organisation.

For a long time it was a zoological puzzle to put together animal with different egg segmentations but with metameric body organization.

Metamery was typical also of Vertebrates among Deuterostomia and it looked an evolutionary non sense to presume that metamery rose three times independently in animal evolution without the use of the concept of parallel evolution.

<sup>49</sup> L. GALLEN, *Darwin, Teilhard de Chardin y los otros. Les tres teorias de la evolucion, op. cit.*, pp. 120-124.

<sup>50</sup> M. A. S. McMENAMIN, «Paleoecological Feedback and the Vendian-Cambrian Transition», *Trends in Ecology and Evolution*, 1988, 3 (8), pp. 205-207.

<sup>51</sup> K. J. PETERSON, J. A. COTTON, J. GEHLING and D. PISANI, «The Ediacaran emergence of blaterians: congruence between the genetic and the geological fossil records», *Philosophical Transaction of the Royal Society*, B, 2008, B, 363, 1435-1443.

<sup>52</sup> M. J. ELFORD, S. J. BURLA, A. ECONOMOU, D. PAPILLON and O. ROTA-STABELLI, «The evolution of Ecdysozoa», *Philosophical Transaction of the Royal Society*, B, 2008, B, 363, 1529-1537.

<sup>53</sup> As an example we refer to flatworms: they were a spiralian basal group and their collocation in Metazoan phyletic tree was problematic: see, L. GALLEN and V. GREMIGNI, «Platyhelminthes – Turbellaria», in: K. G. ADIYODI and R. G. ADIYODI, *Reproductive Biology of Invertebrate*, Part IV, *Fertilization, Development and Parental Care*, Oxford and IBH, New Delhi, 1989, pp. 63-89.

And finally this parallelism was proposed by Conway Morris with a very detailed description of the genetic mechanisms and of the paleontological reperts<sup>54</sup>.

Now the genetical evidence that every kind of metamery starts from the same group of genes, quite probably related to the body head tail symmetry, and paleontological morphological and molecular phyletic trees suggest that Ecdysozoa are separated from Lophotrochozoa and we have only to admit the parallel origin of metamery. Of course using Teilhard de Chardin hypothesis that parallel evolution is not an exceptional event, but a rule, a key problem in animal evolution is solved: it makes sense that metamery originated three times independently in animals but from the same basal genes. When a stage is reached, then the following stages are high probable!

In the long lasting discussion between Simpson and Teilhard on parallelisms these last results give reason to Teilhard de Chardin!

As a matter of fact, in this discussion, Teilhard clearly stated that parallelisms are not one of the many secondary aspects of evolution, but are the main general characteristic of evolution when studied at the continental level.

And as a matter of fact parallelisms at continental level were again described in animals in the parallel evolution of mammals. Marsupial and placental mammals evolved in different continental areas because Marsupial were isolated in Australia and South America but their evolution was parallel and similar solution were presented in front of the colonization of the same ecological niches. Curiously also a solution problematic from an adaptive point of view, i.e. the sabre tooth tiger is reached twice at least both in Placental then in Marsupial mammals<sup>55</sup>.

### *Continental evolution and Mammals phylogeny*

Exactly as stated by Teilhard de Chardin, continental evolution is the tool to describe new aspects of evolution and parallelisms are the main characteristics of general evolutionary trends.

We have just seen that one of the main steps of the present days works on evolution is to find a synthesis between paleontological, morphological, molecular and chromosomal data.

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<sup>54</sup> See: S. CONWAY MORRIS, *The Crucible of Creation*, Oxford University Press, Oxford, 1998. For a general review of these topics see: J. D. BARROW, S. C. MORRIS, S. J. FREELAND and C. L. HARPER, *Fitness of the Cosmos for Life*, Cambridge University Press, Cambridge U.K., 2008. In our opinion all the book is a demonstration that universe is *moving towards* complexity and life *towards* complexity and consciousness, a demonstration that parallelisms are the key mechanisms of evolution together with a theory of the Biosphere. It is a book confirming Teilhard de Chardin theories on evolution, but Teilhard is quoted only once together with Bergson on the *élan vital* a theory which is not that of Teilhard!

<sup>55</sup> And here we refer again to Mivart, who in his book quoted also parallelisms among Marsupial and Placental mammals: see ST. GEORGE J. MIVART, *On the genesis of species*, *op. cit.*, p. 83.



And a recent revision of Placental Mammals could be explained thank to continental evolution.

Molecular, chromosomal, morphological and paleontological data suggest that placental mammals are now grouped in four major groups: Laurasiatelia, Euarchontoglires, Xenarthra and Afrotheria, each of them quite probably evolved in different continental areas, following the various stages of continental separation<sup>56</sup>. Afrotheria evolved in Africa, Xenarthra in south America, Laurasiatelia in Eurasia and finally Euarchontoglires in North America<sup>57</sup>.

As stated by Teilhard de Chardin in his first approach to paleontology of China continental evolution is the key to understand the differentiation inside a specific phyletic group, in this case placental Mammals.

### *Complexity and threshold effect*

Finally we refer to the way Teilhard de Chardin was able to solve the so called Wallace's conundrum<sup>58</sup>.

In the evolution of brain, bringing to the intellectual capacities of our species, Darwin described a continuity and the so called primitive men were half way with apes, while Wallace, living together with non European men during his travel all over the world, observed the presence of the same mental qualities both in the European man that in not civilized man. Natural selection was not able to explain the presence of the capacity of learning mathematics philosophy and art. For this reason he thought that the mental capacities were derived by a rapid evolution and the mental qualities were not gradual between apes and human but there were the experimental proof of a discontinuity.

Continuity or discontinuity? This was the question. Teilhard was able to solve the problem using the complexity concepts and the threshold effect. Discontinuity in continuity was his proposal. According to Teilhard de Chardin in human evolution the continuity of increase in brain size and in intellectual capacity brought to a threshold and then with the addition of few neurons quickly the thinking creature arose in his/her completeness<sup>59</sup>.

The proofs of this threshold effects were looked for in the tools of palaeontology, first of all the fact that *Homo sapiens* moved not for ecological

<sup>56</sup> M. S. SPRINTER and W. J. MURPHY, «Mammalian evolution and biomedicine: new views from phylogeny», *Biol. Rev.*, 82, 2007, pp. 375-392.

<sup>57</sup> D. E. WILDMAN, M. UDDIN, J. C. OPAZO, G. LIU, V. LEFORT, S. GUINDON, O. GASCUEL, L. I. GROSSMAN, R. ROMERO and M. GOODMAN, «Genomics, biogeography, and the diversification of placental mammals», *Proceedings of the National Academy of Science*, 104 (36), 2007, pp. 14395-14400.

<sup>58</sup> See: A. VARKJ, D. H. GESHWIND and E. E. EICHIER, «Explaining human uniqueness: genome interactions with environment, behaviour and culture», *Nature Review, Genetics*, 9, 2008, p. 760.

<sup>59</sup> L. GALLEN, *Darwin, Teilhard de Chardin y los otros. Les tres teorias de la evolucion, op. cit.*, pp. 37-39.

reasons but mainly for curiosity and this happened at once at the very beginning of the species *Homo sapiens*<sup>60</sup>.

So far we have the main points of Teilhard de Chardin scientific program confirmed by the science of evolutionary biology in these last years: we have parallelisms, continental evolution and the *moving towards* cerebralization.

*The final perspective: the theory of the Biosphere*

We have discussed many times this aspect of Teilhard de Chardin final statement; that of looking for general laws of evolution investigating the Biosphere as a whole complex evolving object<sup>61</sup> and its links with the Latin school, mainly with the concept of a general symbiosis connecting living and not living at the Biosphere level described by Piero Leonardi.

His approach was recently proposed again by Jim Lovelock with a new content: that of feedback mechanisms allowing the maintenance of Biosphere stability and so allowing the maintenance of the conditions for life survival on Earth.

In this way all our discussion acquires a different meaning: harmony of nature and ecosystems equilibriums and stability and Biosphere symbiosis are related to the maintenance of chemical physical parameters allowing the survival of life on Earth.

In front of a continuous change of some parameters external to the Biosphere such as the irradiation from our Sun, life evolves with a process of diversification and complexification in order to maintain stability. Evolution itself acquires an adaptive meaning, that of maintain the stability of those parameters which allow life survival.

It is a third level of finalism. We have the teleology which is the finality of a conscious agent in the world; then according to Monod we have teleonomy, which is the finality of a non conscious agent<sup>62</sup>. This agent has anyway a program giving instructions and it is typical of living organisms.

But there is a third level of finalism, that of systems superior to the organisms such as ecosystems and the whole Biosphere. These systems have a different kind of *telos* related to the maintenance of system stability allowing its survival.

Stability is maintained in time and for this reason we are facing a mechanism of homeostasis or homeorhesis<sup>63</sup>.

This is the finalism described by Lovelock with the feedback mechanisms at the Biosphere level. And this is the finalism which could explain the *moving towards* complexity. As a matter of fact, if the feedback mechanisms are the tools for stability, if they are more numerous and the net of connections more complex

<sup>60</sup> P. TEILHARD DE CHARDIN, *Man's place in nature*, op. cit., pp. 73-74.

<sup>61</sup> P. TEILHARD DE CHARDIN, «Gèobiologie et Geobiologia», *Geobiologia*, 1, 1943, 1-8.

<sup>62</sup> J. MONOD, *Le hasard et la nécessité*, Seuil, Paris, 1970.

<sup>63</sup> For the definitions of homeostasis and homeorhesis, see: A. RAY and S. PHOHA, «Homeostasis and Homeorhesis: sustaining order and Normalcy in Human-engineered Complex System», in: <http://www.mne.psu.edu/rayInterdisciplinaryResearch.pdf>.

than we have a major level of stability. To avoid confusions perhaps we can speak of *teleostasis* to put side by side with *teleology* and *teleonomy*.

In our opinion this perspective is fruitful and with a mathematical model we were able to demonstrate that, if there are strong connections at Biosphere level, than evolution is characterized by long periods of stability with small changes related to evolutionary forces acting also today<sup>64</sup>. This period could be called Lyell period. Then there is a quick exit from the equilibriums and a catastrophic event such as mass extinctions: the Cuvier period, and finally a quick diversification where rapid evolution takes place with the colonization of new ecological niches: Darwin period.

So far taking the Biosphere as a whole gives us information such as that mass extinctions are a consequences of the general laws of Biosphere evolution and are not related to an external impact event. In this way Biosphere is characterized also by catastrophic situation which are a tool to reach more efficient levels of stability because of an adaptive radiation following the catastrophic crisis.

In our opinion, thank to Teilhard de Chardin search for general laws in Biosphere evolution and Lovelock vision of Biosphere stability it is possible to reconstruct Biosphere evolution as a sequence of three different stages: a period of slow evolution, followed by a catastrophic period and finally of a rapid diversification and the result could be an increase in stability.

However period of crisis and of mass extinctions are not related to stochastic events such as the meteorite of Dinosaurs extinction, but are the results of the general laws of Biosphere evolution.

### *Teilhard de Chardin and the Latin school forgotten?*

Recently a new scientific paper was published and his title was Geobiology. In the editorial many authors were quoted as forerunners of the geobiological method and among them Hutton, Vernadskij and Lovelock, but no hint was made to the name and work of Teilhard de Chardin. It is completely forgotten that he proposed Geobiology as the science of the evolution of the Biosphere, he founded in China an Institute of Geobiology and finally he published a Journal whose title *Geobiologia* looks like the Latin version of Geobiology<sup>65</sup>.

Of course the journal was published in China at the end of the second world war, but its two issues were reprinted in the collected scientific papers of Teilhard de Chardin and his work on Geobiology was quoted in many international journals and copies of the journals are in many academic libraries.

Why this forgetfulness? A part for ideological reasons, quite probably the idea was that Teilhard had no school and his scientific projects were not fruitful.

<sup>64</sup> V. BENCI and L. GALLENI, «Stability and Instability in Evolution», *Journal of Theoretical Biology*, 194, 1999, 541-549.

<sup>65</sup> See: «Editorial», *Geobiology*, 1, 2003, p. 1.

On the contrary we have showed how Teilhard scientific works could and must be a useful startpoint for any investigation on the future of evolution and that the Latin school of evolution was strictly lined to his scientific works.

As a final example we remember that in a paper dedicated to Crusafont, Ramon Margaleff, one of the more world influential ecologists in the second half of the XX century wrote of the impact that the Cursillos of Sabadell had in his formation and also of the global vision of Teilhard de Chardin<sup>66</sup>:

«El Dr. Crusafont era un entusiasta del P. Teilhard de Chardin (...), fins al punt que els amics li deiem que era el rapresentant del P. Teilhard a la Terra. (...) Això queda redimit en part perquè el pare Teilhard era també un campió de la visió globalitzadora – ecològica – de la Terra, en el sentit de la Biosfera de Vernadskij i de la visió de Gaia de Lovelock, de manera que penso que, d'una forma més o menys conscient, algunes influències d'aquesta mena hi degueren haver de manera suplementaria, ni que no en fossin plenament conscients».

In our opinion ideas and legacy of Teilhard de Chardin and of the Latin school are still to be investigated in full and will be proved to be the key stone for the global vision of evolution.

Acknowledgements: the author wish to thank the colleagues of the Sophia Iberia project and of the Pontifical Comillas University for their invitation to the Academic Seminar on Life, evolution and complexity and for the fruitful discussions. Tanks are also due to Dr. J. M. Gómez Gómez (Observatorio Astronómico de Segurilla – Toledo) for his suggestions about bacteria evolution.

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<sup>66</sup> R. MARGALEFF, «Miquel Crusafont, a la recerca del temps passat», *Paleontologia i evolució*, 26-27, 1993, pp. 7-8.