Natural history and temporalization: reflections on Buffon's *Natural history*

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Abstract

This article presents a rereading of Buffon's *Natural History* in the light of the concepts of temporal reversibility and irreversibility. The goal is to determine to what extent Buffon introduces a transformationist concept of natural forms in this work. To that effect, the main points of classical natural history and the doctrine of preformed germs are analyzed. Subsequently, Buffon's use of the temporal variable is considered. This examination shows that despite his rejection of the theory of preformationism and the scholastic classification system, Buffon continued to use categories based on a reversible temporal matrix.

Keywords: natural history; temporality; organism; Georges-Louis Leclerc, count de Buffon (1707-1788).

In *Vitalizing nature in the Enlightenment*, Peter Reill (2005), presents a vitalist reading of Buffon's work that seeks to highlight the role allotted by this author to historical change in natural forms. This reconstruction is inscribed within the broader framework of a project aimed at deconstructing nineteenth-century interpretations, still in force, which deny or minimize the historical nature of enlightenment thought. According to this author, we need to abandon any uniform concept of this period and recognize that it harbored tendencies opposed to the mechanical and mathematical philosophy that was dominant at the time. These perspectives, shared by Buffon and German intellectuals like Georg Forster or the Humboldt brothers, were characterized by the search for a theory to mediate between spiritualism and mechanical materialism. Thus, in their attempt to explain the complex phenomenon of life, these perspectives gave rise to a philosophy of dynamic nature and revealed the field of historicity.

Although Reill's reading (2005) is commendable for questioning the tendency to project onto the eighteenth century Dilthey's distinction between nomothetic sciences and sciences of the spirit, it also makes the unfounded claim that Buffon's use of the temporal register attributes to time a creative role in the production of organic forms. On this point, the author ignores Buffon's fervent efforts to avoid a transformationist concept of nature. He does so, in our opinion, because he interprets preexisting perspectives in the field of natural sciences as mere conceptual strategies aimed at shoring up a particular social and religious order.

In this article we will attempt to show, firstly, some of the scientific achievements of preformationist perspectives and the scholastic classification system in order to elucidate why Buffon, despite his ambiguities, was eventually reluctant to admit the possible emergence of new natural forms during temporal development. As we shall attempt to demonstrate, Buffon saw time as an interesting resource for dealing with the excess of information available in the mid-eighteenth century (Lepenies, 1976). However, he himself believed temporality played only a negative role in the process of configuring natural beings. From our perspective, this decision was a response to the fact that, in the absence of an alternative explanatory model to mechanical causation, the introduction of the temporal variable in the onto- and phylogenetic field would have made the final disposition of natural beings inexplicable.

Natural history and natural theology

During the seventeenth century, a movement known as physical theology emerged in England (Polianski, 2004, p.27-32; Arana, 1999, p.27-43). Its formulations played a vital role in the process of creating and consolidating modern natural history as a scientific enterprise and a cultural institution. The main goal of this tendency was to counteract the skeptical, pantheist, deist and atheist perspectives that had arisen in Europe since the end of the sixteenth century in reaction to the development of the explanatory model of mechanical causation. Based on the idea that "God works nothing in nature but by second causes" (Bacon, 1988, p.25)[1], natural theology sought to demonstrate by scientific investigation, that is, by empirical study of the "second causes", the world's dependence on god as supreme cause. According to natural theologists, each creature was an illustration of the creator's love, and nature as a

whole was a document of divine nature. Thus, its exegesis yielded not only pleasure; it also constituted a duty for mankind, since it demonstrated the systematic, perfect and beautiful nature of the world, from which one could deduce the existence of god. In this sense, science was becoming the bulwark of religious perspectives because, as faith weakened, it allowed people to approach the creator's greatness in different ways.

In this context, investigations into natural history had, incidentally, to meet the challenge of explaining the existence of evil and justifying the apparent senselessness of some natural forms. However, it would be a mistake to suppose that natural history's adaptation to religious guidelines would have led it to abandon secular goals completely. As a matter of fact, the opposite was true, since the alliance between science and religion allowed nature a functional role. Thus, carrying out one's religious duty to contemplate the perfection of creation could be compatible with deepening and broadening one's scientific knowledge. Furthermore, verifying the functional nature of creation provided an accessory justification for scientific activity, since it contributed to dominating and peopling the earth, as the creator had ordered (Genesis 1:28).

What clearly differentiated modern natural history from earlier studies, from the Greeks on, was its systematizing intent. Thus, the ancient practice of describing and ordering nature began to aspire to completeness and systematicity, reflected in the construction of a figure, the *scala naturae* (Frigo, 2001), which made possible a concentrated vision of the whole of creation. Among the assumptions that led to the construction of this chain of being, according to Arthur Lovejoy (1983, p.181-183), were the plenitude, continuity and hierarchical gradation of nature. The first of these assumptions eliminated the existence of empty spaces in nature and thus made the possibility of change less likely. The second, meanwhile, denied the existence of leaps in the order of different natural beings, while the third principle, lastly, affirmed the existence of a hierarchical organization of natural beings based on their level of complexity and perfection and linked to their usefulness to one another.

On the basis of the first two principles, which guaranteed the stability and continuity of nature, it was possible to divide all existing forms into species, genera, families, orders and classes. The third principle, meanwhile, allowed the assumption of a ladder of increasing perfection, projected from the atom up to the cherubim (Bonnet, 1770, p.383). This last series, as we mentioned, is linked to the functional character of nature as divine creation and was therefore represented as a chain, referring to the usefulness of the lower links to higher forms. Thus, plants, for example, existed because they were useful to animals, while animals' existence and design were useful to man, the pinnacle of creation. For this same reason, it was also possible to assume that divine wisdom had placed each of the natural forms on the earth in such a way that distances would not end up neutralizing god's intentions. This assumption was reflected clearly in the explanation Linnaeus offered of how, over time, vegetation had spread from the equator towards the poles. In his opinion, this process was not in the least haphazard but rather the gradual expansion, caused by climate factors, of an original divine plan. In other words, in the period immediately after creation, all forms of vegetation were located on the surface of an island that possessed a great mountain. The current distribution of vegetation thus corresponds to the gradual, proportional spread of that original design across the entire face of the earth, caused by the descent of the waters that originally covered the surface of the earth (Polianski, 2004, p.136).

Although this image apparently fits the biblical creation narrative, it is not superfluous to explore to what extent modern assumptions underlying its construction constituted a limit in terms of theological claims or, in other words, introduced modifications to the medieval ontological and epistemological order. In this context, it is necessary to refer to the figure of the *Tableau*, since this classification method, which was paradigmatic in the classical period, rested on a series of assumptions that seriously undermined medieval confidence in the possibility of god intervening in earthly affairs. In this sense, it is necessary to remember that the analytical procedure used by early modern natural history was based on the premise that time was not a constitutive element of the physical universe but rather the result of the limitations of our own cognitive abilities. This understanding of the concept of temporality, which Elías Palti (2004, p.69) refers to as reversibility[2], excluded on principle any possible asymmetry between past and future and therefore eliminated the possibility of eventual divine intervention in the context of creation.

Indeed, seventeenth- and eighteenth-century naturalists' analyses were based on comparison and differentiation of the visible features of natural beings and thus depended on the possibility of referring these features to an original scene or moment in which the different organisms presented themselves, as Foucault says (1984, p.131), "one beside another, their surfaces visible, [and] grouped according to their common features."[3] In this context, time became a quality that could only refer to nature if the latter were considered an object of our faulty perception or seen in the state of disorder and confusion to which later historical vicissitudes had brought it. Time, as Foucault indicates, would have been a catastrophe or a cataclysm, always external in terms of the space of original arrangements in which it was possible to reconstruct a complete, simultaneous image of the whole of creation.

As shown by the incorporation of natural history into the field of physics, proposed by Adelung[4], organizing or classifying the various parts of the natural world meant translating into spatial terms those forms that seemed to human eyes to have a temporal existence.[5] The naturalist's task was reduced, in this sense, to extracting the different natural beings from their natural habitat and placing them on a homogenous spatial background that provided the coordinates from which their essence could be determined. In this way, the naturalist could reconstruct, based on disparate elements provided by nature itself in its current guise, a continuous, uniform ladder upon whose rungs all the existing species could be outlined. In this way, the stability of the species was presented as a necessary presumption for the process of classification to function.

The outline of divine faculties, which was introduced by this concept of reversible temporality, could be seen more clearly in the theory of preformation. This theory appeared towards the middle of the seventeenth century and, since it guaranteed the genetic stability of the species, became the true foundation of eighteenth-century taxonomies. The first formulations of the preformationist perspective came from researchers like Malpighia or Swammerdam (Bierbrodt, 2000, p.187), who argued that all the developmental stages of a living being were prefigured in germinal form.[6] Briefly, biological preformationism denied the possibility that any morphological changes took place in the time elapsed between fertilization and the definitive formation of the organism. From this perspective, the development of natural beings consisted of a mechanical process of maturation of a series of qualities matured

that had been in place before fertilization in the ovum – according to the ovulists – or in the spermatozoid – *animaculismus*. In either case, evolutionary development did not involve the creation of new parts but rather the mechanical unfolded, thanks to heat and the absorption of specific humors[7], of those organs that had been embedded from the beginning. In this sense, in preformationism, the concept of 'evolution'[8] meant the opposite of what it would come to mean in the nineteenth century. As Leibniz argued (1840, p.715), proving the fixist nature of biological preformationism:

> Plants and animals do not come from putrefaction and chaos, as the ancients believed, but from 'preformed' seeds, and therefore from the transformation of living beings existing prior to them. There are little animals in the seeds of larger animals, which assume a new guise in conception, which they appropriate and which provides them with a method of nourishment and growth, so that they emerge into a greater stage and propagate the large animal.[9]

On the phylogenetic level, preformationism correlated to the theory of multiple encapsulation. If every living being was prefigured in the seeds deposited by its progenitors, then its own seeds should also contain, folded on an even smaller size, the complete organisms of all its descendants. Ultimately, there must have been an original ovum or a spermatozoid in which every single future generation was encapsulated, one within another.

In accordance with the concept of temporality mentioned earlier, biological preformationism did not seek to investigate the conditions that determined the creation of that original embryo. Independently of whether it came from god or arose from an arbitrary conjunction of atoms, this postulate allowed, firstly, all phenomena that took place 'in time' to be subject to explanations of mechanical causation and thus, associated biological explanations with the scientific theory par excellence, namely, Newtonian mechanics. Secondly, preformationism guaranteed the stability of the descendants of that original seed and thus ensured the fixity of natural species. Time could not introduce unexpected modifications in the descendants of different species, since it was merely the space where whatever was prefigured since the original moment unfolded.

In this sense, preformationism provided an explanation that accounted for the workings of the natural world without needing to resort to a hypothesis of divine intervention. As Laplace ironically noted, if like could only engender like, and growth and procreation were identified with the mere process of evolution, then god was a dispensable hypothesis (Palti, 2001, p.33). Or, more precisely, a hypothesis it was 'necessary' to dispense with, since any divine intervention in nature would put at risk the coherence of a machinery that, on principle, excluded any leaps or possible innovations.[10] Thus, postulating the stability of the species and the explanatory principle of evolution involved a significant reduction of god's power.[11] For, whereas the ontology of the Middle Ages had always contained a space for the active intervention of god, in modern thought any possible hiatus between reproducer(s) and descendants was interpreted as a danger for the rationality of the natural world.

However, modern thought could not do away with divine presence altogether.[12] Even though god could no longer divert the course of creation, he had to be endowed with the power to set up the original group of beings that made up the natural world. In this sense,

it is possible to argue that the preformationist combination of prefigured seeds and *evolutio* must have been attractive to religious thought, because it was a combination that joined the immanent dominion of natural events with the transcendental kingdom of endings or, in other words, the legality and necessity of natural sciences and the preservation of order and the sense of authority. But, despite its apparent solidity, the preformationist system was basically a giant with feet of clay, since its internal consistency rested on strictly renouncing the exploration of its own original vacuum. That is, this system could only guarantee the perfect intelligibility of the natural course of events by denying the origin of those forms that then developed out of strict necessity. The profoundly contradictory nature of this construct explains the incredible speed with which it lost scientific credibility, after the first epigenetic critiques, as well as the strong resistance encountered by the various attempts to replace it with an alternative model. Zimmerman's words on the subject are eloquent (1755, p.383), defending the preformationist perspective from epigenetic attacks: "If order is suppressed in the physical world, the same happens in the moral world and ultimately to religion as a whole".

The crisis of classical natural history

Signs of crisis

But preformationism's difficulty explaining the bases of the generative process was not the only thing endangering the continuity of early modern naturalist concepts, since the taxonomic project was also plagued by profound contradictions. Indeed, the idea of the great chain of being set in motion a research program to construct a system within which it was possible to make ever subtler distinctions so that every single individual on earth would fit. The limit of each division was, in this sense, the starting point for new differentiations that could always be refined, and ultimately, in the case of infinite division, would converge in a *continuum*. The basis for this procedure was the idea that creation harbored all the divine possibilities, in such a way that different individuals were continually being outlined (Metzger, 2002, p.30-40). However, this assumption threatened the integrity of classical natural history for three reasons, which we shall explore as follows.

The continuity of nature brought into play, firstly, a representation relative to the plenitude of nature from which it was perfectly possible to infer the superficial character of the entire system of classification. Secondly, this assumption oriented effort towards the extreme cases, in order to establish subtler distinctions, and therefore it highlighted beings at transition points, like the polyp, or beings that were identified as monstrous or deformed. Such cases could be considered intermediate phenomena that confirmed the idea of nature's essential continuity, but it was also possible to interpret them as signs of the arbitrary nature of the classification system. This impression was supported by the progress of empirical investigations, since in their haste to complete the missing links these were generating a mass of information that did not fit the narrow framework of classical natural history. This is referred to in Lepenies' thesis on the information processing crisis that gripped classical natural history from the mid-eighteenth century onward and that concluded with its downfall.

In Lepenies' view (1976, p.62), seventeenth- and eighteenth-century naturalists concentrated primarily on broadening their knowledge only to realize that their investigation

methods could not adequately handle the huge amount of data systematically. To document this process, Lepenies (1976, p.18) points out that around 1740, zoology had documented six hundred types of animals, a number which had quadrupled by 1840. There was a similar explosion of information seen in the records of Linnaeus, since the first edition of his *Systema naturae*, in 1735, included 549 types, whereas thirty years later it had reached seven thousand (p.54).

However, this extraordinary growth of experience was not accompanied by an immediate crumbling of the classical system, nor did it lead to a rapid temporalization of experience, as Lepenies suggests. On the contrary, young naturalists were particularly reluctant to develop a radical transformationist approach and, despite their lack of faith in preformationism and the scholarly classification system, they continued using categories based on a reversible temporal matrix. As shown by the case of Buffon, to which we will turn shortly, new naturalist research tended to admit the possibility of unloading on history a mass of experiences that were impossible to organize on a merely spatial level. However, these experiences gave the action of time an exclusively negative character and they therefore eliminated the possibility of mutations producing novel natural forms. As we shall see, this attitude did not necessarily derive from religious prejudices, but rather from the fact that conceptual tools simultaneously allowing a dynamic, ordered perspective of natural phenomena did not yet exist.

Buffon and classical taxonomy

Buffon's critical attitude to classical natural history was obvious from the opening pages of his *Natural history*. In this text, which established the broad outlines of his future work, Buffon questioned the rather orderly, functional representation of nature held in previous years. Buffon (1749c, p.9) admitted the possibility that nature might at first glance seem like the result of a plan: "We are naturally inclined to imagine a kind of order and uniformity, and when we look superficially, the works of Nature seem, at first glance, as if she always worked on the same plan". However, the French naturalist (1749c, p.9-10) was liable to attribute this representation of nature to the deficiencies of our understanding of natural processes:

> Since we know only one way to reach a goal, we persuade ourselves that Nature works and operates by the same means and by similar operations; this manner of thinking has caused us to imagine infinite false connections among natural productions; plants have been compared to animals, people have believed they saw minerals vegetating; their organizations, which so different, and their mechanisms, which are so dissimilar, have often been reduced to the same form. The common mold of all these things so dissimilar among themselves, is less in Nature than in the narrow spirit of those who have ill understood her, and who know as little how to judge the force of a truth as about the just limits of comparative analogy.

According to Buffon (1749c, p.11), a more attentive analysis of natural forms would amaze us with the diversity of intentions and the multiplicity of means nature uses to carry things out: "It seems as though everything that could be, is; the Creator's hand seems not to have opened to give life to a certain determinate number of species; but it seems his hand threw out all at once a world of relative and non-relative beings, an infinity of harmonious and contrary combinations, and a ceaseless number of destructions and renewals".

As can be observed in the above passage, Buffon's argument sought to question Leibniz' formula, according to which god created on the basis of a choice between the orders that were effectively possible. In his opinion, while the possibility that nature had even created contradictory things could not be excluded, the classification method used by classical natural history was not valid either. For this method's habit of classifying natural forms in ascending orders of generality based on arbitrarily chosen features rested on the assumption that our logical categories matched the arrangement of natural forms. From Buffon's perspective (1749c, p.9), it was necessary to ignore this tendency to "judge the whole by a single part" and to undertake a complete observation of particular natural beings. The true method, Buffon argued (1749c, p.5), "is related to birth, production, organization, in a word, the history of each particular thing". This change of method meant it was indispensable to take the particular object of study and investigate both the legality of the internal constitution of its parts and its relation to its natural habitat (Dougherty, 1990, p.226).

But if this tendency towards extreme nominalism called into question the principles on which classical natural history's scientific claims had rested up to that point[13], Buffon's critique was not aimed at dismissing all types of general knowledge. On the contrary, his objective was to replace scholastic classifications, which involved progressive subordination of individuals to ever larger classes, with a scheme that differentiated species by virtue of the real relationships that could be established between different specimens. In this sense the distinction Buffon was establishing (1749c, p.53-54) was between mathematical truths and physical truths, and it was aimed at showing the confusion of levels in Linnaeus' artificial system[14] and suggesting a new way of ordering natural beings that was based on something real.

Indeed, Linnaeus' system seemed, to Buffon, an artificial construction, based on principles that were arbitrarily established by human understanding, whereas a scientific approach to natural history should use a classification principle based on observation and comparison of "an uninterrupted succession of events".[15] Buffon found this criterion in the principle of reproduction and thus established a procedure aimed at proving, experimentally, that two existing examples belonged to one and the same species. According to Buffon (1749b, p.10-11), what determined membership of the same species was the ability to procreate fertile offspring: "one must regard as the same species those that, by means of copulation, perpetuate and preserve the similarity of the species, and as different species those that, by the same means, cannot produce anything together".

Put in these terms, Buffon's concept of species strongly relativized the analysis of visible features. This made it a good tool for reconstructing natural families whose members had been dispersed spatially for historical reasons, and had acquired forms that made them unrecognizable side by side. But if the criterion of fertile reproduction made it possible to differentiate the species reliably, it did not determine why nature guaranteed the reproduction of different species or what type of relationship there was between the ability to generate fertile offspring and the extreme morphological similarity that could be detected between members of the same species. On this point, Buffon could not resort to prefigured forms, not just because of their clear metaphysical connotations but also because this would have meant renouncing the possibility offered by the fertile offspring criterion of reconstructing natural families in places where there was no strict formal resemblance.

Faced with this situation, Buffon opted for the hypothesis of the interior mold, which we will discuss later. However, before doing so, he developed an argument to justify the use of hypothesis in the field of natural history, which would break the classic paradigm's tendency to privilege the evidence of direct observation. In the context of the discussion about the hidden means used by nature to produce generation, Buffon (1749b, p.32-33) claimed it was "permissible to form hypotheses and to choose that which seems to be most closely analogous with other natural phenomena" to establish, as a requirement, the exclusion of explanations that assumed "the thing done, for example, the hypothesis that in the first germ all germs of the same species were contained" and of theories based on principles of a teleological nature.[16]

The generative theory

Buffon developed a new concept of generation known as epigenetics, according to which nature was composed of 'organic molecules' that combined in different ways to give rise to different living beings. Buffon claimed (1749b, p.44) "that there exists in Nature an infinite number of living organic particles, that organized beings are composed of these organic particles, [and] that their production costs Nature nothing, since their existence is constant and invariable". To the extent that Buffon believed these organic molecules to be principles whose nature was incorruptible, it is possible to explain both the death and birth of natural organisms in terms of the dissolution and reorganization of the relationships among them. This gave the epigenetic concept a level of dynamism not possessed by the theory of preformation, since it was always possible to imagine the existence of other molecular combinations which explained the emergence of new natural forms.[17]

However, rejecting the premise of preformed germs meant that Buffon was obliged to confront a series of difficulties about how to account for the stable arrangement, 'consistent to the end', of the apparently fortuitous juxtaposition of organic molecules. This difficulty was stressed by Bonnet, who claimed that Buffon's epigenetics had to presume a certain level of preformation in order not to end up attributing organic configuration to mere chance. This was just what happened in the case of Maupertuis (Hoffheimer, 1982, p.119-144), who in his eagerness to be rid of preformationist assumptions, had gone so far as to assert that the earliest forms of life had appeared by spontaneous generation based on haphazard combinations of inert molecules, and that species diversity had arisen *a posteriori*, by chance mutations. Understandably, Maupertuis' position was problematic not only from the religious point of view but also in scientific terms, since it failed to explain the conjunction of organic molecules in a particular organic form.

This difficulty, like the aforementioned need to find a basis for the uninterrupted succession of individuals, explains why Buffon was obliged to presume the existence of an internal organic basis. Buffon (1749b, p.34) called this organic basis an "interior mold" and theorized that it held a force of attraction (*intussusception*) that allowed the absorption of organic molecules and the regular conformation of the various organisms. This process of absorption occurred, according to Buffon, both in the area of nutrition and growth of existing beings and also during the course of procreation. In the former, the hypothesis of the interior mold explained why living beings incorporated organic matter, increasing in mass and volume, without modifying the arrangement of their organs or the quality

of the matter of which they were made. A similar although slightly more complex and problematic process occurred when new individuals of the same species were generated. The similarity between progenitor and offspring was due to the fact that new organisms were made from the excess organic material that adult members of a particular species were able to accumulate. While the new individual developed from the remnants of already modeled organic matter, which the living adult being rejected because it was unnecessary to its own nutrition and development, the offspring had to reproduce the mold of the organism that had shaped the excess molecules (Buffon, 1756, p.79).

Before proceeding, it should be pointed out that although to a certain extent the interior mold restricted Buffon's nominalism, mentioned earlier, this did not strictly mean that he fell back on preformationist premises.[18] Unlike preformed germs, this was a hypothesis involving a force whose existence, while it could not be observed directly, was corroborated by the effects it produced in the experiential field. On this point, Buffon continued to refer to Newton's theory of gravity, since, as with the attraction between bodies, it remained in the field of 'effects', while their 'cause' remained out of reach of our perception (Lenoir, 1981, p.123).

> These forces ... are relative to the interior of matter, and have no relationship to the exterior qualities of bodies, but act on the most intimate particles and penetrate them on all fronts; these forces, as we have proved, could never reach our senses, because their action occurs on the interior of bodies, and our senses can only represent what occurs on the exterior, they are not the kind of thing that we can perceive (Buffon, 1749b, p.45).

But this was not the only example to the Newton model continuing to operate in Buffon's theory. Its persistence can also be seen in the fact that he thought the interior mold could only produce regular effects (Huneman, 2007, p.85-90), completely excluding, as we shall see, the possibility that such a mold could give rise to differentiated forms made out of a stable material.

The theory of degeneration

As we have demonstrated so far, with the hypothesis of the interior mold, Buffon's model ensured the unity of the species and laid the groundwork for building a taxonomic system based on the criterion of kinship. Buffon managed to link the makeup of living beings to internal organic conditions and avoid the danger of seeming to be the result of the haphazard conjunction of organic molecules. Indeed, this principle, which we are unable to observe, imposed a legality that made the fortuitous assembling of elemental molecules a regulated process and thus ensured the integrity of the organism throughout its various appearances. Thus, in the sixth volume of his *Natural history*, Buffon (1756, p.86) attempted to demonstrate the fixed nature of biological species, arguing that "what is most constant, most unalterable in Nature, is the mold of each species, both in animals and in vegetables".

But if Buffon managed in this way to guarantee the stability of species and thereby restore the systematic character of natural history without needing to appeal to preformed germs, he did so at the expense of blurring the transformationist possibilities that were originally inscribed in the 'epigenetic' perspective. Reaffirming matter's inability to prevail

over form, Buffon (1756, p.87) pointed out that organic molecules "seem to be indifferent to receiving this or that form, and capable of bearing all possible imprints: the organic molecules, in other words, the living parts of this matter, pass from vegetables to animals, without destruction and without alteration, and form equally the living substance of grass, wood, flesh and bone".

The problematic nature of this statement was particularly evident in the case of species, like man, that included varieties whose features were necessarily inherited. For, if interior molds introduced regular laws, then it was only possible to explain the existence of stable varieties – or races – by attributing to each one of them a different organic origin. However, Buffon rejected the validity of polygenic hypotheses, not only because of their unreliability, but also because they based morphological variations on an instance that lay outside the field accessible to scientific investigations (Dougherty, 1990, p.228).

For if the basis of race lay within the framework of the generative process, then it had to coincide with the influence of climate conditions on the prototype of each of the species. This hypothesis seemed to be confirmed by experience, which showed an arrangement of features in cases of geographical vicinity, and came to be viewed favorably by Buffon. Thus, around 1753, Buffon agreed it was possible to apply this hypothesis not just to the different human races but to the natural world in general. Thus, Buffon claimed (1753, p.382), it was possible that "each family, whether animal or vegetable, has but a single source, and even that all animals came from a single animal, which, over time, has produced, by perfecting itself and degenerating, all the races of other animals" (cf. Roger, 1983, p.149-172).

However, the climate hypothesis could only be saved from the suspicion of reintroducing contingency and fate if the action of environmental factors was understood in strictly negative terms (Caponi, 2009, p.691-693). This assumed that these, rather than producing new forms, should be limited to opposing particular resistance to the lines imposed by the interior mold, so that it could only carry out its task partially, thus giving rise to a degraded version of the original form. At this point, Buffon, argued that organic matter assimilated by living creatures during the nutrition process could only be completely molded if the climate held stable. Under such conditions, Buffon believed, the action of the interior mold tended to reproduce similar individuals and prevail over the assimilated matter. But if there were large fluctuations in the environment, the organic matter's form changed, hindering the process of absorption carried about by the interior mold. Thus variations were produced that, while imperceptible at first, would eventually give rise to a true degeneration of the species (Buffon, 1753, p.299-301).[19] That is, after a considerable time lapse, the type of particles incorporated would start to prevail over the internal form and show up in the size, color and other peculiar features adopted by the procreated beings.

Final considerations

As we can infer from all this, the interpretational scheme adopted by Buffon did not presume the emergence of new species, but only the corruption of the original forms due to environmental factors. In this sense, his theory cannot be seen as transformationist, since he did not see time as capable of producing morphological innovations: never, according to

Caponi (2009, p.698), "can we conceive of those processes affecting the fundamental structure of an organism, even in its incipient form. These changes affect preexisting structures; but they do not create even the rudiments of new structures". On this point, Buffon's theory of degeneration reproduced the same fixist tendency seen in his concept of generation. For, according to that theory, an organism's growth did not involve the emergence of new forms either, but was derived from merely incorporating preexisting organic molecules.

However, rejecting a transformationist interpretation of Buffon's work does not mean denying its critical effect on classical natural history. This was achieved, firstly, by the fact that Buffon's epigenetics abandoned the preformationist premise of original germs, created directly by god, and replaced it with the mechanical action of the interior mold. This represented a significant departure from classical natural history's viewpoint, seen in the formula of the *scala naturae*, which combined order, beauty and utility. In this sense, widening the field of the mechanical-causal explanation used by Buffon presented an unavoidable obstacle to viewpoints that sought to link the arrangement of natural forms with the infinite goodness of the creator. For this predisposition was now interpreted as a reflection of mechanical forces that, even when they managed to maintain the natural order, were not capable of granting it esthetic qualities or intrinsic usefulness.

But the order established between natural beings by epigenetics was not complete either. On the contrary, Buffon's goal of designing a systematic image of nature based on mere causal mechanics was only possible by introducing a radical distinction between 'natural' time and 'historic' time. As the theory of degeneration shows, Buffon only managed to establish that the means and objectives of his enterprise coincided in the first of these moments, that is, when the interior mold, prompted by a favorable climate, could reproduce similar individuals and prevail upon the matter ingested as food. Beyond those limits, there was a degenerative process characterized by the fact that, while it was perfectly explicable in causal terms, it could no longer be interpreted systematically. This meant that, even when current organic forms could be traced back to a presumed original stock, their effective configuration and the meaning of the process that had led them to the present could only be explained by fate.

This would make Buffon's theory unacceptable in the eyes of Immanuel Kant, who, though he admired the fertile offspring criterion, was sharply critical of Buffon's theory of degeneration (Kant, 2004). What was at stake in this critique was the fact that, if the effect of climate was presumed to contribute the degeneration of natural forms, the 'final disposition' of the alleged original forms became questionable. In this sense, it can be stated that the disconcerting aspect of Buffon's theory was its radical affirmation of the mechanical-causal explanation rather than its substitution with a vitalist model, as Reill argues. For, once the preformationist hypothesis is abandoned, this model left us, as Kant put it (1992, p.348), without any tools for determining whether "many constituents of the form at present found in a species may not be of equally contingent and purposeless origin".[20]

NOTES

[1] In this and other literal quotations of texts from non-English languages, a free translation has been provided.

[2] An irreversible concept of temporality would be one that admitted the existence of transformations that constituted natural forms.

[3] For an examination of the bases of Foucault's method in his analysis of classical natural history, see Foucault (2002). A critique of this method, which emphasizes its inability to show historical continuity, is found in Metzger (2002, p.41-42).

[4] Natural history is presented as the subject of 'various textbooks' that deal with history, in other words, with the list or description of natural bodies belonging to the three natural kingdoms (Adelung, 1798, p.445).

[5] "Natural history traverses an area of visible, simultaneous, concomitant variables, without any internal relation of subordination or organization" (Foucault, 1984, p.137). "The classification of natural history is determined spatially, the varieties of living beings are presented in the form of a *Tableau*. The principles of organization ... are taken from intuition and daily experience. The points of view belonging to a history of development are rejected" (Lepenies, 1976, p.58). The *Tableau* was a presentation form often used by the systematizers to illustrate forms. There certain combinations of features were placed together to allow to position a particular form in this table. In this way, it was identified and the place it occupied in the systematic order was fixed (Breidbach, Ghiselin, 2006).

[6] Previously, the Aristotelian theory of William Harvey (1578-1657) had been accepted, which posited the existence of a joint action between matter, present in the ovum, and the *vis plastica* that provided the form. Generation occurred suddenly, by metamorphosis, or gradually, by the gradual differentiation of undifferentiated matter. Harvey (1651, p.121) called this latter method epigenesis. See Metzger (2002, p.33).

[7] Leibniz (1990, p.101) declared that "the movement of celestial bodies, even the formation of plants and animals, contains nothing apart from their beginning that appears miraculous. The organism of animals is a mechanism that presupposes divine preformation: what arises out of it is purely natural and completely mechanical".

[8] Leibniz would use the concept of *evolutio* in opposition to that of *fulguratio.* While *fulguratio* refers to divine creation by which new beings are created, *evolutio* does so by unfolding later (Palti, 2001, p.35-36).

[9] This citation from Leibniz was sourced from *Self and substance in Leibniz*, Marc Elliott Bobro, Dordrecht, Kluwer Academic Publishers, p.16, 2004.

[10] In this sense Leibniz (1990, p.10-11) pointed out that: "if god performs miracles, this occurs, I believe, not because nature demands it, but rather out of pity: to judge otherwise would involve a truly low estimation of the strength and wisdom of god".

[11] Bonnet (1770, p.383) acknowledges the advanced nature of this theory in the following terms: "at one time, when true natural history was yet in its infancy, and heads were not yet accustomed to strict logic, people resorted to occult forces, formative natures, souls with growth powers, in order to explain the production and reproduction of the animal and vegetable kingdoms. These natures or these souls were entrusted with the task of organizing bodies, and it was believed that they were the architects of the buildings in which they lived, and that they knew how to maintain and improve them".

[12] According to Blumenberg's interpretation (1976, p.137-146), it would be possible to include preformed germs among the principles through which modernity sought to respond to the problem of the world's contingency which followed from late medieval nominalism. Like Spinoza's *conatus* and the principle of inertia, germs guaranteed the conservation of the world by secular means and thus made god's conserving activity unnecessary. However, these perspectives were unable to account for the origin of the world and would therefore continue to assume the existence of a divine creator.

[13] As Buffon remarked (1749c, p.38), "the greater the number of divisions of natural productions, the closer we get to the truth, since in nature only individuals really exist. And the genera, orders and classes only exist in our imagination".

[14] This distinction does not, as Sloan points out, imply that physical truths are temporal in character (Sloan, 1979, p.117-118; Reill, 1992, p.435-436).

[15] Buffon (1749c, p.54-55) reproaches Linnaeus here for having confused mathematical truths, based on definitions and lacking any real content, with physical truths, which are real and based on an uninterrupted succession of events. "Mathematical truths are merely truths of definition and, if you prefer, different expressions of the same things These definitions are based on simple assumptions, but abstract and all the

truths of this kind are just consequences composed, but abstract, of such definitions … Physical truths, however, are not arbitrary and do not depend on us; instead of being based on assumptions we make, they are supported by events; a series of similar events or, if you wish, a frequent repetition and an uninterrupted succession of the same events, constitutes the essence of physical truth".

[16] The reasoning for arriving at the interior mold is as follows: "In the same way that we can make molds to give the exterior of bodies whatever shape we please, let us suppose that Nature could make molds by which she gives not just the outward shape, but also the inner one; could this not be a means whereby reproduction could function?" (Buffon, 1749b, p.34).

[17] However, there was already an obvious tendency towards a static concept of nature, in that the phenomenic level of change and multiplicity continued to be reduced to stable principles that combined in variable ways. In this sense, generation was still, for Buffon, a process that took place in time but not, effectively, across it.

[18] Buffon does not introduce a development principle but remains tied to the idea that the complete structure of organisms is given beforehand. However, this form is not thought of in material terms but as an ideal model of a combination of organic matter (Dougherty, 1996, p.239-250).

[19] Buffon (1749a, p.530) applied this hypothesis also to man and derived from it the white man's original nature.

[20] This citation from Kant was sourced from *Critique of judgement*, translated by James Creed Meredith, Oxford, Oxford University Press, p.249, 2009.

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