The problem of continuity and discontinuity with special reference to modern biology
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Opsomming

In die ontwikkeling van sy teorie van evolusie het Darwin van die klassieke slagspreuk uitgegaan dat die natuur geen spronge maak nie. In hierdie artikel word geargumenteer dat hierdie grondoortuiging aan die een kant die effek van Darwin se uiteindelike toegewydheid aan die moderne humanistiese natuurwetenskapsideaal met die inherente kontinuïteitspostulaat in die wese daarvan demonstreer. Aan die ander kant het dit 'n vooroordeel aan hom besorg,wat die ware feitlike toedrag van sake in die paleontologie teengespreek het.

1. A familiar opposition

In everyday parlance it is quite common to speak of continuity and discontinuity. In most instances it is related to an awareness of the temporal process of coming into being and passing away – with the continuity of a certain period of time in-between. Apart from individuals also societal institutions evince a similar coming and going: states are established and may terminate their existence, through wars or other causes. The relative persistence of individuals and societal forms of life echoes a consciousness of duration which calls for an inquiry into the contexts in which one can refer to *endurance*, *persistence*, *stability* or *continuity*. Of course one may ask if there is a domain where these terms are found in their original meaning, because we encounter them most of the time in qualified contexts, such as *social* constancy, *moral* persistence, *historical* continuity, and so on. What we

are looking for is a context within which these terms are original and primitive, that is to say, *indefinable*.

The sociologist Catton, for example, argued something similar in respect of the concept of *force*: "If a force is that which produces an acceleration, then a physical force is that which accelerates material bodies in physical space, and a social force is whatever accelerates social processes. It makes sense to use the term 'force' in both contexts because both physical forces and social forces are special cases of the general concept" (Catton, 1966:233-234). What Catton actually does is to elevate the concept of *force* to the level of a *genus*-concept, encompassing various *species* of this general concept as special cases. The crucial question, however, is the following: if physical forces and social forces are mere specifications of a general concept of force, what then is the original context of this "general concept" of "force"? As a genus-concept this general concept of force must transcend the diversity of aspects within reality since in every non-physical aspect there occurs only an analogy of force. But every analogy within any aspect refers to some other aspect where it is found in its *original meaning*. Catton almost saw this when he remarked that one does not need to use the adjective "physical" when physical force is intended "because physics got there first and has a prior claim on the word 'force' " (Catton, 1966:234). But to make this remark useful, Catton was in need of a theory of modal aspects and their analogies, for within this perspective it is possible to explain that the concept of force originally refers to the (primitive meaning of the) physical aspect and can therefore only appear as a physical analogy in the social (and other non-physical) aspect(s). Any attempt to subsume analogical concepts under a highest genus-concept must inevitably result in the eradication of the modal boundaries (sphere-sovereignty) of the modal aspects themselves.

The same argument applies to the various terms that we have used – *endurance*, *persistence*, *stability* and *continuity*. The primary issue seems to be the awareness of a *uniform movement* – as it is associated with the initial formulations of the *law of inertia* even pre-dating what Galileo had to say about it (see Maier, 1949).

Classical mechanics, theoretically accounting for (uniform) motion, was over-extended into an entire world view according to which the universe ought to be understood as *particles in motion*. Eventually this view had to give way to the insight that physical change is equally basic. However, as already realized by Plato, *change* can only be affirmed on the basis of something *enduring* or *persistent*, which implies that in its primitive meaning *constancy* (endurance or persistence) forms the foundational condition for *change*. Of course the core meaning of uniform phoronomic or *kinematic* motion itself is dependent on another foundational mode of experience, namely that of *space*. Although spatial continuity is static, its meaning is equally basic and unique in its own right. We shall argue below that in its primary sense spatial continuity is

homogenous, of the same nature on the whole and in all of its parts. Living entities are also characterized by a relative duration or time-span, bound to the biotical time-order of birth, growth, maturation, ageing and dying.

2. The continuity postulate in modern scholarly thought

Since the Renaissance the intellectual history of the West increasingly explored theoretical designs in which particular emphasis was laid upon the notion of *continuity*. In this article we want to show that what may be designated as the *continuity postulate* of modern philosophy, via the thought of Darwin, indeed permeated biological thought thoroughly, mainly through the all-pervasive influence of his understanding of *gradualism*.

The renewed interest in the legacy of Charles Darwin, owing to the influence of his famous work from the year 1859, *On the origin of species by means of natural selection or the preservation of favoured races in the struggle for life*, in a certain sense culminated during 2009 – the year in which his birth 200 years ago was celebrated (150 years after his 1859 book appeared). Additional prominence was given to these celebrations by the announcement of two fossils found in South Africa in 2010, suggested to represent a new species of *Australopithecines*, namely *Australopithecus sediba*.

This single occurrence once more opens up the entire structure of Darwinian evolutionary theory. Darwin assumed that *nature does not make jumps*, captured in the long-standing saying, *natura non facit saltus* (*nature does not make jumps*) – a conviction dating back to Greek philosophy and particularly dominant within modern philosophy since the Renaissance.

The penetrating analysis given by Dooyeweerd of the rise of modern Humanism during and since the Renaissance emphasizes that the *ideal of a free and autonomous personality* gave rise to the *natural science ideal* aiming at reducing all of reality to the continuity of human thought, guided by whatever *aspect* of nature is elevated to become the all-embracing basic denominator for our understanding of reality (see Dooyeweerd, 1997-I:188 ff., cf. 1997-IV:37-38).

Although the freedom motive gave birth to the natural science ideal, the latter turned into a real Frankenstein by leaving no room for human freedom and accountability within the context of a nature which is determined by causal laws ("laws of nature").[1]

1 William Provine from Cornell University, who remarked "that persons who manage to retain religious beliefs while accepting evolutionary biology 'have to check [their] brains at the church-house door'," explicitly holds such a deterministic Darwinian view, excluding human freedom of choice:

The *continuity postulate* of modern Humanism, in its naturalistic garb, from time to time did become suppressed whenever the freedom ideal acquired primacy in Humanistic thought, for example in the thought of Immanuel Kant and of post-Kantian freedom idealism, and also in existentialism, Neo-Marxism and postmodernism. However, the natural science-ideal never stopped to exert its influence upon the intellectual legacy of the West. Its most impressive success became manifest in the ideal of *progress* of the 18th century, which is also known as the era of the *Enlightenment*. The possibilities of human reason, as expressed in mathematics and mathematical physics, were ultimately elevated to become the guide of human life towards an ever-improving future. Of course this immediately reminds one of the famous statement made by Kant: "However, my claim is that in every particular theory of nature only that much science is found as the amount of mathematics present in it."[2]

Sterelny points out that Richard Dawkins strictly continues the *epistemic ideal* of *Enlightenment* rationality – according to which the scientific description of the universe is "true ... beautiful and complete" (as Sterelny, 2001:13, 14 formulates it).[3]

It should be noted, nonetheless, that the diversity displayed by reality did call forth theoretical orientations in which the search after the supposed (discrete) "elements" of reality are explored as ultimate principle of explanation. These *atomistic* or *individualistic* views are usually defended as an alternative to *holistic*

"Modern science directly implies that the world is organized strictly in accordance with mechanistic principles. There are no purposive principles whatsoever in nature. There are no gods and no designing forces that are rationally detectable. …Second, modern science directly implies that there are no inherent moral or ethical laws, no absolute guiding principles for human society. Third, human beings are marvelously complex machines. The individual human becomes an ethical person by means of two primary mechanisms: heredity and environmental influences. That is all there is. Fourth, we must conclude that when we die, we die and that is the end of us. … Finally, free will as it is traditionally conceived – the freedom to make uncoerced and unpredictable choices among alternative possible courses of action – simply does not exist. … There is no way that the evolutionary process as currently conceived can produce a being that is truly free to make choices" (quoted by Johnson, 1991:124-125).

2 Einstein apparently opts for the opposite view when he says, "Insofar as the propositions of mathematics are related to reality they are not certain and in so far as they are certain they are not related to reality." ["Insofern sich die Sätze der Mathematik auf die Wirklichkeit beziehen, sind sie nicht sicher, und insofern sie sicher sind, beziehen sie sich nicht auf die Wirklichkeit" (Einstein, 1921:124)].

3 One may find it strange that the theologian, Wentzel Van Huyssteen, supports this claim by saying that our universe "and that all it contains is in principle explicable by the natural sciences" (Van Huyssteen, 1998:75). Yet, flatly contradicting this Enlightenment trust, he also warns, a mere 40 pages further on in the same work, that we should not overextend rationality "to explain everything in our world in the name of natural science" (Van Huyssteen, 1998:115).

or *universalistic* approaches in which (analogies of) continuity (that is, *wholeness*) play an important role.

As counter-balance for his discrete monads, Leibniz explicitly used what he called the *lex continui* (the *law of continuity* – see Leibniz, 1976:397). During the nineteenth century discreteness once again surfaced within the discipline of mathematics, particularly enhanced by the development of set theory and its arithmeticistic claims without eliminating the alternative emphasis on wholeness found in certain parts of intuitionistic mathematics and in the thought of Frege close to the end of his life.[4]

The mentioned aphorism, *natura non facit saltus*, influenced Linnaeus and subsequently also Charles Darwin himself. In his *Origin of species* one finds four places where the phrase is employed, although the idea of continuity permeates the entire work. Darwin indeed developed his new ideas with an explicit appeal to this *continuity postulate* – in an *a priori* fashion, that is to say, without the support of empirical evidence, and this caused, as will be seen, serious problems for his theoretical stance.

Darwin's first reference to *natura non facit saltus* is slightly critical of what is designated as the *cannon in natural history*: "It certainly is true, that new organs appearing as if created for some special purpose, rarely or never appear in any being;– as indeed is shown by that old, but somewhat exaggerated, canon in natural history of 'Natura non facit saltum'" (Darwin, 1859a:116). A few pages further this "exaggeration" is left behind in the claim that once we broaden our perspective to include the known and unknown inhabitants of the past time it is "strictly true" (Darwin, 1859a:124).

Later on in this work Darwin continues this confident appreciation of the *continuity postulate*:

> As natural selection acts solely by accumulating slight, successive, favourable variations, it can produce no great or sudden modifications; it can act only by short and slow steps. Hence, the canon of "Natura non facit saltum," which every fresh addition to our knowledge tends to confirm, is on this theory [simply – Darwin, 1859:444-445] intelligible (Darwin, 1859a:307).

4 "So an a priori mode of cognition must be involved here. But this cognition does not have to flow from purely logical principles, as I originally assumed. There is the further possibility that it has a geometrical source. ... The more I have thought the matter over, the more convinced I have become that arithmetic and geometry have developed on the same basis – a geometrical one in fact – so that mathematics in its entirety is really geometry" (Frege, 1979:277).

He phrases this continuity postulate also in the following terms: "Natural selection acts only by the preservation and accumulation of [infinitesimally – Darwin, 1859:142] small inherited modifications" (Darwin, 1859a:56).

Remark: *The persistent influence of the continuity postulate*

> Soon after Darwin's *Origin of Species* appeared this continuity postulate was further elaborated by the Marburg school of neo-Kantian thought. Herman Cohen, in particular, the founder of this school, emphasized the connection between *continuity* and the *movement* of human thought. Of course this continuity of the movement of thought has already been identified by Leibniz. Maimon continued this legacy of Leibniz and at once assigns a greater creative power to human understanding: "It [namely understanding] can within an object only accepts with certainty that which itself has put into it (in that it brought forth the object according to a rule that it prescribed), but not as something that in it came from somewhere else" (Maimon, 1790:59-60). Already in the *logic of origin*, developed by Cohen, he attributed to human understanding the ability to bring forth from thought as origin every content: "What must become the first request of thought is to put into thought itself the origin of every content that it can bring forth." A few pages further Cohen writes: "By virtue of continuity all elements of thought, insofar as they may serve as elements of knowledge, must be brought forth from the origin" (Cohen, 1883:92). As in the case of Leibniz the so-called infinitesimal method of mathematics plays a decisive role in this view of the principle of continuity. The infinitely small as movement principle (in the treatment of the tangent problem) leads to the basic principle of continuity: "And this positive meaning, this motive of the infinitely small as a principle of movement which is fruitful for the geometrical determination, ..., leads to the genuine principle of this approach, the principle of *continuity*" (Cohen, 1914:82).

Darwin's *a priori trust* in the validity of the continuity postulate builds upon the idea of "infinitesimally small inherited modifications", that is to say, upon a view analogous to the idea that a line could be seen as a *continuum of points*. This continuity postulate is so deeply rooted in Darwin's entire approach, that he is willing to equate a refutation of this claim with the absolute *break down* of his entire theory: "If it could be demonstrated that any complex organ existed, which could not possibly have been formed by numerous, successive, slight modifications, my theory would absolutely break down" (Darwin, 1859a:109). Gould reminds us that "my theory" here specifically refers "to the mechanism of natural selection (and not simply to the assertion of evolution)" (Gould, 2002:150).[5] Moreover, Gould calls upon Gruber,

5 Dawkins also adheres to the orthodox Darwinian view believing that the power of selection slowly and incrementally build the exquisite and intricate outfit of living organisms. This

Barrett and Mayr who also noted the centrality of gradualism in Darwin's thought and even remarks that by following his chief guru, Charles Lyell, Darwin equated gradualism with rationality.[6]

It is important to note, however, that Darwin's trust in this continuity postulate is not supported by the required empirical evidence. He alludes to the "natura non facit saltum" principle but at the same time is completely honest about the lacking evidence, for in connection with the "hoped-for" intermediate links of the fossil record he writes: "But just in proportion as this process of extermination has acted on an enormous scale, so must the number of intermediate varieties, which have formerly existed, be truly enormous" (Darwin, 1859a:196). To this statement he adds the significant question on the same page: "Why then is not every geological formation and every stratum full of such intermediate links?"

Although this question appears to be nothing but a "neutral statement of fact," the subsequent "explanation" uses the word "imperfection", which demonstrates the hidden assumption of *gradualism* (the *continuity postulate*) expressed in it: "Geology assuredly does not reveal any such finely-graduated organic chain; and this, perhaps, is the most obvious and serious objection which can be urged against the theory.[7] The explanation lies, as I believe, in the extreme imperfection of the geological record." When Darwin says that he *believes* in the "extreme imperfection of the geological record" it means that he believes that there has been a *perfect continuity* but that this *perfect continuity* just did not show up in the fossil record. Compare his following words, still resounding his positive hope that intermediate forms will be found: "But we continually overrate the perfection of the geological record, and falsely infer, because certain genera or families have not been found beneath a certain stage, that they did not exist before that stage" (Darwin, 1859a:210).

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conviction clearly shows a prejudiced and premature pre-occupation by Darwin and his followers with change which prevented modern (Neo-) Darwinian biology to come to terms with the fact that change always presupposes something constant.

6 "Gradualism had been equated with rationality itself by Darwin's chief guru, Charles Lyell. All scholars have noted the centrality of gradualism, both in the ontogeny (Gruber and Barrett, 1974) and logic (Mayr, 1991) of Darwin's thought" (Gould, 2002:151).

7 Hundred and forty years later Jones echoes the problem: "The fossil record – in defiance of Darwin's whole idea of gradual change – often makes great leaps from one form to the next. Far from the display of intermediates to be expected from slow advance through natural selection, many species appear without warning, persist in fixed form and disappear, leaving no descendants. Geology assuredly does not reveal any finely graduated organic chain, and this is the most obvious and gravest objection which can be urged against the theory of evolution" (Jones, 1999:252).

In spite of his equally basic *belief* that, owing to the continuity in descent, the (assumed) *actual* random process must have been going through "an inextricable chaos of varying and intermediate links", he had to concede that the existing diversity of living entities portrays a *real discontinuity* (Darwin, 1859a:102).[8] Being aware of this diversity initially, as we noted above, caused a slight relativization of the continuity postulate, namely when he refers to it, as "somewhat exaggerated".[9]

In spite of this modesty, his deeply rooted belief in the *continuity* of descent convinced him that once the picture is extended to include the *assumed* continuity of the fossil record, it is not any longer necessary to speak of an exaggeration. In other words, when Darwin stretches his imagination beyond the limits of the *available evidence* by including *what he expects* from the paleontological record, his unbridled *faith* in the seemless transitional continuity dominates the core convictions of his work on the *Origin of species*. Just recall his above-mentioned statement: "On the theory of natural selection we can clearly understand the full meaning of that old canon in natural history, 'Natura non facit saltum.' This canon, if we look to the present inhabitants alone of the world, is not strictly correct; but if we include all those of past times, whether known or unknown, it must on this theory be strictly true" (Darwin, 1859a:124).

It is therefore not surprising that, in spite of lacking evidence, he repeatedly *re-affirmed* his *trust* in this principle of continuity, for example where he states: "Natural selection acts only by the preservation and accumulation of small inherited modifications" (Darwin, 1859a:56).

3. Discontinuity

The last fifty to sixty years witnessed an increasing challenge to the classical Darwinian conception of a gradually and continuous transition through numberless incremental small changes over millions of years. This challenge flows from what Gould and Eldredge characterized as the *dominant theme* of the fossil record, namely *stasis* (*constancy* or *fixity*). One may capture the core of this issue by employing the opposition of *continuity* versus *discontinuity*.

8 Darwin writes: "To sum up, I believe that species come to be tolerably well-defined objects, and do not at any one period present an inextricable chaos of varying and intermediate links; first, because new varieties are very slowly formed, for variation is a slow process, and natural selection can do nothing until favourable individual differences or variations occur, and until a place in the natural polity of the country can be better filled by some modification of some one or more of its inhabitants" (Darwin, 1859a:102).

9 Remember his words: "as indeed is shown by that old, but somewhat exaggerated, canon in natural history of 'Natura non facit saltum' " (Darwin, 1859a:116).

> The clear predominance of an empirical pattern of stasis and abrupt geological appearance as the history of most fossil species has always been acknowledged by paleontologists, and remains the standard testimony… of the best specialists in nearly every taxonomic group. In Darwinian traditions, this pattern has been attributed to imperfections of the geological record that impose this false signal upon the norm of a truly gradualistic history. Darwin's argument may work in principle for punctuational origin, but stasis is data and cannot be so encompassed (McGar, 2006: 242).

Of course the problem of continuity and discontinuity cannot be restricted to any academic discipline, because it appears in all special sciences. The only question to be asked, as we have seen, is where the original meaning of this opposition is located in order to be able to discern the similarities and differences between its primtive domain and other domains where it appears analogically – just consider the difference between social force and physical force, and physical space and mathematical space.

In 1925 the world's leading mathematician, David Hilbert, in an article on the infinite, commences by looking at this issue from the perspective of the *infinitely small* and the *infinitely large* (Hilbert, 1925:163 ff.). The discovery of *quanta of energy* on the one hand and Einstein's theory of relativity on the other, eliminates both possibilities. Crucial in his considerations is the distinction between *mathematical space* and *physical space*. He points out that in a purely abstract and functional perspective mathematical space is *both* continuous and infinitely divisible. However, *physical space* is *neither* continuous nor infinitely divisible. Since it is bound to the quantum structure of energy, physical space cannot be *subdivided ad infinitum*. Energy quanta indeed represent the limit of the divisibility of energy.[10] These developments within the discipline of physics therefore uprooted the classical (but above-mentioned speculative) claim that nature does not make jumps (*natura non facit saltus*).

However, at the time (1859) when Darwin elaborated his basic convictions, this modern *continuity ideal* still reigned almost unchallenged. Darwin writes:

> If numerous species, belonging to the same genera or families, have really started into life at once, the fact would be fatal to the theory of evolution through natural selection. For the development by this means of a group of forms, all of which are descended from some one progenitor, must have been an extremely slow process; and the progenitors must have lived long before their modified descendants (Darwin, 1859a:210).

10 An *analogy* is present whenever differences are shown in what is *similar*. In this case: both mathematical space and physical space are *extended* (their similarity), but in being discontinuous and not infinitely divisible (their *differences*), the latter differs from the former.

We have mentioned that during and after the Renaissance modern Humanism was driven by the ideal to proclaim the freedom and autonomy of humankind – as a law (*nomos*) unto itself (*autos*). This autonomous freedom was supposed to flow from the the first half of the 17th century and had already clearly manifested the basic motive of what the Renaissance initiated during the 14th and 15th centuries. It concerns this ideal of an all-encompassing natural science (physics) as the intrument in the hand of the ideal of autonomous freedom. Since Descartes, the ideal of such an encompassing natural scientific control of all of reality started to dominate the scene. In order to proclaim its autonomy (being a law unto itself) and its freedom, the human person had to master reality with the aid of the newly developing natural sciences. In the mould of this new spiritual climate, the "world" no longer encloses the human being. Rather, the world is recovered as an "object" at the disposal of the autonomously free rational human being with its all-determining natural scientific abilities. In his discussion of the thought of Descartes, Von Weizsäcker reveals a penetrating understanding of this orientation: "This state of affairs is characteristic of modernity. It is not the world in which I find myself that guarantees my existence. This guarantee is not lost, for when I recover the world then it is as the object of my self-assured thinking, that is to say, as an object which I can manipulate."[11]

We use the expressions "naturalistic science ideal", "rationalistic science ideal" and "science ideal" as synonyms, all of them bringing to expression that they manifest the humanistic science ideal (the nature motive of modern Humanism). In its supposed autonomy sovereign human thought is "entitled" to eliminate every boundary and subsume whatever there is under one, all-encompassing continuity perspective. However, since the world in which we live is given in diverse aspects or modes of explanation, the choice to be made merely concerns which *functional perspective* (*aspect* or *mode of being*) will be chosen as basis for these continuity claims. Descartes still subsumed (natural) reality under a spatial denominator. Hobbes, by contrast, chose for *movement*.

4. 'Imperfection' of the fossil record?

One section of Darwin's *Origin of species* has the title: "On the Absence of Numerous Intermediate Varieties in any Single Formation." In the light of several considerations Darwin remarks that "it cannot be doubted that the geological

11 "Dies ist ein charakteristisch neuzeitlicher Sachverhalt, Nicht die Welt, in der ich mich vorfinde, garantiert mein Dasein. Diese Garantie geht nicht verloren, und wenn ich die Welt wiederfinde, dann als Gegenstand meines selbstgewissen Denkens und darum als Objekt, das ich hantieren kann" (Von Weizsäcker, 2002:130-131).

record, viewed as a whole, is extremely imperfect; but if we confine our attention to any one formation, it becomes much more difficult to understand why we do not therein find closely graduated varieties between the allied species which lived at its commencement and at its close" (Darwin, 1859a:203-204).

Ever since Darwin pointed at the "imperfection" of the fossil evidence, gradualist followers of him continued to safeguard their faith in the continuous line of descent with an appeal to this alleged *imperfection* of the fossil record. For example, when the Neo-Darwinist, George Gaylard Simpson, had to explain gaps in the fossil record, he claims that if we had all the intermediate fossils there would be no gaps. Thus, instead of explaining the gaps, he simply *denies* that they exist, owing to the gradualist belief in the "imperfection" of the fossil record (see Simpson, 1961:359 ff.). By contrast, Gould states: "The extreme rarity of transitional forms in the fossil record persists as the trade secret of paleontology. The evolutionary trees that adorn our textbooks have data only at the tips and nodes of their branches; the rest is inference, however reasonable, not evidence of fossils" (Gould, 1980:179 ff.).

Insisting that the fossil record is "imperfect," according to no one less than Gould, is not a stance supported by data. The powerful assumption upholding this prejudice of "perfection" is a faith in slow, incremental ("infinitesimal"), continuous change. Two things must be noted in this respect. (i) First of all, that the continuity postulate, known as "gradualism", indeed serves as the basis of Darwin's thought, and (ii) secondly, that this assumption is not merely peculiar to a biological conception following from the operation of natural selection. Let us quote what Gould said in both these respects:

> (i) Gradualism may represent the most central conviction residing both within and behind all Darwin's thought (Gould, 2002:148);
> (ii) I believe, therefore, that Darwin's strong, even pugnacious, defense of strict gradualism reflects a much more pervasive commitment, extending far beyond the simple recognition of a logical entailment implied by natural selection – and that this stronger conviction must record such general influences as Darwin's attraction to Lyell's conflation of gradualism with rationality itself, and the cultural appeal of gradualism during Britain's greatest age of industrial expansion and imperial conquest (Gould, 2002:151).

The significant element in Gould's analysis of Darwin's position is that he draws attention to the fact that for Darwin natural selection does not represent his core conviction – this position is occupied by the *continuity postulate*. Moreover, it is important for those interested in intellectual history ("the history if ideas") to realize that the primacy given in Darwin's thought to the continuity postulate (nature does not make jumps), evinces the rootedness of his thought in the modern

humanistic science ideal. Just as Leibniz struggled with the relationship between his discrete monads and his *lex continui* (law of continuity), Darwin had to reconcile the discreteness displayed in the currently living nature (the "Natural System" in terms of *Biological systematics*), and the incremental, step-by-step (i.e. continuous) transitions assumed to have happened in the past. But we have seen that Darwin had the honesty to formulate the most serious objection that anyone can raise against his theory. Let us repeat his significant words fully:

> But just in proportion as this process of extermination has acted on an enormous scale, so must the number of intermediate varieties, which have formerly existed, be truly enormous. Why then is not every geological formation and every stratum full of such intermediate links? Geology assuredly does not reveal any such finely-graduated organic chain; and this, perhaps, is the most obvious and serious objection which can be urged against the theory (Darwin, 1858a:196).

It is at this point where Darwin then introduces his "explanation", namely that the absence "of such intermediate links" follows from the "imperfection" of the geological record: "The explanation lies, as I believe, in the extreme imperfection of the geological record" (Darwin, 1859a:196).

This idea of the "imperfection" of the fossil record is synonymous to Darwin's belief that evolutionary change took place by means of minute, incremental (continuous) change over long periods of time. At the time when his book appeared in print, in 1859, this belief at once embodied a serious hope, namely that fossils of the continuously changing transitional forms will be found through continued paleontological research and the discovery of new fossils. But let us see what Ernst Mayr, one of the key figures in the "New Synthesis" of Darwinism (that gave rise to the label Neo-Darwinism) had to say after more than 130 years: "Paleontologists had long been aware of a seeming contradiction between Darwin's postulate of gradualism … and the actual findings of paleontology. Following phyletic lines through time seemed to reveal only minimal gradual changes but no clear evidence for any change of a species into a different genus or for the gradual origin of an evolutionary novelty. Anything truly novel always seemed to appear quite abruptly in the fossil record" (Mayr, E. 1991:138).[12]

Excursion: *Thomas Hobbes*, *John Locke*, *Adam Smith and Charles Darwin*

The modern humanistic science ideal directed political theory and economic theory. The view developed in the *Leviathan* of Hobbes (1651),

12 Already in 1982 Mayr wrote: "What one actually found was nothing but discontinuities. All species are separated from each other by bridgeless gaps; intermediates between species are not observed. … The problem was even more serious at the level of the higher categories" (Mayr, E. 1982:524).

where the "state of nature" is portrayed as a battle of everyone against everyone (*bellum omnium contra omnes*), forms the background of Darwin's idea of a "struggle for existence." Via the political philosophy of Locke and the classical school in economic theory, the discreteness element, i.e. individualism, made its contribution to Darwinism. It should be kept in mind that Locke's orientation to the science ideal caused him to construct society through a social contract, with (equal and sovereign) individuals as elements. The state of nature is simply continued, with the exception of two rights that had to be given up, namely "to do whatsoever he thinks fit for the preservation of himself and others within the permission of the law of Nature," and the "other power a man has in the state of Nature is the power to punish the crimes committed against that law" (Locke, 1966, § 128). The individualistic (atomistic) underpinnings of his contract theory is found in his starting-point – the equality of "kings." In the "state of Nature" "man" is the "absolute lord of his own person and possessions, equal to the greatest and subject to nobody." In the state of Nature "all being kings as much as he, every man his equal" (Locke, 1966, § 123).

Clearly, the political philosophy of John Locke (based upon his atomistic contract theory) and the ideas of the classical school in economics (Adam Smith and his followers) were both in the grip of the natural science ideal of modern Humanism. Viner's characterization reveals this direction-giving science ideal: "The claim to fame of Smith in the first place therefore appears to have a foundation, because he has applied the conception of a uniform, natural order just as comprehensively to the world of economics; an ordering that functions on the basis of a natural law and, if left to its own functioning, will be beneficial to humankind" (Viner, 1956:92).

Against the argument of Paley about the good design and the harmony of ecosystems, assumed to illustrate God's existence and benevolence, Darwin reverted to the quasi-Hobbesian atomistic view of struggle, supported by his discovery of Malthus in 1838, according to which this simply follows from natural causes operative amongst struggling individuals. As Gould explains Darwin's view: "But his interpretations could not have been more askew – for these features do not arise as direct products of divine benevolence, but only as epiphenomena of an opposite process both in level of action and intent of outcome: individuals struggling for themselves alone" (Gould, 2002:124).

In following the analysis of the physicist and historian of science, Silvan S. Scheber, Gould advances the following strong claim: "In fact, I would advance the even stronger claim that the theory of natural selection is, in essence, Adam Smith's economics transferred to nature" (Gould, 2002:122).

> Analogous to the thought of Leibniz, with the inherent tension between the discrete monads and the law of continuity, also Darwin had to cling to both elements: the overall dominance of the continuity postulate in his thought and his simultaneous emphasis on a struggle between individual living entities: "First, and foremost, we grasp the theoretical centrality of Darwin's conclusion that natural selection works through a struggle among *individual organisms* for reproductive success" (Gould, 2002:125).

Of course the problem of discreteness, in an equally fundamental sense, relates to the "bio-diversity" presently found and accounted for in the "Natural System", as well as to the discontinuous appearance of fossils, as noted above.

These two problems are explicitly mentioned in a recent work on evolution. Coyne refers to *discrete clusters* of living entities known as *species*: "And at first sight, their existence looks like a problem for evolutionary theory. Evolution is, after all, a continuous process, so how can it produce groups of animals and plants that are discrete and discontinuous, separated from others by gaps in appearance and behavior?" (Coyne, 2009:184). Coyne designates a discrete cluster of sexually reproducing organisms as a species, and continues on the same page by saying that the discontinuities of nature are "not arbitrary, but an objective fact" (Coyne, 2009:184).

In other words, while Darwin advanced a typical *nominalistic* view in respect of living entities (see Strauss, 2009:25, 226), Coyne reverts to a *realistic* idea of entities (currently!) living. This view approximates the idealistic orientation of Wilhelm Troll, who believes that it is not descent that decides over morphology, but the other way around.[13]

The acknowledgment of discreteness is irreconcilable with the notion of evolutionary continuity – unless one subscribes to the intrinsically antinomic stance of emergence evolutionism. The latter idea fits the spirit of the irrationalistic leg of nominalism, rejecting any structural or typical feature belonging to "reality out there". However, faithful to the inherent inconsistency of nominalism (being rationalistic and irrationalistic at the same time), Coyne, at once, acknowledges that species have "an objective reality and are not simply arbitrary human constructs" (Coyne, 2009:186). From what is asserted on the previous page, it is clear that in the thought of Coyne primacy is given to the irrationalistic side of nominalism, because it is the continuous process of

13 "Es ist nicht die Deszendenz welche in der Morphologie entscheidet, sondern umgekehrt: die Morphologie hat über die Möglichkeit der Deszendenz zu entscheiden" (see Zimmermann, 1968:19).

evolution that produces *discrete* groups: "For years after publication of *The origin,* biologists struggled, and failed, to explain how a continuous process of evolution produces the discrete groups known as species" (Coyne, 2009:186).

However, without being an adherent of the view of an idealist morphology, it is still possible to give primacy to the natural system, that is to *discreteness*. After the Neo-Darwinian "New Synthesis" was well established, Portmann, who wrote a standard textbook on the comparative morphology of the vertebrates (see Portmann, 1969) maintains: "Many biologists practically never any longer contemplate the fact that systematics forms the foundation of the entire theory of descent, that it is what is certain, that what we know, while the theories of evolution are what we conjecture" (Portmann, 1965:10).[14]

Moreover, both in the thought of Darwin and Coyne the ultimate primacy is given to the continuity postulate of the science ideal. Coyne holds that evolution is a continuous process while Darwin assigned to his gradualism (continuity postulate) even a more central role than natural selection. Gould clearly saw this:

> … gradualism stood prior to natural selection in the core of his beliefs about the nature of things. Natural selection exemplified gradualism, not vice versa – and the various forms of gradualism converged to a single, coordinated view of life that extended its compass far beyond natural selection and even evolution itself (Gould, 2002:154-155).

Gould stumbled upon what Dooyeweerd designated as die *continuity postulate* of modern Humanism, which represents just the one pole of the modern humanistic ground-motive of nature and freedom. It is clear that the primacy assigned to this nature pole in Darwin's thought, directed his *core scientific belief* that there simply must have been an incremental (infinitesimal) continuous development stretched over a very long period of time.

5. Conclusion

Darwin proceeded from the ultimate commitment of the modern humanistic science ideal with its inherent aprioristic continuity postulate, leveling all boundaries between distinct creatures. Gould did realize the deeply rooted and all-pervasive impact of this motive in the thought of Darwin and its effects upon Neo-Darwinism. This postulate burdened the practice of paleontology severely and at the same time demonstrates that theoretical thought cannot escape from a

14 "Gar mancher Biologe denkt kaum mehr daran, dass die Systematik die Grundlage der ganzen Abstammungslehre ist, dass sie das Sichere ist, das, was wir wissen, während die Entwicklungstheorien das sind, was wir vermuten."

foundational theoretical view of reality. In a follow-up article this issue will be explored further.

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