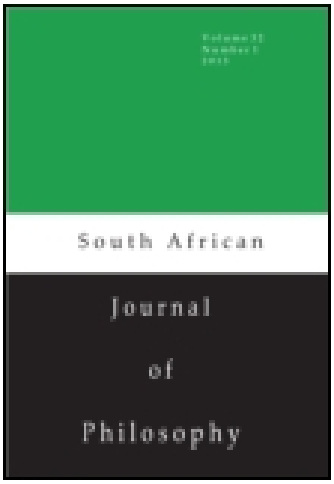


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# Factual states of affairs - uniting diverging philosophical orientations and setting them apart: illuminating the impact of a non-reductionist ontology

Daniël F.M. Strauss[a]
[a] School of Philosophy, North-West University, Potchefstroom Campus, Potchefstroom, South Africa
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# Factual *states of affairs* – uniting diverging philosophical orientations and setting them apart: illuminating the impact of a non-reductionist ontology[1]

**Daniël F.M. Strauss**
School of Philosophy, North-West University, Potchefstroom Campus, Potchefstroom, South Africa
dfms@cknet.co.za



'Facts have no independent existence in science, or in any human endeavor; theories grant differing weights, values, and descriptions, even to the most empirical and undeniable of observations' (Gould 2002: p. 759).

All academic disciplines have access to undeniable states of affairs that require meaningful and constructive accounts of them. Oftentimes such an account reflect diverging theoretical views of reality. Wittgenstein's view 'that only connexions that are *subject to law* are *thinkable*' paves the way for a discussion of the state of affairs that theoretical thinking is characterised by a 'special abstraction', namely 'aspect-abstraction' resulting in 'aspect-disciplines'. As an example of diverging ontological commitments Cantor's famous diagonal proof of the non-denumerability of the real numbers is briefly discussed. Another example is given by means of a brief analysis of the wave-particle duality, focused on distinguishing different modes of explanation, designated as *representations*. Occam's razor (the principle of thought-economy) provides a further example of a state of affairs shared by different philosophical orientations, albeit that some ascribe a purely *logical* nature to it while someone else may discern in it an analogical link between the logical-analytical aspect and the economic aspects of ontic reality. The problem of persistence and change and the state of affairs that change can only be detected on the basis of constancy permeated the history of philosophy and the various academic disciplines, including the discipline of paleontology. The dominant pattern of the paleontological record, namely *stasis*, poses empirical and theoretical limits to the definition of evolution as 'continuous change'. Apart from showing that special science (aspect-disciplines) always operate on the basis of philosophical assumptions, the underlying aim is to advance a non-reductionist approach to undeniable states of affairs.

## From substance to law-conformative connections

One of the remarkable features of Wittgenstein's famous *Tractatus Logico-Philosophicus* [TLP] is that it commences with *what is the case* but considers this to be different from *things*. 'What is the case – a fact – is the existence of states of affairs' (TLP 2). Yet it is immediately added that a state of affairs is a combination of entities, things [*Sachen*, *Dingen*] (TLP 2.01). Nonetheless, Witgenstein holds that only law-conformative (*gesetzmäßige*) connections are *thinkable* (TLP 6.361). This view reveals the underlying shift from the Greek–Medieval emphasis on entities ('substances') to the modern preference for relations between entities, i.e. for concepts of function. At the same time it shows that Wittgenstein combined it with the distinction between law and

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subject. The English version of the *Tractatus* translates the German sentence as follows: 'that only connexions that are *subject to law* are *thinkable*'.

The state of affairs emerging from these remarks by Wittgenstein points at the distinction between *entities* and their *attributes*, closely connected to the difference between what is universal and individual, traditionally accounted for in terms of what is known as *realism* and *nominalism*. Contemporary authors on metaphysics discuss in this connection ordinary things ('concrete particulars'), such as 'individual persons, animals, plants, and inanimate material objects' – see Loux 2002: p. 97). It is done in terms of opposing views of 'substratum theories' and 'bundle theories'.

**Theoretical thinking – defined by a 'special abstraction'?**

Leaving these issues for the moment aside, we may commence our discussion of the uniting and separating effects of certain states of affairs by looking at the problem regarding the distinctive feature(s) of the scholarly enterprise.

During the rise and development of logical positivism there was a search for criteria characteristic of scholarly thinking. Moritz Schlick, in the second impression of his work, *Allgemeinen Erkenntnislehre* ('A General Theory of Knowledge'), searched for a criterion regarding the truth of scientific propositions, which he found in the principle of verification, for according to him the sole way to establishing truth is through verification (Schlick 1925: p. 151).

In his famous article on *The Turning Point in Philosophy* ('*Die Wende der Philosophie*'), published in the newly established journal *Erkenntnis* (1930–1931), Schlick introduced the notion of *meaning*: 'Every science … is a system of cognitions, that is, of true experiential statements. … philosophy is that activity through which the meaning of statements is revealed or determined. By means of philosophy statements are explained, by means of science they are verified' (Schlick 1959: p. 56).

In the subsequent developments alternative views on the nature of scholarly thinking and on the relationship between philosophy and the various academic disciplines were advanced. Berger, for example, holds that a particular kind of *abstraction* enables the sociologist to find a certain *aspect* present in all human activities:

> The sociologist finds his subject matter present in all human activities, but not all aspects of those activities constitute this subject matter. Social interaction is not some specialized sector of what men do with each other. It is rather a certain aspect of all these doings. Another way of putting this is by saying that the sociologist carries a special sort of abstraction (Berger 1982: pp. 39–40).

In a similar fashion Diemer explores the multi-aspectual nature of the 'objects' of our everyday life, using a coin as an example: such a coin (*Münze*) can be something physical-chemical, historical, aesthetic, a means of payment and eventually even a cultic object. He relates the many-sidedness of a coin with possible scholarly angles of approach by speaking of an 'aspect discipline' (*Aspektediziplin* – see Diemer 1970: p. 219).

Those who may agree that scientific disciplines 'carry a special kind of abstraction' may still differ about the status of this abstraction. Does the abstracted aspect belong to ontic reality or is it merely a view-point inherent to the cognitive capacities of the thinking subject (compare the categories of human understanding in the thought of Immanuel Kant)? So even if there may be agreement as to the nature of *aspectual abstraction* as a defining feature of theoretical thinking, this very agreement may still harbour underlying differences, ultimately determined by alternative views of reality. Since the aspects of reality could also be seen as modes of being and modes of explanation, the distinctive feature of scholarly thinking, *aspectual abstraction*, could also be designated as *modal abstraction*.

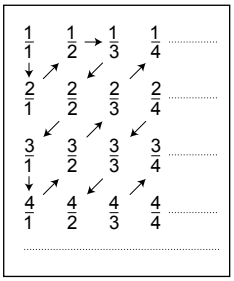
If a special science explores as an angle of approach to reality one specific aspect or mode of being, then special sciences inevitably operate on the basis of a foundational theoretical view of the unity and diversity of functional modes. The various disciplines therefore presuppose these ontic modes, such as the aspects of number, space, movement, the physical, the biotical, sensitive-psychical, logical-analytical, cultural-historical, the lingual, social, economic, aesthetic, jural,

moral and certitudinal. Subsequently, we intend to argue that only a non-reductionist ontology can meaningfully account for the uniqueness of and coherence between the various aspects of reality.

Instances of apparently undeniable states of affairs will not only elucidate alternative interpretations, but also highlight the significance of underlying ontological commitments.

**(Non-)Denumerability**[2]

Meschkowski considers the famous diagonal proof of the non-denumerability of the real numbers by Cantor (in 1874) as the moment of birth of modern mathematics. When the elements of a set can be correlated one-to-one with the natural numbers [0, 1, 2, 3, ...] then it is called *denumerable* (*countable*). Clearly, the fractions are countable because one can correlate 1 with 1/1, 2 with 2/1, 3 with 1/2, 4 with 1/3, and so on.




In the case of the real numbers the closed interval [0,1] (i.e. $0 \leq x_n \leq 1$) may represent all the real numbers because they can be correlated one-to-one with all the real numbers.

In his diagonal proof Cantor assumes that there is an enumeration $x_1$, $x_2$ $x_3$, ... of real numbers satifying $0 \leq x \leq 1$ given by

$$x_1 = 0.\ a_1, a_2, a_3 \ldots$$
$$x_2 = 0.\ b_1, b_2, b_3 \ldots$$
$$x_3 = 0.\ c_1, c_2, c_3 \ldots$$

Cantor now considers another real number – $y$ – such that $y_1$ is different from $a_1$; $y_2$ from $b_2$; $y_3$ from $c_3$ and so on. This number $y$ belongs to the closed interval [0,1] because $0 \leq y \leq 1$.

Yet it differs from every $x_n$ in a least one decimal position, from which Cantor concludes that every attempt to enumerate the real numbers within this interval will leave out at least one real number – and that therefore they are *uncountable* or non-*denumerable*. However, what should be realised is that the entire proof rests upon the assumption of an infinite *totality* that contains all its elements *at once*.

The problem is that intuitionistic mathematics only accepts the *successive* (potential) infinite. In rejecting the *at once* (actual) infinite, assumed in Cantor's demonstration, an intuitionistic understanding of this proof does not yield non-denumerability. Consequently, this apparent undeniable state of affairs suddenly turns out to be dependent on a particular understanding of infinity. Although intuitionism accepts this proof, it does so in a *constructivist* way that accepts the potential (successive) infinite and rejects the actual (at once) infinite. However, no constructive transition from the potential infinite to the actual infinite is possible (see Fraenkel 1928: p. 239 note 1; Heyting 1971: p. 40; Fraenkel et al. 1973: p. 256, 272). In the absence of the idea of an infinite totality Cantor's diagonal proof merely affirms that for a given sequence of successively infinite sequences of numbers it will always be possible to find another sequence of numbers differing from the given sequence of successively infinite sequences of numbers at least in one decimal place. In this interpretation non-denumerability nowhere surfaces!

2 For a more extensive analysis of non-denumerability within a different context, see Strauss (2011).

From the perspective of a non-reductionist ontology this situation is not contradictory. The mentioned two kinds of infinity merely reflect the inter-modal connection between number and space as ontic modes of being. The most basic and primitive meaning of infinity is given in the successive infinite: one, another one, and so on endlessly, infinitely. Only when this primitive meaning of infinity is *deepened* by being directed towards the two key elements safe-guarding the uniqueness of the spatial aspect, namely spatial *simultaneity* (at once) and the spatial *whole-parts relation*, is it possible to employ the idea of the at once infinite. The status of Cantor's diagonal proof is not contradictory. An undisclosed, not-yet-deepened use of the infinite does not yield non-denumerability. The latter is only accomplished when the at once infinite is assumed.

Those who may think that the differences between diverse mathematical schools of thought are not serious may contemplate what Brouwer says where he highlights the underlying differences between intuitionism and formalism. He states 'that classical analysis … has less mathematical truth than intuitionistic analysis' (Brouwer 1964: p. 78) and then proceeds:

> In many respects it [intuitionistic mathematics] deviates from classical mathematics. … As a matter of course also the languages of the two mathematical schools diverge. And even in those mathematical theories which are covered by a neutral language, i.e. by a language understandable on both sides, either school operates with mathematical entities not recognized by the other one: there are intuitionist structures which cannot be fitted into any classical logical frame, and there are classical arguments not applying to any introspective image. Likewise, in the theories mentioned, mathematical entities recognized by both parties on each side are found satisfying theorems which for the other school are either false, or senseless, or even in a way contradictory. In particular, theorems holding in intuitionism, but not in classical mathematics, often originate from the circumstance that for mathematical entities belonging to a certain species, the possession of a certain property imposes a special character on their way of development from the basic intuition, and that from this special character of their way of development from the basic intuition, properties ensue which for classical mathematics are false. A striking example is the intuitionist theorem that a full function of the unity continuum, i.e. a function assigning a real number to every non-negative real number not exceeding unity, is necessarily uniformly continuous (Brouwer 1964: pp. 78–79).

What appears to be uniting mathematicians – Cantor's diagonal proof – therefore at the same time sets them apart. Yet, a non-contradictory perspective on the two kinds of infinity, based upon a non-reductionist ontology, explains why a view on the inter-modal coherence between number and space entails both a restricted (undisclosed) and deepened understanding of Cantor's proof: assuming the successive infinite entails denumerability and assuming the at once infinite entails non-denumerability. John Bell recently points out that for Brouwer 'continuity and discreteness' are 'complementary notions, neither of which is reducible to each other' (Bell 2006: p. 217).

Of course a non-reductionist ontology should be able also to account for the way in which concretely existing entities function in different *modes of being*. Considering the role of waves and particles in quantum physics will explain this point.

**The wave-particle duality**

Through his principle of uncertainty Werner Heisenberg has shown that measuring the impulse and position of an electron at the same time is impossible. According to the Copenhagen interpretation of quantum physics the notion of *complementarity* should be applied to this situation. Its aim is to leave room for two irreducible – and complementary – *modes of explanation*, namely a spatial designation ('place') and a kinematic description ('impulse'), respectively. Yet, the state of affairs that physical entities could be described either as particles or as waves appears to be undeniable.

Surely, this is not the end of the story, because sometimes this distinction is turned into a *dualism*, as if we have two types of entities, the one kind is *particle-like* and the other *wave-like*. Does this mean that we have to apply a *substratum* theory and a *bundle* theory at once? If the

answer is affirmative, will it then still be possible to account for the entitary unity of what is at stake? Alternatively, does an acknowledgement of the typical *totality structure* of an entity allow for a *unitary interpretation of wave and particle*?

When Einstein reintroduced a particle theory regarding the nature of light it turned out that it is always possible to ascribe a wave-character to elementary particles. On the other hand, the Compton-effect – regarding the interaction of a photon and an electron – provided evidence in support of distinct particles. De Broglie broadened this perspective by showing that one can associate a wave with every moving particle (cf. Eisberg 1962: p. 81, 151). Although it turned out to be impossible to establish experimentally at the same time both the particle and the wave nature, Bohr claims that these two perspectives are complementary (cf. Bohr 1966: p. 20 ff., 50 ff. – see also Stafleu 2002: p. 96 ff., 101 ff.).

In the light of the generalisation provided by De Broglie one may ask: if it is possible to describe or explain entities characterised by energy in terms of *two mutually exclusive experimental perspectives*, namely as *particles* and as *waves*, is it then still meaningful to speak about their unitary structure? At this point a special scientific description reaches its limits and needs to take recourse to a perspective transcending the confines of special scientific inquiry.

What is needed here is a non-reductionist philosophical view exceeding the mere combination of one or more (aspectually delimited) special scientific viewpoints. The idea of the unity and identity of an entity does not follow from adding up its various modes or functions within reality, because this underlying unity is presupposed in the many-sided functioning of an entity. Strictly speaking this idea of an entity in its totality – preceding an analysis exploring its modes of explanation – therefore refers to an individual whole embedded in the inter-functional and inter-structural coherence of reality. One implication of this insight is that concepts such as *particle*, *field*, and *wave* are not *type concepts* (entitary concepts) but (modal) *functional concepts*. They may also be designated as *elementary basic concepts* of physics. Consequently, the terms *particle* and *wave* reflect backward-pointing moments of coherence within the structure of the kinematical aspect, namely *movement multiplicity* (numerical analogy) and *movement extension* (spatial analogy).

Since number, space and movement remain irreducible functional aspects of reality regardless of the nature and type of entities functioning within them, it is also from this perspective understandable why the functionally distinct concepts *particle* and *wave* cannot be reduced to each other – a *state of affairs* supported by experimental data (see also von Weizsäcker 2002: pp. 315–320). As noted, irreducible aspectual perspectives indeed also serve as modes of scientific explanation.

Although they are not acquainted with an ontology distinguishing many-sided functioning entities, Born, Pyrmont and Biem are justified in rejecting the suggestion that here we struggle with a *dualism*. According to them it increasingly becomes clear that 'nature could neither be described by particles alone, nor solely through waves'. They hold that a proper understanding cannot switch between a 'particle image [*Teilchenbild*]' and a 'wave image [*Wellenbild*]'. This leads to a *unitary view* of physical systems. What we have called *modes of explanation* these authors designate as *representations* '*Darstellungen*' – and they specifically mention three distinct (but simultaneously present) modes of explanation: an '*Ortsdarstellung*' (spatial representation: position), a '*Wellendarstellung*' (impulses or velocities – kinematic explanation) and an '*Energiedarstellung*' (the physical mode of explanation) (Born et al. 1967–1968: pp. 416–417).

Once again, the interpretation of this state of affairs, namely that physical entities display a particle and wave character at once, is found on the level of the underlying ontologocial distinctions.

We now shift our attention to an example from the humanities.

**Occam's razor**

What is known as the principle of *the economy of thought* has played an important role in the history of philosophy. Particularly William of Occam objected to an unnecessary duplication of entities (what he had in mind is knowledge acquisition through mental copies of external objects). The rules should rather not multiply entities beyond what is strictly necessary (*entia praeter necessitatem non esse multiplicanda*). Much later, Hamilton designated this principle as the *law of parsimony* by

calling it Occam's razor (see Hamilton 1852: p. 590; see also Hamilton 1866: Appendix 1; Cloeren 1984: pp. 1094–1095). Yet even before Hamilton, Immanuel Kant already employed the phrase '*lex parsinomiae*' in his discussion of the formal teleology of nature: 'nature takes the shortest route' ('*Die Natur nimmt den kurzesten Weg*' – Kant 1790: p. XXIX, 1793: p. XXXI).

Acknowledging the state of affairs captured in this principle of *thought-economy* (*logical economy*) unites logicians and epistemologists. But accounting for its status sets scholars apart. Is it purely logical in nature or does it reveal something *ontic*? John Stuart Mill, for example, criticises Hamilton's view that this principle is 'ontological' (see Mill 1865: pp. 238–240). Hugo Dingler agrees with Mill that the principle of thought-economy is purely logical (Dingler 1967: p. 228). The characterisation of this principle as the principle of thought-economy derives from Ernst Mach (see König 1972: pp. 108–109).

On the basis of his theory of modal spheres and their interconnections, Herman Dooyeweerd distinguishes between backward-pointing and forward-pointing analogies, respectively, also designated as retrocipations and anticipations. This theory discerns an *ontic order* of succession between the various aspects and this order determines which analogies are retrocipatory and which are anticipatory in nature. Since the contrary logical–illogical is foundational to the meaning of the economic aspect, the principle of thought-economy represents an anticipatory analogy of the economic aspect within the structure of the logical-analytical aspect of reality. The economic anticipation within the sign mode is identified as 'linguistic economy', which is similar to the principle of 'cultural economy' (see Dooyeweerd 1997: p. 66, 286).

Occam's razor is appreciated across the boundaries of different philosophical traditions because it highlights an *undeniable state of affairs*. Nonetheless, as soon as philosophers engage in explicating what this principle means their account is coloured by their own ontological views. It appears that a non-reductionist ontology clearly explicates the uniqueness and inter-modal connections between the economic aspect of reality and various other aspects.

We now look at one of the perennial issues of philosophy and all the academic disciplines, namely the intricate links between what endures and what changes and conclude by contemplating some problems that surfaced in this context for the data of paleontology.

**What is enduring and what changes**

During the Enlightenment universal reason reigned the day, but this dominating position was soon challenged by the rise of historicism at the beginning of the nineteenth century. The relativism involved in historicist claims that everything is subject to change caused the search for a new horizon, which, during the twentieth century, was found in the dimension of language as a new universal (Heidegger). This eventually resulted in the postmodern belief that everything is *interpretation*.

It does not mean, however, that we do not still experience the after-effect of historicism, because in all disciplines we are constantly confronted with the demand to be 'up-to-date', i.e. to be properly informed about what is considered to be the *current state of affairs*. Are these *states of affairs something static*? *Are they not themselves taken up in the on-going process of historical flow*? *Or is the only detectable change found in our altering interpretations of particular states of affairs*? These questions touch upon the problem of continuity and change, which is always related to our understanding of any particular state of affairs.

After De Saussure contemplated the mutability and immutability of the sign, he rephrases his stance in such a way that justice is done to the undeniable state of affairs that change presupposes constancy. He writes: 'In the last analysis, the two facts are interdependent: the sign is exposed to alteration because it perpetuates itself. What predominates in all change is the persistence of the old substance; disregard for the past is only relative. *That is why the principle of change is based on the principle of continuity* (my emphasis in italics; see De Saussure 1966: p. 74). Already Kant acknowledged *the law of the continuity of all change* (Kant 1787–B, p. 254) ['*das Gesetz der Kontinuïtät aller Veränderung*'].

Saying that 'the principle of change is based on the principle of continuity' is exactly what we have in mind with the statement that change can only be detected on the basis of something

lasting, i.e. on the basis of constancy (continuity). Although Plato discovered that change presupposes an element of persistence or endurance, we are today not inclined to follow his solution, found in assuming eternal, supra-sensory, static, ontic forms. Yet both Gallileo (inertia) and Einstein (the vacuum-velocity of light) accept Plato's insight that change presupposes constancy. The lasting influence of Plato is also seen in what ought to be the proper formulation of the first law of thermodynamics, *energy constancy*. It represents a retrocipation from the physical to the kinematic aspect.

The undeniable state of affairs that change presupposes constancy indeed permeates every academic discipline as well as all areas of life, including the world of advertising. *First National Bank* once had a double full-page advertisement where the one page highlights all the elements of uncertainty and change in life while the other page informs the reader that amidst all these changes the reliability of this financial institution never changes, it remains the same. More recently an advertisement asked: 'When was the last time that you have done something for the first time?'

Throughout the intellectual history of the West, thinkers wrestled with the issue of constancy and dynamics, both within the field of philosophy and within the various academic disciplines (the natural sciences and the humanities).



**Continuity and discontinuity: paleontology**

Although most Darwinian and neo-Darwinian biologists share the *gradualist* expectation of Darwin, namely that *nature does not make jumps* (*natura non facit saltum*), paleontologists all the time have known that the fossil record tells a different story. Comparing the ideas of the two prominent paleontologists of the twentieth century may be quite instructive. G.G. Simpson accepts phylogenetics as the basic discipline of biology. O.H. Schindewolf, by contrast, opposes this idea.

***Simpson and Schindewolf***

Interestingly they do not differ about the factual state of affairs. The *Archaeopteryx* is a case in point: it was discovered in 1861 with reptilian and avian hall-marks. Simpson and Schindewolf largely concur regarding the factual information, but they proceed from radically divergent theoretical points of departure. Marjorie Grene neatly characterises Simpson's approach: 'Simpson says *Archaeopteryx* was a species like any other, originating by normal speciation from other reptilian species; only when we look back over the whole vista of evolution do we say, this particular species was the first of what turned out to be a new class' (Grene 1974: p. 130). According to Schindewolf *Archaeopteryx* represents the new class of *Aves* (birds). His view is embedded in his *typostrophism*, a theory which accounts for paleontological trends. It commences with the appearance of the more general systematic category within which all differentiation and specialisation then take place. His assumption is a discontinuous macro-mutation – nature is capable of bringing forth genuinely new types. After an initial phase of *typogenesis* a period of steady differentiation and transformation takes place, leading to a directed (orthogenetic) development of the particular structural type: the phase of *typostasis* (the flourishing of the type). Finally, a period of degeneration and eventual extinction sets in – designated as *typolysis* (analogous to the cell organelle known as *lysosomes*, which actively participate in the decomposition of a dying organism) (see Schindewolf 1993: p. 255 ff.).

Grene notes that Simpson and Schindewolf charge each other of similar mistakes. She shows that negating the premise of the one serves as the conclusion of the other – while hardly if at all differing about the states of affairs: 'Simpson, wedding paleontology to the statistical methods of population genetics, sees a gradual change in populations such that the sharp divisions of traditional morphology become false. Schindewolf, basing his theory on the logical priority of morphology, concludes that gradualist, statistical picture of neo-Darwinism is false. To put it very schematically, Simpson argues: the neo-Darwinian theory is true; morphology implies that neo-Darwinism is not true; therefore morphology is wrong. Schindewolf argues: morphology must first be accepted as true; morphology implies that the neo-Darwinian theory is wrong; therefore the neo-Darwinian theory is mistaken. Or to put the matter another way, they agree on the major premise: traditional morphology and neo-Darwinism are incompatible' (Grene 1974: p. 132).

What leads to a conflicting understanding of the paleontological record is found in the underlying philosophical views on continuity and discontinuity. Schindewolf articulates the dilemma as follows: 'Meanwhile we shall remain with the question that has occupied us up to this point: gradual, continuous refashioning of species or abrupt, discontinuous transformation of types' (Schindewolf 1993: p. 255). Earlier in this work he explains the 'absence of gradual transitions' as follows: 'The material we study in paleontology has led us to the realization that, contrary to the classic theory of evolutionary descent, the individual types of structural designs are not smoothly connected by a long chain of transitional forms linked by small transitional steps, that the features peculiar to them are not smoothly bridged, but that they appear in contrast with one another, set apart by large discontinuities' (Schindewolf 1993: p. 168).

This situation caused Eldredge to remark: 'No wonder paleontologists shied away from evolution for so long. It never seemed to happen. Assiduous collecting up cliff faces yields zigzags, minor oscillations, and the very occasional slight accumulation of change over millions of years, at a rate too slow to account for all the prodigious change that has occurred in evolutionary history. When we do see the introduction of evolutionary novelty, it usually shows up with a bang, and often with no firm evidence that the fossils did not evolve elsewhere! Evolution cannot forever be going on somewhere else. Yet that's how the fossil record has struck many a forlorn paleontologist looking to learn something about evolution' (Eldredge 1995: p. 95).



***Gradualism and stasis***

Nevertheless, mainstream neo-Darwinism did not come to terms with these discontinuities and as a result has attempted to avoid them by introducing the idea of the 'imperfection' of the fossil record. Gould points out that 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: p. 179 ff.). By contrast, as Gould and Eldredge emphasise, the fossil evidence rather portrays the picture of what they designate as *stasis*. A type appears, remains constant over millions of years and then disappears. In spite of this dominant pattern of the fossil record, the continuity postulate of gradualism has seen in *stasis* 'just another failure to document evolution . . . Stasis existed in overwhelming abundance, as every paleontologist always knew' (Gould 2002: p. 759). Gould honestly states: 'But this primary signal of the fossil record, defined as an absence of data for evolution, only highlighted our frustration – and certainly did not represent anything worth publishing. Paleontology therefore fell into a literally absurd vicious circle. No one ventured to document or quantify – indeed, hardly anyone even bothered to mention or publish at all – the most common pattern in the fossil record: the stasis of most morphospecies throughout their geological duration' (Gould 2002: pp. 759–760). In 1999 Niles Eldredge affirms this assessment: 'Traditionally seen as an artifact of a poor record, as the inability of paleontologists to find what evolutionary biologists going back to Darwin had told them must be there, stasis was, as Stephen Jay Gould put it, "paleontology's trade secret" – an embarrassing one at that' (Eldredge 1999: p. 21).

Gould understood Darwin's commitment to the modern (philosophical) continuity postulate, which in fact overrides the role of natural selection: 'We often fail to recognize how much of the Origin presents an exposition of gradualism, rather than a defense of natural selection' (Gould 2002: p. 151). And: '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: p. 122). Perhaps his most significant remark in this regard is given in his realisation that the widespread and generally defended neo-Darwinian basic definition of evolution is problematic. 'These stories begin from the same foundational fallacy and then proceed in an identical erroneous way. They start with the most dangerous of mental traps: a hidden assumption, depicted as self-evident, if recognized at all – namely, a basic definition of evolution as continuous flux' (Gould 2002: p. 913).

From our brief remarks we may conclude that sometimes there is a blind spot for an undeniable self-evident state of affairs – such as in the case of the dominant pattern of stasis that prompted

Gould and Eldredge to recommend to biologists saying 'a mantra ten times before breakfast': 'stasis is data, stasis is data . . .' (Gould 2002: p. 759). This shows that the underlying ontological commitment to the continuity postulate of modern philosophy, dating back to Leibniz's *lex continui*, may overrule the dominant state of affairs.

***The mystery of the Cambrian explosion***

Of course it may also happen that newly emerging data (states of affairs) challenge pre-existing expectations. The recent intensification of the discussion of the fossils of the Cambrian explosion is a good example. Although in his excavations at the Burgess shale in Canada, Charles Walcott collected more than 65 000 fossil specimens by 1917, it was only when later specialists, such as Gould and Whittington, re-examined the fossils that it became clear that Walcott's attempt to squeeze the Cambrian forms into a restricted number of taxonomic groups was unsuccessful.

What has been called the *mystery* of the Cambrian explosion is that multiple forms belonging to higher systematic categories (phyla, subphyla and classes – disparity) appeared first (the initial time scale of 30 million years is now reduced to about 6 million years), subsequently followed by variation within these categories (diversity of genera or species). The top-to-bottom pattern is the opposite of what (neo-)Darwinism would expect with its bottom-to-top approach, according to which diversity (continuity) would precede disparity (discontinuity). The Burgess shale fossils do not commence with more and more species 'eventually leading to more genera, leading to more families, orders, classes and phyla' but rather 'shows representatives of separate phyla appearing first followed by lower-level diversification on those basic themes' (Meyer, 2013: p. 41). A remark by Lewin in *Science* concisely captures this state of affairs: 'Several possible patterns exist for the establishment of higher taxa, the two most obvious of which are the bottom-up and top-down approaches. In the first evolutionary novelties emerge, bit by bit. The Cambrian explosion appears to conform to the second pattern, the top-down effect' (Lewin 1988: p. 292) – and it also approximates Schindewolf's theory of typostrophism.

This appears to be an instance where it is not merely a matter of alternative views or interpretations, but rather a situation where the actual state of affairs *rules out* the incremental (gradualist) conception. It may also explain why the said mystery caused Erwin and Davidson to state that the origin of *de novo* body plans present in the Cambrian explosion is not explained by any current theory of evolution. They concede that these novel body plans do not have any 'parallel to currently observed biological processes' because they insist that the events of the past were fundamentally different. Meyer summarises this succinctly: 'the cause responsible for generating the new animal forms, whatever it was, must have been unlike any observed biological process operating in actual living populations today' (Meyer 2013: p. 356).

The disparity of phyla, subphyla and classes here represents the element of constancy, underlying the diversity of genera or species (change).

**Concluding remark**

States of affairs are unavoidable and necessary for philosophical and special scientific thinking, but our analysis of various kinds of states of affairs shows that it is not *sufficient*. Our human cognitive faculties are not a *tabula rasa* because establishing states of affairs is always co-determined by and embedded in underlying ontological views. It is on this level that theoretical endeavours have to engage in scholarly debate. The view advanced in this article is that a non-reductionist ontology entails a fruitful alternative option. On the level of the basic modes of being – such as the numerical, spatial, kinematic, physical, logical-analytical, cultural-historical and economical – this option entails an acknowledgement both of the uniqueness of these modalities (aspects) and of their unbreakable mutual coherence. Moreover, it liberates us from the one-sidedness present in all *monistic isms*, such as arithmeticism, physicalism, logicism, historicism, legalism and moralism. The untenability of such *isms* is a direct consequence of the fact that monistic isms always harbour theoretical antinomies. In other words, such antinomies result from confusing irreducible modal aspects – therefore they are *inter-modal* in nature. Logical contradictions, by contrast, are merely intra-modal. Confusing a square and a

circle gives rise to something illogical, a *square circle*. It concerns figures appearing within one aspect, that of space. But confusing movement and space results in a slash of the laws of motion and those of space, which shows that an antinomy (*anti* = against; and *nomos* = law) is inter-modal in nature (just compare Zeno's paradoxes, which attempted to reduce movement to static pace.)

Exploring the implications of a non-reductionist ontology in more detail exceeds the scope of this article (but compare Strauss [2012] for a more encompassing explanation).

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