

# A Nature of Variations Making Evolution Possible

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## Abstract

An externalist discourse on evolutionary process proceeding through selective retention of slightly modified heritable traits requires a generator of variations to be subjected to natural selection. This externalist classification takes the generation of variations to be totally independent of the subsequent selective processes. Prior variations are functionally symmetric in keeping the cause and the effect of the variations mutually interchangeable, otherwise they would be temporally asymmetric and evolutionary by themselves. The operation of natural selection that makes those symmetric variations temporally asymmetric in the effect is upon the accumulation of the preceding variations of similar nature. Natural selection viewed from the externalist perspective refers to a functional characteristic pertaining to the accumulated variations. Natural selection as a consequence of the accumulated variations is grounded upon the very accumulation process. Further elucidation of the accumulation process can be made by switching to the internalist stance.

What is unique to the internalist stance is to make both the operations of generating variations and natural selection inseparable. Variations are generated in the process of identifying the variations already made. The generation is in and of itself selective since the variations that could occur at whatever internal observers depend upon how the preceding variations could come to be observed and identified by the observers in the absence of the global perspective. The variations thus perceived can be embodied in the form of suppliers and consumers of resources of evolutionary significance. The internal observers functioning as either suppliers or consumers are both generative and selective. Natural selection can be seen as a consequence of the interplay among the internal observers aiming at necessary resources. The internalist stance grounds itself upon observation and measurement proceeding internally on material basis. Variations resulting in natural selection are a demonstration of the internalist stance *par excellence*.

Evolution is a mode of natural dynamics, in which many participants interact with each other. In particular, any dynamics can identify itself by explicating how it addresses itself to the following two questions. (1) How does each participant come to detect others? (2) How does each move with and act upon others? The Galilean-Newtonian mechanics concentrates on the second question on movement dynamics by dismissing the significance of the first question on detection dynamics only except for mentioning its role of identifying the initial conditions. Thermodynamics, on the other hand, emphasizes the role of detection dynamics as demonstrated in its second law stating that if the process of detection proceeds only locally as it should, movement dynamics would necessarily exhibit an irreversible enhancement of randomization. We note that any detection dynamics proceeding internally is local in the sense that complete identification of evolving systems in a globally simultaneous manner is not attainable. Detection dynamics of necessarily local character comes to imply that there is an inevitable time-delay between detecting others in the neighborhood and acting upon them accordingly. The time-delay between detection and action perceived by each participant, or in the eyes of the participants, serves as a causative factor of evolutionary dynamics of any type.

Most indicative of the time-delay between detection and action is heterotrophic activity, in the latter of which an arbitrary participant in an evolutionary process has the capacity of taking in necessary material resources as responding to detecting what its neighborhood looks like. Although it leaves behind only material flow continuity, heterotrophic activity as the capacity of wanting material resources for the sake of the continuity in the record is an agency connecting between detection and movement dynamics.

**Keywords:** Consumer, Internal Measurement, Natural Selection, Supplier, Variation

## 1. Introduction

Natural selection is about contingent and particular processes in evolution. This specification imparts upon natural selection a unique property that could not be found in general and universal phenomena. At the same time, the operation of natural selection is mechanistic in letting preceding stage influence its succeeding stage. Natural selection is thus seen mechanistic and particulate. This aspect makes a sharp contrast to the prevalent scheme accepting both being mechanistic and universal (Matsuno, 1996).

Mechanistic doctrine is unquestionably universal and synthetic as being grounded upon that the basic categories of space, time, causality and interaction are guaranteed *a priori*. When the present mechanistic doctrine is applied to natural selection, particulate aspects inherent in natural selection would have to be observed in other than space, time, causality and interaction. The source of contingencies and particulates would have to be sought in the periphery of causality and interaction, since both space and time conceived in the mechanistic doctrine have no periphery. That is boundary conditions. Needless to say, the boundary conditions would certainly furnish natural selection with contingencies and particulates. Neo-Darwinian natural selection just happens to be this case. Nonetheless, neo-Darwinian natural selection open only to exogenous contingencies is quite limited in coming up with various evolutionary novelties including the eyes of vertebrates.

Noting that evolutionary contingencies act upon what evolutionary processes have accomplished so far, one comes to see that the conditions making the four of space, time, causality and interaction to be the invariable basic categories would be too stringent even if natural selection operates mechanistically. Then, a question arises as to how to adjust or modify the mechanistic doctrine so as to be adapted to the operation of natural selection.

It is undoubtedly indisputable that natural selection operates in letting preceding stage influence its succeeding stage. This is, however, not about a universal characteristic but about each particular event or process. It does not necessarily refer to time as an *a priori* category, or a globally synchronous time, in specifying the mechanistic order of influencing. Even if time is taken to be local as in the form of locally asynchronous time, the mechanistic specification of the order of influencing can be maintained and be available to those organisms sharing one and the same local time. While it maintains a mechanistic backbone, natural selection in particulates proceeds in locally asynchronous time. This contrasts with natural selection as a class property conceived in a globally synchronous time, in the latter of which the genesis of contingent variations remains exogenous to the natural selection.

In contrast, natural selection in particulates is generative in itself in the process of precipitating a globally synchronous time pertaining to the finished record out of a locally asynchronous time in progress. For insofar as what evolutionary processes have accomplished so far is concerned, time read into the finished record is globally synchronous in that it leaves the global record, once finished, intact. Transference from locally asynchronous time in progress to globally synchronous time in the record is generative in passing the leftover

constantly forward. Natural selection in particulates is inseparable from the genesis of variations.

## 2. Evolution in Asynchronous Time

Evolutionary processes following the origin of life could be a significant material manifestation of the reflexivity between actions and reactions in locally asynchronous time (Matsuno, 1996). How the reflexivity develops, instead of its presence or absence, may be more emphasized (Depew and Weber, 1994). More specifically, the contrast between evolution in time and evolving time should be focused because the relational activity of locally asynchronous time yielding globally synchronous one in the record addresses that time could also evolve in evolutionary processes. The aspect that time is moved instead of moving others now provides evolutionary processes with a unique characteristic. Those global notions such as fitness and its landscape specified in globally synchronous time (Dawkins, 1978) should be taken to be derivatives from local dynamics proceeding in locally asynchronous time. Even natural selection would be no exception in referring to globally synchronous time when it is understood as a quality conferred upon a global context (Sober, 1984). At issue is how time can be moved.

What is significant to locally asynchronous time is the constant generation of a signal inducing the subsequent action while reacting to the preceding signal. Successive alternation between action and reaction through constantly generating the signal for action is in fact autocatalytic in the respect of generating the signals of a similar kind (Ulanowicz, 1996). Autocatalysis is actually a material embodiment of the transference of locally asynchronous time into globally synchronous one in that the skewed synchronism in the finished products constantly provides further signals for making the products of a similar kind (Matsuno, 1982; Kauffman, 1993). Material capacity of rendering preceding products to be a signal for subsequent production underlies autocatalysis. The present conglomeration of material production and signaling makes autocatalysis to be informational. Although contingent generation and communication of a signal and the determinate material production thereupon are simply incommensurable each other, it is information that serves as a mediator connecting contingency to determinacy. On the other hand, however, any signal for autocatalysis has made itself embodied in a material form. The material aspect of a signal now raises a question on how some material products could serve as a signal, but others do not (Salthe, 1993). *The underlying theme is the material context in which signals could be generated.*

Occurrence of a signal is antithetical to mechanistic dynamics in which every degree of freedom in motion can be specified and determinate at any moment. Insofar as the number of the total degrees of freedom in motion remains fixed, the mechanistic stipulation could prevail simply by declaring identification of the relevant boundary conditions. There would be no room for a signal resulting in a contingent action to intervene. In contrast, if degrees of freedom in motion remain indefinite through, for instance, their degeneracy, a production yielding either association or dissociation of degrees of freedom among those identified in the record could generate a signal (Matsuno, 1997). There is no mechanistic stipulation prescribing how and when degrees of freedom in motion could further be associated or dissociated. Although the global synchronism in the record specifies each degree of freedom involved in the finished movement because the degrees of freedom are defined as those objects whose every detail can be identified in a globally consistent manner, locally asynchronous time on the scene does not have such a global identifiability. Even if the notion of degrees of freedom is useful and valuable in other respects, communication dynamics connecting contingency in the making to determinacy in the record is set free from observing the constancy of degrees of freedom. Signal of material origin just refers to the material capacity

of either associating or dissociating degrees of freedom in locally asynchronous time.

Autocatalysis is a material pattern and form of associating degrees of freedom more closely than being dissociated thanks to enhancing material accumulation having a similar functional characteristic (Matsuno, 1978). Rather, autocatalysis is one specific mode of enhancing material association grounded upon the capacity of taking in material resources. It is in fact a manifestation of two fundamental attributes of matter, inertia and signal, in the manner that both could be visible at the same time. Compared to mechanics addressing inertial bodies, autocatalysis is a mode of communication dynamics acting on the signal producing a signal of a similar production characteristic successively. This is of course an instance of dissipation asynchronous with conservation in locally asynchronous time. Evolutionary processes found themselves upon the communication dynamics of constantly generating signals inducing subsequent actions. Evolution thus perceived is internally caused in letting an indigenously generated signal be a causative factor for action in the participating material bodies. Internal causation in evolution is unquestionably materialistic and physical in locally asynchronous time. Nonetheless, such internal cause cannot externally be identified because the causation proceeds in locally asynchronous time. Internal communication does not survive in the finished record. What can be identified in the record is necessarily manifested in globally synchronous time that preserves the global consistency among those identified.

Internal causation in evolution is in the transference from locally asynchronous to globally synchronous time. Autocatalysis as a prototypic evolutionary dynamics can yield evolutionary variations in the difference between the signals successively generated. Mutations certainly exhibit a consequence of such internal causation. In particular, the presence of molecular clocks manifesting the stochastic regularity in generating point mutations indicates that the transference from locally asynchronous to globally synchronous time has a regular stochastic pattern on an evolutionary time scale. An evolutionary sequence of autocatalytic signals being capable of generating their derivatives of a similar characteristic could establish a similarity even in making evolutionary variations. The rate of mutations as a stochastic parameter characterizing the generator of evolutionary variations is an example of exhibiting a sustaining similarity over the sequence of autocatalytic signaling. Availability of molecular clocks witnesses the likelihood of a sustaining similarity in making evolutionary variations. What is more, constancy in the rate of mutations could also serve as a cause for establishing a hierarchy of the rates themselves, because the hierarchy provides a homeostatic stability in the rates even if perturbations that could disturb them may intervene.

Evolutionary constancy as exemplified in the presence of molecular clocks is in fact a characteristic of the globally synchronous time resulting from locally asynchronous time in action. Such constancy in globally synchronous time exhibits a distinct contrast to natural selection as a global characteristic of evolutionary variations. Although the contrast between constancy and variations in globally synchronous time has historically been referred to as a dichotomy between genotype and phenotype, it may invite a serious conceptual conflict if both are taken to proceed in the same globally synchronous time. The difficulty could have been most serious at the point of establishing the effective separation between genotype and phenotype, since the underlying dynamics has been one and the same in time that is global. The separation between evolutionary constancy and variations, that is between genotype and phenotype, could be at most epistemological in the sense of being dependent upon the perspective. What one concerns at this point is whether such a separation of epistemological origin could survive in time. At issue is again the role of time.

That globally synchronous time remains legitimate only in the finished record reminds us that it is an artifact at the best. But, the global synchronism of an object in globally synchronous time, that is vertical in time there, is instrumental in securing a constant and

invariant character of the object. In contrast, the global synchronism of the participants in locally asynchronous time, that is skewed in time there, is necessarily undercomplete in constantly supplying a signal anticipating the succeeding actions. Natural selection ascribed to the skewed synchronism in locally asynchronous time, while being global, is generative compared to evolutionary constancy in the rates of mutation perceived in globally synchronous time. Recognition of locally asynchronous time underlying evolutionary dynamics clarifies that natural selection upholds the evolutionary emergence of constancy and a hierarchy of the rates of mutation. The consequence of the operation of natural selection is a self-organization in that the skewed synchronism in locally asynchronous time constantly generates signals anticipating the succeeding actions internally. In contrast to the self-organization in globally synchronous time (Kauffman, 1993), natural selection is about self-organization in locally asynchronous time.

Natural selection perceived as a skewed synchronism in locally asynchronous time is also a factor for moving time itself. When it is conceived solely in globally synchronous time, natural selection could be mechanistic as being moved with the flow of time. In fact, whether natural selection could be mechanistic or self-organizing for the sake of the self depends upon how time is moved. If time is taken to be globally synchronous without allowing any intervening intermediaries, whatever operates in time comes to be moved by time. Natural selection could be no exception. Globally synchronous time cannot be moved by others because there is nothing more global that which could subordinate the former. Final causality is legitimately dismissed in globally synchronous time. Only mechanistic counterpart survives there. On the other hand, however, once it is duly recognized that locally asynchronous time is moved by a material signal for the sake of fulfilling the global synchronism, natural selection can be more than what mechanistic stipulation could prescribe. Natural selection as a principle bringing about a unity of experiences is locally final in fulfilling the global synchronism in a skewed manner.

### **3. In the Eyes of the Local Participants**

Among many alternatives, there is one unique perspective toward evolutionary processes, namely, the perspective of the participants in evolution (Matsuno, 1989; Salthe & Matsuno, 1993). One can, however, immediately find that this insider's view of evolution is very subtle. No matter how strongly one may wish to advocate the insider's view, this position is still the outsider's enabling the viewer to see how the insiders would behave. This problem is of course not new. What we would like to push forward is to ask ourselves whether there is any possibility to save the insider's or internalist viewpoint in evolution and if so, to see the extent to which it may be possible.

To begin with, let us start from a very quick survey of the viewpoint available to how dynamics is formulated and perceived. Needless to say, evolution is a mode of natural dynamics par excellence. As a matter of fact, any dynamics has two components. One is the process of detection, and the other is that of movement.

In mechanics in physics, a very strange stipulation has been accepted and taken for granted. That is, any detection could supposedly be accomplished instantaneously over the whole space (Earman, 1986). Such an instantaneous accomplishment of detection over the whole space guarantees legitimacy and identification of initial-boundary conditions. Once initial-boundary conditions are identified, all the rest is the movement of things that can uniquely be determinate through the law of motion.

What is unique to mechanics, whether classical or quantum, is a complete detection accomplished instantaneously and the movement of things that cannot remain indecisive. Mechanics thus does not necessitate the internalist perspective that could differ from the

externalist one. As far as the externalist perspective like that of physicists is guaranteed, there would be no need to invoke the internalist position or the perspective of the participants. But, the price to be paid for the dismissal of the internalist perspective is to admit an unphysical detection process propagating at an infinite velocity. In other words, mechanics did not assume that the observer was a physical being. Simultaneous and instantaneous detection in mechanics is to assume the presence of nonphysical intelligent beings capable of communicating at an infinite velocity (Rychlak, 1991). The only difference between classical and quantum mechanics is that in quantum mechanics, we do not let such an instantaneous detection inevitable to its theoretical framework be also inevitable to physical detections proceeding in reality. The problem of actual detection and measurement in quantum mechanics is taken to be the problem to be examined in its own light (Matsuno, 1985).

Once it is admitted that any detection is communicated at a finite velocity internally, every material participant in the process, whether it may be a molecule or a human being (Artigiani, 1993; Csanyi, 1993), can only be in one place at a time and not everywhere at once. This lack of simultaneous communication necessarily leads to an internal conflict such that how to detect others depends upon which path the communication would take and the detections of the same object through different communication paths would give different results. This kind of conflicts in detection would never happen in mechanics because there, no time-delay is allowed irrespective of whatever communication path may be taken.

Detection internal to natural dynamics is inevitably incomplete and conflicting internally (Matsuno, 1989). However, the movement of things has to be definite and determinate as in the case of mechanics, because things, whether they may be matter or field, cannot remain indecisive. Any movement has to be complete and consistent globally. In fact, there is a finite time-delay between detection and movement or action. What now turns out to be evident at this point from the trios of internally conflicting detections, globally consistent movement and the time-delay between detection and action is that movement or action is solely responsible for eliminating those internal conflicts arising from internal detections as leaving behind no conflicts in the record. It is not an impartial uncommitted externalist, but the mutually conflicting, committed participants that make the world go round.

Unique to natural dynamics is internal movement toward a global consistency from those local detections conflicting internally. What is more, this movement cannot be stopped once gets started. For any movement anywhere is to be detected elsewhere later at a time and causes internal conflicts in detection subsequently. In short, change a little something somewhere and everything else changes subsequently. Constant generation of changes is latent in natural dynamics as a transformation from internally conflicting detections to a globally consistent movement (Matsuno, 1992a). This property of constant generation of changes exhibits a marked contrast to mechanics, in the latter of which dynamics proceeds from a globally consistent and complete detection to the similarly consistent and complete movement. There is no need for eliminating internal conflicts because there is none. There are neither changes nor chances in mechanics. One has to supply changes externally insofar as one stays in the framework of mechanics.

In contrast, natural dynamics as a transformation from an internally conflicting, incomplete detection to globally consistent movement serves as a generator of changes. But, this generator is not the prey of pure chance (Laszlo, 1993). Insofar as one notes that fulfilling various conservation laws such as on energy and on matter are referred to as a necessary condition for any movement, the internal movement toward a global consistency is seen in the process of generating only those changes that could fulfill these conservation laws in the actual movement. At this point, one should emphasize that incomplete detection cannot completely control the movement, as differing from the case of mechanics in which movement is

completely controlled by what is detected. Internal movement for completion in natural dynamics maintains in itself the capacity of actualizing movements in the manner not fully controlled by detection.

#### **4. Heterotrophic Activity in Natural Dynamics**

When energy flow continuity as a local expression of the conservation of energy that is empirically incontrovertible is taken as an attribute of movement, then the internal movement toward a global consistency actualizes itself as that toward fulfilling energy flow continuity (Matsuno, 1989). Here, one can see an instance of those movements due to that, for the sake of which they are making the case. Internal movement for fulfilling energy flow continuity is just another name of heterotrophic activity that is so ubiquitous in biology (Matsuno, 1992b). The origin of heterotrophic activity is very simple and physical (Matsuno, 1995). It arises from the internal movement for energy flow continuity conditioned by the presence of the inevitable time-delay between detection and action. Needless to say, heterotrophic activity comes from an internalist perspective, because appraisal of internally conflicting detections that underlie heterotrophic activity is characteristic exclusively to internalists or the participants in the game. To externalists, on the other hand, heterotrophic activity means simply that there is no such things as a free-lunch in the real world and that one party's gain is just another party's loss and nothing more. Externalists cannot see those conflicts internalists are seriously facing. What externalists can see instead is the completed movement that has already been finished in a globally consistent manner.

Heterotrophic activity is in fact a way of playing with probabilities as preventing each participant from becoming a mere miserable victim of chance while observing the materially incontrovertible constraint identified as energy flow continuity as an invincible form of grammar. As a matter of fact, heterotrophic activity is a form of stochastic laws allowing alternatives and at the same time tailoring chances in the manner suited exclusively to internalists (Laszlo, 1993).

One can now associate heterotrophic activity with consumer-regulated dynamic as a polar opposite to supplier-controlled one, because heterotrophic activity materializes in consumers. While suppliers behave as externalists toward those that consume what are supplied, consumers behave as internalists in the respect that they found their behaviors upon heterotrophic activity internal to themselves. Consumer-regulated dynamics puts its primary focus upon consumers as letting suppliers meet what consumers require, being contrary to the case of supplier-controlled dynamics letting consumers cope with what suppliers have already provided.

Consumer-regulated dynamics based upon heterotrophic activity requires at least three hierarchical levels (Salthe, 1985, 1989); the focal, upper and lower levels. It is the focal level which supplies the products to meet the consumption at the upper by recruiting necessary resources from the lower level. In contrast, only two levels, the focal and the lower, are required as a minimum condition for supplier-controlled dynamics in which the focal level is involved in production process as utilizing resources from the lower level irrespective of whether or not the upper level behaving as a consumer is present.

Evolutionary significance of consumer-regulated dynamics is in its sustainability compared to supplier-controlled counterpart. In view of the fact that evolutionary sustenance of any consumer is in the availability of resources to be consumed, supplier-controlled dynamics would easily lead to an extinction of the lower level to be exploited by the focal level as increasing the extent of production there. By contrast, consumer-regulated dynamics is less prone to its failure due to resource depletion, because the extinction of the lower level to be exploited by the focal level could be possible only when the consumption to be met would be

available from the upper. The runaway explosion of production at the focal level within the scheme of supplier-controlled dynamics could happen through production process solely at that level, whereas such an explosion for consumer-regulated dynamics could be possible only when there could be maintained a coordination among three of the focal, upper and lower levels leading to a runaway explosion. Evolutionary sustenance of dynamics favors, by definition, the one that could postpone indefinitely its own bankruptcies such as a runaway explosion of production. As a matter of fact, consumer-regulated dynamics fills the role of evolutionarily sustainable dynamics.

## 5. Occasional Extinctions of Species

Runaway explosions of supply and consumption in natural evolutionary dynamics can lead to extinctions of species if any one of trophic levels in evolving ecosystems has exhaustively been exploited. If the lowest trophic level would be exhausted, most of the then existing species would go extinct. In particular, the Permian-Triassic boundary occurred at almost 245 million years ago was marked by high extinction rates of Palaeozoic phytoplankton accompanied by those documented for skeletonized marine invertebrates (Sepkoski, 1983; Knoll, 1989). Similarly, the Mesozoic-Cainozoic phytoplankton record including the Cretaceous-Tertiary boundary at about 65 million years ago clearly parallels palaeozoological data on the timing and severity of mass extinctions (Haq, 1973; Bujak & Williams, 1979; Roth, 1987; Knoll, 1989). Nevertheless, closer examination of those records reveals a more complex picture. Several marine invertebrate groups as well as the calcareous nannoplankton declined in diversity through part or all of the Maastrichtian, but extinctions do not cluster at the K-T boundary (Roth, 1987). Phytoplanktonic extinctions from late Eocene to early Oligocene took place throughout an interval of several million years, but do not show uniquely high or even notable increases in extinction rate at the E-O boundary (Corliss et al, 1984). On the other hand, the K-T boundary is characterized by truly high rates of extinction during a very short interval followed by expansion of disaster species which, proliferating after major extinctions, look tolerably like those that disappeared (Perch-Nielsen, 1985). The E-O boundary, on the other hand, is characterized by moderate rates of extinction spread through several million years followed by unusually low rates of origination, while the Miocene phytoplankton diversification in the Cainozoic era cannot be related to the clearing of ecosystems by mass extinction (Knoll, 1989).

Recorded parallel extinctions between phytoplankton and palaeozoological species suggest that both suppliers and consumers of trophic energy went extinct roughly at the same time. However, the extinction of consumer follows that of supplier, but not vice versa. Analyzing this sequence of extinction can provide further classification of the paths toward extinction depending upon how the runaway explosion of supply and consumption develops in time, as demonstrated in the difference between the K-T and the E-O boundary episodes.

## 6. Consumer Power

Although it would be inevitable to have a runaway explosion of supply and consumption in the long run if supplier-controlled trophic dynamics in one form or another is allowed to intervene, there could also be a room of resource-guaranteed trophic dynamics over only a limited time interval in an approximate sense. Resources to consumer would temporarily be guaranteed if there is a finite time interval over which resources for consumer may be available without being depleted independently of how they would be consumed. This type of interplay between supplier-controlled and consumer-regulated trophic dynamics turns out to be substituted by a form of consumer-regulated dynamics under temporary resource guarantee. Consequently, maximization of the efficiency in resource utilization reduces to a common



denominator of consumer-regulated trophic dynamics under temporary resource-guarantee as evidenced in the ecological succession toward its climax (Margalef, 1968; Matsuno, 1978). However, maximization of the efficiency of resource utilization cannot continue indefinitely because resources available to consumption eventually comes to depend upon how they have been consumed or usurped including the possibility of being completely exhausted.

Prevalence of consumer-regulated trophic dynamics is rooted in eventual sustenance of ecosystems (Brown & Vincent, 1992) even if depletion of some of the trophic levels is inevitable due to the runaway explosion of supply and consumption. Genesis of new consumers as evidenced in the appearance of disaster species in the vacuum made by mass extinctions near at the K-T boundary can be a typical example of the functioning of consumer-regulated dynamics (Knoll, 1989).

Less drastic manifestation of consumer-regulated trophic dynamics is alternation of species on the same trophic level. Major predators of epifaunal suspension-feeding ophiuroids or brittlestar beds in the Mesozoic were teleostean fishes, neoselachian sharks and decapod crustaceans, while seastars, fishes and crabs are their predators in modern ecosystems (Aronson, 1992). A more pronounced case is alternation of dinosaurs by mammals near at the K-T boundary.

Specialization of resources to be consumed comes to localize the scope and the extent of would-be extinctions. In fact, the lush subtropical dinosaurs' habitats were gradually giving way to cooler temperate forests which favored mammals in the last several hundred thousand years of the Cretaceous (Benton, 1990). Whether one may take as a model of the mass extinction near at the K-T boundary either the gradualist ecological succession model of Van Valen (1984) or the catastrophist extraterrestrial impact one of Alvarez (1983, 1987), the extinction of the dinosaurs was observed to occur over the period of 7 million years, with an acceleration of the rate in the last 0.3 million years (Sloan et al, 1986). These palaeontological records confirm terminal Cretaceous extinctions on two time scales such as a slow decline unrelated to the bolide impact and a sharp truncation being synchronous with and probably caused by the impact (Alvarez et al, 1984; Buffetaut, 1984; Kauffman, 1984). The alternation of dinosaurs by mammals is thus seen as a consequence of the interplay between two dynamics, one is endogenous and the other exogenous. What is endogenous is the mutual interference between supplier-controlled and consumer-regulated trophic dynamics among the then available suppliers and consumers. Once a particular resource to a particular consumer is depleted due to the runaway explosion of both supply and consumption, the extinction of the consumers involved would become inevitable and only those consumers that did not rely upon the depleted resources could come to dominate the surviving ecosystems.

## 7. Concluding Remarks

Natural dynamics implements itself in the transition from internally conflicting detections to a globally consistent movement. Consumer-regulated dynamics grounded upon heterotrophic activity is just a representative case of such natural dynamics. In fact, evolution exhibits an autonomy of consumer-regulated dynamics by letting every participant be an agent consuming others, though occasionally interrupted by inevitable supplier-controlled dynamics. Intrusion of supplier-controlled dynamics may lead to occasional bursts, extinctions or bankruptcies of species in evolution while accompanied by temporary enhancement of the efficiency of resource utilization.

One lesson we may expect to get from the ubiquity of heterotrophic activity and consumer-regulated dynamics is that even though our linguistic instruments are extremely suitable for supplier-controlled dynamics or mechanics equipped with the capacity of complete global detection, natural dynamics is simply not the case. To ask to describe the inconsistency

among internal detections in a consistent manner would come to violate the principle of the excluded middle or to destroy the underlying linguistic integrity.

A compromise is to allow within natural languages some room for violating the principle of the excluded middle and to pass the capacity of actualizing the global consistency onto the material participants like ourselves, instead of onto natural languages themselves that are uniquely human institutions.

Minimizing the supplier-controlled perspective with a mechanistic flavor and instead assimilating ourselves to the material participants in evolution provide a modest way to approach evolution and evolutionary thought.

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