*Uroboros, or biology between mythology and philosophy*
*ed. by W. Ługowski & K. Matsuno*
*Wrocław 1998 Arboretum*

**Koichiro Matsuno**
Department of BioEngineering, Nagaoka University of Technology
Kamitomioka, Nagaoka, 940-21, Japan

# THE UNCERTAINTY PRINCIPLE AND THE ORIGINS OF LIFE: AN ODD COUPLE

## 1. INRODUCTION AND FORMULATION OF THE PROBLEM

It has been, and still is, awfully difficult to settle the definitional matter of what life is (Schroedinger 1946). The difficulty is both scientific and philosophical in its origin. If one dares to commit oneself to paraphrasing the definitional problem of life by following the standard procedure of practicising science in a positivistic and reductionistic manner, it would have to be imperative to atomize the phenomenon under scrutiny so as to let the measurment apparatus be able to examine what has been claimed. Unless an observation of unchanged character is guaranteed, there would be no scientific articulation of life nor the unchangeable and atomized actualities serving as fundamental predicates of the phenomenon of life.

Crucial to the positivistic deciphering of the phenomenon of life is whether such an armory of atomised invariants is available. Of course, it is and has been possible to analyze various aspects of the phenomenon of life by using the invariant analytical tools developed in physics, chemistry and biochemistry. One can in fact witness that molecular biology as a champion of the present day reductionistic sciences has uncovered that each component process of life must be nothing but a molecular automaton. This seemingly triumphant proclamation of mechanistic deciphering of the phemonenon of life is exclusively founded upon its very queer methodology (Grene 1988) that lets everything appearing under its own umbrella be part of a machine, irrespective of whether life could be reduced to a machine in the first place. Above all, no methodology has any prerogative to decide what is going on beyond its own limits. Any positivistic methodology is destined to be crumbled once it is asked who in the world would endow it with an unbeaten positivistic power.

Mechanistic methodology of molecular biology that necessarily reduces life to a machine does not have any final say on what does like look like. The real problem is not how one can apply the ready-made analytical tools developed for other purposes to the phenomenon under investigation, but how one can develop durable custom-made tools, if any, for paraphrasing the phenomenon of life.

Life as we know it today emerged on the planet Earth about 3.8 billion years ago and has persisted since then. This perpetuation of the life phenomenon makes it extremely difficult to atomize it in the time domain of evolution. If it were a stop-and-go process, its atomization in time and the resulting search for invariant protoprocesses could be expected. However, the reality is just the opposite. Evolutionary process persistently defies its temporal atomization, not to mention the spatial one. The problem of duration or persistence thus comes to the forefront. It is about how to reconcile duration with observed phenomena where philosophical reflections legitimately enter.

Of course, physics has long established its own stance in how to cope with the presence of duration. The time-honored Galilean-Newtonian mechanics in essence (Matsuno 1986) asserts that unless acted upon by external agents, every moving body perpetuates its own movement as imputed initially by others. This view on duration, or inertia in particular, is undoubtedly legitimate within the methodology giving responsible for giving birth to it. However, the content is necessarily meager. If duration were equated to inertia within the Galilean-Newtonian scheme, every evolutionary novelty would have to be an outcome of the act of external agents which by definition we know nothing about. Evolutionary process would have to let itself be miserable victim of the of the unmerciful external agents of the environment.

Inertia as the seemingly sole canidate for duration does require such artifacts that moving bodies may be clearly separated from external agents being capable of acting upon the former and that the latter may remain untouched and invincible. Despite, this separation does not proceed without causing its own drawback. The incompetence of inertia as a legitimate candidate for the process of duration encountered in evolutionary process is within the arbitrariness in distinguishing moving bodies under examination from external agents acting upon them. It could happen that some of the external agents conceived in the previous scheme come to appear as forced moving bodies simply by shifting the demarcation line between the moved and the mover. The previous mover would forcibly have to be changed into the moved. The origin of this apparent contradiction is merely methodological, and by no means real because of the artificially imposed character.

Duration other than inertia has primarily been focused in philosophical domains, though this philosophical orientation by no means prevents a thorough discussion of duration from influencing the material aspect of the phenomenon of life as we try to see in the remaining part of this article.

A principal characteristic of duration is found in the Whiteheadian (1969) distinction between the presented locus of an actual entity and a locus in unison of becoming with the actual entity. The presented locus already lacking unison of becoming is easily associated with the observed past fact which the measurment apparatus can identify a posteriori. The past fact is present only under abstraction in the sense that it has already been deprived of the capacity of being unison of becoming. Elimination of unison of becoming is the standard procedure of securing objectification of the observed datum, whatever it may be, that remains atomized and invariant by itself. It is this invariant atomization which makes positivistic and reductionistic practicing of science feasible. However, there is an important price one has to pay for such an invariant atomization of observed data. That has to be elimination of unison of becoming.

Unison of becoming as a principal factor of duration has long been discarded in positivistic practicing of science in general and physics in particular. The supposedly most difficult part in so-called scientifically coping with unison of becoming is its antithetical nature against the very reductionistic spirit insisting that everything has to be well demarcated from its surroundings and definite in its implication. There is indeed a unison of becoming in the present, but merely a definite datum in the past. This apparent asymmetry between the a priori indefiniteness and the a posteriori definiteness latent in the development of unison of becoming (Matsuno 1985) makes the positivistic underpinning of the process of duration untenable, and so there has been a good reason to leave the problem of duration in the hands of nonpositivistic philosophers. But, the problem of duration is all too important to leave it only to those philosophers concerned. In so far as we admit that evolution leading to and diverging from the emergence of life is unquestionably a material process, it would become imperative to scrutinize the material aspect of duration in general or unison of becoming in particular without being entrapped by the positivistic and reductionistic hindrance.

Suggestive of the material underpinning of the process of duration is the distinction between the a priori indefiniteness and the a posteriori definiteness associated with the temporal transference of unison of becoming (Matsuno 1985; Shimizu & Yamaguchi 1989; Benzon & Hays 1990). Measurement as a proces in fact provides an example of serving as an agent for distinguishing between before and after its own act. Consequently, one can identify measuring agents within material processes (McCance 1986). The possibility of upholding a material ground for unison of becoming could thus be envisaged as more than just a philosophical paper moon. It is only after one can identify material agents being capable of distinguishing between before and after their own acts of measurement that the phenomenon of life could be deciphered without being affected by positivistic articulation of the invariants supposedly atomized in the evolutionary time domain.

## 2. MEASUREMENT AND THE UNCERTAINTY PRINCIPLE

Although measurement may sound anthropocentric in the sense that the measurement apparatus is provided externally by the experimenter, it is no more than a form of interaction between an object to be measured and another object called the measurement apparatus. Measurement as a form of interaction is in fact ubiquitous as long as interacting bodies are available. Which one functions as the measurement apparatus or the measured object is irrelevant. Given an arbitrary pair of interacting bodies, either one of the two serves as an apparatus measuring what is going on in the remaining other. Meter reading taking place in any measurement instrument, no matter how primitive or sophisticated it may be, is realization of the interaction between the meter and the input signal entering the instrument.

Following exactly the similar line of argument, one can observe that any interacting molecule is to measure what is going on at other molecules. An interacting molecule thus serves as an agent of measurement taking place internally as much as any measurement apparatus provided externally functions as an external agent of measurement (Matsuno 1985). Both internal and external measurement come to operate in the process of material interaction in general. Furthermore, even if the measurement apparatus to be provided externally is absent, internal measurement is still going on.

What is unique to measurement after all is temporal assymetry in that measurement cannot identify what signal will arrive before it has actually arrived. The origin of temporal asymmetry, latent in any measurement, whether internal or external, is in the established empirical fact that nothing propagates at superluminal velocities. One does not have any material means to detect what is happening at other places right at the same moment. Unless such a nonlocal artifact of claiming a simultaneous bird's eye view of everything over distances is imposed, the intrinsic temporal asymmetry latent in measurment or detection holds and remains intact. Although it has been a widely held theoretical practice, particularly from the mechanistic viewpoint, to insist on the separability between the law of motion as expressed in terms of equations of motion and the nonlocal boundary condition applied to it, such an insistence would simply violate the reality of intrinsic temporal asymmetry. For the identification of the nonlocal boundary condition at a given moment would require nonlocal measurement proceeding at an infinite velocity over distances.

The intrinsic temporal asymmetry latent in measurement maintains the distinction between the indefiniteness about what is going to be measured and the definiteness about what has already been measured. Any interacting molecule as an agent of internal measurement thus carries the capacity of transforming what is possible into the actual or, that is to say, lets itself be a carrier of unison of becoming. Crucial to this observation is the recognition that the interacting molecule persistently remains indefinite in its implication at least for the reason of maintaining the future capacity of similar transformations. Every interacting molecule behaves as a unison of becoming while constraining itself with time, but does not exhaust its own armory of becoming. It should, however, be emphasized at this point that every molecule as a unison of becoming is simply an outcome of the plain fact that nothing propagates at superluminar velocities and no more, even though it may seem unavoidable to think of a close parallelism to the related philosophical discourse.

Any interacting molecule as an agent of internal measurement lets itself be a carrier connecting the indefiniteness latent in what is going to be measured and the definiteness about what has already been measured. In particular, so far as only the measured characteristic is concerned, one can identify more specific aspects of internal measurement inherent to interacting molecules.

One of them is the empirically incontrovertible principle of the conservation of energy, matter and the like. No matter how much complicated or convoluted the process of internal measurement among interacting molecules may be, the incontrovertible principle of the conservation of energy imposes upon each interacting molecule such an endogenous constraint that the conservation of energy or energy flow continuity as its local equivalent may be fulfilled a posteriori. Otherwise, the principle of conservation would be violated. Internal measurement is thus to proceed in such a manner that interaction changes imputed to internal measurement come to fulfill the condition of energy flow continuity locally everywhere, while maintaining the temporal asymmetry between before and after each act of internal measurement.

In order to see what is locally going on among interacting molecules, let us suppose that the preceding condition of energy flow continuity in a local region subsequently comes to be disturbed by propagating interaction changes originating elsewhere. The condition of energy flow continuity has to be recovered there by all means, since there is no source nor sink of energy. Such a recovery process proceeds through internal measurement. Detection of the impetus for fulfilling the condition of energy flow continuity is followed by the implementation of what is required for actualizing the condition.

What is more, the present process of detecting and then implementing the condition of energy flow continuity constantly spills over into the neighborhood through interaction. Interaction changes for energy flow continuity in one local region subsequently provide a cause of disturbing the preceding condition of the continuity in the neighborhood. Still, there is no material means to identify what kind of disturbances will arrive before they have actually arrived. Energy flow continuity has to be fulfilled a posteriori everywhere among interacting molecules, but there is an obvious distinction between the a priori indefiniteness about how interaction will be modified and the a posteriori definiteness about the interaction changes that have been actualized.

Internal measurement entailed by and upholding energy flow continuity locally does not fail in inducing the similar internal measurements in the neighborhood. Since there is no mechanism of coordinating the whole nonlocal configuration of molecular interaction all at once in a simultaneous manner, internal measurement is necessarily perpetuated in a propagative manner.

Fluctuations in the energy flow induced by internal measurement assume two roles at the same time. One is to recover the condition of energy flow continuity in one place, and the other is to disturb the similar condition in other places in the neighborhood through interaction. Important to the occurrence of these fluctuations is that it takes time for detecting and then implementing the condition of the continuity because of the finiteness of the propagation velocity of interaction changes in the medium. This observation leads us to admit that fluctuations in the local energy flow are always associated with the nonvanishing rate of their variation, since the fluctuation intensity induced and measured over a finite time interval is necessarily accompanied by its temporal variation over the same interval. The resulting intimate relationship between the fluctuation intensity and the rate of its variation is no more than a form of the uncertainty principle of Heisenberg, of course, within the scheme of internal measurement in which the uncertainty principle is understood to refer to a fundamental characteristic inherent to any process called measurement (Matsuno 1985; Conrad 1989). Measurement takes time, and any quantity measured over a finite time interval does necessarily entail an uncertainty in the rate of its variation. Once a quantity is measured, the rate of its variation cannot be determined arbitrarily. This is what the uncertainty principle is all about.

The uncertainty principle on fluctuations in energy flow in a local region of interacting molecules yields the nonvanishing rate of their variation, which necessarily brings about further flow fluctuations in the neighborhood because of the conserved nature of energy. Conversely, the uncertainty relationship between local fluctuations in the quantity to be conserved on a global scale and the rate of their variation, is in fact a consequence of the interplay between internal measurement and the empirical principle of the conservation. This mechanism makes every interacting molecule a carrier of unison of becoming in the sense that fluctuations originating in its interaction changes with others are constantly generated while maintaining the temporal asymmetry between the a priori uncertainty about fluctuations to be generated and the a posteriori certainty about those already generated.

We are thus equipped with material agents that can do measurement internally. These material agents or interacting molecules involved in internal measurement satisfy at least one requirement for being able to serve as a fundamental predicate in terms of which the phenomenon of life could be deciphered or paraphrased. Interacting molecules as measuring agents prevent themselves from reducing themselves to the invariant entities to be atomized in the evolutionary time domain, while maintaining themselves necessarily indefinite and not fully committed to what they are going to measure. A decisive test on whether interacting molecules as measuring agents may successfully be able to cope with the phenomenon of life is to see how they worked at the crucial step of the emergence of life.

## 3. THE ORIGINS OF LIFE

A plain fact about the phenomenon of life is that the material agents associated with the phenomenon are open to material flow like the biologically full-blown organisms are through their metabolic function. This observation naturally leads us to the view that one of the necessary, though of course not sufficient, conditions for the origins of life is the emergence of material aggregates open to material flow. The open material aggregates certainly interact with other molecules and aggregates in the neighborhood. Furthermore, in view of the fact that any interacting molecule serves as the agent of internal measurement, such open material aggregates can also assume the role of measuring agents. What is specific to open material aggregates as the agents of internal measurement is observing a posteriori the empirically incontrovertible principle of the conservation of matter or its local equivalent of material flow continuity. Open material aggregates are characterized by the endogenously generated process of internal measurement entailed by and upholding material flow continuity as much as an arbitrary interacting molecule is characterized by that of the similar internal measurement as regards energy flow continuity.

Once open material aggregates are generated by whatever means, they come to install a built-in mechanism of constantly inducing fluctuations in material flows coming in and going out there thanks to the underlying uncertainty principle that keeps maintaining the nonvanishing rate of their variation. The preceding fluctuations generated in order to meet the condition of material flow continuity in one local region constantly cause the subsequent fluctuations for the similar condition in the neighborhood. The successive accumulation of variations at an arbitrary open material aggregate entailed by and upholding material flow continuity is thus to apply successive constraints to the carrying aggregate. This successive accumulation of constraints is equivalent to limiting the extent of what is possible at the open material aggregate with time. A consequence of the successive accumulation of constraints is enhancement of specificity at the open material aggregate with evolutionary time.

There is in fact experimental evidence suggesting that open material aggregates, once generated and maintained as they are, enhance with time their specificity both in functional capacity and in morphological structure. When the reducing gas mixture of methane, ammonia and water as a simulated model of the atmosphere of the primitive Earth (Miller and Orgel 1974) is supplied with energy by, for instance, an electric discharge, various amino acids as key material elements constituting the phenomenon of life can be synthesized thereof. The synthesis proceeds through the intermediate products such as hydrogen cyanide and aldehyde. Molecular aggregates such as hydrogen cyanide and aldehyde are understood to be open to molecular flow in the reaction mixture. In fact, only those material aggregates that have succeeded in fulfilling the condition of material flow continuity can survive there and thus exhibit their survival in the form of the enhancement of specificity. This implies that an amino acid molecule is a more constrained form of its constituent molecules of hydrogen cyanide and aldehyde.

The enhancement of constraint proceeds at open molecular aggregates processing molecular flows both coming in and going out there at least in a manner so as to fulfill the condition of material flow continuity a posteriori. Amino acid molecules are just an indication of how open molecular aggregates enhance their own specificity through internal measurement entailed by and upholding molecular flow continuity, though, of course, amino acids are not the end products that could have enhanced their specificity through processing both coming-in and going-out molecular flows.

A possible subsequent enhancement of specificity following the synthesis of amino acids is their polymerization (Fox 1984). Thermal synthesis of tripeptides from three different kinds of amino acid, glutamic acid, glycine and tyrosine, was found to yield only two different kinds of tripeptide (Nakashima et al. 1977; Hartmann et al. 1981). Other theoretical tripeptide isomers were not identified even though there is no thermodynamic argument against the synthesis of the other isomers. This self-limiting constraint acting upon the synthesis is at least of endogenous origin, depending upon whether open molecular aggregates, once generated endogenously, could further induce interaction changes for molecular flow continuity since then by using whatever means available internally. The synthesis of two different kinds of tripeptide certainly witnesses that only limited aggregates of amino acid molecule succeeded in fulfilling the condition of molecular flow continuity during the tripeptide synthesis and accordingly enhanced its specificity by limiting the number of the kinds of surviving tripeptids.

Thermal polymerization of amino acids as well as synthesis of amino acids from methane, ammonia and water provides experimental evidence showing how it is possible to conceive of open material aggregates as the agents of internal measurement entailed by and upholding material flow continuity. Furthermore, at least on our planet Earth, there has been historical evidence that open material aggregates have survived and succeeded in fulfilling the condition of material flow continuity over the past 3.8 billion years. Biological organisms are certainly the agents of internal measurement entailed by and upholding material flow continuity, although it is more common and natural to say that surviving organisms have successfully exploited material resources necessary for their sustenance.

In essence, active participation of resource exploitation by organisms is a special case of internal measurement underlying the sustenance of material flow continuity. The agent of internal measurement does not have any material means to detect what is going on at others right at the same moment, but is under the inevitable constraint that material flow continuity has to be fulfilled a posteriori by all means. The measuring agents have to commit themselves to others before detecting how all of the others make their own commitments and still are constantly under the need for revising the previous commitments by detecting and conforming to what others have done.

What is characteristic to the agent of internal measurement is its opportunistic attitude toward making its own commitment to others. The commitment is by no means ordained and controlled uniquely by the necessity. When the preceding condition of material flow continuity measured by the agent is disturbed by propagating interferences originating elsewhere, the recovery of material flow continuity there has to be done necessarily without causing the instantaneous establishment of the total conformity with all of the others. Every measuring agent has to keep making commitments without having a unique correspondence with those of all of the others except for that the condition of material flow continuity has to be observed a posteriori everywhere.

Making commitments lacking their uniqueness of occurrence is an instance of making a choice out of possible alternatives. The agent of internal measurement is opportunistic in making a choice out of the possible because the choice is not uniquely predestined by the necessity. Precisely for this reason, the agent of internal measurement is active. Biological organisms are active in their resource exploitation in that they keep making commitments to meet their need for material resources without establishing a complete coordination with all of the others that are also concurrently involved in exploitation of their own resources.

Open material aggregates appearing in abiotic synthesis of monomers and polymers are also active in making commitments that are not uniquely controlled by the necessity originating elsewhere. The condition of material flow continuity, though incontrovertible empirically, is not specific enough because there is no material means to detect and to coordinate everything involved at every moment. Conversely, material flow continuity guarantees the emergence of active agents of internal measurement.

The agent of internal measurement entailed by and upholding material flow continuity thus serves as a common and durable actor seen all through the evolutionary stages extending from the origins of life up to the speciation of the full-blown biological organisms and species. Therefore, a more fundamental question about the origins of life reduces to why and how it could become possible to conceive of and materialize the agent of internal measurement entailed by and upholding material flow continuity. This problem is necessarily related to another question: why the phenomenon of life as we know it could not be found on the planet Mars, for instance. There is no obstacle in physics that would prevent the measuring agent entailed by and upholding material flow continuity from appearing. Only the fitness of the environment (Henderson 1913) has a final say on the likelihood of the appearance of such measuring agents in the material world.

## 4. CONCLUSION AND A PERSPECTIVE

Appraisal of the agent of internal measurement of material origin has long been foreign to the positivistic practicing of material sciences. Measurement by definition distinguishes between before and after its own act. The resulting temporal asymmetry contradicts the long-held positivistic view on the spatialization or geometrization of the universe which has been all too obvious and familiar to positivists and naive realists (Hill 1985). Evolutionary process could be spatialized and geometrized if one dared to commit oneself to engineering the atomized invariants in the evolutionary time domain. The positivistic methodology therefore has to denigrate the status of measurement for its own sake. The only role that measurement be allowed to assume under the methodology has been to confirm the certitude of invariants that could well fit into its own choice of an atomized universe. However, whether spatialization of the material universe could be tenable is not a matter of personal confession by practitioners, but a very serious problem that has to be settled independently of the convictions they may have.

Mechanistic causality as a legitimate offspring of positivistic methodology has in fact been extremely influential since its inception. Mechanistic causes, once identified, are supposed to be definite in their implication and to fully control the subsequent development of the process. Nonetheless this domination of static categories over dynamic ones does not proceed without inducing a fatal backlash against itself. A simple empirical fact saying that nothing propagates at superluminal velocities yields that it is intrinsically impossible to detect a nonlocal object in an instantaneously simultaneous manner. The boundary condition set as a mechanistic cause separately from the dynamics is certainly nonlocal. Accordingly, there is no material means to secure the presence of mechanistic causes as they are, no matter how useful the methodology thereupon may be for other purposes. Mechanistic causality thus ceases to be a genuine scheme of dynamics just because of the unattainable spatialization of its causes.

In contrast, the material agent of internal measurement makes itself indefinite by maintaining the distinction between before and after its own act. The capacity of measurement yet to be done remains indefinite simply because it is only after the measurement has been done that one can identify what will be measured.

Recognition of the material agent of internal measurement marks a decisive departure from the overwhelming positivistic tradition of practicing mechanistic causality. Internal measurement, when coupled with the empirically incontrovertible principle of conservation, is to operate in a mode of final causality in the sense that the measuring agents act so as to fulfill the principle a posteriori when the indefiniteness latent in what will be actualized is transferred into the definiteness of the measured actuality (Matsuno 1986, 1989).

Mechanistic causality under positivistic methodology is very special in letting causal precedents be assimilated with logical antecedents in positivistic logic. This assimilation is unique only to the methodology that has been employed, and is by no means guaranteed on a firm justifiable ground. Whether causal precedents may be assimilated with logical antecedents is not a matter of personal conviction, but a serious problem that has to be settled by all means. In this regard, final causality latent in the material agents of internal measurement is restrained in claiming that causal precedents are not forced to be equated with logical antecedents that are definite by definition in their implication. Causes driving the material agents of internal measurement are necessarily indefinite, while mechanistic causality within the positivistic framework allows only definite causes. Mechanistic causality is thus reduced to a limiting case of final causality letting its causes almost definite.

Once indefinite causes are legitimately allowed to enter the discourse of material processes in general and the evolutionary process in particular, we are required to set ourselves free from the positivistic stipulation of approving only definite causes. Although such a positivistic stipulation has long been viewed as the only norm to be met in almost all scientific endeavors, the fragility of the positivistic norm cannot be kept concealed forever unless our understanding of material processes is forcibly destined to be reductionistic as envisioned by positivists and naive realists.

In contrast, philosophical discourses on the phenomenon of life have kept the nonpositivistic tradition surviving in no less significant way. Duration as a process rather than inertia of mechanics as a champion of positivism has been a major focus in the tradition. Each of unison of becoming, continuance, persistency and the like, points to the attribute of duration other than inertia. Nonetheless, the nonpositivistic impact upon the positivistic practicing of material sciences has not been serious enough to give the latter genuine second thoughts. The positivistic tradition has guarded itself simply by closing eyes to those undeniable but unwelcome intruders of nonpositivistic origin. But, something one would not like to face up to does not disappear simply by closing eyes.

It is undeniable that measurement as a process is a fact to everybody, positivist and nonpositivist alike. Furthermore, it is also a plain fact that nobody can tell what will be measured before the measurement has actually been taken. This line of argument naturally leads us to the view that the measured realities could not be limited to those of invariants atomized in the temporal domain unless accompanied by the specific articulation contrived for the purposes. In fact, the significance of measurement in material processes is most evident in Heisenberg's uncertainty principle. The material agents of internal measurement are thus an authentic and legitimate outcome of material processes unless forcibly covered by the positivistic veil.

The essence of the problem of the origins of life is n asking whether it could be tractable in the research program of currently prevailing positivistic and reductionistic tradition. What we have observed is that positivistic methodology is a kind of manipulation to mold the problem arbitrarily into the type it could fit in. The necessary price we have to pay for the positivistic manipulation is denial of indefinite causes as seen in a unison of becoming in the present. Although approval of something indefinite may seem to be an indication of theoretical defeatism by accepting something that cannot be identified, this positivistic charge could be worth paying attention to only within the methodology it dares to admit.

If one understands that scientific endeavours should be directed only to those quantities and qualities that remain definite and invariant, the material agents of internal measurement would have to be ostracized from the kingdom of such an enterprise simply because of possession of something indefinite. However, whether material processes are free from being indefinite is totally a different matter that does merit a serious scrutiny for its own sake. No serious discourse on material processes should deprive themselves of infiniteness without presenting a legitimate accusation, if any. Nonpositivistic tradition in some quarter of philosophy has been keeping kindling the momentum for a legitimate discourse on the phenomenon of life in general and its origins in particular independently of whatever methodology the activity one calls science may have been asking.

## References

Benzon W.L., Hays D.G. (1990), Why natural selection leads to complexity, "Journal of Social and Biological Structures" v. 13, p. 33-40.

Conrad M. (1989), Physics and biology. Towards a unified model, "Applied Mathematics and Computation" v. 32, p. 75-102.

Fox S.W. (1984), Proteinoid experiments and evolutionary theory, in: M.W. Ho, P.T. Saunders (eds.), Beyond neo-Darwinism. An introduction to the new evolutionary paradigm, London: Academic Press, p. 15-60.

Grene M. (1988), By our epistemology you shall know us, "Geografiska Annaler" v. 70B, p. 301-304.

Hartmann J., Brand M.C., Dose K. (1981), Formation of specific amino acid sequence during thermal polymerization of amino acids, "BioSystems" v. 13, p. 141-147.

Henderson L.J. (1913), The fitness of the environment, New York: Macmillan.

Hill L. (1985), Biology, philosophy, and scientific method, "Journal of Biological Education" v. 19, p. 227-231.

Matsuno K. (1985), How can quantum mechanics of material evolution be possible? Symmetry and symmetry-breaking in protobiological evolution, "BioSystems" v. 17, p. 179-192.

Matsuno K. (1986), From physics to biology and back. Part 1. Conservation and equilibration, "Rivista di Biologia" v. 79, p. 269-285.

Matsuno K. (1989), Protobiology. Physical basis of biology, Boca Raton FL: CRC Press.

McCance D.C. (1986), Physics, Buddhism, and postmodern interpretation, "Zygon" v. 21, p. 287-296.

Miller S.L., Orgel L.E. (1974), The origin of life on the Earth, Englewood Cliffs: Prentice Hall.

Nakashima T., Jungck J.R., Fox S.W., Lederer E E., Das B.C. (1977), A test for randomness in peptides isolated from a thermal polyamino acid, "International Journal of Quantum Chemistry: Quantum Biology Symposia" no. 4, p. 65-72.

Shimizu H., Yamaguchi Y. (1989), How animals understand the meaning of indefinite information from environments? "Progress of Theoretical Physics" v. 90, supplement, p. 404-424.

Schroedinger E. (1946), What is life?, New York: Macmillan.

Whitehead A.N. (1969), Process and reality, New York: Free Press [1929].