

Entity, Environment and Their Relationship in Evolution: No Antagonistic Essence between Neo-Darwinians and Lamarckians §

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Abstract

The question "whether or not does the environment directly cause inheritable variation?" has been debated between neo-Darwinians and Lamarckians for more than a century. In Lamarckian's concept, genetic material is not constant and is changeable or plastic. And nucleotide sequence of DNA passed to offspring is changeable under the impact of the environment. In contrast, neo-Darwinians insist that inheritable variation is from endogenesis, and not caused by the environment either directly or indirectly. In this paper, I restate that Darwin himself was not different from Lamarck in understanding the important effect of the environment on the formation of individual variation within a species or population. Furthermore, I propose the following novel viewpoints: (1) the "entity" and the "environment" is two relative concepts. An "entity" cannot exist without its "environment" and an "environment" is meaningless without its "entity". (2) While evolutionary macro-entities including animals and plants are studied as the inhabitants of natural habitats, they actually are the "niches" or "habitats" of evolutionary micro-entities including fungi, bacteria and viruses. Moreover, the natural environments including air, soil and water actually contain various evolutionary micro-entities including phages, viruses, bacteria, fungi and protist besides macroorganism entities. (3) The interaction between an evolutionary entity and its environment can be interpreted as the interaction between the evolutionary entity and its environmental evolutionary entities at the same and/or different evolutionary levels. (4) Environmental heterogeneity may be the consequence of the inequality of evocasion or the evocasional variation on macro-, and/or micro-evolutionary entities. (5) Interactions between evolutionary entities such as eukaryotic and prokaryotic cellular entities, subcellular entities including viruses and phages, and molecular entities including plasmids and transposable elements play a central role in the diversity and evolution. In my belief, neo-Darwinians and Lamarckians have no conflict in understanding the essence of evolution.

Key words: Darwin; Lamarck; entity; environment; Neo-Darwinian; Lamarckian; evocassion

Background

In the recent articles,^[1-5] the following notion has been expressed clearly: genetic alteration in both prokaryotes and eukaryotes is not only endogenous as neo-Darwinians insisted, but also exogenous as Lamarckians claimed. It is well-known that the Modern Synthesis, our modern understanding on evolution, is the neo-Darwinians' theory in which Lamarck's environment-driven acquisition of heritable alterations is fully discarded.^[3-10] However, during the past decade, mounting articles have revealed the deficiencies of the Modern Synthesis.^[4,9-22] Nick Lane and colleagues pointed out "the 'modern synthesis' of the past century explained evolution in terms of genes, but this is only part of the story."^[23] Recently, a novel theoretical model called the "UPOEE Model" has been proposed^[5] in which evolution of evolutionary entities happens at the same or different evolutionary levels,^[4,5] instead of the notion that DNA-centered neo-Darwinian genetic variation such as random mutation, genetic recombination and genetic drift happens only at the molecular and population levels.^[24-27] Therefore, how to account for the disputation between neo-Darwinians and Lamarckians and even merge their argument into the UPOEE model is the task that I try to complete in this paper.

The debate between Neo-Darwinians and Neo-Lamarckians focusing on gene's plasticity

The fundamental difference between Neo-Darwinian's and Lamarckian's mechanisms of evolution, just as Ernst Mayr, one of the most famous zoologists in the 20th century summarized, "is that for Lamarck the environment and its changes had priority. They produced needs and activities in the organism and these, in turn, caused adaptation variation. For Neo-Darwinians, random variation was preset first, and the ordering activity of the environment ('natural selection') followed afterwards. Hence, the variation was not caused by the environment either directly or indirectly."^[28]

Heritability is an essential feature of species' long-lasting and carries the parentally heritable material to offspring generation by generation. Ernst Mayr coined a term "soft inheritance" to present Lamarck's concept, which refers that genetic material is not constant, and is changeable or plastic. Lamarck thought evolution was driven by an organism's inner need to adapt to its environment. In his famous example of giraffes, Lamarck explained that giraffes stretched their necks to reach the upper branches of trees and then passed on the phenotypic trait of longer necks to progeny. In other words, evolution occurs when parent organisms pass on to their offspring characteristics they have acquired during their lifetimes. Now, it is well-known that in the modern genetic theory, heredity is determined by genes or DNA, and in the time of Lamarck and Darwin, there was no the idea of DNA, but the concept of heredity. So, Lamarck's concept usually be modernized to the following statement: nucleotide sequence of DNA passed to offspring is changeable under the impact of the environment. However, recently, some authors have argued that biological heredity should include the fertilized oocyte-mediated cytoplasmic inheritance (FOMCI), the pregnancy-associated whole cellular inheritance

(PAWCI), and the non-polyribonucleotide-mediated-inheritance, which are missed in genetics.^[1-5,29-31] Undoubtedly, in Lamarckians' view, the environment is the source of evolutionary driving power. Even today, as the American biologist Niles Eldredge once asserted in his 2005 book *Darwin: Discovering The Tree Of Life*, "no doubt about it, the environment has been the ultimate driving force behind the evolution of Darwin's finches."^[32] Lamarck himself and Lamarckian researchers have believed that the environment plays a critical role in a species to acquire inherited characteristics and to drive evolution.^[33]

The novel traits can be initiated by environmentally-induced heritable alterations as well as spontaneous mutations. West-Eberhard argued that environmentally-initiated novelties may have greater evolutionary potential than mutationally-induced ones.^[7] In fact, during the past decades, the argument between Lamarckians and neo-Darwinians in modern academic words has focused on two essential questions: one is "whether could the environment change the heritable information?" and the other is "whether could the environment change the heritable information of germ-line cells?" For neo-Darwinians, the answers to the above two questions absolutely are "No!"—the first question has been denied by hard inheritance, and the second may be rejected not only by hard inheritance, but also by a physiological barrier, called "Weismann Barrier".^[29] For Lamarckians, before trying to answer "Yes!" and successfully to convince neo-Darwinians, they actually face much more difficulties than neo-Darwinians do. In fact, Lamarck's endowment-based and environment-driven acquisition of evolutionary change or simply "the inheritance of acquired characteristics" has been neglected by many modern evolutionary biologists, especially by neo-Darwinians and Mendelians since the mid-20th century.^[4,6,34]

While denying that environmental factors could cause the variations that occur in a population, neo-Darwinians insist that random mutations in a gene or chromosome are inheritable changes, which are the primary mechanism for maintaining variation within the population, and that genetic variation is the essential ingredient for natural selection. However, Kidwell and Lisch pointed out that even in the mid-20th century, Dobzhansky already acknowledged that less than 1% of random mutations were attributable to genetic variation, which alone was not enough to account for the speed of evolution.^[35]

West-Eberhard argued that "an environmental factor can affect numerous individuals at once, whereas a mutation initially can affect only one. The larger the population affected, the greater the likelihood that an environmentally induced novelty occurs in a favorable genetic, phenotypic, or selectively advantageous environment in at least some subpopulation of the individuals affected, and the larger the probability of genetic variation that can result in an evolutionary response to selection."^[7] Moreover, Kashtan, Noor and Alon believed that "varying environments can speed up evolution."^[36] Clearly, an environmental factor can play the role of an evolutionary accelerator in Lamarckians' eyes, which can remedy the defect in the neo-Darwinians' mechanism of evolution.

No View Difference between Darwin and Lamarck for the Environment as an Evolution-Driving Power

Despite the debating between Neo-Darwinians and Lamarckians, in fact, Darwin himself admitted a proposition that was most closely associated with Lamarck's, which

can be easily found in Darwin's *Origin of Species*. The first edition of Charles Darwin's *Origin of Species* was published in 1859, and since then, five other editions were printed. The sixth edition is usually regarded as the last that Darwin corrected.^[37] On November 24, 1859, the first edition of *On the Origin of Species by Natural Selection, or the Preservation of Favoured Races in the Struggle for Life* was published, in which Darwin remarked that "we have reason to believe, as stated in the first chapter, that a change in the conditions of life, by specially acting on the reproductive system, causes or increases variability; and in the foregoing case the conditions of life are supposed to have undergone a change, and this would manifestly be favourable to natural selection, by giving better chance of profitable variations occurring; and unless profitable variations do occur, natural selection can do nothing."^[38,40] Thirteen years later, in the 6th edition of *Origin* (1872), which had four times the content of the 1st edition, Darwin restated "we have a good reason to believe, as shown in the first chapter, that changes in the conditions of life give a tendency to increased variability; and in the foregoing cases the conditions have changed, and this would manifestly be favourable to natural selection, by affording a better chance of the occurrence of profitable variations. Unless such occur, natural selection can do nothing."^[40] What Darwin stated in the first chapter of the first edition and the sixth edition of *Origin* was "I think we are driven to conclude that this greater variability is simply due to our domestic productions having been raised under conditions of life not so uniform as, and somewhat different from, those to which the parent-species have been exposed under nature. There is, also, I think, some probability in the view propounded by Andrew Knight, that this variability may be partly connected with excess of food. It seems pretty clear that organic beings must be exposed during several generations to the new conditions of life to cause any appreciable [great (in the 6th edition)] amount of variation; and that when the organization has once begun to vary, it generally continues to vary [varying (in the 6th edition)] for many generations."^[41-43]

Darwin also admitted that the effect of use and disuse could cause inheritable variation. In the 6th edition of *Origin* (1872), he wrote "I think there can be no doubt that use in our domestic animals has strengthened and enlarged certain parts, and disuse diminished them; and that such modification are inherited."^[44] "It is very difficult to decide how far changed conditions, such as of climate, food, etc., have acted in a definite manner. There is reason to believe that in the course of time the effects have been greater than can be proved by clear evidence."^[45] from which, it is clearly that Darwin himself did not reject the important effect of environments on the formation of individual variations within a species or population.^[6,46] He accepted three potential sources that could cause inheritable variation: (1) an effect of changes in the environment that induce increased variability; (2) the direct effect of the environment; and (3) the effect of use and disuse.^[6,46] Richards pointed out "Darwin was not a neo-Darwinian."^[47] Darwin himself was not different from Lamarck in understanding the important effect of environments on the formation of individual variations within a species or population. Unfortunately, even since his time, many evolutionary scientists have considered that Darwin adapted Lamarck's thought to his theory was his only major mistake.^[48]

Entity, Environment and Their Relationship in the Fimpological Perspective

What is the Entity?

In the fimpological perspective, the “entity” and the “environment” are two essential concepts. An entity refers to a spatial and temporal occupant, which may be invisible or visible with naked eye, inorganic or organic, and abiotic or biotic. Monomers and polymers (such as atoms, inorganic and organic molecules, and compounds), monophasers and polyphasers (such as viruses, phages, and prokaryotic cells, and eukaryotic cells), plants, animals, rivers, lakes, oceans, mountains, satellites, planets, comets, the solar system, and galactic systems are the examples of entities.^[5]

Entities may exist in a free, or a compound form, or united structure in nature, and therefore, have their unique structural and functional significance. It is worth mentioning that the “entity” and the “evolutionary entity” are two distinct concepts, but sometimes there are overlaps between them. Moreover, the list or content of entities and the evolutionary entities depends on the spatial and temporal criteria used and the extent of our understanding, and therefore, is dynamic and developmental. For instance, the extant species and the extinct species of micro- and macro-organisms have different spatial and temporal criteria in the history of evolution.

In traditional microbiology and macroecology, a given species or population of macroorganisms such as human beings, non-human animals, or plants is composed of its individual macroorganisms; and these individuals are usually treated as independent macro-entities living in their habitats or their corresponding aerial, aquatic, and land environments. Since the last decade of the 20th century, newly emerged molecular techniques have revealed that these macroorganism inhabitants actually are the “niches” or “habitats” of evolutionary micro-entities including fungi, bacteria, and viruses at the cellular and subcellular levels. For instance, an adult human body contains more than 10^{13} host eukaryotic cells and 10^{14-15} prokaryotic cells,^[31,49-51] and evolutionary micro-entities such as bacteria, viruses, and fungi have been described in human body habitats,^[52-60] non-human animal body habitats,^[61-69] and plant body habitats.^[70-89]

What is the Environment?

The difference between Neo-Darwinians and Lamarckians should be attributed to their dissimilar and unclear definitions for the environment, and therefore, it may be critical to define the environment first for solving their disparity. From the fimpological perspective, the whole of other entities or things surrounding an entity or organism make up the environment of it, which is the definition in general for the environment of the entity. Furthermore, the following notion is proposed: (1) an environment includes not only the physical agents, but also the biological or living components which make up an entity’s surrounding conditions; (2) to define an environment depends on which entity we are going to study. If an entity is determined, the other surrounding entities constitute its environment; and (3) the scope of whole surrounding entities may be unlimited and our understanding on the surrounding entities depends on the extent of our technical advance and therefore, on the one hand, it is impossible to cover the whole things while doing research on the environment of a specific entity, and on the other hand, our understanding of the entity and the environment is developmental. Therefore, an environment, as the surrounded agents of an entity, should be recognized to be relative, not absolute; dynamic,

not fixed; and furthermore, it is evolving, stratified and diverse in its content. So we have to select or set a border for an environment, and select the most related things which may be known or just supposed sometimes in a particular circumstance.

For instance, the climate in a geographic area, the air in a closed chamber or space, and the gastrointestinal tract in the human body may be defined as the relevant environment of selected entities. Moreover, cellular hosts could be considered as the environment of virus;^[90-92] substrate-based growth media, or soil as that of bacteria;^[93-98] and soil-borne microorganisms as an environmental factor of plants.^[99-103] In ecology, environments are believed generally to be complex, heterogeneous, partitioned and changeable.^[93,104-109] Therefore, it is a common phenomenon that on the one hand, the entity is clear at a given evolutionary level, on the other hand, the environment of the entity is “a black box” that may have environmental entities at different evolutionary levels. Sometimes, it is hard to know the whole picture of interactions occurred between the entity and its environment. Because of no agreement on the whole profile of any given environment, it is extremely difficult to elucidate the mechanisms for the ecological and evolutionary relationship between macro- and micro-organisms in nature.

Although in 1959, ecologist Hutchinson^[110] already proposed that the “environment” is a mosaic, to which however, no much further information was added at that time. In the traditional macroecology, for example, plants and animals were defined to be biotic organisms (inhabitants); and soil and water were believed to be abiotic.^[111] Therefore, in traditional microbiology and macroecology, environments refer “niches”, “habitats”, or geographic “areas”, where there are inhabitants including human beings, non-human animals, and plants. The further dissecting studies on the environmental mosaic structure and its evolutionary significance had not been realized until the emergence of molecular analysis techniques in the late 20th century. During the past two decades, accumulating evidence has indicated that naturally existing air, soil, and aquatic habitats actually contain various microorganisms including phages/viruses,^[112-120] bacteria,^[121-137] fungi,^[138-142] and protist.^[143-151] Therefore, we can say that the aerial, aquatic, and terrestrial environments are open, dynamic, and biotic since the emergence of cellular life on Earth. An aquatic or land environment on Earth contains various evolutionary micro- and macro-entities such as molecules, subcellular viral entities, prokaryotic and eukaryotic cells, multi-cellular organisms, populations of macroorganisms.

The Inequality of Evocation or the Evocasional Variation: Variation from Entities to Environments and from Macro-evolutionary Entities to Micro-evolutionary Entities

In the recent article,^[5] the term “evocation” refers to the *external* opportunities of evolution that will initiate a process of natural selection action on evolutionary entities. For a dispersed microorganism-, or macroorganism-individuals of a species, the inequality of evocation or the evocasional variation together with the “evolvability” that concerns the internal opportunity and mechanism of evolution,^[5] is destined to result in the variation of evolutionary entities in an environment or a habitat, which can theoretically account for the environmental heterogeneity in ecology.

The Relationship of an Evolutionary Entity and its Environment is the Interaction between the Entity and its Environmental Entities at the Same and/or Different Evolutionary Levels

Entities constitute environments, and environments are composed of entities. Evolutionary entities evolved from and constitute evolutionary environments.

In nature, there is no entity without being encompassed by its environment, and there is no environment without containing its entities. An entity and its environment constitute an interactive contradiction. An entity cannot exist without its environment, and an environment is meaningless without its entities. Sometimes, defining an entity and its environment is easy, and sometimes not, which depends on the development of our recognition or understanding and the methods used. So, the definition for an organism and its environment is the unity of opposites between relativity and absoluteness, and between generality and specialty. To study the relationship between macroorganisms and their environment produced a specific discipline—Ecology in the life sciences, the term originally coined by the German zoologist Ernst Haeckel in 1866.

In the UPOEE model,^[5] entities of the lower evolutionary levels, or “Evolutionary Background Entities, EBE,” are the evolutionary background organisms of the entities at higher evolutionary levels.^[5] For instance, the EBEs of eukaryotic multicellular macroorganisms include not only prokaryotic entities, but also all prelife evolutionary entities such as viruses, phages, genes, and other relevant organic and inorganic entities.^[5] Therefore, the interaction between an evolutionary entity and its environment, from a fimpological perspective, could be interpreted as the interaction between the evolutionary entity and its environmental evolutionary entities at the same and/or different evolutionary levels. I argue that interactions between evolutionary entities, such as eukaryotic and prokaryotic cellular entities, subcellular entities including viruses and phages, and molecular entities including plasmids and transposable elements, play a central role in diversity and evolution.

It is noteworthy that it is critical to correctly identify which evolutionary entity and which environmental evolutionary entity constitute an interactive contradiction, as such interaction can result in environment-driven evolution. If we fail to do so, we may be unable to reach a correct conclusion. The best example of this may be the historically famous giraffe’s evolutionary theory proposed by Lamarck himself. From a fimpological perspective, giraffes’ evolution was not caused directly by the interaction between giraffes’ inner need to stretch their necks higher because of the upper branches of trees available for reaching. Instead, the heritable phenotypic characteristic of longer necks might be initiated by the interaction between giraffes’ cellular, subcellular, and molecular evolutionary entities and their environmentally evolutionary entities, which is then passed on to progeny. A similar circumstance also occurred in 1891 when August Weismann, the German biologist who first proposed germ cells-nuclear inheritance, tried to get tailless rat progeny through chopping off the tails of parental rats.^[30,152] However, the acquired tailless parental rats did not produce tailless descendants, by which Weismann

discarded Lamarck's environment-driven evolution. From a fimpological perspective, Weismann chose the wrong environmental factor (chopping the tails) to interact with the evolutionary entity (rats) and, as a consequence, he certainly reached an incorrect conclusion. In fact, chopping tails was an environmental factor at the organ level of rats, which could not initiate the interaction between rats' cellular, subcellular and molecular evolutionary entities and their environmental evolutionary entities.

Over the past decades, experimental evidence has shown that at the cellular level, the interaction of DNA-molecular entities via the mechanism of horizontal gene transfer (HGT) or lateral gene transfer, which refers to the relocation of genetic entities across the species barriers of cellular entities, can occur within intra- or inter-species of prokaryotic cells lineages.^[153-164] In this paper, I list only a few examples, such as ancient and recent lateral gene transfer from diverse bacteria to *Bdellovibrio bacteriovorus*,^[165,167] the dispersion of sodium-pumping NADH: ubiquinone oxidoreductase (Na⁺-NQR) genes through multiple horizontal transfer events to other bacterial lineages such as Chlamydiae, Planctomyces, and α , β , γ and δ -proteobacteria,^[167] conjugal transfer of Tn916-like elements from *Lactococcus lactis* to *Enterococcus faecalis* in vitro and in vivo,^[168] HGT via plasmid from *Pseudomonas putida* to the indigenous bacteria on Alfalfa sprouts,^[169] SXT/R391 family in several species of gram-negative bacteria, including *Vibrio cholerae*, playing an important role in the dissemination of antibiotic resistance genes in *V. cholerae*,^[170-172] and human intestinal and animal enterococci such as *Enterococcus faecium*, *E. faecalis*, *E. gallinarum* and *E. casseliflavus* transferring antibiotic-resistance via multidrug-resistant plasmids.^[173-181] Moreover, the interaction of DNA-molecular entities via HGT also occurred among different eukaryotic cells lineages,^[182-188] and even between prokaryotic cells and eukaryotic cells.^[188-196] For example, many genes in the genomes of plants and other eukaryotes are believed to be of bacterial origin,^[197-202] although endosymbiosis, another mechanism might be involved.^[203-205] Plant glycerol transporters might result from a single event of horizontal gene transfer from bacteria, which was estimated to have occurred approximately 1,200 million years ago.^[206] Dyer, Jaenike and Noor showed that the host mitochondrial DNA (mtDNA) of fly *Drosophila innubila* exhibits substantially geographic differentiation, which was believed to be mainly caused by gene transmission with *Wolbachia*, an endosymbiont bacterium in arthropods.^[207]

Bulgakov and colleagues reported that *Agrobacterium* can transfer genetic information to animal (sea urchin) embryonic cells and suggested that *Agrobacterium* transformed sea urchin cells by a mechanism similar to its mediating T-DNA transfer to plants.^[208] Broothaerts and colleagues revealed that when rice calli were co-cultivated with *Sinorhizobium meliloti* that contains plasmids (pTiWB3) and (pCAMBIA1405.1), 0.6% of this rice plant showed that the T-DNA had integrated into rice chromosome 11.^[209] Therefore, HGT promoted by subcellular and/or molecular entities such as viruses, phages, plasmids, transposable elements, and even highly fragmented and damaged DNA may accelerate genome evolution of prokaryotic cells^[210-219] and eukaryotic cells.^[88,185,189,220-229] Moreover, the interaction of molecular entities at the subcellular level has also been detected. For instance, the consequence of natural selection was revealed for DNA-molecular entities in maize streak virus (MSV)-A,^[230,231] hepatitis virus,^[232,233] human immunodeficiency virus,^[234] dengue virus,^[235, 236] Torque teno virus (TTV) variants,^[237,238] porcine endogenous retrovirus,^[239,240] picornaviruses,^[241,242]

human adenoviruses,^[243] human cytomegalovirus,^[244] and human coronavirus;^[245] and for proteins in biological membranes.^[246,247]

Co-Evolution of Evolutionary Entities and their Environment: the Consequence of Interaction

The interaction between entities and their environments impacts each other and results in co-evolution of them. During the past decades, myriad evidences have been revealed from both the interaction focusing on the effects of the changing environments on entities and the interaction focusing on the effects of the changing entities on environments.

The study on the interaction between plants and soil has revealed that soil can affect the genotype and phenotype of plant species and plant species can alter soil abiotic and biotic properties.^[248-253] For example, studies on plant-habitat interaction focusing on the effects of the changing habitat environments on alpine and pine showed that pine and alpine species that grow in different habitats have a high genetic diversity,^[254-256] Although the mechanisms are still unclear well, soil microorganisms, as an environmental entity were believed to be an important regulator in plants' growth, diversity, and adaptation.^[248] Studies on the plant-soil interaction focusing on the effects of the changing plants on soil showed that plant species can alter soilborne microbial communities, which may be accomplished via selectively attracting microorganisms to rhizospheres and excreting root exudates including ions, free oxygen, water, enzymes, mucilage, and primary and secondary metabolites to surrounding soils.^[253,257] Lange and colleagues showed that plants, as the inhabitants of soil habitats, their diversity at the macroorganism-individual level can affect soil microbial communities (the fungal-to-bacterial biomass ratio).^[258] Koberl and colleagues compared the bacterial communities in desert soil having a 30-year-agricultural history to that in native desert soil, and revealed that long-term planting in desert soil resulted in an increase in soil bacterial diversity, Firmicutes becoming dominant, and the disappearance of several extremophilic bacterial groups including *Acidimicrobium*, *Rubellimicrobium* and *Deinococcus-Thermus* in native desert soil.^[259] In contrast, long-term cultivation in agricultural soils was associated with a decrease in soil microbial diversity.^[260,261] Moreover, in the study on the plant-insect interaction focusing on the effects of the changing plants on insects, Nylin, Slove and Janz showed that plasticity in host-plant use was associated with phenotypic diversification in nymphalid butterflies.^[262] In the study on the fish-habitat interaction focusing on the effects of the changing lakes on fish, Millet and colleagues revealed that phenotypic plasticity and genetic (microsatellites) differentiation in threespine stickleback were associated with the spatial environmental variation of different lakes.^[263] Furthermore, Kerschbaumer, Mitteroecker, and Sturmbauer showed a more interesting evidence for the fish-habitat interaction focusing on the effects of the changing water depth on fish within the same lake,^[264] in which, differences of both phenotypic plasticity and heritable traits between non-sympatric and sympatric *Tropheus* of the cichlid genus in Lake Tanganyika were related to their habitats varied in depth.^[264]

Concluding Remarks

In this paper, I restate that Darwin himself was not different from Lamarck in understanding the important effect of environments on the formation of individual variation within a species or population. From the fimpological perspective, I try to elucidate the following novel viewpoints: (1) The “entity” and the “environment” are two relative concepts. An entity cannot exist without its environment, and an environment is meaningless without its entities. (2) Macro-evolutionary entities including animals and plants, while they are studied as the inhabitants of habitats, actually are the “niches” or “habitats” of micro-evolutionary entities including fungi, bacteria, and viruses. (3) Naturally existing air, soil, and water actually contain various micro-evolutionary entities, including phages, viruses, bacteria, fungi, and protist. (4) Environmental heterogeneity may be the consequence of the inequality of evocation or the evocasional variation on macro-, and/or micro-evolutionary entities. (5) The relationship of an evolutionary entity and its environment is the interaction between the entity and its environmental entities at the same and/or different evolutionary levels, which results in co-evolution of evolutionary entities and their environments as the consequence of natural selection. (6) Interactions between evolutionary entities such as eukaryotic and prokaryotic cellular entities, subcellular entities including viruses and phages, and molecular entities including plasmids and transposable elements play a central role in diversity and evolution. In my belief, the “entities” that neo-Darwinians stressed are only the entities at the molecular level and the population level of macroorganisms, and the “environment” that Lamarckians focused on actually contain evolutionary entities not only at the molecular level of micro-entities and the population level of macroorganisms, but also at the subcellular and cellular levels of micro-entities. The two schools truly decipher evolutionary mechanisms from different aspects and therefore, neo-Darwinians and Lamarckians have no conflict in understanding the essence of evolution.

Abbreviations

UPOEE: the Universal Pattern of Evolutionary Entities;

EBE: Evolutionary Background Entities;

FOMCI: the fertilized oocyte-mediated cytoplasmic inheritance;

PAWCI: the pregnancy-associated whole cellular inheritance;

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