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Niche, Competition and the Laws of Conscious Individual Dynamics: Similarities with Laws of Classical and Quantum Physics

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ABSTRACT

Although ecological niches are species-specific we have made the idea more microscopic by coming down to the level of individual niche.The adaptation leads to genetic diversification with the rate of evolution depending on the type and intensity of competitive stress. The equivalents of Newton's three laws in classical mechanics are formulated and explained for individuals in a niche. The niche exclusion principle of Gause in biology and the Pauli exclusion principle of quantum physics are compared and the fermionic nature of the individual ego is established for future development of its quantum dynamics. The third law of individual dynamics in niche is obviously more general than the third law of Newton. This arises because the individual is a conscious being and is dynamically evolving by its own conscious adaptations rather than by unconscious forces of nature alone.

KEY WORDS: Competition, Individual dynamics, Newton's laws, Pauli Exclusion, Gause exclusion principle, Niche inertia, variation, co-evolution, consciousness

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1. INTRODUCTION:

An organism's niche is its guarantee for survival and as such any threat to the niche is a threat to the survival of the occupant[1]. An individual therefore develops possessiveness for its niche. In evolutionary ecology, variability in the biotic and abiotic environment is one of the causes of phenotypic and genotypic diversification and subsequent speciation. Variable environments can allow different specialized traits to evolve and coexist. The environmental variation is due to variation in the resources available. The individual competes for resources and thus builds its niche by developing various adaptive traits. The individuals compete for a resource that varies continuously along a single axis and (in the absence of consumption) reaches highest densities for an intermediate value on this axis**.**

The dynamics of the ecological niche of a species, and of the species itself, can be studied as an integrated effect of the individual dynamics in its own niche that is a subset of the species niche. The individual's niche consists of all components from psychological to genetic to ecological, and can at each level be integrated to yield the aggregate niche of the species. The individual can be defined as that abstract entity whose first envelope is its psychological niche. The psychological niche consists of a core having several traits deriving from and attendant upon it. The integrated psychological niche of all individuals constitutes the cosmic mind having a cosmic core and innumerable traits surrounding it seething with possibilities for the appearance and evolution of various species. These traits gradually make the corresponding individuals and the objects manifest in a series of objectification processes[7]. The whole physical universe can thus be seen to be the grand cosmological niche for the cosmic mind. From the cosmic mind different cores branch out to give form to different species of living organisms and their biotic and abiotic requirements[8,9].The grossifcation of the cosmic psychological niche is the cosmic genetic niche that is the totality of all the microscopic genetic niches of the individuals. This contained the blue print for the evolution of everything through the bigbang. The structure formation, nucleosynthesis, formation of galaxies and stars and planets and satellites etc all proceed because of the cosmic genetic blue print which is to take the form of interacting species in living planets like the earth. Once the individuals and species are in place, their interactions can be any form of symbiosis, from exploitation to mutualism[10, 11,12].

2. NICHE AND COMPETITIVE EFFECT

The competition for resource can lead to the adaptive radiation or adaptive diversification and splits the consumer population. Competition results in adaptive diversification and speciation when the niche width does not expand any more. The organism requires a fixed niche and refines the conditions for adaptive diversification and thus tries to minimize competition. Every niche has its

own carrying capacity. When the carrying capacity of the niche reaches optimum in terms of use of resources, it fails to sustain the organism, and thus automatically exclusion principle works to maintain the equilibrium. Sharing of a single niche narrows the niche but the diversification of the organism by adaptive diversification especially by changing their physical environment. By definition, competition occurs when interaction between two or more individuals or populations adversely affect growth, survival, fitness and or population size of each, typically when a common resource is in short supply[13].

3. WHO WINS IN THE COMPETITION?

Competition for common niche in the intra- and inter-specific sense is the single most powerful driving force for evolution. The exact mechanism by which competition leads to evolution has not yet been unraveled. Any competition leads to psychological, physiological and also sociological stress in the organism. Both the competing parties tolerate the stress during the period of competition. Exposure to such stress in general evokes different response from the competing organisms. These responses, in their turn, are determined by intensity of the urges to fulfill the needs from the common niche. These urges derive their intensity from the relative position of the particular instincts in the hierarchy such as perpetuation, power and mother instinct. The stress generated in an organism or species is thus proportional to the intensity of the urge and the level of the instinct in the hierarchy.

3.1 Competition and Survival Of The Fittest

In competition for survival the winners are those that successfully develop the necessary traits for their continued existence, although in a newer form. This means that the species in its earlier form (that got eliminated from the system) actually failed to sustain itself in that particular system. But the severe stress of competition and the looming possibility of elimination led to newer adaptations best suited for its survival in a newer form, depending on whether the species continues in that environment under the severe competitive stress. Or else, it leaves that system and migrates to become part of another system in a newer environment.

The adaptation leads to genetic diversification with the rate of evolution depending on the type and intensity of competitive stress[9, 10]. More marked will be the variations in those which stay in thatenvironment than those which escape to another. Because in the ease of the former the adaptive requirement is more intense due to the impending threat of extinction from that system and thus new species can emerge in such situation leading to separate branches of evolution, while in the escaping group there will only be variations as would enable them to thrive in the new environment.

In this latter case it may be the evolution of some sibling species or a new species with not much variation from the original depending on the environmental pressure.

4. THE CLASSICAL DYNAMICS OF INDIVIDUALS IN THEIR NICHE

The laws of individual organismic dynamics in a niche can be formulated exactly along similar lines to Newton's laws of Classical dynamics.

(1) The First law (Law of inertia): Just as in purely physical systems there is a continuity of state of rest or motion in the absence of external forces, similarly also in biological systems:

There is a tendency to continue with an existing niche unless and until there are factors that force a change.

This tendency of the organism to maintain its existing niche is its *niche inertia*. The factors may be biotic and abiotic stresses coming from a dynamically evolving niche-occupant interacting system. Note that when such factors generate evolutionary stress, the niche change may be in the genetic niche of the individual in which case mutations beyond the normal rate may occur leading to speciation. Thus when there is no evolutionary stress, the rate of mutation will be the normal rate for the species in the ecosystem, and the species thrives well there with stable population growth rate. This is the niche inertia or evolutionary inertia of the species.

In the absence of evolutionary stress, the normal rate of mutation in an individual in its genetic niche is the equivalent of the velocity for a particle in Newtonian mechanics. Similarly, in the absence of evolutionary stress the normal growth rate of population is the corresponding equivalent for species dynamics in the ecological niche.

If this normal mutation rate for the individual or normal population growth rate for the species is $\frac{dr}{dt}$ =constant, and evolutionary stress is F, then,

$$\frac{d^2r}{dt^2} = 0 \Leftrightarrow F = 0. \qquad (1)$$

This is the mathematical statement of the first law.

(2) The second law (Law of stress):

The rate of adaptations (change of niche) is proportional to the evolutionary stress.

Mathematically, $F \propto \frac{d^2r}{dt^2}$

Or, $F = k\frac{d^2r}{dt^2}$ (2)

k =proportionality constant. The quantity $\frac{d^2r}{dt^2}$ is the equivalent of acceleration.

As stated above, the stresses may be from biotic and abiotic factors and the adaptive changes may be genetic mutations and/or ecological niche alterations. The psychological niche is where the stresses are actually felt and adaptations are sown which germinate as epigenetic marks in the genome and sprout as mutations.

Three possible types of factors can be there for an organism in a given niche:

a. Positive factors that contribute to its sustenance and growth and thus ensure survival and perpetuation. These are akin to attractive forces of electrodynamics. The organism and species population grow in an accelerated manner. There is positive rate of change of the rate of mutation or population growth.
b. Negative factors that endanger survival and perpetuation. These are akin to repulsive forces of electrodynamics. These factors may be biotic or abiotic. The growth is stunted and population dwindles, and consequently the individual has either to adapt or migrate elsewhere for a new niche. There is again positive rate of change of mutation rate but negative rate of population growth ($\frac{d^2r}{dt^2} < 0$). The sign difference can be absorbed in the sign of the proportionality constant for population growth.
c. Neutral factors which have no direct bearing on the survival and perpetuation of the organism. The individual is not affected by them. The first law is valid in such cases and no evolutionary stress is there from such neutral factors in the niche and the mutation rate and population growth rate remain independent of them.

No niche is entirely positive for an organism, since some amount of negative change in the niche is inevitable during the very process of living of the organism. Accelerated population growth or mutation rate is the result of positivity of the niche, but it also brings in niche degradation and intra-specific competition. The changes are usually quasi-static and hence give the illusion of there being no instantaneous change in either the niche or the organism, but when integrated over a finite time period, their changes become clearly discernible.

Because of its inherent inertia to maintain its comfortable niche, the organism resists all such negative changes that threaten its survival, as exemplified by the corresponding law of Effect due to Throndike in animal behavior [16, 17]. Sometimes lacking foresight, and out of ignorance, it may even instinctively oppose a positive change, which appears to be somewhat negative on the face of it. Adaptive evolution results from its struggles for survival against the negative factors.

(3) The third law (law of coevolution):

The occupant and its niche co-evolve in time.

Utilization of the niche by the organism for its survival is associated with unavoidable degradation to it, unless replenishment mechanisms are in place. The organism is capable of adaptation at some rate and to some extent commensurate with the changes in the niche, but ultimately the organism either adapts and suffers mutation, or changes its niche and undergoes niche replacement or fails to adapt and suffers extinction. Of course, the organism attracts and is attracted by the positive factors of the niche and repels and is repelled by the negative factors. This also points to the fact of the possibility of the niche also being a conscious player as proposed by us in our earlier work.

In case where the niche is a biotic factor, which in a special case, may be just another individual with whom the organism interacts purposively, the law takes the familiar form of Newton's third law: *Every action has an equal and opposite reaction.* This means that in case of a pair of interacting individuals, not necessarily of the same species: *Love begets love; hate begets hate and indifference begets indifference.* We can then write:

$F_{12} = F_{21}$ (3)

This is the truth of a pair of individuals (1 and 2) interacting through the fields of their psychological niche. Such interactions have their effects on the genetic, physiological, ecological, social and cultural niches of both.

The third law of individual dynamics in niche is obviously more general than the third law of Newton. This arises because the individual is a conscious being and is dynamically evolving by its own conscious adaptations rather than by unconscious forces of nature alone.

5.GAUSE EXCLUSION, PAULI EXCLUSION AND QUANTUM NATURE OF SELF

Although ecological niches are species-specific we have made the idea more microscopic by coming down to the level of individual niche. The ecological niche is a good macroscopic concept to start with but inevitably we have to deal with individuals at a deeper level and then integrate to get the species level interactions and responses. This may sound reductionist but it has its own special advantages as in physics. Thus we can treat individuals in a species as particles in a many-particle system in physics and try to derive macroscopic properties. To this end, we show the similarity to Pauli exclusion principle here.

The niche exclusion principle is often stated as: ***No two entities can have exactly the same niche***. This is similar to the famous Pauli exclusion principle of quantum theory: ***No two fermions can have exactly same quantum numbers***. It applies to fermions *e. g.* spin-1/2 particles like electrons, protons and neutrons. The quantum numbers are the characteristic properties like energy, angular momentum, spin etc. that determine the behavior of fermions.

Such fermionic quantum nature of the individuals has been proposed in the literature and can be utilized to explain many of the behavioral patterns of individuals and their interactions[20]. The basic differences are at the genetic level. No two individuals have exactly the same DNA *i.e.* the genetic niche. Similarly no two individuals inhabit the same body *i.e.* the physiological niche. No two individuals have the same mind *i.e.* the psychological niche. These basic differences lead us to the understanding that the interactions of individuals with their niche will be different according to their differing requirements and hence each will carve out a different niche for itself. This is enough to give us an explanation of why the niche exclusion principle works, where it seems to work. Truly, the microscopic niches are different though macroscopically they seem to be alike. Thus niche exclusion is as stringent as the Pauli exclusion.

6. SPATIO-TEMPORAL CONTINUATION OF VARIATIONS

Just as in the evolution of a newer species from an earlier one there are intermediate species which interpolate in a chronological evolutionary sequence between them. Same kind of spatial continuity of variations among the existing species can be observed across the boundaries of distinct environmental conditions. This is because boundary between habitats such as a desert and a forest is not a sharply demarcated one but stretches across tens of kilometers where a mixed habitat holding intermediate species can be observed such continuity of species across distinct spatio-temporal locations is more apparent in the lower species of smaller dimensions than in the species higher up, due to the very subtle nature of the variations. For example, insects in the desert habitat will be more in grey, brown or sandy colors while those in the adjoining forest habitats will be more colorful with intermediate colors seen in the boundary regions. Similarly in moving from one species another which in the latter of chronological evolution in the geographical time scales intermediate species though not discernible at present must have existed during such evolution.

In regard to temporal continuation of variations we just need to note the discovery of remains of such species which have now become extinct but which are placed as intermediate between two well developed species. Among the extant species also such interpolating species are found which may be having a relatively shorter span of existence compared to the preceding and succeeding species at ends.

Thus, even if we do not yet have direct evidence of all the interpolating intermediate species, we cannot say that they did not exist. The very hypothesis of randomness of variations means that the entire parameter space for any definite character must have had its manifestation out of which the particular ones that survive got perpetuated. If a mutation has not survived, it means that it could have fizzled out at any point of its manifestation between its being a mere mutation is thus only recognizable at the level of a single mutation or to be even more precise at the level of a single epigenetic mark i.e. at the level addition, removal or replacement of a single functional group. Mutations occurring at the molecular level ultimately lead to modification of a single observable trait. So far only spatio-temporal patterns of distribution of species richness have been studied but the continuation of variations which thus proves to be a future area of exploration[21].

7. CONCLUSION:

The individual is not to be identified with any of its niche and we are led to propose that it must be understood to be that which exists when the organism is denuded of all niche. What then is the true nature of the individual that lives and moves through all these ensheathing niches? Does it have any structure? Is it an independent functioning entity that can exist bereft all niches. What is the ultimate limit of its dynamical evolution through adaptation and alteration mechanisms in all these niches? If at all, as our analysis suggests, the individual is distinct and different from all its conceivable niches, why and how did it get unsheathed by them in the first place? Can its evolution be accelerated by more profound conscious adaptations than adopted by it driven by nature? How far can we proceed in analyzing the conscious individual as an entity of Classical or quantum Physics? These are some of the deepest questions that are sure to keep evolutionary scientists engaged in coming years, we have just endeavored to lift the veil of the mystery a little by showing the analogies that can be capitalized on to formulate more rigorous laws for both, the individual and the niche, whereby we can aspire for a unified description of subject and object.

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