METACRESCENCE

ORIGINS OF HIERARCHICAL LEVELS: AN "EMERGENT" EVOLUTIONARY PROCESS BASED ON SYSTEMS CONCEPTS

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ABSTRACT

This paper describes a dynamic process that results in the origins of hierarchical levels in natural systems. It introduces a generalized version of dualistic philosophy (eg. Yin/Yang) as a new principal systems concept named "counterparity". It also introduces "concrescence" and "potential spaces" as principal systems concepts. The 5-step process involves these concepts and general probability to form aggregates that feed hierarchical evolution, which is pictured as a self-organizing, self-referencing cyclical process involving successive events of "emergence" from one level to another, accompanied by developmental proliferation of variants within levels. A brief history of the concept of counterparity, criteria for its more rigorous definition and use, as well as a table of specific examples is provided.

INTRODUCTION

Hierarchical structures are found in all types of known systems (Wilson, 1969). Unfortunately, the word is popular and consequently used loosely. Lists of unambiguous criteria to distinguish between what are and what are not hierarchies or to distinguish between types are still in development (Wilson, 1976). But hard empirical evidence for definite levels in astronomical systems (de Vancouleurs, 1970; Page, 1969; Wilson, 1969; Kauffman, 1969), and to a lesser extent in biological systems (Pattee, 1973; Troncale, 1976; Miller, 1977) are now appearing and are becoming accepted even by practitioners of these specialty fields. These empirical studies purport to show that the naturally occurring entities of these systems are found in "clusters" when compared by quantitative measurement of certain important parameters typical of the entities. Graphs of the appropriate parameters for all entities in one of the systems (eg. all entities in astronomical systems) do not show random or homogeneous distribution, but rather associate into definite groupings separated by large "gaps" wherein no naturally occurring entities are found. The groupings or clusters of entities are called "levels" in a hierarchy. Examples of such graphs are shown in Figure One. The levels often bear subunit-to-unit relationships to each other, and thus the word hierarchy is applied since no other word in our lexicon approaches the phenomenon.

The importance of the concept of hierarchies can be seen in two developments. First, there is a

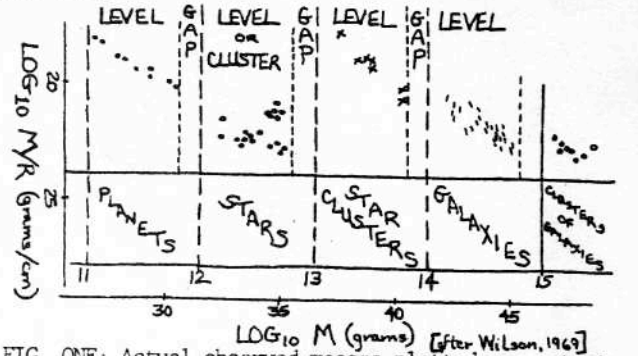


FIG. ONE: Actual observed masses plotted vs. potentials for cosmic bodies show the levels (clusters) & gaps feature of hierarchies (empirically proved).

a growing literature on hierarchies (Wilson, 1969; Wilson, 1976; Pattee, 1973; Mesarovic, 1970; Weiss, 1971; Simon, 1962; de Vancouleurs, 1970; Page, 1969; Wilson, 1969; Kauffman, 1969; Troncale, 1972; Troncale, 1976; Whyte, 1969; Miller, 1977; Koestler, 1969). Odum (1977) points out the utility of the concept to understanding ecological and environmental problems, which indicates further the social significance of studying hierarchies in theory. Both of these developments suggest that a more rigorous understanding of hierarchies would be useful. Several suggestions as to the efficiency of hierarchical organization can be found in the literature (eg. Simon, 1962; Odum, 1977). But the most important question has not been asked.....What causes hierarchies? How are hierarchical levels continuously formed over cosmological time, one from the other, by the natural forces inherent in the entities themselves?

The current concept of hierarchies (devoid of the process that forms them) is equivalent to the concept of distinct, but static species before the introduction of Darwinian and non-Darwinian evolutionary processes. Hierarchical organization should become more understood and their taxa more realistic with the elucidation of the process behind their formation. As suggested graphically in Figure Two, mans limited abilities at perception inhibits his ability to "see" the less stable and transient entities and their dynamics which connect the various levels in hierarchies (shown as *). Man can "see" the entities within the levels (shown as #) because of their greater structural stability and lifespans. This problem of perception of process has occurred over and over again in the history of science - static taxonomy precedes concepts of

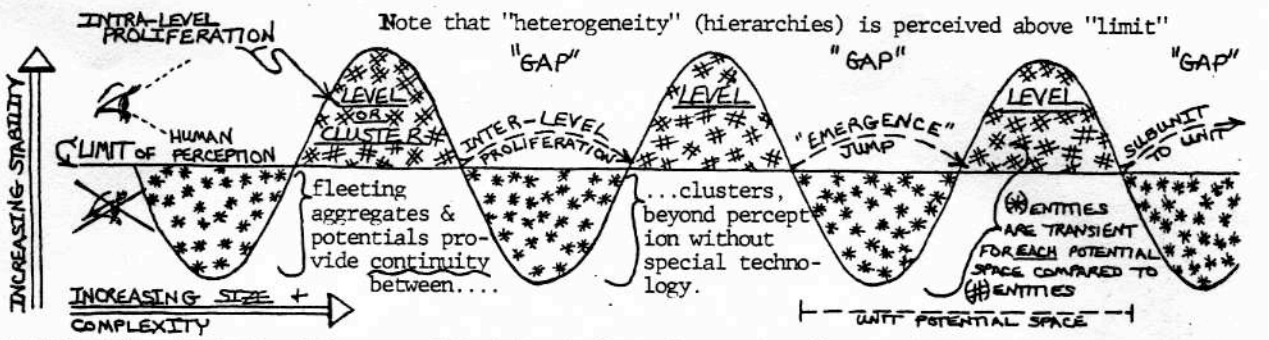


FIG. TWO: Role of Relative Lifespans of Entities in Human Perception of Natural Hierarchical Levels.

evolution, identification of cell structures precedes understanding of organellar functions, anatomy precedes an understanding of embryology, etc. Overall, recognition of structure precedes recognition of natural evolutionary mechanisms. This paper tries to "image" a process for evolution of hierarchical structure.

There are ways to look at the importance of explaining a process other than stating its importance to the scientific understanding of a phenomenon. The ancient myths of man, collected over eons by the wise and sensitive, are as important as science. If we look at such myths we find three major themes or processes which are constantly found across many cultures. These comprise the stories of "creation", "growth", and "change" or "evolution." None of these myths adequately explains the concept of "emergence" which we suggest is the fourth great universal process, and the one most tied to the concept of hierarchy. It is not surprizing that ancient civilizations have no such myth since our modern recognition of hierarchies requires a perspective, an accumulation of data, and types of calculation only recently available. Nevertheless, the seeds of an emergent evolutionary process to explain hierarchies does exist in ancient philosophy. This paper also attempts to unite some of these ancient ideas with modern scientific ideas to provide a measurable, testable, mechanism for origins of hierarchical levels. The ancient idea we turn to first is that of dualities.

COUNTERPARITY AS A PRINCIPAL SYSTEMS CONCEPT

Principal systems concepts (Troncale, 1977) are a select grouping of general systems ideas which are thought to be found in virtually all natural systems. They are fully transdisciplinary. In the 1977 paper, nine criteria are suggested for distinguishing principal systems concepts from other general systems terminology for the purpose of simplifying establishment of linkages between them. A description of the entire knowable set of these P.S.C.'s with their interconnections (linkage propositions), and their "potential spaces" would describe what is true of most "systems" on a theoretical level. We are suggesting here the inclusion of an old, non-scientific idea, significantly updated and extended by scientific studies, as a new principal systems concept called "counterparity." Counterparities, we are suggesting, are a special class of dualities which occur naturally in most systems and play a central role in the emergent evolution of new hierarchical levels.

BRIEF HISTORY OF THE CONCEPT OF DUALITY

The concept of duality is almost as old as recorded history. The earliest and perhaps most generally developed recognition of duality is the Yin/Yang concept which dates back to times earlier than 300 B.C. (more than 2500 Y.B.P.)(see Watts, 1975 and many other translations of the I Ching). Contained in the Book of Changes, the yin (often described as the female principle) and the yang (male principle) refer in general to any complementary pairs of opposites which can be found in nature. These male/female principles are rather anthropomorphically projected on natural systems, so that the idea of dual pairing is extended far beyond the sexual imagery to many of the things and forces that man was aware of in those times. In terms of Eastern thinking the opposite forces never win completely over one another, rather they continue to exist in dynamic equilibrium. The opposite polarities, although named individually are seen as parts of one indivisible unity or wholeness (Tao). The Eastern wisemen felt the Yin/Yang concept as fundamental to all natural and human activities. Later the Yin principle became more abstracted to the passive or static state and it always precedes the active or dynamic principle, the Yang.

Eastern philosophy was not alone in its recognition of dualities. Early Western philosophers (Russell, 1945) such as Heraclitus (ca. 500 B.C.), as well as more contemporary men such as Hegel (1770-1831) recognized and gave prominant importance to dualities of an opposing nature in their philosophies. Heraclitus stated "Men do not know how what is at variance agrees with itself. It is an attunement of opposite tensions like that of the bow and the lyre. ...Couples are things whole and things not whole, what is drawn together and what is drawn asunder, the harmonies and the discordant." He felt the unity was created out of the strife between the opposites. Hegel's famous dialectic method.....counterposing a "thesis" with an "antithesis" to achieve a "synthesis" is clearly a duality in logic similar to Eastern dualities. Generally, the dialectic results in chains of pairings and syntheses - each contributing to the next. These may be seen as hierarchies of logic with built-in self-referencing as is also true of natural hierarchies. Still, Hegel would emphasize the whole over the opposite parts.

American Indians, apparently independently, developed similar concepts of duality. Blackburn (1975) shows that the Chumash Indians of So. Calif. used the concepts of "Negative-Positive Integration" and "A Dynamic Equilibrium of Oppositions" in their oral narratives which were used to pass on their cultural traditions and worldview. Of course these abstract ideas were couched in terms of stories about coyotes etc. for better communication. There are many examples such as this for independent recognition by cultures of the primary importance of dualities. This is, in itself, interesting.

Recently, Levins (1977) pointed out that duality concepts are common to myths of several ancient cultures. These early cultural allegories show a consistent pattern of behavioral duality between images representing opposing forces of cooperation and antagonism (eg. in father/son pairings) which he interprets as the build-up of forces for change.

A.J. Toynbee (1972) notes that philosophers as separate in time as Empedocles and Herbert Spencer use the "complementary opposites" concept in their philosophy in ways similar to that presented here, that is, as a generative force. Spencer even alludes to what we now call hierarchies when he states that matter progresses from "an indefinite, incoherent homogeneity to a definite, coherent heterogeneity" by coupled series of "integrations" and "differentiations "(Spencer, First Principles, 4th edition).

Finally, Niels Bohr, the renowned physicist, introduced the concept of complementarity to physics to resolve the wave/particle paradox by declaring that neither was correct alone, but were merely dual pictures of the same unit phenomenon. He suggested the concept be applied beyond physics and even had the Yin/Yang symbols on his coat of arms.

It is clear from the above examples that duality is an old, reaccuring theme associated with dynamic change. Still the change is not described in terms of process mechanisms, nor is it clearly "emergent" hierarchical evolution. To achieve these features we must marry the concept to other concepts.

DEFINITION OF COUNTERPARITY

We suggest the new term counterparity to name all of the various specific, non-traditional types of duality which may contribute to hierarchical evolution, and secondly to supercede its established, but separate and distinct meanings, in myths, philosophy, and science. This renaming of a fertile concept has a very important significance -- it is our agreement to pursue a use of an idea that is one and the same time more generalized than its previous uses and yet more subject to a more rigorous and controlled usage to allow better specific application than formerly possible. The Yin/Yang terminology is sufficiently generalized, but is too loosely used and defined to gain acceptance by scientists today (our target audience).

Counterparity; parsing the word yields its meaning. The word "parity" may be defined as equality, equivalence, or similarity as in amounts, status, or character. The word "counter" implies the existence or application of a force acting against or opposing some simultaneously coexistent force. Together in the word counterparity we refer to populations of two paired entities occuring in the same system and which exhibit mutually opposed characters, yet which characteristically combine into units. Together the words imply a much more dynamic condition than simply the word duality. Counterparity also denotes the necessary coexistence of the two paired entities in the same ranges of magnitude (i.e. on the same hierarchical level) better than the word complementarity. However, the word is not as good as complementarity in suggesting the role of opposites in forming wholeness. However, we feel that the formation of units is better ascribed to the process generated by the existence of counterparity than to the counterparities themselves. These two interlocked but seperate events are confused in old discussions of complementarity and duality.

Counterparity is actually the modern empirical version of the ancient concept of dualism. This is by no means the first such unification attempt (see Bohr; and Capra, 1975). Simple examples of counterparity abound in science as well as the humanities. On the physico-chemical level, the requirement for pairs of electrons of opposite and complementary spins to complete orbitals in shells of atoms may be a counterparity....Note also that the (+) and (-) charges that exist on both the subatomic and atomic levels induce bonding and neutral pairings. It is important to note in these examples that the entire entity is not required to fully participate in the bonding event as the active agent, or synonymously, the counterparity; it is sufficient that counterparities only at the periphery of the entity act as the active agent. For example, valences in atoms are in the outer shell, not in the interior. This observation is especially true of counterparities involved in emergent evolution as we shall see.

Two states of counterparity exist; they are unsatisfied and satisfied counterparity. Unsatisfied counterparity refers to the unpaired members of a potential couplet of opposite, but equal entities, or parts of entities. These unpaired and therefore unsatisfied counterparities possess residual energies for combination. The lowest energy state for unpaired members is to be coupled with their "complement" at which time they no longer exist as a "potential." The fundamental dualities of matter & energy apparently create the concept of "attraction" or bonding from the lowest to the highest levels of the hierarchy. These attractions lead to an immense number of possible combinations. It is this fundamental attraction potential that provides the large population of variants which are the basic raw material for systems-level, hierarchical evolution. A specific example of unsatisfied counterparity is an atom of hydrogen ($H^{\bullet}$) which could accept another electron of opposite spin in its outer shell, as it does when combined into water, ($H:\ddot{O}:H$). But note that hydrogen and its potentiality combines with many other atoms producing a wide range of variants.

This is just one example. Even though the attractive forces are different in their specifics on each level of the hierarchy, their general relations are invariant across all levels of the hierarchy. This allows us to recognize and name unsatisfied counterparities.

Satisfied counterparity refers to opposite, but equal entities coupled together in a local space/time configuration such that they have no remaining potential. Completed pairs of electrons in the outer shells of elements in compounds are examples of satisfied counterparity (the subunit atoms, that is, not the compounds). Their opposite nature (consisting, in part, of counterpoised spins) causes them to bind together as if each has what the other needs for wholeness. That is why they exist in pairs when complete and neutral. Being coupled means being satisfied, which also means "not conducive to further combination." The energy used in the combining act appears to come, in part, from the lack of wholeness of each counterparitor when alone. Our central problem in this paper will be to explain how the appropriate "lack of wholeness" is built a priori into each counterparitor before its participation in complementary binding. How does the counterparitor come into being so nicely formed that it appears to have an a priori knowledge of the whole it is yet to form? In any case, when merged, the energy for combination is tied up in the act of structuring, and energy becomes a cluster of matter.

Two generic types of counterparities exist in addition to the two states described above. Some counterparities contribute only to growth in numbers of entities within a level. For example, male/female couplings in most species create the numbers of individuals in the population of the species, but they do not (by themselves) cause new hierarchical levels to emerge. These "growth-in-numbers" counterparities we suggest calling "endocrescent" counterparities because they cause proliferation of entities within an hierarchical level ("endo", L.,= inside of; "cresco", L.,= to grow). A second type we would like to call "transcrescent" counterparity because it causes new, emergent levels of hierarchies to appear, or causes proliferation across the gaps between levels ("trans", L.= across; "cresco", L.,= to grow). An example of transcrescent counterparity would be the combination of atoms to produce the next hierarchical level (a gap away) which we call macromolecules.

The mechanism behind the emergence of new hierarchical levels is the subject of the remainder of the paper. This requires a more exacting definition of counterparity and concrete examples.

CRITERIA DEFINING COUNTERPARITY

Some have pointed out that one of the major problems in general systems theory is the ambiguity allowed in terms by investigators (Troncale, 1972; Oliva & Capdevielle, 1977). The following ten criteria are suggested to distinguish counterparity from other general terms and encourage its unambiguous use;

(1) Dual Morphology - All entities, counterparities included, have general form. In both Eastern and Western formulations the two entities involved in the duality always have a substantially similar form (by "form" here we mean idealized and abstract structure, process, or structurprocess). Counterparities have more in common than different as regards "form."..however, from that substantial sameness the population diverge into two variants which are equally represented in numbers. An example would be the intersex status of the fetus before sufficient hormones are activated for female/male commitment in the development of the human.

(2) Mirror-Image Opposites - for some as yet ill-understood reasons the parities formed appear frequently as simple permutations of subparts of a whole that follow distinctly bimodal distributions. The two variants appear to be the farthest extremes of the potential variation between the parts of the whole. As such the counterparities share in the stability derived from the parent whole, but appear to possess antithetical potentials and directional forces. The appearance of directional force may result from the tendancy of the counterparity to seek its opposite to return to the primal state of wholeness.

(3) Complementary Binding - It is possible that the vectorial force and potential of each counterparity taken alone derives from their origins as permutations of an original unity or wholeness to which they forever seek to return. As such their natural state together is presumed to be their lowest, or at least primeveal energy state. Thus, the counterparities tend to bind together in complexes even though they are opposites. The binding is amenable because of their essential and bulk similarities due to their common source. But since all bifurcations of the original whole are not exactly the same, many variant bindings are possible.

(4) Similar Orders of Magnitude - Paired entities possess the same relative sizes, volumes, densities, and masses. Again, this is partly due to their generation within a level by bifurcation or divergence from a similar primal entity. Any suggested counterparity without this similarity may be confusions between two opposites on two different hierarchical levels.

(5) Similar Stable Life Times - The wholeness from which the counterparities diverge has its own characteristic life span of stability before decay. Since the divergent counterparities are still primarily composed of the wholeness with a few peripheral exchanges they also retain the parents stable lifetime.

(6) Similar Binding Energies and Distances - Since the counterparities arise from the same "potential space" (discussed later) they are restricted to binding with each other within that space with the spaces' characteristic types of forces operating over limited distances.

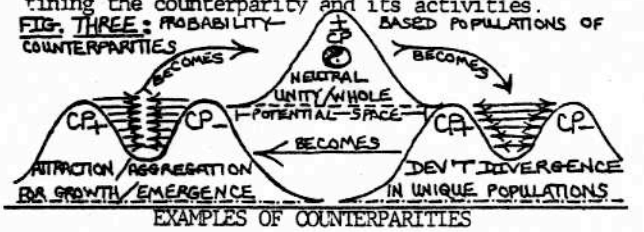
(7) Equal - Neither one nor the other counterparity is ever able to overpower the other in the long term, although in the short term one may temporarily increase in numbers. This equality maintains the dynamic tension between them and provides the force for continued and self-organizing generation of the unities and dualities. They "dance" around an equilibrium position in the potential space forever. The expansion of one automatically becomes the force for the complementary, responsive expanse of the

partner. This self-referencing feature maintains their equality without creating stagnation.

(8) Pairs On Same Level of Hierarchy - Due to the similarities mentioned in (4), (5), and (6) properly defined counterparities will have both partners of the duality within the same level of the natural metahierarchy.....they will not stand in counterparity across levels of the metahierarchy (see Troncale, 1972 for definition of metahierarchy).

(9) When Alone A Counterparitor Creates A Potential In A Potential Space - For many millennia man has recognized static things and named them. Static would be defined here as anything having a sufficiently long stability (lifetime) to be noticed by man or his recent technology. To this dimension of thingness Gerard suggests adding the concept of "entitation", To really "know" a thing you must not only "know" its physical representation, you must also "know" all of its connections with other things (see Troncale, 1977 for "linkage propositions" and discussion of this added dimension of knowing). Another dimension is suggested by the mechanism described for origins of dualities. This dimension concerns "knowing" a thing by knowing the fullness of its "potential space", that is, all of its possible changes and connections. This "potential space" is presumed to be definable (eventually) but not in the Western sense of reductionism. It may be defined mathematically as a totality without full knowledge of all the particulars analogous to treatments of probability. In any case, full knowledge of a thing requires knowledge of its physicalness, its entitation, and its potential space. An unsatisfied counterparitor has many potential spaces of combination with other counterparitors as they all seek their original energy state. So an unsatisfied counterparity cannot rest and is in constant "potentialness" or seeking until it is satisfied.

(10) When Bound To Its Partner, The Unit Complex Is Neutral - When the two pairs of the counterparity bind together they are reestablishing a variant on the wholeness from which they were derived. They are satisfied. They have replaced their potential for their rest state. Below we represent these states including the divergence and concrescence as normal distributions to emphasize in a crude diagram the importance of probability in defining potential space and the importance of potential space in defining the counterparity and its activities.



EXAMPLES OF COUNTERPARITIES

Table One shows specific suggestions of possible counterparities in real systems. They are grouped roughly in the conventional fields for convenience. Actually this grouping is devoid of hierarchical clustering. For information as to the hierarchical levels suggested for these fields see Troncale (1972) and the suggestion of a continuously forming set of levels called the metahierarchy. Future studies will need to apply the ten criteria of the last section to each of these suggested counterparities to eliminate all but those that meet the full set of criteria. Further study would classify counterparities into endocrescent and transcrescent types, examine the meaning of satisfied and unsatisfied states for each, and then collect empirical data relevant to these states for their better definition in each case. Possibly much of the data already collected by the reductionist methodologies of the specialties and disciplines which represent many of the hierarchical levels may be used for these holistic purposes. Each of the surviving examples of counterparity can then be analyzed in detail as specific representatives of the "emergent" evolutionary process at work in origins of hierarchical levels much as Darwin did for many biological examples of speciation in the Origin of Species. The data will be used to test the prediction of a constant range of concrescence ratios across all hierarchical levels leading to emergence.

The specific nature of the binding between counterparities changes drastically over the various conventional systems described in Table One. Focusing on these differences would undoubtedly inhibit recognition of the general similarity of form and function which is true of the counterparities across all of the specific systems surveyed. This is the central problem of perception which separates many reductionists from holists. Some individuals are more comfortable with higher levels of abstraction than others. The cases shown in Table One are certainly all different as regards specifics and their similarities are not noticeable until one permits their abstraction to high levels of generality of form and behavior.

It is also interesting to note that even in this brief survey of possible counterparities one finds they are represented in all complex natural systems cited. This places the concept on a par with concepts like cycling, feedback, etc. -- i.e. it is a major general systems concept that we should begin to use to explain and predict systems structure and function. It is as fundamental to study metahypotheses like counterparity using modern science and empiricism as the early sages believed it was to study its role in philosophically-based cosmologies (metahypotheses are explained in Troncale, 1977).

SEVEN STEP PROCESS RESULTING IN THE ORIGIN OF HIERARCHICAL LEVELS

The headings of the next seven sections should be read as a step-by-step schema. Together their action results in the emergent evolutionary process which for convenience may be called "metacrescence" (or "the process of growing together and beyond). The process is self-organizing in that it arises solely from the nature of the entities on each level and their normal interactions. Despite the tremendous differences in the specific nature of entities between levels (eg. compare galaxies to cells to nations) the process remains generally the same when described in this high order of abstraction.

This model holds best for the natural systems from astronomy to physics, chemistry to biology. It is more difficult to justify on the level of social

hierarchies. It also presumes that much of what are called hierarchies today are, in fact, loose uses of that term or not hierarchies at all. Many social and symbolic hierarchies are relatively "artificial" compared to what we might call natural hierarchies. They depend on mans conscious activity. The hierarchies so formed would disappear if man did. In fact, they often exhibit rapid turnover even within the short period of the history of man (Toynbee, 1972). As such they are incredibly short-term, transient, and unstable compared to the natural systems hierarchies discussed in Troncale (19 72), and partially shown in Figure Four. These hierarchical attempts of man at present fall into the transient parts of Figure One as he struggles to give birth to the next level of the metahierarchy. In contrast, the natural hierarchical levels of Figure Four last millions and billions of years and do not depend on man (rather vice versa). It is to these levels that the seven-step process of emergent evolution applies best.

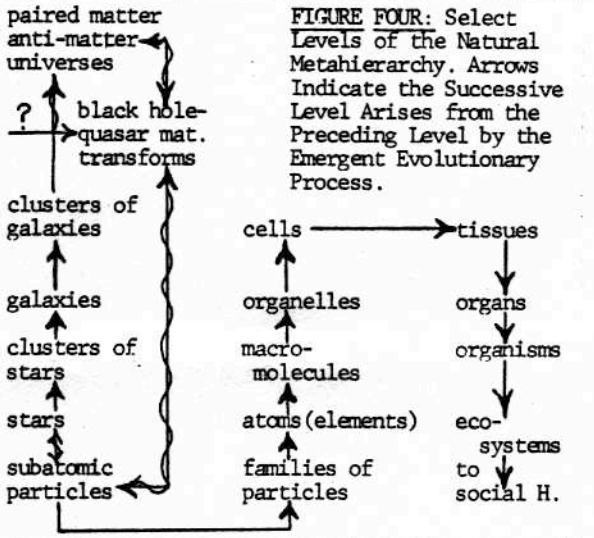


FIGURE FOUR: Select Levels of the Natural Metahierarchy. Arrows Indicate the Successive Level Arises from the Preceding Level by the Emergent Evolutionary Process.

Clearly, the above is a very restrictive and parsimonious definition of hierarchy designed for the specific purpose of simplifying the number of hierarchies to reveal the emergent evolutionary process. Many would argue with it for it excludes hierarchies so near and dear to man. The purpose of this paper is not to challenge these other meanings or discourage work on them but rather to draw attention to a specific and potentially quite profitable set of studies with a rigorously defined set of hierarchies.....which additionally have a large collection of empirical data associated with them allowing tests of hypotheses and predictions. In any case, it is our assumption that the mutual and self-referencing definitions of the natural levels and the evolutionary process are the determinants of what is and what is not a natural hierarchy.

Darwinian evolution can be seen as a special case of this seven step process. Actually Darwinian evolution is a more general process than its usual application to bio-change on earth. Neo-Darwinian sophistications would also apply to living system changes on other planets. Since Neo-Darwinism is such a powerful special case, it has many areas of correspondence with this emergent evolutionary process, which it instructs, and upon which it is based. Perhaps the mathematical and empirical developments from this theory will return the favor by answering for Darwinian evolution some of the recent objections of mathematicians to the incompleteness of the Darwinian process (Moorland and Kaplan, 1967).

STEP ONE: SPECIFIC COUNTERPARITIES FORM FROM POTENTIAL WHOLES NATURALLY, AND AT ALL LEVELS OF ORGANIZATION.

How are counterparities formed? The secret of understanding may lie in not staring so hard at the entities themselves but rather considering their potential as more important than their physicalness. The reason for the bifurcation of a potential whole entity into partner counterparities may involve considerations stemming mainly from the "context" or "environment" of a specific counterparity not from the entity itself. This may be called a self-referencing feature because the event obtains its meaning through its relation to its context and without its context it has no meaning. This self-referencing feature of counterparities (hereafter CP's) may be what leads to the self-referencing nature of the hierarchies they generate (Wilson, 1977). From the above it follows that the magnitudes of size, volume, density, energy, binding distances, life spans, etc. which denote the environment of the potential whole which bifurcates into CP's is of central importance. To understand why the bifurcation happens at all and why it takes the duality form man must shift his concept of what a wholeness is to include these holistic considerations of its potential space.

Let us consider a wholeness not as a material thing but rather a "potential space." Further, let us see the space as limited figuratively to an area of effective and relative stability by the magnitudes of parameters of its environment (mentioned above). Within this space several alternative material wholeness'es are possible. But again the context will select among these since only some will last long enough to function and therefore to "materialize" sufficiently for man to experience their lifetimes. Now among those that do "materialize" from the space, it is generally erroneously thought that they materialize in static form (and become what man calls entity or thing). But this may not be an accurate or complete description! The entities surviving the context are actually still creatures of the "potential space" as much as they are creatures of the material world. Once divorced from preoccupation with man's limited time span of perception, the real vision of things sees that they oscillate around an equilibrium position (E) within the potential space as seen in Figure Five. They oscillate in time and spatial dimensions not easily seen by man's common senses. In the Figure, (P) is the "potential space" (seen here only two dimensionally) and it contains all allowable "wholeness'es" for its context. The oscillating path (O) is a purely figurative representation of one set of instantaneous fates of one entity (other paths of potential wholeness coexist within (P)). The shaded areas are

where the counterparities (CP's) arise. They branch off and experience an increase in stability at the extremes, thus becoming preserved entities only in these ranges. The populations of CP's so produced are always dual and opposite to each other in small ways as a result of the dynamic oscillation of the potential "whole" around a never-realized stillpoint (equilibrium position). This oscillation occurs in two directions as most do. Why do the CP's form in the shaded regions? Because here they experience sufficient stability to "materialize" (become perceptible to man). But why do they experience stability here? This is a very difficult question that cannot be answered in our typically Western science manner of linear causality. An explanation would require simultaneous awareness of several sets of causal conditions acting together at once (network causality, see Troncale et. al., 1976). We are told by psychologists man cannot hold more than a few items simultaneously in his memory. Therefore, use of network causality is at present a very fumbling enterprise for man. So we must express why CP's experience stability at extremes in a quasi-linear network of causality.

The field potential provides a dynamic context which works again and again to generate CP's, probabilistically. For example, one portion of the network of causes entails the rest of this paragraph. The distance of the oscillations from the stillpoint is such that the potential CP's that form in the shaded region experience maximum attraction for each other. This "threshold" attraction is required if they are to interact as successful CP's to form new aggregates despite all the counterposed forces in the potential space. By interacting they provide new material units (from each two CP's) which in turn achieve new levels of parameter magnitude stability. These new levels are a new potential space. The CP's are the subunits of these new units with new emergent stabilities. By their participation in the formation of new levels, the CP's are caught in their stable forms and thus experience with the units they form new potential lifetimes. This emphasizes their feature of self-referencing. They partly create their own environment while experiencing it and having it create them. All of these results are themselves the cause of CP's probabilistically experiencing more stability and materializing in the extreme opposite regions of the "potential space" of their parent wholeness. But more than one type of CP emerges at the extremes. Due to the extent of the "potential space" more than one wholeness can populate it. As a result, all bifurcations are not the same. A population of slightly variant CP's form from the figurative range of wholenesses possible. Yet the family of wholenesses are enough similar that all the variant CP's on one level can still interact with each other.

It must be noted that at the present time an insufficient number of CP's have been identified to account in specific ways for generation of the hierarchical levels shown in Figure Four. This paper only explores the hypotheses and formulates some initial predictions to stimulate future work. It has no pretensions as to proof or even completeness as regards elucidation of steps or overall description. See Figure Three for a diagrammatic representation of Step One.

STEP TWO: UNGUIDED PROBABILITY LEADS TO POOLS OF VARIANT COUNTERPARITIES: THE ROLE OF STABILITY VERSUS DIVERSITY.

The field of probability is, in a sense, one of mans first expression of awareness of "potential spaces". All things that can happen, will happen, and we will call the total happenings = to 1. The generator is chance -- of which we know little, so we characterize the results of chance, of which we know a little more. Chance also has a central role in this process. It was pointed out for Figure Five

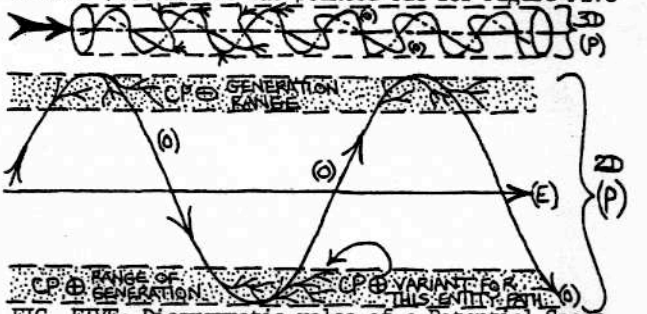


FIG. FIVE: Diagrammatic roles of a Potential Space (P) and Its Oscillations of Entities in Origins of Different Populations of Complementary CP's.

that several potential wholenesses existed per potential space. Each may or may not succeed in generating its set of CP's depending upon many variable influences of its context. Probability theorems may help describe this process, or at least its results, so in Figure Three we used normal distributions to indicate that, given three things, CP generation can be treated as a statistical phenomenon. These three are; (i) some empirical data on the magnitude parameters for that level of hierarchy, (ii) an expression of the range or tolerable limits of the potential space in terms of these parameters, and (iii) some devices to measure the transients man cannot yet perceive. Since having all three is unlikely we may resort to general formulations along the lines of probability theory.

The upshot of these considerations is that besides the family "type" of a counterparity emerging (eg. opposite spins to electrons /or/ matter, antimatter particles) many variants of each CP type also emerge due to chance (in the above, respectively, many orbital combinations, shells, & valences in different atoms /or/ families of subatomic particles). This action of chance in producing populations, not single sets of pairs, is the key insight for this step in the process. The populations allow probability to be used.

In recent ecosystems analysis literature there is a growing debate over the counterposed forces of stability versus diversity -- which is the dominant influence? (McNaughton, 1977; May, 1973; May, 1977; First Int. Cong. of Ecology, 1974). How do they interact? The empiricism and math theory developed in this debate could apply to this step in the emergent evolutionary process. For example, the "materialization" of the CP's involves considerations of their

stability relative to their "potential space" while the forces of chance result in the appearance of a diversity of CP's. So these two features also interact in this process and fertilization from the ecosystems field is likely. Study of potential spaces may reveal a "limit" relationship between tolerable stability and tolerable diversity when together in one context, thus helping the ecosystem field.

STEP THREE

CONCRESCENCE AND ENDOCRESCENT COUNTERPARITY: CP+ VARIANTS AND CP- VARIANTS COMBINE INTO A SPECTRUM OF AGGREGATES OF VARIED STABILITY (Formation of Entities Within A Hierarchical Level).

CP's might be expected to show a tendency to decay to the "equilibrium position" from which they arose by oscillation. But in the presence of a similar population of opposites bifurcated from the same whole, and in a deviation from idealized still point in exactly complementary ways, the CP instead experience forceful combination and union with its partner CP rather than decaying. Further, Figure 5 should be a 3-dimensional picture showing a pool of variant CP's arising in the peripheral zone, such that 2 CP's from uniquely different wholeness paths can also experience attraction. This heterogeneous binding of cross-wholeness CP's results from their inbuilt similarities as spin-offs of the same potential space. These bindings yield a large number of new aggregates, arising from different sets of CP's, some of which are stable, some not.

We call this tendency of CP's to recombine, but in new ways....concrescence (L., con = together; cresco = to grow; -ce = the action or process). Concrescence means the action or process of CP's coming together into aggregates. Concrescence is a natural process arising as spontaneously as counter parity and is likewise common to many natural systems and to all levels of the metahierarchy. It is another important principal systems concept deserving study.

The CP+ and CP- aggregations make up the substance of material entities for their "potential space," or hierarchical level. This aggregation is intra-level proliferation of entities. It populates the space within the level and distinguishes it from the gaps on either side that separates this cluster from others. An example of this would be the generation of many elements from the same basic subunits of subatomic particles. All of these elements are built from the same CP type and function, and all are within the same range of parameter magnitudes, (i.e. the same H. cluster). When the full set of CP variants combine, they do so in non-homogeneous ways. For example, an element is not homogeneous - it exists as a nucleus and electron shells. The nucleus and inner e- shells are completely paired sets of CP's. They are stable and give the entity feature to the element. They combine in ways that give a "central" stability to the element by within-level CP interactions. We call these endocrescent counterparities, because their process of growing together operates solely within the level ("endo" L. = inside of). These types are all satisfied counterparities. A future paper will develop endocrescence mathematically.

STEP FOUR: CONCRESCENCE RATIO AND TRANSCRESCENT COUNTERPARITY: AN INVARIANT RANGE OF RATIOS OF SATISFIED TO UNSATISFIED CP'S CAN FORM EMERGENT COMPLEXES (Formation of Entities Jumping to a New Hierarchical Level)

Let us continue with the same example. At the periphery of elements in the outermost electron shells are certain counterparities which have the potential for combination but are not fully complemented. For example, in oxygen, :Ö• , two pairs of e- are satisfied in the presence of their opposites but two others remain unpaired. The unpaired CP's comprise the peripheral instability characteristic of unsatisfied CP's. This enables the elements to combine with other elements within the level at the allowed magnitudes of bonding distances, energies, etc. When sufficiently large units within the level combine in sufficiently complex ways (usually involving several peripheral CP's built on already large complexes built up from endocrescent CP's) they form such large new units, that these new units become the base population of an entirely new level of organization. This new level of organization (or H. cluster) has new characteristic magnitudes of parameters, and therefore new "potential spaces," new variant CP's and new central and peripheral stabilities and instabilities.

These new complexes are called "emergent" because of their new qualities. This process describes how macromolecules emerge from elements but we suggest that this model also holds for other levels. Those peripheral CP's that are unsatisfied and lead to the emergent complexes by seeking their complement, we call "transcrescent" counterparities (L., "trans" = across or beyond). These CP's cause their associated central stabilities to act like subunits forming aggregates that transcend their potential space.

Again probability plays a role. Many types of elements are possible. Most elements, however, do not form the next level (transcend to) macromolecules. The inert elements do not combine at all. The radioactive elements are not stable alone, much less in combination. This range of unreactive to overreactive entities is reminiscent of a statistical distribution in which chance plays a role. It probably occurs at all levels. Some range of entities on each level that have sufficient central stability (satisfied CP) to last long enough in populations....combine with other such entities in significant ways....and yet have sufficient peripheral instability (unsatisfied CP) to promote emergence of new aggregates and new levels. The relative amount of satisfied to unsatisfied counterparity (central to peripheral stability) potentially can be measured for entities in physical systems. Our hypothesis is that the very same range of ratio of SCP to -SCP will be characteristic of those entities on one level of the hierarchy which give rise to the next no matter what the specific nature of the CP or at what level the measurement is taken. Further, there is a good chance that this invariant ratio (or probably tight ratio range) would bear significant relationships to other invariant laws of our universe due to its role in generating hierarchies which are an important feature of our universe.

This invariant ratio we call "concrescence ratio", and since it arises naturally from the counterparities at each level of the metahierarchy, it is another candidate principal systems concept deserving study.

STEP FIVE:

CONCRESCENCE FORCES ARE ACTED ON BY BOUNDARY LIMITS RESULTING IN HETEROGENEITY WITHIN THE POTENTIAL FIELD AND BETWEEN POTENTIAL FIELDS

Albert Wilson states..."if in a system (given sufficient mass); (i) there exists a force of gravity (or an aggregating force), and (ii) there also exists in that system a "boundary" limiting the potential field, then when that system comes to equilibrium, it will be a modularly hierarchical structure," (Wilson, 1978). The most important feature of this statement is its mathematical equivalent. Although the aggregating force equation must take the form of the level of the hierarchy under study, the "boundary" equation, for astronomical systems, takes the form,

$$\frac{GM}{c^2R} < b$$

where G= gravity, M= mass, c^2= the velocity of light, R= radius, b= bounds, and ρ= density of object. As

$$M = \rho R^3$$

and

$$\frac{G}{c^2}\rho R^2 < b$$

then

$$\rho R^2 < b$$

which states that for matter at a given density, the size is bounded (or for a given size the density is bounded), and the boundary delimits essentially what we see as the cluster limits of the hierarchical level.

Although these observations have been developed primarily in the field of astronomy, they could profitably be extended to and tested in other hierarchical levels as the same dynamics exist in all following the above discussion. The gravitational forces active in astronomical systems should be considered a specific type of concrescence tendency typical of that level. The extension of the concept of concrescence to concrescence ratio and this to the root concepts of counterparities should provide a number of new "handles" to use in seeking relevant and measurable parameters at each level of the metahierarchy to apply the above equations, (or their generalized modifications). These kinds of studies will aid in understanding the mechanisms active at each level (so contributing to the special fields) while at the same time providing a basis for the unity of knowledge.

One key insight that emerges from defining the interrelationships of material aggregates (entities) and "potential spaces" is to recognize that they are the most primeveal and abstract counterparity from which all others arise. The two truly form each other given the emergent evolutionary process. Their interaction (material vs. space/time field) actually produces what we call energy at all levels, and the three taken together yield the heterogeneity we call hierarchies, as partially described in generalized versions of the above equations.

Potential spaces are new types of beasts for Western man to explore. He has all but entirely ignored them, but now they pop up all over...in atomic physics, in astronomy....wherever Western science finally gets down to fundamental questions. Potential spaces are so important that it is impossible to describe completely such basic concepts as material entities, natural system counterparities, energy or directional force, or hierarchical evolution without including them in the equations. This reminds us again of the indivisible unity or holistic nature of natural systems and brings us back full circle to the Yin/Yang philosophy with which we began. It is comforting that science and philosophy are indeed counterparities themselves and will be one again.

Steps Six and Seven will be explained more completely in future papers. Step Six is "NEWLY EMERGENT COMPLEXES GENERATE NEWLY EMERGENT COUNTERPARITIES: THE SELF-ORGANIZING, GENERATIVE CYCLE CONTINUES. Step Seven involves mathematical statements of the previous steps which are then related to several existing mathematical systems in an attempt at unification of several natural processes.

CONCLUSIONS

The following statements are suggested; (i) the continuous, self-referencing, and self-organizing origins of hierarchical levels can be explained in terms of one generalized natural process, (ii) the concepts of counterparity, concrescence, concrescence ratio, and potential spaces are fundamental abstractions true of so many diverse systems that they deserve recognition/study as principal systems concepts, (iii) systems evolution is a central process too long ignored by systems theorists, (iv) any one counterparity-type exists as a population and much of its functional significance derives from this fact, (v) counterparities and concrescence ratios have features which are amenable to measurement, which measurements once undertaken will sharpen our understanding of these concepts, the emergent evolutionary process in which they function, and will encourage the formation of testable and falsifiable predictions.

The metascientific (Troncale, 1977) and systems study of counterparity adds considerable dimension to the ancient concepts of dualism, &/or complementarity. The old conceptualizations generally do not link dualism to (a) the generation of hierarchies, (b) to stability/diversity mechanisms, (c) to measurables in real systems, (d) to populations of dualities, (e) to boundary limits and potential spaces, or (f) to processes of "emergence". This paper links counterparity to all of these phenomena.

POSTSCRIPT: A bubbling waterfall in a stream does not exist apart. Instant by instant it is remade by the constant flow of different waters over the same potential spaces of the rocks. Likewise hierarchies do not exist apart. They are continuously formed by the flow of things thru potential spaces. Trying to explain either will never be as beautiful or complete as the natural processes themselves.

TABLE ONE: EXAMPLES OF SUGGESTED COUNTERPARITIES FOR SEVERAL SYSTEMS

ASTRONOMICAL	PHYSICS	CHEMICAL	BIOLOGICAL	SOCIOLOGICAL	SYMBOLIC
*matter vs. anti-matter	*wave vs. particle complements	*L-forms vs. D-forms	*bilateral symmetry	*Yin/Yang	*word pairs in languages (good/ evil; in/out,etc.)
*black hole vs. quasar cosmology	*opposite spins on electrons	*anabolic vs. catabolic reactions & networks	*ag-ab complexes (steric fit)	*thesis/anti-thesis	*duality theory in computer programming math.
*space vs. time	*energy vs. matter	*oxidation vs. reduction reactions	*male/female	*tonal vs. nagual	*holism vs. reductionism; analysis vs. synthesis
*gravitational attraction vs. size limits (all GENERAL levels)	*dual resonance hadrons	*positive vs. negative ions/ charges	*complementary bases:r.DNA	*challenge vs response (or S/R)	*binary math
*stability vs. variation	*poles in magnetic fields	GENERAL (cont.)	*genetic palindromes	*worldview value cycles	*duality processes in Markovian proc.
*stability vs. diversity	*continuous vs. discontinuous matter	*entropy vs. negentropy	*left/right brain hemisphere specializations	*goal vs. process orientations	*subjective vs. objective reality
*satisfies vs. unsatisfied counterparity			*opposing muscle groups	*Eastern vs. Western philos.	*protagonist vs. antagonist in drama & mythology
			*compl. social calls in animal behavior (attraction vs. repulsion/ birds)	*conscious vs. subconscious	
			*post div. cell migrations		

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