Ecological Metaphysics: Room for a Creator

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1. An Indeterminate Conversation:

Yesterday, I engaged in no small amount of deconstruction. My aim, however, was not to belittle the laws of physics. Obviously, their formulations stand among the crowning achievements of the past three centuries. I did argue, however, that they are not the totalizing, all encompassing constraints that so many in science regard them to be. Their ontological status is usually exaggerated. There are historical, logical and practical reasons why the laws of physics, although inviolable, remain incapable of determining all that happens. Such inefficacy owes to the fact that, in order to be as general as possible, the universal laws must be cast in homogeneous terms. The living world, however, is munificently heterogeneous, and the enormous numbers of combinations among so many categories means that large numbers of possibilities attach themselves to any particular juxtaposition of laws. The laws are not violated. They simply lose their abilities to discriminate among equiponderant possibilities. The sheer magnitude of combinations defeats attempts to structure a determining set of boundary specifications.

Fortunately, the world does not fall into total chaos as a result. Self-reinforcing constraints arise through serial selection of historical contingencies and exert endogenous selection upon its constituents to stabilize their own configurations. The autocatalytic nature of these process configurations inclines them to sequester resources in centripetal fashion and act as semi-autonomous agencies. The incorporation of new contingent events by extant configurations is non-random – the great majority of contingent events that are encountered are not selected, only the very few that conform and abet existing dynamics. Exactly which appropriate event will next be encountered remains a matter of contingency, however. As a result, evolution appears as a non-random but indeterminate process.

I found it difficult at first to wrap my mind around a process that is nonrandom but also indeterminate. For me, one of the most helpful metaphors was scripted by physicist John A. Wheeler (1980), who suggested that the evolution of science is like a parlor game (Ulanowicz 2012): A number of guests are invited to a dinner party. Dinner is late, and so the hostess encourages the company to entertain themselves with a game. They elect to play the game ''20 Questions'' in which the object is to guess words. One individual is sent out of the room, while those who remain are to choose a particular word. It is

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explained to the delegated person that upon returning, he/she will pose a question to each of the group in turn and these questions may only be answered with a simple ‘‘yes’’ or ‘‘no’’ until a questioner guesses the word. After the chosen player leaves the room, one of the guests suggests that the group not choose a word. Rather, when the subject returns and poses the first question, the initial respondent is completely free to answer ‘‘yes’’ or ‘‘no’’ on unfettered whim. Similarly, the second person is at liberty to make either reply. The only condition upon the second person is that his/her response may not contradict the first reply. The restriction upon the third respondent is that that individual’s reply must not be dissonant with either of the first two answers, and so forth. The game ends when the subject asks, ‘‘Is the word XXXXX?’’ and the only response coherent with all the previous replies is ‘‘yes’’. At any point in the game, the response is not fully random, and yet it is impossible beforehand to ascertain which word will end the game.

Important here are the rules of the game. Even when the rules are never violated, they only constrain what can happen, but they obviously do not determine the outcome. What does specify the outcome? A little reflection will reveal that the game is cast as a conversation, or more accurately a dialectic. On one side stands the questioner, who continuously attempts to narrow down the range of possibilities. Against him are the respondents, who are free to choose answers that could serve to extend the game. One perceives the same agonism in nature. We saw how in autocatalysis order and form are built by the progressive inclusion of contingencies into the existing configuration of its processes. On the other hand, such order as has arisen is constantly being impacted and eroded by entropic contingencies.

Evolution as first proposed by Darwin was truly dualist, not on the sense of Descartes, but rather like that described by Heraclitus, who saw nature as the outcome of actions that build up as apposed to events that tear down – or akin to the ancient Tao, where the active agency of Yan stands in contrast to a more passive and conservative Yin. Perhaps even more accurately, the dynamics were described by Chardin (1972) as a “law of attraction" that emerged out of countervailing directions of convergence/divergence.

We discern as well two separate levels of causality, the first of which plays out among homogeneous entities as they obey the universal laws of physics. These laws are not violated, they simply lack direction and remain indifferent to more proximate constraints that build around local and historical occurrences that select a specific pathway (direction) of events. Charles Saunders Peirce (1935) called these local constraints “habits” of nature, while Stanley Salthe (personal communication) calls them “laws of matter”. I prefer the designation, “proximate laws”, even though these laws are at times very widespread, like the constraints occasioned by the nexus of reactions involving DNA/RNA that provides direction for the development of all surviving living forms on earth. We thus realize that it is not the force laws themselves that *drive* the selection dynamics of the *Utricularia* community, but rather the mutualistic set of services that the participants perform for one another. We conclude, therefore, that every enduring form that one encounters is the outcome of mutual beneficence selectively accumulating contingencies.

2. **Quantifying Processes:**

Although the ecological narrative of evolution seems coherent, science is generally required to deal with quantitative, testable hypotheses. Assuming that life is process and that the dynamics of life are driven by cycles of processes, how could one quantify such process dynamics so as to allow the formulation and testing of hypotheses? It happens that systems ecologists have been occupied for over 70 years with linking together processes of trophic transformations into quantified networks (Lindeman 1942). Figure 1, for example, is a schematic of "who eats whom and at what rate?" in the middle Chesapeake Bay ecosystem (Baird and Ulanowicz 1989). Because a process is a sequence of transitions from one distinguishable state to the next, one may regard each pathway in the network as describing a process. Each cycle in the network outlines some form of feedback dynamics. Heterogeneity explicitly appears as the multiplicity of distinguishable nodes. All of the elements needed to portray the ecosystem as a configuration of processes are present in the network in quantifiable form.

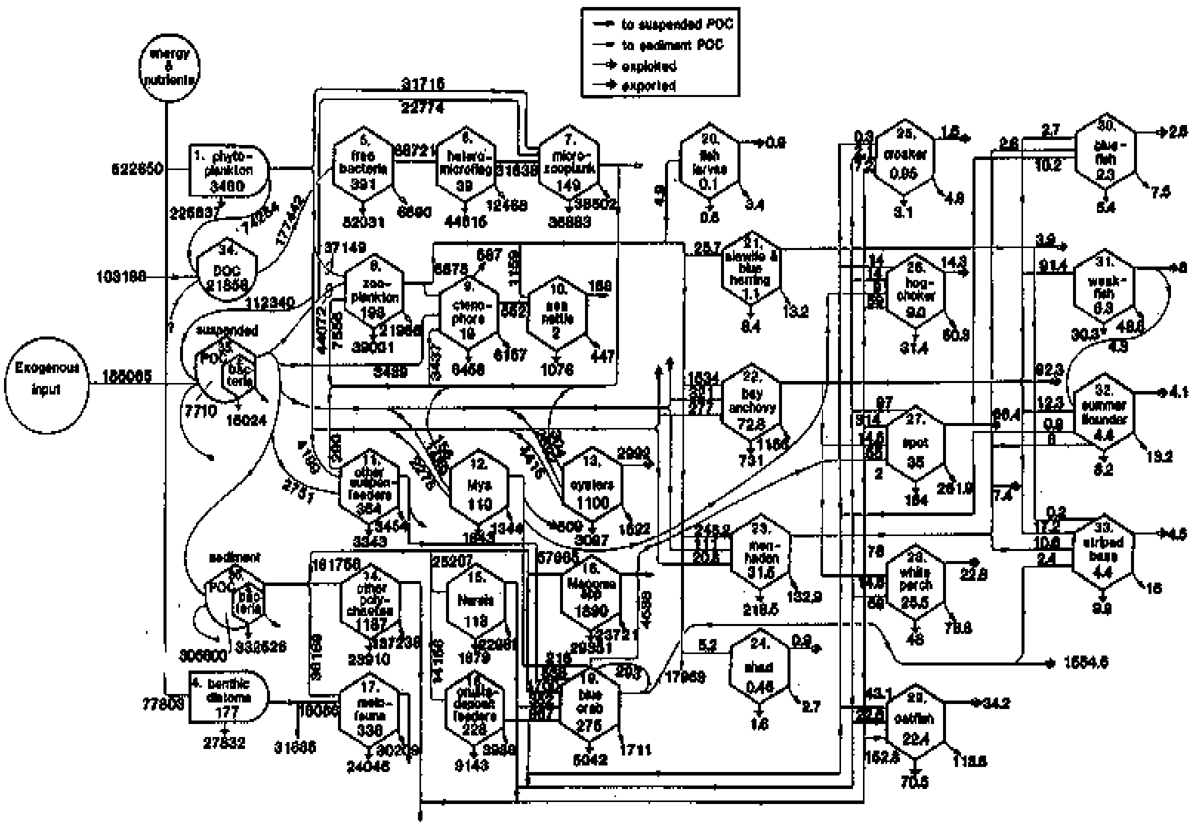

Figure 1: Carbon flows among the 36 major trophic components of the mid-Chesapeake Bay ecosystem. Arrows indicate flows from prey to consumers as measured in $mgC/m^2/y$. Numbers inside nodes are the estimated densities of that taxon in mgC/m^2.

It happens that physicists more recently have also discovered networks, so that a huge literature has grown around the topic. Unfortunately, the great bulk of this research is devoted to the search for mechanical explanations of why certain types of networks occur under various conditions. That is, emphasis focuses almost entirely upon the constraints interact in the networks. But we have been emphasizing the strong role played by contingency and the indeterminacy that it imparts to natural dynamics. Such indeterminacy also resides in networks, albeit it is usually ignored. Networks are amalgams of constraint and contingencies (Pahl-Wostl 1995). For example, if one is at a particular node in a network, transition usually cannot occur directly to all other nodes. Algae are not immediately ingested by striped bass in Figure 1. Any number of factors can *constrain* such action from happening. On the other had, from a given prey node, it is usually indeterminate to which predator transition will next occur (who will eat it?) It is unknown *apriori* whether a particular variety of zooplankton will be eaten by a variety of filter-feeding fish or by a host of bottom-dwelling invertebrates. Networks encompass both constraint and indeterminacy.

Although one cannot physically disentangle the web of most networks[3], it is serendipitous that one can mathematically assess how much network activity is being guided by constraints in contrast to how much freedom remains for events to transpire in indeterminate fashion. It is easy to envision the forms of those networks that constitute the extremes of full constraint and total indeterminacy. For example, in the cycle graph of Figure 2a all transitions are determinate and equiponderant. Only one flow enters or exits each node. There is no indeterminacy. Figure 2b, however, depicts the other extreme. Transition between any two nodes is equally likely. There are no visible constraints, only indeterminacy. How then does one quantify how far between these extremes a particular network lays?

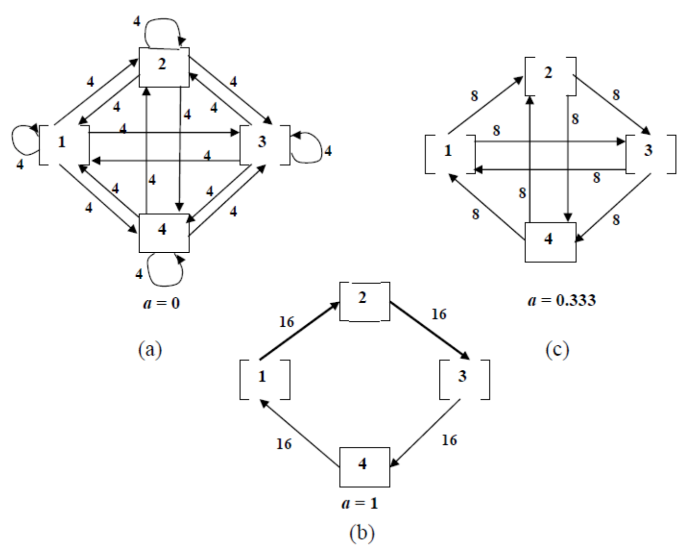

Figure 2: (a) A four-component network with no constraints (a = 0) and maximal indeterminacy. (b) A four-component digraph that is fully constrained (a = 1). (c) An intermediate network with both constraint and indeterminacy (a = 0.333).

[3] But see Ulanowicz (1995).

It is beyond the scope of this paper to derive the appropriate measure (Those interested see Ulanowicz and Norden, 1990.) Suffice it to say that information theory applied to networks allows us to define a "degree of order", a, that characterizes the percentage of constraint inhering in a given network. For any quantified, directed network the percentage of constrained flow can be calculated such that $0 \leq a \leq 1$.[4] For example, the value of a for the network in Figure 2c is approximately 0.3333. The measure a permits one to track the order in a configuration of process as it either progresses or degenerates.

It was originally thought that investigators would see a progressively rise with the development of ecosystem processes over time (e.g., Ulanowicz 1980). This expectation was never realized. (The hypothesis was falsified!) Instead, ecosystem networks of trophic processes, calculated over a diversity of habitats and environments, showed remarkable consistency and clustered around $a \approx 40\%$ (Figure 3). Such consistency seemed to indicate that a particular balance was being struck between internal order (and efficiency) and freedom (often in the guise of inefficiency or redundancy of pathways) across a wide range of circumstances.

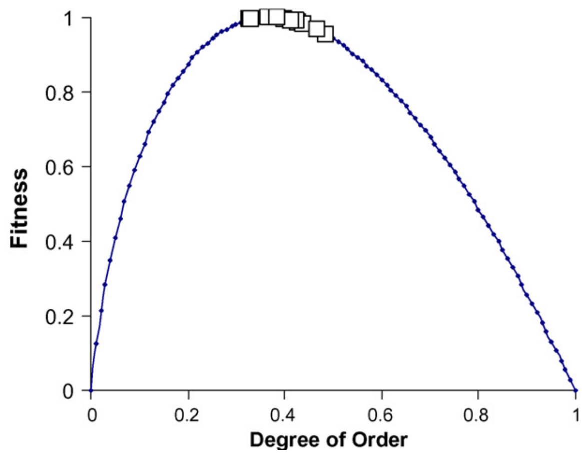

Figure 3: The clumping of articulated ecological trophic networks around the "degree of order" $a = 0.40$. (Fitness is measured as $-a\log(a)$, and represents the potential of the system to evolve further as the product of the system's order [a] times its relative disorder, [$-\log(a)$].)

3. Why Disorder?

The seeming existence of a balance immediately prompts the question, "Why doesn't the efficiency of natural networks increase beyond a certain point?" Why not maximize efficiency, as most expect nature to do? The ecological answer to this question seems to be that, when a system is disrupted by a *novel* disturbance, its ability to reconfigure itself to meet the challenge depends on how many adaptive repertoires it can fashion from among its mix of processes that hitherto had appeared as useless or inefficient. A system

[4] If T_{ij} represents the effect of node i upon node j, then
$a = -\{\Sigma_{i,j} T_{ij} \log([T_{ij}\Sigma_{k,l}T_{kl}]/[\Sigma_k T_{kj}][\Sigma_l T_{il}])\}/\{\Sigma_{p,q}T_{pq} \log(T_{pq}/\Sigma_{k,l}T_{kl})\}$.

that is allowed to wax efficient without retaining such “strength in reserve” will become “brittle” (Holling 1986) and highly vulnerable and will collapse in the face of some new disruption. As Chardin (1960, p100) wrote, "In the spiritual life, as in all organic processes, everyone has their optimum and it is just as harmful to go beyond it as not to attain it." To endure, dissipative systems must retain some degree of “overhead” that serves as insurance against novel perturbations.

I would like to pause at this point for an important diversion and consider what might be called “scientific eschatology” – the popular consensus that the ultimate fate of the cosmos is “heat death” by which is meant an end state that consists of nothing but widely-dispersed, low-energy photons. This conclusion flows from theory that is rooted in models of systems that are rarefied, homogeneous and (at most) weakly-interacting. It is an equilibrium akin to that depicted by the point $a = 0$ in Figure 3. But the value of a is actually an index of how strongly interactive system elements are. If elements remain relatively non-interactive, there is not other possible equilibrium than heat death.

It happens, however, that $a = 0$ is not the only possible equilibrium point in Figure 3. As soon as one begins to treat systems wherein elements can interact significantly, another possible endpoint equilibrium appears at $a = 1$. In terms of networks, that point always represents a cycle, or collection of cycles, in which all links are equiponderant and in which each element is the consequence of only one other element and transitions to only one other node (e.g., Figure 2a). No exogenous inputs are required to maintain the cycling. I have noted elsewhere (Ulanowicz 2009a) how this cyclical configuration is reminiscent of the electron orbits in stable matter, which quantum theory depicts as standing waves, or perpetual harmonies. As a simplistic example, a hydrogen atom, consisting of a single proton and a ground-level state electron could conceivably endure in isolation without limit.

Concerning such harmonies, we note an event during the evolution of the cosmos called the “Recombination”, that occurred some 378,000 years after the Big Bang. Before that time, light could not penetrate very far through the dense mix of radical particles. With further expansion and cooling, however, neutral matter (mostly in the form of hydrogen) precipitated out of the mix. Other forms of neutral matter followed and the cosmos, which until that time could have been considered a unitary dissipative structure, effectively separated into neutral matter (near $a = 1$) and dispersed heat ($a = 0$), the latter of which is still visible today as 3.7K background radiation. This event could be visualized on Figure 3 as a system with an intermediate value of a separating into two parts – one (dissipated heat) migrating to $a = 0$, and the other (enduring harmonies) moving to $a = 1$.

I mention this, because a “cosmology of despair” (Haught 2000), so fashionable in academic circles, is predicated upon the universe having but a single endpoint – heat death. But is heat death the only inevitability? One could regard today’s humanity as a highly dissipative structure (not an inaccurate portrayal!). As the universe continues to cool, what is to preclude another Recombination-like precipitation that would give rise to some self-contained, eternal and equiponderant configuration? I can’t conceive of exactly how that utopia could come about, suffice it to say it would not be unprecedented and that the outcome would bear strong resemblance to Chardin's (1959) Omega Point, towards which he suggested creation is proceeding (Ulanowicz 2009a).

4. Dualism Redux?:

In the spirit of recombination, it is time to pull together the assorted threads I have been discussing into a systematic whole. The reader has likely already noticed the theme of duality suffusing what has been written, but Cartesian duality is not where this narrative is leading. Rather two interpenetrating realms of causality have emerged, each following its own separate metaphysics:

Demarcation between the two domains lies more along the dimensions of complexity (heterogeneity) and density than with time and space. Ironically, science began with models that represented rarified, homogeneous and weakly-interacting systems which only could have emerged very late in cosmic evolution. Under such circumstances, the four force laws allow for determinate predictions, whenever the accompanying boundary statement can be predicated in full.

Manifold heterogeneity and significant interactions, however, erode the validity of the classical assumptions that allowed the laws to be formulated. Although the laws are not necessarily violated in the dense, heterogeneous realm of living phenomena, they lose their power to discriminate among enormous numbers of possibilities that characterize the second realm. Causality there appears to arise more out of configurations of processes, the descriptions and workings of which differ significantly from those of conventional physics. The governing rules in the heterogeneous realm come into being through an historical compounding of contingent events, and they apply only within circumscribed regions of time and space. Within those areas, however, they are able to specify outcomes that elude prediction by the universal laws.

Causalities in the two realms work in opposing directions as in a Heraclitian dialectic. The laws as they apply among rarefied, homogeneous and independently acting entities do not impart coherence, and so centrifugality dominates, as with entropic decay (the second law). The dynamics in heterogeneous systems, by contrast, are dominated by centripetality and order-building, give rise to structures of ever more effective autocatalysis. The forms that ensue are the product of a "tug-of-war", as between Chardin's "countervailing directions of convergence/divergence ". This exchange cannot result in the extirpation of either agonist, however. If centripetal efficiency were to eliminate all disordered actions, the ensemble would be able neither to progress nor to maintain itself. Reciprocally, ever greater streamlining of processes tends to generate more overall dissipation.[5]

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[5] Dissipation, when calculated on a per-capita basis, sometimes decreases.

5. A New Metaphysics:

The existence of complementary dynamics suggests that different fundamental assumptions may pertain to each realm. In the realm of classical physics it was discussed how five assumptions were thought necessary to describe dynamics: (1) closure, (2) atomism, (3) reversibility, (4) determinism and (5) universality.

In the discussion that followed, as the transactional scenario for ecosystem development unfolded, it was necessary to invoke three fundamental axioms along the way (Ulanowicz 2009b):

i. Contingency – Systems are continually being impacted by arbitrary events that are not amenable to complete description by laws subject to closed-form boundary specifications.

This axiom posits contingency as an ontological reality. It's not that the contingent events violate any law; it's that the accompanying requisite associated boundary statements cannot be formulated in closed form.

ii. Feedback – Processes, via interaction with other processes, are capable of influencing themselves.

This is a radical assumption. It violates closure and the Aristotelian prohibition against circular reasoning. It legitimates mereology (Juarrero In press) and sets the stage for autocatalysis and its attributes, which are fundamental aspects of living systems.

iii. History – Systems differ from one another according to their histories, some of which is recorded in their material configurations.

This assumption formalizes what Darwin long ago assumed about the natural world – that there is simply no way to create history using only reversible laws.

6. A Natural Agonism:

Of particular interest, each of these last three statements stands as the antithesis to one of the fundamental assumptions of Enlightenment physics: Contingency is the opposite of determinism; feedback violates closure and history negates reversibility. Atomism and universality have no counterparts in the revised metaphysics. In a world where relationships are primary, atomism either doesn't exist or serves no useful function.

The three fundamental axioms (*i – iii*) lead to the corollary notions that: (*iv)* configurations of processes function as agencies and (*v)* the dynamics of creation are dialectical. Together the scheme constitutes what I have called "process ecology" (Ulanowicz 2009b).

Returning to the chasm which began this essay: For three hundred years the reigning consensus in the West has been that nature is monist and functions according to a single metaphysics. Furthermore, it has been assumed (and still is by most) that continued research will demonstrate that the same laws and metaphysics will eventually fully penetrate the intellectual chasm that living systems inhabit. To doubt that belief is to exhibit what John Haught (2000) calls “metaphysical impatience”. If the immediate world of the senses does not seem to correspond to the rarefied, homogeneous, detached models upon which the Enlightenment worldview rests, then we are encouraged to adjust our attitude and believe that it does.

Ecology, nestled in the pit of the chasm, seems to be telling us a very different story. Dense, heterogeneous systems do not entirely escape the constraining influence of universal laws, but they come to possess the freedom (indeterminacy) to satisfy those constraints in a virtual infinity of possible ways. To explain how they do operate, it is necessary to turn the conventional metaphysic on its head, and to embrace a nature that results out of agonistic tendencies. Life is process and ecology is explicitly so. Shifts in perspectives (a *metanoia*) must occur from being to becoming (Prigogine 1981), from stasis to creativity, from object to relationship, from Parmenides to Heraclitus.

Making such a radical readjustment does not mean that we must forsake the scientific method. The metaphor of the network makes it possible to construct quantitative and testable hypotheses based on processes rather than things. With process ecology the pathway from physics to life (and beyond) can be bridged. Science and the humanities can now reconnect. Theology need not be extirpated from the academic world.

7. A Revised Science:

Ascribing to a dual metaphysic will markedly alter the scientific enterprise. For one, as Stuart Kauffman (2011) suggests, acknowledging the necessary role of indeterminacy spells an end to “The Era of Physics”. Of course, physics will continue to advance and enlighten humanity, but the preoccupation with physical substrate must wane. Knowing the nature of the most elemental particles very likely will not be, as commonly supposed, the key to understanding higher phenomena. Furthermore, the possibility that the physical universe and its laws have evolved since the Big Bang is becoming a serious consideration (Chaisson 2001, Ulanowicz 2009b, Unger & Smolin 2014). Empirical evidence now exists that the fundamental constants of the universe have changed over time (Webb et al. 2001). In a manner similar to how neutral matter precipitated out of a dissipative milieu during the Recombination, the laws of nature could as well have sequentially emerged as the universe expanded.

Obviously, biology and evolution need to be re-evaluated in the light of process thinking. For example, Darwin’s original narrative was essentially about a balanced transaction between Malthusian growth and (exogenous) natural selection. Since Darwin, however, the generative side of the evolutionary transaction has atrophied, so that almost all attention is now focused upon the eliminative actions of external conditions (natural selection). That significant selection can occur within the system is a key element of process ecology that has been proscribed from the Neo-Darwinian story. In the now prevailing scenario, agency is attributed to the material genome. But according to Aristotle material causality plays a largely passive role in events, just as it is portrayed in process ecology. It becomes necessary to shift more attention to the metabolic network of proteomic and enzymatic reactions that read, edit and act upon the molecular genome.

8. Theological Ramifications?:

Most relevant to Cosmos and Creation, accepting process ecology as a legitimate pathway to natural description would provide significant philosophical and theological opportunities. Starting with the question of free will, it becomes a given in a narrative that posits indeterminacy as a key attribute of nature. The burden of proof would shift to the determinists, who would then need to demonstrate how neuronal firings make their way through some five hierarchical layers of mind, each with its compliment of indeterminacy, to *determine* higher-level thought and choice.

An indeterminate world invites creativity of all kinds – natural, human and possibly even Divine. Philip Hefner need no longer worry about God lacking any "wiggle room" to act in the natural world. Wiggle room abounds in a heterogeneous universe! An immediate corollary is that process thinking allows for intercessory prayer. I know a number of Christian colleagues and friends who, in almost Neo-Deist fashion, are reluctant to engage in or even talk about intercessory prayer, despite clear scriptural exhortations to do so. True, a mature prayer life should be judicious and patient, but there is no *natural* reason to abandon the possibility of intercession.

Unfortunately, theodicy, the problem of evil and suffering, cannot be dismissed as easily. It does not disappear, even through the lens of process theory. But process ecology does provide a different avenue along which to approach the problem. In the process scenario, the agonism in the natural dialectic is tempered by the requirement that neither agonist may extirpate its counterpart without fostering major system collapse. Even Thomism recognizes that good can accidently result from bad or erroneous events. As an example, I like to cite the behavior of Albert Einstein, while he worked at the Swiss Patent Office. He spent the bulk of his time in his office working on the Special Theory of Relativity instead of attending to patents, as he was paid to do. His petty evil resulted in a benefit to humanity of major proportions. To attempt to eliminate every evil would result in forfeiting all hope of human progress and is the reason why attitudes like the Jansenist revival among Catholic youth, or the "broken window" policy for policing West Baltimore are to be avoided. The parable of letting weeds grow along with the wheat is explicit process wisdom, which now takes the form of the call by Francis, the Bishop of Rome, for compassion.

Of course, no one should confuse minor indulgence with a call to abandon all normative judgment. While process ecology does resolve the ontological question "Why evil?", it does not speak to the issue of magnitude, i.e., "Why enormous evil and suffering?" – like the Shoah or the recent Indonesian tsunami. I mentioned earlier that certain dynamics like centripetality need to be judged according to their context. For example, Bonaventure recognized an ultimate good through his belief that the love among the persons of the Holy Trinity constitutes the basis of all action (Delio 2005). Much the same idea was expressed by Chardin, as a convergence drawing creation to God. The Trinitarian affections are also reflected in the perpetual harmonies extant within all stable matter, serving as a Divine "signature". This signature may be what prompted Therese de Couderc (1866) when she looked at a chair and saw the word "goodness" (la bonté) appear on it. She looked at another nearby object and the same word appeared on it as well. All of enduring creation bears the signature of its Creator. At the same time, the centripetality occasioned by mutual beneficence at the physiological level gives rise to the notion of human selfhood, which at times manifests itself as extreme "selfishness" that can occasion major sin, like the wars and genocides of the 20th Century.

Doubtless, some believers are disquieted by this emphasis on process. Chardin's predilection for process likely played a significant role in his having been silenced. There are many, especially among the current Church hierarchy, who see Christianity almost exclusively through the lens of Thomistic Neo-Platonism. To them the idea that creation is ongoing is most unsettling. It represents a slippery slope into what is condemned as "process theology", wherein God is seen as changing along with creation. Whence, process is largely eschewed by Thomistic purists, who hold fast to the proposition that "God is immutable!"

For me it is important that Jesus Christ lived during a time of clash between the Hellenic and Hebraic cultures. The tensions between those cultures contributed to the vibrant amalgam that Christianity has become. Unfortunately, over the intervening centuries the histories of these two cultures have not been retrieved in proportion to their contributions. Thanks to Maimonides and Thomas Aquinas, Neo-Platonic and Aristotelian insights were rediscovered and applied to Judaeo-Christian thought. Less attention, however, has been given to reviving the Hebraic notion of the human-Divine conversation, and we have seen how conversation is fundamental to process thinking. (Hebrew scripture played a marginal role in Catholic ritual before Vatican II.) A noted Thomist theologian told me that theologians regard the Hebrew narratives wherein a prophet converses with a God and changes God's intentions as simply interpretive metaphors. They should not try telling that to today's practicing Jews! Witness Rabbi Bradley Shavit Artson (2013), who in his book, "God of Becoming and Relationship", regards Neo-Platonism as an unattractive patina overlying authentic Judaica.

Just as ecological thought bridges the middle ground between physics and the humanities, I also believe that process ecology can help reconcile this theological controversy. In recent decades ecology has adopted what has been called "hierarchy theory", the idea that dynamics at disparate scales of time and space can be qualitatively different (Allen and Starr 1982). I believe this notion possesses theological currency as well. In hierarchy theory events at the largest scales change very slowly, if at all. In eschatological terms, God remains truly immutable. It makes no sense to me, however, to confine God to that distant realm. God is active at *all* scales of nature and beyond. By "active" is meant engagement with a changing world, and it would be inconsistent to hold that God cannot respond to human activity, which we have already established is freely-willed. A God incapable of lower-level change would be less than human in nature.

Consonant with hierarchy theory, Christians need not abandon Thomist insights. They represent what will be in the end, and those ends are supremely good.[6] At the same time we encounter reality at the meso-levels. There creation is continuing in our midst. ("The Kingdom of God is among you!") Therefore, I think we need to make more room in Christian theology for process thinking, much of which already fills Holy Scripture. Only by recognizing process can we fully appreciate and celebrate immanent reality.

9. A Natural Bridge:

Of course, full reconciliation between process thinking and the Neo-Platonist attitudes in physics and theology will come about only slowly, but now we at least have an inkling of how it might happen. Process thinking is already extending from philosophical narrative into a quantitative theory of networks compatible with the testing of hypotheses. I mentioned earlier how data on ecological networks have already disabused me of preconceived notions. Unfortunately, many in the humanities still eschew the quantification of phenomena, because they (mistakenly, in my opinion) fear that quantification is what makes conventional science totalizing and determinate. Totalizing is certainly not the promise of process ecology. It can, however, provide a deeper understanding of living reality and guidelines for hedging our speculations about how to act in a complex world.

Although the spectrum of creation, from the quantum realm to the eschatological, is not smoothly continuous, neither is it as disjointed as it has been perceived over the last three centuries. Even now, existing barriers between natural philosophy and belief are eroding, so that eventually the sciences and the humanities will be able to converse with mutual respect. Most important for this forum, with process reasoning antagonism between science and theology is no longer a given. God, nature and humanity are free to resume their most fecund conversations!

10. **Miles Yet to Go**:

Lest I end on a note of unbridled optimism, I should make brief mention of obstacles yet to overcome. My adventures into process ecology have been met with strong and vitriolic resistance during the course of peer review, foreclosing the possibility of publication in highly visible outlets. In my (admittedly biased) opinion, most of the response has been ideological, emotional and only marginally concerned with content. When I seek out the motivations behind such formidable opposition, I remind the reader of Sagan and Hawking's belief that, in a world of totalizing laws, there is no room either for God or for Divine action. By contrast, it is difficult to use process thinking to build a case against either. Not that process thinking makes a case for the transcendental, it simply remains equivocal regarding it. This confrontation of worldviews was articulated nicely by

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[6] One is reminded of an aphorism from the recent movie, "The Best Exotic Marigold Hotel" -- "All things will be well in the end. If things are not all well, then it is not yet the end!"

Leonard Susskind in the online forum “Edge” when he quoted an anonymous colleague, who opposed his “multiverse” hypothesis,

> *“From a political, cultural point of view, it’s not that these arguments are religious, but that they denude us of our historical strength in opposing religion.”*

I find impressive the peregrinations that some make to ignore obvious natural phenomena that might weaken their own convictions against religion. It begins to resemble what Wojtyla likely had in mind as idolatry or false absolutes.

Sr. Ilia Delio, a frequent participant in Cosmos and Creation, quotes Thomas Aquinas (1264) to the effect that “A mistake about creation can lead to an error about God.” This is so very true, and pushes us to get the science correct and complete. At the same time, when I behold what to me seems on the part of some to be unreasoning avoidance, I can’t help but think, “A mistake about God can lead to an error about creation”.

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