PSYCHOLOGICAL PANARCHY: STEPS TO AN ECOLOGY OF THOUGHT

Will Varey
Institute for Sustainability and Technology Policy,
Faculty of Sustainability, Environmental and Life Sciences,
Murdoch University, Western Australia
email: w.varey@murdoch.edu.au

ABSTRACT

Since its origination, researchers in the field of ecology have been faced with complex questions of considerable complexity (Clements, 1905; Elton, 1927; Tansley, 1935). To consider an entity within its habitat involves recurring problems of definition; of the entity, the boundary of the inquiry and the criterion for observation (Ahl & Allen, 1996; Allen & Starr, 1982; Allen, Tainter, & Hoekstra, 2003). The increasing sophistication of systems theory in the construction of ecosystem models provided new ways of studying ecologies as processes, independent of the botanical organisms they contain (E. P. Odum, 1975; H. T. Odum, 1994). Extensions of hierarchy theory allowed multiple scalar levels of systemic interactions to be observed (Allen & Starr, 1982; O'Neill, 1989; O'Neill, DeAngelis, Waide, & Allen, 1986; Simon, 1962). The development of panarchy theory has now provided a cyclical perspective on complex ecologies in multiple spatiotemporal spans (Carpenter & Cottingham, 2002; Gunderson, Holling, & Light, 1995; Holling, 1973). Yet in all the advancements of our observations of complex ecological systems, we have advanced only slightly in our observation of the observer.

Recent research into developmental psychology suggests that psychosystems, like ecosystems, are not unimodal and continuously distributed in terms of their constituent parts (Commons, Richards, & Armon, 1984; Commons, Richards, & Kuhn, 1982). Patterns of thought may also form complex hierarchies appropriate to the environments of existence (Graves, 2005; Graves & Lee, 2002). Panarchy principles have proven useful in providing metaphors for the complexity of socio-political and socio-cultural dynamics (Berkes & Folke, 2002; Westley, Carpenter, Brock, Holling, & Gunderson, 2002). The governing dynamics of human thought are now being seen as crucial for the resilience, sustainability and liveability of our future societies (Homer-Dixon, 1999, 2006; Tainter, 1988). The potential exists for a more detailed construction of a theory of panarchy for human psychology to provide an explanation of the role of thought in understanding human and ecological systems. This paper considers parallels between recent findings in developmental psychology and developments in the panarchy research into complex ecologies to assess the viability of the application of panarchy theory to the ecology of human thought. Five distinctive features of a panarchy inquiry are considered with reference to the viability of their application to the psychological dynamics operating in evolutionary human social systems. The paper concludes that a theory of psychological panarchy is viable, and necessary, if roles of the observer and the observed are to be understood so as to progress the study of the resiliency of complex human societies.

Keywords: ecosystems, ecology, systems theory, psychosystems, panarchy

"God! I would give all man can know or guess
to pass the veil of man's self-consciousness."

(Vickers, 1983a)

Introduction

A significant contribution of the systems sciences has been to enable a theoretical investigation into the intangible dynamics between physical and empirical forms. Static structures of rigid botanical taxonomy have been revealed through the use of systems perspectives to be dynamic evolutionary ecologies, enriching our knowledge of natural environments. The development of the systems sciences reveals a human fascination with understanding the many processes of our world. The process of development of our understandings of the world's processes is equally fascinating. As the modes of inquiries change from empirical observations, to creative theory, to detailed experimentation, to examining contextual situations, to modeling the dynamics of formation, discerning temporal locations and speculating in philosophical abstractions, the world is gradually revealed as comprising of things, in relationships, in locations, that are changing over time. A universe constructed thus is made in the processes of human thought. The universe of human thought is also altered by this process and our familiarity with the world shifts accordingly in processes of evolutionary change. This paper asks a question within the patterns of the evolution of knowledge, being: *What if the observer, and not just the observations, were subject to the same processes of evolutionary progression?*

This question is grounded in findings being revealed from the cognitive sciences and developmental psychology. We know that the cognitive capacity of individual adults may move through distinct stages of development in the ability to hold different forms of abstractive logic independent of intelligence (Commons, et al., 1984; Commons, et al., 1982; Fisher, Hand, & Russel, 1984). Moral reasoning as a complex system of sense-making also shows distinct stages or phases of development (Kohlberg, 1969). Individual values-structures appear to generate distinct levels of organization in systems of thought (Graves, 1970, 2005). However, recently it appears that these known stages of cognitive capacity are also in a process of evolutionary development (Commons, et al., 1984; Cook-Greuter, 2000, 2004; Graves, 2001; Graves & Lee, 2002). Development is occurring by an increase of content within the different levels of cognition and in the number of forms of cognition that are potentially available (Graves, 2001; Graves & Lee, 2002). Human thought as a system is apparently altering in the complexity of its composition (Cook-Greuter, 2000, 2004). A pattern is beginning to appear in the ecology of human thought. How are we then to adequately observe this process of evolution and its direction when our observation is its content? How is the process of observation done when the tool of inquiry, the human mind, is the object being inquired into? These are merely some of the many challenges presented by the potential for an adequate study of the ecology of thought. The proposal of this research is to examine these questions and propose appropriate means for their investigation.

Steps into the Ecology of Minds

The concept of an ecology-of-mind is not a new concept. Key minds and distinguished researchers have speculated on the ecological nature of the formation of human thought. Rather than a discipline of inquiry, this reflective process on the ecological nature of our thinking has often been the privilege of the society level commentator after a lifetime of observation of the processes of one's own and others' thinking situated culturally and historically. In reviewing these reflections it is noted that different thinkers have thought about various aspects of human thought differently. Each provides a different perspective on the same phenomenon from a different location. Collectively they provide a mosaic of something collectively seen, but not yet fully described.

Notably, Gregory Bateson, an innovative anthropologist, unified theories of semiotics, psychiatry, cybernetics and evolutionary social history in applying the knowledge of different disciplines as stepping stones to a more systemic view of human thought. His collection of thirty-five years of essays in *Steps to an Ecology of Mind* (Bateson, 1972) had the express aim to shift research perspectives beyond the isolation of single disciplines. He sought to examine the 'aggregate of ideas' that he called 'minds', initiating in individuals and forming within societies. In discernable layers of abstraction, he examined the changing nature of learning as the process of evolution of thought itself and radically proposed a new way of thinking about ideas as an 'ecology', being 'a science that does not yet exist as an organized body of theory or knowledge' (p.21).

Theoretical quantum physicist, David Bohm, also proposed that we examine *Thought as a System* (Bohm, 1994) combining body, emotion, intellect, reflex and artifact as 'one unbroken field of mutually informing thought'. He did so after identifying a systemic fault in the whole of thought, likening the human situation to the processes of pollution in a lake, where the source of the degradation is unlocatable from within (Bohm, 2002). He instigated the idea of a methodology for the discovery of thought by our participation in it collectively, consciously seeing what occurs in emergent dialogue and observing that process as a system while being a participant within it (Bohm & Nichol, 2004). Biologist and neuroscientist, Francisco Varela in identifying processes of recursion in the *Embodied Mind* (Varela, Thompson, & Rosch, 1993) applied the principles of biological autopoiesis to neurophenomenology to disclose the formation of insights, looking at the production of thought itself experientially (Depraz, Varela, & Vermersch, 2003). Innovative animal physiologist and cyberneticist, Jakob von Uexküll proposed a cybernetic system of formation of the self-worlds (*umwelten*) of animals and man founding the field of biosemiotics as the window into the thoughts of different species unique in their individual historical experiences (Uexküll, 1992). Similarly, policy administrator and systems analyst, Sir Geoffrey Vickers (Vickers, 1968, 1970, 1983a, 1983b), described his perception of an 'ecology of ideas' in an 'enduring yet changing conceptual world, partly though never fully shared' (Vickers, 1983b) from which 'we must admit the existence of' a unique and 'ill-defined but inescapable mental-field' representing the appreciative reality system of our inner-worlds (Vickers, 1968).

We could include other intellectual luminaries, such as Jesuit paleontologist Pierre Teilhard de Chardin (Delfgaauw, 1969; Teilhard de Chardin, 1964), journalist and

novelist Arthur Koestler (Koestler, 1967, 1970), astrophysicist and systems scientist Erich Jantsch (Jantsch, 1980; Jantsch & Waddington, 1976), neurologist and psychiatrist Viktor Frankel (Frankl, 1984), journalist and author George Orwell (Orwell, 1949, 1951), anatomical biologist Thomas Huxley (T. Huxley, 1906, 1947), evolutionary theorist Julian Huxley (J. Huxley, 1961, 1965), social theorist and author Aldous Huxley (A. Huxley, 1941, 1962), evolutionary psychologist Steven Pinker (Pinker, 1989, 1995, 1997), planetary meteorologist James Lovelock (Lovelock, 1979, 1988), geneticist Richard Dawkins (Dawkins, 1976) and anthropological geographer Jared Diamond (Diamond, 2005), in the list of those who have contributed insightful questions and personal views on discrete aspects of the 'system' of human thought. When combined, a systems of systems exists in potential, yet investigated from so many knowledge domains, these observations lack any apparent organizing principle.

What can we potentially learn from the speculations on cybernetic theory from anthropologists, on sociology from quantum physicists, in phenomenology from a cellular biologist or musings on systems theory from evolutionary humanists? The proposal is that the combinations of these many observations provide the interlinking and trans-disciplinary steps from which to consider different forms of human thinking, ecologically, as an evolving dynamic system. In essence, works like these, supported by modern psychology and systems theory, provide the steps of stone to a foundational theory of an ecology of thought.

As each of these theorists may have found, discussions of the ecological nature of mind have distinct problems outside of the realms of philosophy. For a theory of the psychological dynamics of thought-ecologies to be viable knowledge in scales ranging from the formation of thoughts individually to the potential of human consciousness collectively will need to be co-joined effectively. Such a theory will need to face and resolve questions of definition, function, relation, prediction, resilience and potential in definable scales of complexity. The challenges include problems of definition, problems of observation, problems of location, problems of description and the problems of delimitation. However, these are theoretical problems that the field of biological systems theory has already overcome in examining the systems of life in observable ecologies. While the processes for determining and correctly discerning the research objects, scopes of location, gradients of boundaries and temporal frames for human thought will be less distinctly drawn when observing the intangibility of an ecology of mind, methodological comparisons may be drawn. Similar, but new, research questions will be required. New and surprising insights may result.

For example, prospective questions include: Is thought an object synonymous with the thinker? If so, is the location of a group of thinkers the location of the thought? In what spatiotemporal scale does the lifecycle of a concept occur? Can a thought 'die' or cease to exist within a thought-population? If so, what defines its existence in an initial sense? What are the discernable functions of different organizational levels of thought? What are the dynamics of their cross-scalar conjunctions, individually and societally? Do these dynamics compound or contribute, or both? Is thought a system in advance or in decline? What do our assumptions about this say about our thinking? The problems of comparison of thought-ecologies to biological ecologies are real, yet the potential benefits of their

exploration in comparison and conjunction are great. The inquiry posed is whether we can learn from the advances in one discipline so as to make conscious the process of our advances in another?

The Status of Human Thought

It is not unfamiliar knowledge to us that the world's biological systems are in processes of transition. One observation of those transitions is that our biological ecologies are in decline from any number of criteria, and particularly those that examine the prospects for continuation of key ecosystem functions within those ecologies (Daily, 1997). At the biome level of global regional landscapes, land degradation and habitat loss are increasing (Hassan, Scholes, & Ash, 2005). This is now adversely impacting on ecoservices essential for human wellbeing and supportive of not only species health, but ecosystem integrity (Daily, 1997; Rapport, 1999). Life itself on our planet in many forms, and potentially in all its forms, is under threat.

Of less familiarity is the fact that the world's psychological systems are also in transition. Predictions of indicators of psychological wellbeing are that mental health is declining, even though standards of human biological health and access to education are increasing (Desjarlais, Eisenberg, Good, & Kleinman, 1995). The cost of human psychological impairment is measured in terms of mortality (i.e. suicide, health choices, life expectancy) and also in the contributive disablement represented by the net years of diminished capacity (Ustun, 1999). When a ranking of 107 diseases is based on mortality, mental health disorders are never ranked in the Top 10, yet when disability and impairment are used as the criteria, mental disorders surpass HIV and all forms of cancers in their impact on global health (Ustun, 1999). In a 1990 study, it was predicted that by 2020 unipolar depression would be second only to heart disease in terms of the causes of the global health burden (Lopez & Murray, 1998; Murray & Lopez, 1996). The stressors to non-human species also should not be discounted from considerations of the ecology of thought (Dickinson & Murphy, 2007). This question of biological and psychological decline triggers a corresponding inquiry into our sociological wellbeing, of the resilience of our local communities and ultimately the global society of humanity. It appears we are facing a biological, sociological and psychological conjunction that cannot be neglected in its systemic trend. This highlights the need for a correlating theory of the systemic nature of thought.

In approaching this question, of arresting a process of decline while situated in an environment of decline, it is possible that the development of our understanding of the complexity of our thought-ecologies might parallel in its progression our gradual understanding of the complexity of biological ecologies, following a similar path of insights, developments, confusions, conjunctions and hard won gains (Saarinen, 1980). In the spirit of Bateson (Bateson, 1972), this paper asks what might we learn about our previous pattern of learning so as to inform this prospective learning path? In a process of deutero-learning the first step is perhaps to identify the set of learning choices already created before moving to describe options within a meta-pattern of thought.

Learning from Learnings in Ecology

The development of the field of ecological systems research has been in its own process of progression and evolution for over one hundred and fifty years. Ostensibly, beginning with Charles Darwin's observations on the governing relationships between species in *The Origin of Species* (Darwin, 2006), the field of ecology has extended progressively in its systems-based approaches (Saarinen, 1980). Darwin's contemporary, German biologist Ernst Haeckel is attributed with the first use of the term '*oekologie*' in *Generelle Morpologie der Organismen* in 1866. Danish botanist, Eugenius Warming, together with Norwegian zoologist Martin Vahl, co-published in 1895 the *Oecology of Plants: An Introduction to the Study of Plant Communities* (Warming & Vahl, 1909) to advance early ecological education. American plant ecologist, Frederic Clements (Clements, 1905) published *Methods in Ecology* beginning a discipline in the examination of the relationship of plants and their environments (Clements, 1920). Sir Arthur Tansley (Tansley, 1935, 1946) described the relationships between plants and animals and established the use of the term 'ecosystem'. English zoologist, Charles Elton (Elton, 1927) published *Animal Ecology* initiating the work leading to many of the concepts of modern systems ecology such as food chains, invasive species and ecological niches. Systems ecologists, Howard and Eugene Odum, expanded the systems perspective of ecologies over many decades, continuing these traditions of education and exploration (E. P. Odum, 1975, 1993; H. T. Odum, 1988, 1994). The innovations of complexity thinking for emergent systems allowed for the consideration of ecosystems as holarchical, self-organizing, holarchical, open-systems of multi-layered co-evolutionary potentials (Kay & Boyle, 2008; Kay, Regier, Boyle, & Francis, 1999; Schneider & Kay, 1994). Esbjörn-Hargens and Zimmerman (Esbjörn-Hargens & Zimmerman, 2009) have recently provided a retrospective sociological history of trends in ecological scientific research, classifying key persons and periods for ecology in the United States into the metaphors of: organismic (1910s-40s), economic (1940s-1960s), ecosystemic (1960s-70s) and chaotic (1970s-2000s). The most recent addition to this set is probably the metaphor of 'panarchic (2000s-)' representing the role of panarchy theory as a model for understanding ecologies as an ecological science now emerging globally (Holling, Gunderson, & Peterson, 2002). The history of ecological systems theory is dynamic in its emerging complexity. Significantly, these different eras of thought are not exclusive in their knowledge domains. They are to some extent inclusive and cumulative. New thinking has led to new thought, the letting go of old ideas and new paradigms of practice in generative processes of accumulation and differentiation. New species of ecological inquiry have formed in increasing complexity in changing environments of opportunity.

Within each of these major periods of ecology different schools or sub-disciplines of thought have emerged containing discernibly different methodologies, motivations and epistemic assumptions. The scales of observation, the research questions of orientation and the metaphorical comparisons used disclose distinctly different approaches to the conceptualization of biological ecologies. Ecologist and educator, Stanley Dodson (Dodson, 1998) provides guidance, structuring the dominant schools of ecology using four different 'ways of approaching' ecological study, being; *concepts, locations, organisms* and *applications*. These are combined with the different organizing criterion of landscape, ecosystem, organism, population, community and biosphere to provide

useful modes for observation (Allen & Hoekstra, 1992). When these predominant forms of inquiry are combined with studies of different organisms, in different habitats, for different purposes (i.e. conservation, policy, agriculture, restoration) a complex ecology of possible ecological investigations results. Each ecological study formed from the combination of these approaches is equally valid and contributive to the wider field of ecology as a totality. The thought processes for ecological research can therefore be seen ecologically, each forming a dynamic and intrinsic part of a whole system of inquiry.

By way of contrast, Esbjörn-Hargens and Zimmerman (Esbjörn-Hargens & Zimmerman, 2009) take a different approach to the ordering of the disciplines of ecology. They recognize that the different perspectives adopted in each ecological study inherently 'reveal and conceal different aspects of the environment' (Esbjörn-Hargens & Zimmerman, 2009). They define the problem as an absence of integration in pluralism within a paradigm of partialness, seeking 'a means to sort and organize this maddening multiplicity of ecologies'. Using an integral epistemology they discern over 200 schools of ecology, organizing these within twenty-five primary approaches using a single criteria, individual consciousness, as the ordering principle. An aesthetically ordered nested 'ecology of ecologies' results. Significantly, they expand the domain of scientific ecology to incorporate inquiries involving aspects of ecological interiority (i.e. phenomenology, somatic meaning, eco-spirituality, psychodynamic relationships, biosemiotics etc.) to provide a balanced, expanded and comprehensive view, being one that already includes psychological aspects within a pre-defined definitional frame.

Each of these two classification systems represents approaches in the definition and observation of ecologies using objects of focus (empirical), in different spatial and temporal spans (systemic), using different organizing criterion (hermeneutic) for different purposes or motivations (phenomenology). They each represent a structured organization of an aggregation of ideas; in effect disclosing the ecology of thought used by the field of ecology to consider its own formation. The difference between these approaches is that one involves a dynamic multi-dimensional inquiry without the express inclusion of psychological interiority; the other relies on mono-definitional criteria to reveal a unity of exterior, interior, individual and social correlations. Each has benefits in an application to a theory of psychological ecology. The question arises: *Which of these two approaches represents a better approach to disclosing the full complexity of an ecology of thought?*

A Crisis of Choice in Paradigms

In examining the processes of thought we notice that the definition of a problem will often delimit the possibilities of its solution. The problems of ecological theory might be defined as a problem of unification, within pluralistic diversity. These problems also can be characterized as a problem of integration, within a pre-existing unity. The chosen definition of a problem usually also indicates our preference for its resolution. This preference for a solution supposes that there is some desirable state, being a mental-model of how things should be naturally, pragmatically or aesthetically. The problem of the many forms of conceptual ecology is not really a problem of the discipline of ecology. It is perhaps a very natural feature of the ecology of thought.

One solution to the 'problem' of pluralism is unification through a mono-definitional approach. The entire ecology is ordered using a single definitional principle rather than empirical observation (Ahl & Allen, 1996; Allen & Hoekstra, 1992). This offers a way for different perspectives from partial conceptions of ecological realities to be reconstructed into a single system of understanding. The definitional criteria can be applied at all levels of meaningful scale in a hierarchy of pre-defined nested levels of organization. A consistent portrayal within the definitional frame of a hierarchical system of nested abstraction provides its own epistemological validation. The phenomenon as chosen by the observer supports an absolute ordering of the levels of observation. The problems of definition and integration are resolved. The new organizing theory can then inform and orientate all research methodologies with greater efficiency. This approach accords with an integral epistemology that orders thought based on philosophical inquiry.

However, complex ecologies are not always emergent in forms corresponding to human definitional classifications. Our levels of observation do not necessarily accord with defined levels of organization (Allen, O' Neill, & Hoekstra, 1999). Complex ecologies, generally, are not nested in pre-arranged conceptual holarchies. In an empirical hierarchy, levels of observation are discerned by changes in gradient by moving through surfaces (Ahl & Allen, 1996; Allen, et al., 1999). Rather than the study of the ecology being concerned solely with a single aspect (such as nutrient concentration, organism distribution, ecosystem function, a vegetation form or a landscape type) coherent conceptual ecologies may require different criterion in discrete studies evoking distinct and discernable cross-scalar relationships. To discover how a complex system is organized observations must be made from what is discernable from the system's functions located contextually, spatially, historically and hierarchically. This approach recognizes the observer's role in forming epistemological validity (Allen, et al., 1999).

To resolve this choice between approaches a useful distinction is offered between a nested definitional holarchy (containing conceptual definitions in levels of inclusivity) and a non-nested experiential holarchy (containing manifested functions in levels of dependency)[1]. Ahl and Allen (Ahl & Allen, 1996) explain how neither of the defined or discovered approaches is incorrect, each simply being complementary philosophies appropriate at different phases of an evolving understanding:

> "Nested hierarchies are most suitable for exploration, where nestedness draws attention to a hierarchical system and helps keep order while intuition explores some poorly known phenomenon. … After the exploratory phase, however, nestedness itself becomes uninteresting, or at least incidental. With further elaboration nestedness becomes subordinate to new, less general organizing criteria, such as rates of enzymatic reactions. The new criteria link between adjacent levels, but do not apply from top to bottom. More often than not, nesting serves its purpose as the point of departure for the investigation, only to be abandoned as other ordering relations come to the forefront." (Ahl & Allen, 1996) (pp. 113-114)

Seen then as an evolutionary progression, the discovery of the limitations of one paradigm of inquiry signals a shift to another, then the next.[2] The progression towards

resolution of the tensions between the two approaches of nested definition and non-nested exploration is potentially found in the application and adoption of new methodologies, expanding significantly the scope of inquiry. The shift occurring in complex systems ecology is from a state of pluralistic anarchy, into simplified definitional holarchy, leading to the use of multi-scalar experiential investigations of panarchy. This involves a natural evolutionary transition of paradigms in the ongoing evolution of systems ecology.

Panarchy Principles: Theory, Model and Methodology

The field of panarchy provides three distinct advantages in resolving the definitional dilemma of how to approach complex ecologies. Firstly, a panarchy approach provides for hierarchical ordering without enforcing a single criterion as its defining principle so that complex non-nested ecologies can be represented without constriction by pre-definition. Secondly, a panarchy is composed of multiple spatiotemporal cyclic frames, transforming static hierarchies into dynamic evolutionary living holarchies more suited to the observation of adaptive and adapting ecologies. Thirdly, a panarchy frame assumes multi-state potentialities, with the system revealing multiple potential forms of theoretical and practical integrity. Rather than providing a model of how things 'ought to be', panarchy in ecological theory provides a methodology of how actual events and system features 'may be'. This provides a meaningful transition from unordered pluralism, through ordered integralism, to dynamic (multi-scalar) co-emergent holism.

The origins of panarchy theory are found in observations of the patterns that emerge from linkages in increasing scales of complexity from the applied study of environmentally managed ecologies (Gunderson, Holling, & Allen, 2010). This approach involved a shift of assumptions from single-state ecosystems to the assumption of multi-state equilibria caused by the cyclic and phase-like effects of historical disturbances to ecological stability and integrity (Holling, 1986). In a recent reflection on the development of panarchy theory, Gunderson, Holling and Allen (Gunderson, et al., 2010) described how ecological levels of complexity are increasingly seen in terms of the interaction of slow, broad variables with smaller faster variables, in a reciprocal hierarchical system of top-down and bottom-up interactions. The key features of the panarchy model involve discerning dynamic systems at different scales, in sub-systems of adaptive cycles, with cross-scalar dynamics coupling those systems (Gunderson, et al., 2010). In a panarchy approach, system states with alternative domains of stability occur in specific scale ranges for scale-dependent conjunctions of ecological entities. Ecological resilience is a system property of panarchies resulting from within-scale diversity of ecological functions and processes of cross-scale redundancy and reinforcement (Walker, Holling, Carpenter, & Kinzig, 2004). This approach seeks to discover a system with a certain level of coherence and an enduring integrity of functions, even in the event of perturbations and disturbance. This is an attractive characterization when considering the potentials for the system of human thought.

The primary limitation of a panarchy approach is it looks to the integrity of the ordering of cross-scalar dependencies in the patterns of complexification of living systems. For systems that are apparently without order, without patterns of integrity, without coherence, without complexity in terms of hierarchy, that are not yet formed or are in

systemic decline so as being unlikely to endure, a panarchy approach cannot reveal the orderings that are not perceptibly there. Its limitation is in its application to coherent patterns in the ordering of the complexity of hierarchical forms. It is of limited use in inquiring into the incoherence of non-living forms, in non-equilibrium states, in single levels of organization or chaotic states of existence. In providing specific criterion and assumptions for arrangement the model is intentionally self-limiting in terms of observing or predicting the chaotic nature of far from equilibrium dynamic states (Kay, et al., 1999).

The view of an ecology that panarchy theory offers is to discern phases in adaptive cycles for multiple levels of spatiotemporal organization. In a simplified form, the entity, the cyclic duration, the spatial frame and resultant product are inquired into for different levels of organization for a hierarchical cross-linked system of ecological functions. Rather than being constrained to a single criterion across all scales, the panarchy depiction may make use of multiple domains of inquiry, provided they are appropriate for their discrete levels of observation. This allows for a system of observation that is both dependent on, and independent of, the roles of its observers. A holarchy of inquiry formed in this way potentially allows us to see the whole hierarchy of a system's complexity by the use of different frames of inquiry. This signals a shift from epistemic relativism to an ontological contextualism allowing for co-dependent systems of reality to be formed by methods of observational co-construction. It is this feature, in an evolution away from naïve realism, that is essential for any inquiry into the nature of thought, which must use different levels and forms of thought as its modes of observation.

However, ecological panarchy theory is presently evoking its own crisis of paradigm. In deriving from the investigation of the biological aspects of ecologies it is increasingly being found that other factors, such as human social effects and human-ecological interactions, have determinate effects on ecosystems that cannot be ignored but fall outside of the initial paradigm of inquiry. This has led to panarchy theory progressing in its scope to include socio-ecological considerations (Berkes, 1998; Berkes & Folke, 1998). The human role of social system dynamics in ecological management has meant panarchy principles have been extended theoretically to also apply to sociological (Carpenter & Gunderson, 2001) and socio-cultural (Holling & Sanderson, 1996) hierarchies. These analogous adoptions now extend to non-biological domains, including the socio-political (Hanna, Folke, & Maler, 1996), socio-economic (Brock, Maler, & Perrings, 2002), organizational (Garmestani, Allen, Mittelstaedt, Stow, & Ward, 2006), policy and governance (Clark, Jones, & Holling, 2010; Gunderson & Light, 2005; Walters & Holling, 1990), individual mental health (Robinson & Westley, 2009), urban forms (Garmestani, Allen, & Gunderson, 2009) and world-level ecological trends (Gotts, 2007). The missing component from this diversity of forms remains the integration of psychological considerations, which are largely absent from the theories of explanation. A correlating discipline in the discernment of the psychological dynamics of panarchical socio-ecological systems will be necessary if the field is to progress adequately and pragmatically in the future. To be meaningful, socio-ecological systems theory will need to include a theory of meaning. This extension would be the next logical step in the evolutionary progression of a convergence of socio-ecological-psychological dynamics. The potential for this progression drives the aims outlined in the remainder of this paper.

Ecological Panarchy - Characteristics

To enable a process for the application of ecological panarchy principles to psychological phenomena it is necessary to first establish some identifying criteria. From the definitions of panarchy provided by the leading researchers in that field certain characteristics are common to this form of inquiry. The following is a recent useful description:

> Panarchies are hierarchically arranged, mutually reinforcing sets of processes that operate at different spatial scales, with all levels subject to an adaptive cycle of collapse and renewal, and with levels separated by discontinuities in key variables. (Holling, Peterson, & Allen, 2008) (p.3)

These definitional components of 'hierarchically arranged', 'sets of processes', of 'different spatial scales', operating in 'adaptive cycles' of 'mutually reinforcing' 'levels separated by discontinuities' when viewed together describe one coherent conceptual approach. These distinct components can be set out clearly and separately for the purposes of comparison. Drawing from the theory, the distinctions between each of these five components are explained:

Holarchical

A panarchy study seeks to transform static definitional hierarchies into a dynamic set of discernable levels of observably nested complexity (Holling, et al., 2002). It draws from ecological hierarchy theory in recognizing that complex systems are ordered in discernable levels of functions (Koestler, 1967; Simon, 1973). Rather than relying on an observer based definitional hierarchy using pre-determined principles (e.g. smaller into larger) a panarchy system has discrete holarchical categories of functional phenomena forming its definitional levels. It is the principles for the dependent ordering of levels based on discrete dynamic cycles, being more than arbitrary observer based definitions, that gives a panarchy its conceptual integrity and practical significance. This aspect of holarchy makes a panarchy approach identifiably different to a systems-of-systems approach, which links variables in processes heterarchically in one level of organization.

Scalar

In ecological research scale is often context dependent and is based on identification of the organism or habitat being considered. In a panarchy approach, multiple discrete systems of scale are observed simultaneously (Walker, et al., 2004). This is not simply an ordering of scale based on observation protocols (i.e. large or small extent and course or fine grain), but rather is based on the spatial scale of the phenomenon observed to the extent of its scope of organization. In recognizing that different phenomena (e.g. bacterial infection, fire outbreak, bird migration, fish stock depletion) occur in different spatial scales, in a panarchy study a composite picture of multi-scalar phenomena is composed.

Temporal

The unusual feature of a panarchy approach is to recognize that a phenomenon occurs and is observable in temporal spans specifically relevant to the phenomenon observed, rather than to the period of observation chosen by the observer. In a panarchy hierarchy, fast and slow variables at different scalar levels operate in discrete timeframes and require different periods and forms of observation (Carpenter & Turner, 2000; Roughgarden, May, & Levin, 1989). Some cycles may be a few milliseconds (e.g. cell mitosis) and others may take eons of time (e.g. glacial formation and retreat). Combining these multi-temporal perspectives into one inquiry is a feature of the panarchy approach. A panarchy study involves a conjunction of multi-temporal systems.

Cyclical

The adaptive cycle is perhaps the defining heuristic of the panarchy model (Holling, 1986). It is often equated to the theory itself, with the tendency to examine a single cycle within an undefined holarchy of inquiry with the phases of the adaptive cycle then being applied deterministically. In a panarchy approach, the cycles observed potentially indicate the presence of the processes of constraint and entrainment that define and enact the panarchy structure. It is this periodicity in levels that provides the means for the structural coherency for the panarchy system (Carpenter, Walker, Anderies, & Abel, 2001). The system itself influences the periodicity of the observable cycles.

Cross-Scalar Dependent

Panarchy systems are more than arranged comparisons of ecological processes in various levels of scale. The system also contains causal connections between the adaptive cycles in different levels of spatiotemporal organization (Garmestani, et al., 2009). Rather than feedback loops in varying sequences of probability and delay as in chaotic systems, a panarchy system is defined by the discernment of cross-scalar dependencies (Holling, 2001). The arrangement of the system may involve assumptions of multi-state equilibria in a complex arrangement[3] (Carpenter & Turner, 2000). An understanding of the cross-scalar dependencies operating enables the model of panarchy dynamics to be predictive of those states.

Summary

These five defining features distinguish a panarchy approach from similar inquiries. The naming and description of these components is not contentious, as the intention is they are definitional, not definitive. The argument, however, is that the omission of one or more of these components means a particular study would not be an application of panarchy theory in the way that term is defined. This is the case even though a study may contain some of the elements of a panarchy study and rely heavily on its terminology (e.g. resilience, potential, connectedness, levels, adaptive cycles etc.) in its intentions and descriptions. A study of the whole (i.e. *pan*) requires perception of all the distinguishing parts and their processes of connection. These are determined by the phenomena being observed, rather than the phenomenon that is the observer. To benefit from and rely on

the many years of carefully focused research into the properties of panarchy systems it may be necessary to include these definitive components to enable valid comparisons to be made. The definition of these essential components for the purposes of comparison allows for the examination of the viability of a theory of psychological panarchy.

Psychological Panarchy - Characteristics

The research question is posed: *Is there evidence that systems of thought demonstrate panarchy-like qualities?* A review of the psychology literature reveals a panoply of perspectives, in multiple dimensions, without organizing principles and no discernable system of causation or relation. While the questions asked by those many inquiries may have different intentions and frames of definition, the results of those investigations may be revealing of something not previously seen. The five components of a panarchy system may be used to discern if the correlates of panarchy-like criteria are demonstrated from the existing knowledge we have of the systemic structure of human thought.

Holarchical – Psychological Panarchy

The system of human thought is quite easily characterized as having hierarchical complexity. In developmental psychology, the discernment of clear levels, phases or even structural stages in thought has been a common finding, revealing gradients and discontinuities in a range of observation sets. From the work of Jean Piaget (Piaget, 1928) on the thought processes of children, to Lawrence Kohlberg (Gilligan, 1977; Kohlberg, 1969; Lapsley, 2006) on the moral development of adolescents, of William Perry (Perry, 1999) on the learning of graduate students, by Jane Loveinger (Loevinger & Blasi, 1976; Loevinger, Wessler, & Redmore, 1970) on ego development in adults and from Bill Torbert (Torbert, 1999, 2000; Torbert & Fisher, 1992) of the thinking styles of senior executives, study after study provides evidence for the existence of discernable holarchical stages of development in thought. More recent studies of psychological moral development in the full range of ages (ages 5-86) shows the shape of the distribution of these stages revealing the discrete discontinuities and connections between them, providing a picture of adult thought as a holarchical developmental process (Dawson-Tunik, Commons, Wilson, & Fischer, 2005). However, discontinuity in the distribution of one form of thought (i.e. adult cognition) does not reveal a panarchy any more than variance in the body masses of a bird species reveals a complex hierarchical ecology. Thought would need to be demonstrated as having a holarchical nature across all scales, from individual thinking to the pattern of human evolutionary development, not only as stages of cognitive development. For a panarchy to be present the holarchical nature of thought would need to also be observed in systems at scale.

Scalar – Psychological Panarchy

We can see that from synapse firing to transitions in human epochs, thought as a system is a multi-scalar phenomenon. Discernable spatial scales in the systems of thought may be indicated by, but should not be confused with, physical scales of thought. A community is not larger in its scale of thought than a person, simply because of its physical spread in terms of geography. Thought exists in scale by the scope of the

cognitive content contained. For example, in individual cognition a spatial geometric metaphor is used to describe the 'spurt-like' acquisition of abstractive cognitive skills in adults, with small-scale and large-scale changes occurring in abstract representation (Fisher, et al., 1984). In subject-object relations theory the psychosocial domain of individuals increases in degrees of inclusion, creating different constitutions of the self, to perceive more and include more in different 'orders of consciousness' (Kegan, 1982). Graves (Graves, 2005; Graves & Lee, 2002) in studying levels of psychological organization proposed a neurological, psychological, sociological, societal and humanity level pattern of human thought in different scales. Similarly, tests for degrees of moral inclusion, from protection of ourselves only, to others close to us, to other humans, to the abstract environment, to interspecial and even intergenerational equity disclose distinct 'spans' of moral concern (Benack, 1984; Lapsley, 2006). This pattern of scalar organization leads to the related component of an ordering based in time, in this case psychological time, to fully discern spatiotemporal distribution.

Temporal – Psychological Panarchy

In the study of thought as a system a corresponding range of temporal contexts exists for each discernable spatial scale. In psychology, we know that individual perceptions of time are similar, yet distinctly personal, giving rise to the concept of personal phenomenological time as distinct from the universal of chronological time (Block, 1990). It is psychological time that is the relevant criterion for discerning psychological panarchy, rather than the universal of chronological time. At the individual level, the study of chronobiology demonstrates how the micro-cycles of the human body enable and constrain the processes of individual thought (Dunlap, Loros, & DeCoursey, 2004). In developmental psychology, the mental relationship of individuals to time as an abstract concept alters in scope and form in distinct phases correlating with maturation of one's 'action-logic self-sense' (Cook-Greuter, 1990, 2000, 2004). The concept of time itself has been ordered into distinct temporalities of the atemporal, prototemporal, eotemporal, biotemporal and nootemporal for different psychological 'self-worlds' (J.T. Fraser, 1975; J.T Fraser, 2001). Our conceptions of what an 'immediacy' is alters when looked at from the perspective of the humanity level temporal frame of the Holocene using a 10,000 year period for the calendar of hominid experience (Emiliani, 1992). The conception of time is informed by alterations in phenomena observed over time and, in the processes of thought as a system, is inexorably linked with the perception of periodicity.

Cyclic – Psychological Panarchy

The fields of developmental and evolutionary psychology have traditionally involved the assumption of mono-modal descriptions of direction. A psychological panarchy approach examines the short and long cycles of different scales of phenomena in thought observing that within an overall pattern of progression, there is cyclic recursion. While the formation of a thought is definable as a single event, at a finer grain of observation the formation of consciousness at the quantum level in microtubules appears to exhibit recurrent cycles of increase and collapse (Hameroff & Penrose, 1996). Other thought functions also have cyclical natures of definable time periods when the process of thought is observed rather than its products. Studies into the lifecycles of adult development

reflect cyclic phases within each life period, with childhood, adolescent, adult and aged cognitive patterns requiring different research premises (Howe, 1988; Reigel, 1973; Smolak, 1993; Stevens-Long & Commons, 1992). Systems psychologist, Clare Graves (Graves, 1974, 2005) proposed a four phase recurring cycle of satisfaction, dissonance, regression and insight for the process of transitions between developmental stages in psychological levels of existence. These transitions in orders of consciousness in adult maturation may take periods of years and recur periodically in cycles of increasing development (Kegan, 1982, 1994). At larger scales, the process of the transition of paradigms in normal science is seen to have a particular structure and pattern in repetition not entirely explained by processes of enculturation (Kuhn, 1996). Similarly, knowledge production in trans-disciplinary research is seen as cyclic involving, and even requiring, periodic epistemic breakdowns (Miller, et al., 2008). Over longer time frames the collapse of the knowledge domains of sophisticated civilizations may indicate distinct cycles with phase like rates of knowledge acquisition which lead inexplicably (or inexorably) to societal decline (Diamond, 2005; Tainter, 1988). However, not everything that is cyclic indicates the presence of an adaptive cycle within a panarchy. It is the cross-scalar dependencies in a panarchy system that enact and entrain adaptive cycles in levels of organization and enable the entire system to have resilience and maintain integrity in response to small perturbations at different levels of complexity.

Cross-Scalar Dependencies – Psychological Panarchy

Cross-scalar connections and dependencies in different levels of organization of thought are primarily evidenced by psychological tensions. The complexity of these tensions relates to every interaction, between every level of organization, for each scale of observation. For example, the pharmacological treatment of depression shows that re-establishing neurochemical balance can restore psychological capacity in a short period of time (Robinson & Westley, 2009). The cognitive capacities of individuals are influenced by the tensions of their psychological contexts, as reflected in the study of the sociological dynamics of groups and individuals and inter-group conflicts (Taifel, 1982). There is the psychological tension of sustaining personal autonomy and values within the integrity of identity in warring national ideologies (Vickers, 1983a). Transitions in developmental levels can impact adversely on relationships between partners established in different orders of consciousness (Kegan, 1994). The effects of 'webs of mind' are found in the cybernetic coactions between the strata of human social inequity (Haskell, 1972). Systems of worldviews can cause constraint dynamics and tensions across timescales involving many centuries of conflicts (Gotts, 2007). The systemic nature these conflicts was recognized by Sir Geoffrey Vickers (Vickers, 1968) in observing how inner worlds '… clash, excite, modify and destroy each other, or preserve their stability by making strange accommodations with their rivals." (p. 51), innovatively seeing thought as an evolutionary ecology formed 'under its own laws and own time scale'. What is unclear is how societal levels of thinking may entrain individual thought patterns other than through social norms, and conversely whether small changes in individual thinking can alter longer timeframes of thought, perhaps even transitions in worldviews. It is on these essential questions, on the potential for change and the barriers to changes in thought, that sustainability and evolutionary theorists are primarily concerned. Systems of causation are difficult to isolate where there has been no previous definition or

observation of the components of the system. Without definition of the parts the description of the whole is difficult to discern (Phillips, 1976). This obscure area holds the most potential. It is in this area, of the tensions in cross-scalar relationships, that the most research work needs to be done.

Summary

At this stage, the development of the psychological systems literature might resemble the assemblage of sub-domain specific insights of the ecological disciplines of the 1970's, looking for organizing principles. In the absence of a methodology to focus our empirical inquiries it may be our findings on the opinions and potentials of human thought and societal thinking, if not inconclusive and contradictory, are simply untidy with no discernable higher order question in mind (Ahl & Allen, 1996). As demonstrated, using the principles of panarchy theory there exists a means of ordering the existing research on psychological functions to inform a hierarchical psychological systems theory. In summary, in the words of Sir Geoffrey Vickers:

> "So I regard it as a legitimate analogy, though not of course, an exact one, to speak of our interpretive system – I call it an appreciative system – as an ecological system, even though the laws which order and develop a population of ideas (conflicting, competing, and mutually supporting) in communicating minds are different from those which order and develop a population of monkeys in a rainforest or of insects under a paving stone." (Vickers, 1968)(p. 12)

The potential therefore exists for research into those areas where discernible patterns can already be seen, yet the framing of the relevant research questions has not previously been possible due to the absence of a meaningful research taxonomy and paradigm of inquiry. It is the investigation of the linkages between processes of the system of thought where the interesting work begins. The ordering of our thoughts, about thought, provides the structure to reveal clearly where the gaps in our existing knowledge might be.

Taxonomy for Psychological Panarchy

A vital step in the progression of a viable theory of psychological panarchy is the creation of a taxonomy of potential levels of organization. While it is arguably necessary for constructive discourse to allow any ambiguity of meaning to resolve itself into creative insight over time, differences of perception or opinion are not to be confused with fundamental differences in definition (Bohm & Nichol, 2004). Philosopher Karl Popper (Popper, 1994) argued that the absence of a common framework of assumptions and principles does not make within discipline conversations impossible, only extremely difficult. However, considering the form of the cross-disciplinary dialogues psychological panarchy research would involve, particularly the requirement for a mindfulness of mind, observational criteria (such as that used in ecological research) in levels of abstraction would enable the convergence necessary for coherence in this field. This would allow distinct classes of inquiry to be identified without the category errors that cause a collapse of meaning (Whitehead & Russell, 1927). The progress made in the disciplines of theoretical ecology and panarchy may provide the scaffolding for a step- by-step,

concept-by-concept, application of panarchy principles to human thought, avoiding a simple analogy, depiction, characterization or metaphorical approach. An initial example may assist in showing how a stepwise approach to the task of an application of existing ecological principles and practice to this study may work.

In ecological research often the organism is used as the focal point for a study. As a representative individual of its species, the organism provides a discernible entity for observation. Observations of the organism provide a basis for extensions to the community level of inquiry and provide a normative reference for unit-based statements about populations through sampling and aggregation. The organism is fundamental and useful in drawing conceptual distinctions between the object of focus and the environment within which it is situated. In developing a theory of psychological panarchy, by analogy there would need to be a corresponding entity to the organism – which logically would be - the person. If we desire to study the system of thought, it would be natural to begin with the thinker. The analogy is that the biology of the organism is to ecological panarchy as individual psychology is to psychological panarchy. This logic is incorrectly placed.

If we were to develop a valid taxonomy for psychological panarchy theory, the psychological concept that correlates to an individual species in a psychological system is - the *concept*. As psychological panarchy concerns the organization of the complexification of thought in the psychological domain, its entities for observation are the conceptual and intangible. In the psychological domain the objects of focus are non-physical (or more accurately, non-biological and non-sociological). The field exclusively concerns the intangible aspects of thought as a system, with individual thoughts within that system operating as individual organisms would in complex biological ecologies. This represents a major paradigm shift and presents new challenges when drawing from the fields of psychology focused on the behaviors or opinions of a discrete physical entity (e.g. a person, a group, a community, or population sample). It does not alter, however, the validity of the observations made from within these disciplines where those disciplines provide a valid means of observation of the psychological panarchy dynamics operating within that level of observation. With inquiry in the fields of psychology being ostensibly into ‘what or how people think’, an inquiry into ‘why thought thinks’ requires a different approach entirely. This gives rise to the need for the meta-theory of psychological panarchy.

Looking to a definitional taxonomy for psychological panarchy we might begin with a simplified form using familiar distinctions. Comparisons are provided with ecological concepts to facilitate the drawing of new distinctions based on recognitions of the familiar. A criterion based approach for a biological-ecology in different levels of organization (dependent on the focus of a particular inquiry) might be: *processes, organisms, species, habitats, communities, populations, ecosystems, landscapes, biomes, ecoservices, biospheric potential*. These are not organized by scale so much as organized by possible levels of observation in nested systems of contribution and constraint as a system of biological functions. The corresponding sequence of a thought-ecology as a panarchy using similar distinctions would be: *thinking, thought, concepts, conceptions, understandings, presumptions, assumptions, worldviews, philosophies, capacities,*

potentials. Illustrative parallels can be drawn between entities in a biological ecology with those of a psychological ecology, being: processes *(thinking),* organisms *(thought),* species *(concepts),* habitats *(conceptions),* communities *(understandings),* populations *(presumptions),* systems *(assumptions),* landscapes (*worldviews),* regions *(philosophies),* services *(capacities),* and spheres *(potentials)*.

Using this exemplar taxonomy, a panarchy perspective of an ecology of thought reveals how stimulation and perception (*processes*), generates individual thoughts (*organisms*) which produce recognizable concepts (*species*), that inhabit recurrent locations (habitats), in a conjunction of understandings (*communities*), to create a series of held presumptions (*populations*). In perpetuation of these understandings over time their underlying assumptions (*systems*), gradually form and transform worldviews (*landscapes*), which can historically be seen as periods of philosophical thought in historical contexts (*regions*). The resulting capacities of thought within those landscapes of time and place (*services*), then fail or fulfill the available systemic potentials (*spheres*) and so thought as a system evolves or devolves in cycles of response and evolutionary adaptiveness (*panarchy*). From neuron to noosphere thought is then seen to be a system of dynamic formation and constraint.

Each taxonomic level of observation of this psychological panarchy already has a discrete discipline of inquiry, for example: neurology (*thinking),* psychology *(thought),* semiotics *(concepts),* developmental psychology *(conceptions),* social psychology *(understandings),* sociology *(presumptions*), psychological systems theory *(assumptions),* anthropological psychology *(worldviews),* philosophical post-metaphysics *(philosophies*), evolutionary psychology *(capacities),* and consciousness theory *(potentials)*. This initial ordering taxonomy can be expanded to include dimensions similar to those necessary for ecological inquiries. The locus of observation, the related spatial span, the correlating temporal span and the resultant forms for observation would be separately identified. This formulation enables a conscious choice of parameters of observation in psychological panarchy theory. Observations would then be made with reference to the specific characteristics of human thought within a system of panarchical dynamics. The discernment of these dimensions as distinctions is possibly the nexus for conjunction of different studies in thought at different levels of observation. A heuristic matrix of levels of observation is provided for discussion and evaluation (Appendix A).

Importantly, this proposed approach to a taxonomy is not one of using a definitional holarchy of pre-determined arrangements of existent objects relying on a single definitional criteria. It is merely an organizing language to allow the researcher, as observer, to consciously scope and define their selection of the criterion for observation for their inquiry. The taxonomy provides an approach to the ecology of thought, combining the virtues of a holarchy of definition and a hierarchy of investigation, into a panarchy for exploration. Discussion is sought on its potential for use, its inherent limitations and the likelihood of future progressions in this field.

Methodological Problems – Research Questions

In entering a paradigm of practice in transition the relief of the dissonance from the non-convergence of contradictory approaches is replaced instead with the anxiety of an expanse of methodological unknowns (Kuhn, 1996; Sharrock & Read, 2002). While many of these unknowns have been faced in parallel problems of methodology in recent ecological or psychological inquiries, others will be novel and unique. Some preliminary methodology questions representing opportunities in and challenges for psychological panarchy research are noted:

Consciousness as Object: In this field the focus of observation and the means of observation are the same, being thought as a form. We are observing the ecology of thought of which we are a part. Objectivity is perhaps by definition unavailable, yet it is not impossible. Meta-cognitive functions are required, which is why a taxonomy of inquiry becomes an essential tool to allow one to observe the choices made by the observer in the process of observation.

Researcher as Subject: In psychological panarchy the means of measurement (the thoughts of the researcher or research methodology designer) is also an object for inquiry. In a way the researcher is also a subject of the study, disclosing information in their choice of methodology or entity of observation (i.e. cognitive complexity). The expansion of the problem domain now paradoxically includes the observer, the means of observation, and the observed.

Environment as Context: If ecology is the study of an entity in relationship to its environment, in psychological panarchy that environment is the system of thought[4]. Sub-systems of thought are defined by the spatiotemporal scale of the phenomenon being studied. Considering the constraints of psychological time, this makes the perception of boundaries and gradients particularly difficult to perceive, sometimes being beyond the scope of the observer for observation.

Context as Formative: In environmental psychology context can be determinate (e.g. neurochemical state, environmental stressors, intra-group dynamics etc.). In looking at the structures of thought, context (which includes historical experience) can be formative of the content. To examine the structure of thought as a system the processes of formation of thought must also be seen. This presents a paradigmatic challenge in the use of non-dynamic stage theories independent of context as forms of assessment.

Evolution as Normative: An often held assumption in ecological systems theory is that the state prior to degradation is a desirable state. In panarchy theory multi-state scenarios are equally valid. The assumption that our existing evolutionary progressions in thought are desirable, that they are to be sustained, made more resilient or are optimal are not maintainable. This makes determining the ideal model for the system problematical.

The complexity of this field of inquiry requires new research methodologies. Using the analogy of an ecology these methods may draw from the knowledge gained in structuring ecological inquiries. The reality is that this is a very different modality, which will

require care, in, of and for thought itself. Mindfulness in the structuring of research will not only be desirable for the purposes of multi-researcher correlation, but essential for any form of objective validation. Yet, the system sciences have history of successfully disclosing the unseen (Carpenter & Turner, 1998, 2007). The ecology of thought is not unavailable, simply at this time it is not disclosable, an absence that is easily remediable. Like any complex systems that scientists have investigated, the disclosure of thought as a system is only another form of inquiry. The potential exists to see the system of human thought by finding 'the entity within its habitats', in increasing ecological situated scales, as a panarchy of complexity, in potentials of resilience and vulnerability. In doing so we might bring a modern ecological perspective to the evolutionary capacity of the thoughts of humanity leading to the governance of our own resilience, for the first time.

Conclusion and Opportunity

The absence of a viable theory for the system of thought will not prevent thought occurring. Thought is the food of meaning for the ecology of the human mind. The activity of thought continues on regardless and, in non-human forms, will continue without us. It appears that the ongoing process of meaning-making is more important to us than even oxygen. We can hold our breath for one or two minutes, yet we will not allow even a moment to pass without exercising our mind in the formation of meaning, even in the simplicity of an analytical meditation in stillness. We expend great intellect to develop systems to model and measure the degradation (and restoration) of our natural environments and the fragmentation (and generation) of our communities. The closing question to perhaps ask is when will we expend even a few minutes in examining the cause of the underlying urgency in those inquiries by, consciously, looking into the structures and conditions of the system of thought. With an intentional link to Gregory Bateson's desire for generative learning in an 'ecology of minds', there has already been a recognition that an appreciation of an 'ecology of ideas' is needed to guide the ecology of thought to enables our future and our peace:

> "For if my analysis is remotely right, the future of our society depends on the speed with which it can *learn*; learn not primarily new ways of responding, though these are needed but primarily new ways of appreciating a situation which is new and new through our own making; and thus of finding a basis to combine in securing, so far as we still know, what belongs to our peace." (Vickers, 1983b) (p. 233)

This initial discussion proposes a comparison, a pattern of evolution, selects a pathway and provides a guiding taxonomy towards that particular inquiry. In understanding the distinctions in the focal entities in psychological panarchy, of psychological habitats and communities, at different levels of organization, discerning the locus of observation in psychological space, and in temporal cycles in psychological time, this approach may provide some steps towards an understanding of an ecology of thought. Perhaps from this small beginning, great strides are possible.

	Focal Entity	**Locus of Observation**	**Spatial Span**	**Temporal Span**	**Resultant Form**
A.	Thinking	Stimulation	Synapse	Perception	Impression
B.	Thought	Ideas	Neocortex	Proposition	Experience
C.	Concepts	Models	Mind	Mode	Interpretation
D.	Conceptions	Beliefs	Identity	Phase	Frame
E.	Understandings	Norms	Commonality	Process	Forms
F.	Presumptions	Values	Identifications	Pattern	Description
G.	Assumptions	Principles	Systems	Paradigm	Depiction
H.	Worldviews	Knowledges	Contexts	Period	Explanation
I.	Philosophies	Domains	Realms	Era	Theory
J.	Capacities	Realities	Horizons	Age	Ideals
K.	Potentials	Futures	Consciousness	Cene	Intentions

NB: This Annexure uses the convention of an apithology matrix. This particular format sets out points in a spatial organization of interlinked concepts. Rather than containing content, each cell contains a signifier which bounds the content existing between each other reference point. The delineations between cells mark the gradients of transitions in the domains of content. This approach in holistic structuralism allows for the definition of the scope of inquiry without pre-definition of the phenomenon found within.

REFERENCES

Ahl, V., & Allen, T. F. H. (1996). *Hierarchy theory: A vision, vocabulary, and epistemology*. New York: Columbia University Press.

Allen, T. F. H., & Hoekstra, T. W. (1992). *Toward a unified ecology*. New York: Columbia University Press.

Allen, T. F. H., O' Neill, R. V., & Hoekstra, T. W. (1999). Interlevel relations in ecological research and management: Some working prinicples from hierarchy theory. In S. I. Dodson, T. F. H. Allen, S. R. Carpenter, K. Elliot, A. R. Ives, R. L. Jeanne, J. F. Kitchell, N. E. Langston & M. G. Turner (Eds.), *Readings in ecology* (pp. 393-412). New York Oxford University Press.

Allen, T. F. H., & Starr, T. B. (1982). *Hierarchy, perspectives for ecological complexity*. Chicago: University of Chicago Press.

Allen, T. F. H., Tainter, J. A., & Hoekstra, T. W. (2003). *Supply-side sustainability*. New York: Columbia University Press.

Barker, R. G. (1965). Explorations in ecological psychology. *American Psychologist, 20*(1), 1-14.

Barker, R. G. (1968). *Ecological Psychology: Concepts and methods for studying the environment of human behavior* Stanford, CA: Stanford University Press.

Bateson, G. (1972). *Steps to an ecology of mind*. San Francisco: Chandler Publishing Company.

Benack, S. (1984). Post-formal epistemologies and the growth of empathy. In M. L. Commons, F. A. Richards & C. Armon (Eds.), *Beyond formal operations: Late adolescent and adult cognitve development* (pp. 340-356). New York: Praeger.

Berkes, F. (1998). Indigenous knowledge and resource management systems in the Canadian subarctic. In F. Berkes & C. Folke (Eds.), *Linking social and ecological systems: Management practices and social mechanisms for building resilience* (pp. 98-128). Cambridge, U.K.: Cambridge University Press.

Berkes, F., & Folke, C. (2002). Back to the future: Ecosystem dynamics and local knowledge. In L. H. Gunderson & C. S. Holling (Eds.), *Panarchy: Understanding transformations in human and natural systems* (pp. 121-146). Washington, DC: Island Press.

Berkes, F., & Folke, C. (Eds.). (1998). *Linking social and ecological systems: Management practices and social mechanisms for building resilience* Cambridge, U.K. : Cambridge University Press.

Block, R. A. (Ed.). (1990). *Cognitive models of psychological time*. Hillsdale, NJ Lawrence Erlbaum Associates.

Bohm, D. (1994). *Thought as a system*. London: Routledge.

Bohm, D. (2002). *Wholeness and the implicate order*. London: Routledge.

Bohm, D., & Nichol, L. (2004). *On dialogue*. London: Routledge.

Brock, W. A., Maler, K.-G., & Perrings, C. (2002). Resilience and sustainability: The economic analysis of nonlinear dynamic systems. In L. H. Gunderson & C. S. Holling (Eds.), *Panarchy: Understanding transformations in human and natural systems* (pp. 261-289). Washington, D.C.: Island Press.

Carpenter, S. R., & Cottingham, K. L. (2002). Resilience and the restoration of lakes In L. H. Gunderson & L. Pritchard Jr. (Eds.), *Resilience and the behavior of large-scale systems* (pp. 51-70). Washington, D.C.: Island Press.

Carpenter, S. R., & Gunderson, L. H. (2001). Coping with collapse: ecological and social dynamics in ecosystem management. *Bioscience, 51*(6), 451-457.

Carpenter, S. R., & Turner, M. G. (1998). At last: A journal devoted to ecosystem science. *Ecosystems, 1*, 1-5.

Carpenter, S. R., & Turner, M. G. (2000). Hares and tortoises: Interactions of slow and fast variables in ecosystems *Ecosystems, 3*(6), 495-497.

Carpenter, S. R., & Turner, M. G. (2007). A decade of ecosystems. *Ecosystems, 10*, 519-522.

Carpenter, S. R., Walker, B., Anderies, J. M., & Abel, N. (2001). From metaphor to measurement: Resilience of what to what? *Ecosystems, 4*, 765-781.

Chess, S., & Thomas, A. (1992). Interactions between offspring and parents in development. In B. Tizard & V. Varma (Eds.), *Vulnerability and resilience in human development*. London: Jessica Kingsley Publishers.

Clark, W. C., Jones, D. D., & Holling, C. S. (2010). Lesson for ecological policy design In L. H. Gunderson, C. R. Allen & C. S. Holling (Eds.), *Foundations of ecological resilience* (pp. 331-394). Washington, D.C.: Island Press.

Clements, F. E. (1905). *Research methods in ecology*. Lincoln, Nebraska, USA: University Publishers.

Clements, F. E. (1920). *Plant indicators: The relation of plant communities to processes and practices*. Washington, D.C.: Carnegie Institution of Washington.

Commons, M. L., Richards, F. A., & Armon, C. (Eds.). (1984). *Beyond formal operations: Late adolescent and adult cognitve development* New York: Praeger.

Commons, M. L., Richards, F. A., & Kuhn, D. (1982). Systemic and metasystemic reasoning: A case for levels of reasoning beyond Piaget's stage of formal operations. *Child Development, 53*, 1058-1069.

Cook-Greuter, S. R. (1990). Maps for living: Ego development stages from symbiosis to conscious universal embeddedness. In M. L. Commons, F. A. Richards, C. Armon & L. Kohlberg (Eds.), *Adult Development: models and methods in the study of adolescent and adult thought* (Vol. 2, pp. 79-104). New York: Praeger.

Cook-Greuter, S. R. (2000). Mature ego development: A gateway to ego-transcendence *Journal of Adult Development, 7*(4), 227-240.

Cook-Greuter, S. R. (2004). Making the case for a developmental perspective. *Industrial and Commercial Training, 36*(6/7), 275-281.

Daily, G. C. (Ed.). (1997). *Nature's services: Societal dependence on natural ecosystems* Washington D.C.: Island Press.

Darwin, C. (2006). The origin of species: by means of natural selection; or the preservation of favoured races in the struggle for life. In E. O. Wilson (Ed.), *From So Simple a Beginning: Darwin's Four Great Books (Voyage of the Beagle, The Origin of Species, The Descent of Man, The Expression of Emotions in Man and Animals)*. London: W.W. Norton & Company

Dawkins, R. (1976). *The selfish gene*. Oxford: Oxford University Press.

Dawson-Tunik, T., Commons, M. L., Wilson, M., & Fischer, K. W. (2005). The shape of development. *European Journal of Developmental Psychology, 2*(2), 163-195.

Delfgaauw, B. (1969). *Evolution: The theory of Teilhard de Chardin, Pierre* (B. Towers, Trans.). London: William Collins and Sons.

Depraz, N., Varela, F. J., & Vermersch (Eds.). (2003). *On becoming aware: A pragmatics of experiencing*. New York: John Benjamins Publishing Co.

Desjarlais, R., Eisenberg, L., Good, B., & Kleinman, A. (1995). *World mental health: Problems, and priorities in low-income countries*. New York: Oxford University Press.

Diamond, J. (2005). *Collapse: How societies choose to fail or survive*. Camberwell, Australia: Allen Lane.

Dickinson, G., & Murphy, K. (2007). *Ecosystems* (2nd ed.). London: Routledge.

Dodson, S. I. (1998). What is ecology?: Looking at nature from different perspectives. In S. I. Dodson (Ed.), *Ecology* (pp. 1-24). New York: Oxford University Press.

Dunlap, J. C., Loros, J., J., & DeCoursey, P. J. (Eds.). (2004). *Chronobiology: Biological timekeeping*. Sunderland, Mass.: Sinauer Associates.

Elton, C. S. (1927). *Animal ecology*. London, U.K.: Sidgwick and Jackson

Emiliani, C. (1992). *Planet earth: Cosmology, geology, and the evolution of life and environment*. Cambridge, England: Cambridge University Press.

Esbjörn-Hargens, S., & Zimmerman, M. E. (2009). *Integral ecology: Uniting multiple perspectives on the natural world*. Boston: Integral Books.

Fisher, K. W., Hand, H. H., & Russel, S. (1984). The development of abstractions in adolescence and adulthood. In M. L. Commons, F. A. Richards & C. Armon (Eds.), *Beyond formal operations* (pp. 43-73). New York: Praeger Publishers.

Frankl, V. E. (1984). *Man's search for meaning*. New York: Washington Square Press.

Fraser, J. T. (1975). *Of time, passion, and knowledge: Reflections on the strategy of existence* New York: George Braziller.

Fraser, J. T. (2001). The extended Umwelt principle: Uexkull and the nature of time. *Semiotica, 134*(1/4), 263-273.

Garmestani, A. S., Allen, C. R., & Gunderson, L. H. (2009). Panarchy: Discontinuities reveal similarities in the dynamic system structure of ecological and social systems. *Ecology and Society, 14 (1)*(15).

Garmestani, A. S., Allen, C. R., Mittelstaedt, J. D., Stow, C. A., & Ward, W. A. (2006). Firm size diversity, functional richness, and resilience. *Environment and Development Economics, 11*(4), 533-551.

Gilligan, C. (1977). *In a different voice: Psychological theory and women's development* Cambridge, MA.: Harvard University Press

Gotts, N. M. (2007). Resilience, panarchy, and the world-systems analysis. *Ecology and Society, 12 (1)*(24).

Graves, C. (1970). Levels of existence: An open system theory of values *Journal of Humanistic Psychology, 10(2)*(Fall 1970), 131-155.

Graves, C. (1974). Human nature prepares for a momentous leap *The Futurist,* 72-78.

Graves, C. (2001). Emergent cyclical levels of existence theory [Audio Tape]. Santa Barbara, CA: ECLET Publishing.

Graves, C. (2005). *The never ending quest*. Santa Barbara, CA: ECLET Publishing.

Graves, C., & Lee, W. R. (2002). *Graves' levels of human existence: Transcription of a seminar at the Washington School of Psychiatry, October 16, 1971*. Santa Barbara, CA: ECLET Publishing.

Gunderson, L. H., Holling, C. S., & Allen, C. R. (2010). The evolution of an idea - the past, present, and future of ecological resilience. In L. H. Gunderson, C. R. Allen & C. S. Holling (Eds.), *Foundations of ecological resilience* (pp. 423-444). Washington, D.C.: Island Press.

Gunderson, L. H., Holling, C. S., & Light, S. S. (Eds.). (1995). *Barriers and bridges to the renewal of ecosystems and institutions*. New York: Cambridge University Press.

Gunderson, L. H., & Light, S. S. (2005). Adaptive management and adaptive governance in the everglades ecosystem. *Policy Sciences, 39*, 323-334.

Hameroff, S., & Penrose, R. (1996). Orchestrated reduction of quantum coherence in brain microtubules: A model for consciousness. *Mathematics and Computers in Simulation, 40*, 453-480.

Hanna, S., Folke, C., & Maler, K.-G. (Eds.). (1996). *Rights to nature: ecological, economic, cultural, and political principles of institutions for the environment*. Washington, D.C. : Island Press.

Haskell, E. (1972). Framework of the periodic table of human cultures. In E. Haskell (Ed.), *Full circle: The moral force of unified science* (pp. 111-168). New York: Gordon and Breach.

Hassan, R., Scholes, R., & Ash, N. (Eds.). (2005). *Ecosystems and human well-being: current state and trends; findings of the Condition and Trends Working Group of the Millennium Ecosystem Assessment*. Washington D.C.: Island Press.

Holling, C. S. (1973). Resilience and stability of ecological systems. *Annual Review of Ecology and Systematics 4*, 1-24.

Holling, C. S. (1986). The resilience of terrestrial ecosystems: Local surprise and global change. In W. C. Clark & R. E. Munn (Eds.), *Sustainable development of the biosphere* (pp. 292-320). Cambridge, United Kingdom: Cambridge University Press.

Holling, C. S. (2001). Understanding the complexity of economic, ecological and social systems. *Ecosystems, 4*, 390-405.

Holling, C. S., Gunderson, L. H., & Peterson, G. D. (2002). Sustainability and panarchies. In L. H. Gunderson & C. S. Holling (Eds.), *Panarchy: Understanding transformations in human and natural systems* (pp. 63-102). Washington: Island Press.

Holling, C. S., Peterson, G. D., & Allen, C. R. (2008). Panarchies and discontinuities. In C. R. Allen & C. S. Holling (Eds.), *Discontinuities in ecosystems and other complex systems*. New York: Columbia University Press

Holling, C. S., & Sanderson, S. (1996). The dynamics of (dis)harmony in human and ecological systems. In S. Hanna, C. Folke, K.-G. Maler & A. Jansson (Eds.), *Rights to nature: ecological, economic, cultural, and political principles for institutions for the environment* (pp. 57-85). Washington, DC: Island Press.

Homer-Dixon, T. F. (1999). *Environment, scarcity, and violence*. Princeton, N.J.: Princeton University Press.

Homer-Dixon, T. F. (2006). *The upside of down: catastrophe, creativity, and the renewal of civilization*. Washington: Island Press.

Howe, M. L. (1988). Measuring memory development in adulthood: A model-based approach to disentangling storage-retrieval contributions. In M. L. Howe & C. J.

Brainerd (Eds.), *Cognitive development in adulthood: Progress in cognitive development research*. New York: Springer-Verlag.
Huxley, A. (1941). *Ends and Means*. London: Chatto & Windus.
Huxley, A. (1962). *Island*. London: Chatto & Windus.
Huxley, J. (1961). *The humanist frame*. London: G. Allen and Unwin.
Huxley, J. (1965). *Growth of ideas: knowledge, thought, imagination*. London: Macdonald.
Huxley, T. (1906). *Man's place in nature and other essays*. London: J.M. Dent.
Huxley, T. (1947). *Evolution and Ethics*. London: Pilot Press.
Jantsch, E. (1980). *The self-organizing universe: Scientific and human implications of the emerging paradigm of evolution*. Oxford: Pergamon Press.
Jantsch, E., & Waddington, C. H. (1976). *Evolution and consciousness: Human systems in transition*. Reading, Mass.: Addison-Wesley.
Kahn, P. H. (2006). Nature and moral development. In M. Killen & J. G. Smetana (Eds.), *Handbook of moral development*. Mahwah, NJ: Lawrence Erlbaum Associates.
Kay, J. J., & Boyle, M. (2008). Self-organizing, holarchic, open systems (SOHOs) In D. Waltner-Toews, J. J. Kay & N. Lister (Eds.), *The ecosystem approach: Complexity, uncertainty, and managing for sustainability* (pp. 52-78). New York: Columbia University Press.
Kay, J. J., Regier, H. A., Boyle, M., & Francis, G. (1999). An ecosystem approach for sustainability: addressing the challenge of complexity. *Futures, 31*(7), 721-742.
Kegan, R. (1982). *The evolving self: Problem and process in human development*. Cambridge, Mass.: Harvard University Press.
Kegan, R. (1994). *In over our heads: The mental demands of modern life*. Cambridge, Mass.: Harvard University Press.
Kelly, J. G. (2006). *Becoming ecological: An expedition into community psychology*. Oxford, United Kingdom: Oxford University Press.
Koestler, A. (1967). *The ghost in the machine*. London: Hutchinson Publishing Group.
Koestler, A. (1970). *The act of creation* (Revised Danube Edition ed.). London: Pan Books.
Kohlberg, L. T. (1969). Stage and sequence: The cognitive development approach to socialization. In D. A. Goslin (Ed.), *Handbook of socialization theory and research* (pp. 347-). Chicago: Rand McNally.
Kuhn, T. (1996). *The structure of scientific revolutions* (Third ed.). Chicago: The University of Chicago Press.
La Llave, J., & Commons, M. L. (1996). Comparing psychodynamic, cognitive developmental, and behavior-developmental views of psychological boundaries *Clinical approaches to adult development* (pp. 175-209). Norwood, New Jersey, USA: Ablex Publishing
Lapsley, D. K. (2006). Moral stage theory. In M. Killen & J. G. Smetana (Eds.), *Handbook of moral development*. Mahwah, New Jersey, USA: Lawrence Erlbaum Associates.
Loevinger, J., & Blasi, A. (1976). *Ego development: Conceptions and theories* (1st ed.). San Francisco: Jossey-Bass Publishers.
Loevinger, J., Wessler, R., & Redmore, C. (1970). *Measuring ego development*. San Francisco: Jossey-Bass.

Lopez, A. D., & Murray, C. (1998). The global burden of disease, 1990–2020. *Nature Medicine, 4*, 1241 - 1243.

Lovelock, J. (1979). *Gaia, a new look at life on Earth*. Oxford: Oxford University Press.

Lovelock, J. (1988). *The ages of Gaia: A biography of our living Earth* Oxford: Oxford University Press.

Luhmann, N. (1989). *Ecological communication*. Chicago: University of Chicago Press.

McKenzie-Mohr, D., Neiroff, L. S., Beers, L., & Desmarais, S. (1995). Determinants of responsible environmental behavior. *Journal of Social Issues, 51*(4), 139-156.

Miller, T. R., Baird, T. D., Littlefield, C. M., Kofinas, G., Chapin III, F. S., & Redman, C. L. (2008). Epistemological pluralism: Reorganizing interdisciplinary research. *Ecology and Society, 13*(2).

Murray, C., & Lopez, A. D. (Eds.). (1996). *The global burden of disease: A comprehensive assessment of mortality and disability from diseases, injuries and risk factors in 1990 and projected to 2020*. Boston, Mass.: Harvard School of Public Health, World Health Organization, World Bank.

O'Neill, R. V. (1989). Perspectives in hierarchy and scale. In J. Roughgarden, R. M. May & S. A. Levin (Eds.), *Perspectives in ecological theory* (pp. 140-156). Princeton, New Jersey, USA: Princeton University Press.

O'Neill, R. V., DeAngelis, D. L., Waide, J. B., & Allen, T. F. H. (1986). *A hierarchical concept of ecosystems*. Princeton, NJ: Princeton University Press.

Odum, E. P. (1975). *Ecology: The link between the natural and social sciences* (2nd ed.). New York: Holt, Rinehart and Winston.

Odum, E. P. (1993). *Ecology and our endangered life-support systems* (2nd ed.). Sunderland, Mass.: Sinauer Associates, Inc.

Odum, H. T. (1988). Self-organisation, transformity, and information. *Science, 242*, 1132-1139.

Odum, H. T. (1994). *Ecological and general systems: An introduction to systems ecology*. Niwot, Colorado: University Press of Colorado.

Orwell, G. (1949). *Nineteen eighty-four: A novel*. London: Secker & Warburg.

Orwell, G. (1951). *Animal farm: A fairy story* Harmondsworth, England: Penguin Books.

Perry, W. G. (1999). *Forms of intellectual and ethical development in the college years: A scheme*. San Francisco: Jossey-Bass.

Phillips, D. C. (1976). *Holistic thought in social science*. London: The Macmillan Press Ltd.

Piaget, J. (1928). *Judgment and reasoning in the child* (M. Warden, Trans.). London: Routledge & Kegan Paul.

Pinker, S. (1989). *Learnability and cognition: The acquisition of argument structure*. Cambridge Mass. : MIT Press.

Pinker, S. (1995). *The language instinct: The new science of language*. London: Penguin.

Pinker, S. (1997). *How the mind works*. London: Allen Lane.

Popper, K. (1994). *The myth of the framework: In defence of science and rationality*. London: Routledge.

Rapport, D. J. (1999). Regaining healthy ecosystems: The supreme challenge of our age. In D. J. Rapport, W. L. Lasley, D. E. Rolston, N. O. Nielsen, C. O. Qualset & A. B. Damania (Eds.), *Managing for healthy ecosystems* (pp. 5-10). Boca Raton, Florida USA: Lewis Publishers.

Reigel, K. (1973). Dialectical operations: The final period of cognitive development. *Human Development, 16*, 346-370.

Robinson, K., & Westley, F. (2009). *Resilience and positive disintegration in mental health systems*. Waterloo: Social Innovation Generation, University of Waterloo.

Roughgarden, J., May, R. M., & Levin, S. A. (1989). *Perspectives in ecological theory*. Princeton, N.J: Princeton University Press.

Russel, J. A., & Ward, L. M. (1982). Environmental psychology. *Annual Review of Psychology, 33*, 651-688.

Saarinen, E. (Ed.). (1980). *Conceptual issues in ecology*. Dordrecht, Holland: D. Reidel Publishing.

Scheffer, M., Westley, F., Brock, W. A., & Holmgren, M. (2002). Dynamic interaction of societies and ecosystems: Linking theories from ecology, economy, and sociology In L. H. Gunderson & C. S. Holling (Eds.), *Panarchy: Understanding transformations in human and natural systems* (pp. 195-239). Washington, DC: Island Press.

Schmuck, P., & Schultz, P. W. (2002). *Psychology of sustainable development*. Boston: Kluwer Academic.

Schneider, E. D., & Kay, J. J. (1994). Complexity and thermodynamics: Towards a new ecology. *Futures, 26*(6), 626-647.

Schoggen, P. (1989). *Behavior settings: A revision and extension of Roger G. Barker's Ecological Psychology*. Stanford, CA: Stanford University Press.

Sharrock, W., & Read, R. (2002). *Kuhn: Philosopher of scientific revolution*. Cambridge, United Kingdom: Polity Press.

Simon, H. A. (1962). The architecture of complexity. *Proceedings of the American Philosophical Society 106*, 467-482.

Simon, H. A. (1973). The organization of complex systems. In H. H. Pattee (Ed.), *Hierarchy theory* (pp. 3-27). New York: George Braziller.

Smolak, L. (1993). *Adult development*. Englewood Cliffs, New Jersey, USA: Prentice Hall.

Stevens-Long, J., & Commons, M. L. (1992). *Adult life: Developmental processes*. Mountain View, CA: Mayfield Publishing Company.

Taifel, H. (1982). Social psychology of intergroup relations. *Annual Review of Psychology, 33*, 1-39.

Tainter, J. A. (1988). *The collapse of complex societies*. Cambridge: Cambridge University Press.

Tansley, A. (1935). The use and abuse of vegetational concepts and terms. *Ecology, 16*, 284-307.

Tansley, A. (1946). *Introduction to plant ecology; a guide for beginners in the study of plant communities* (2nd ed.). London: G. Allen & Unwin.

Thompson, E. (2007). *Mind in life: Biology, phenomenology, and the sciences of mind*. Cambridge, Mass.: The Belknap Press of Harvard University Press.

Teilhard de Chardin, P. (1964). *The future of man* (N. Denny, Trans.). London: William Collins and Sons.

Torbert, W. (1999). The distinctive questions developmental action inquiry asks. *Management Learning, 30*, 189-206.

Torbert, W. (2000). A developmental approach to social science: a model for analyzing Charles Alexander's scientific contributions. *Journal of Adult Development, 7*(4), 255-267.

Torbert, W., & Fisher, D. (1992). Autobiographical awareness as a catalyst for managerial and organizational development. *Management Education and Development, 23*(3), 184-198.

Uexküll, J. v. (1992). A stroll through the worlds of animals and men: A picture book of invisible worlds. *Semiotica, 89*(4), 319-391.

Ustun, T. B. (1999). The global burden of mental disorders. *American Journal of Public Health, 89(9)*, 1315-1318.

Varela, F. J., Thompson, E., & Rosch, E. (1993). *The embodied mind: Cognitive science and human experience*. Cambridge, Mass.: The MIT Press.

Vickers, G. (1968). *Values systems and social process*. Harmondsworth, Middlesex, England: Penguin Books.

Vickers, G. (1970). *Freedom in a rocking boat: Changing values in an unstable society*. Harmondsworth, Middlesex, England: Penguin Books.

Vickers, G. (1983a). *Human systems are different*. London: Harper & Row.

Vickers, G. (1983b). *The art of judgment: A study of policy making*. London: Harper & Row.

Walker, B., Holling, C. S., Carpenter, S. R., & Kinzig, A. (2004). Resilience, adaptability and transformability in social-ecological systems. *Ecology and Society, 9*(2).

Walters, C. H., & Holling, C. S. (1990). Large-scale management experiments and learning by doing? *Ecology, 71*(6), 2060-2068.

Warming, E., & Vahl, M. (1909). *Oecology of plants* (Reprint 1977 (Arno Press Inc) ed.). Oxford, England: Clarendon Press.

Westley, F., Carpenter, S. R., Brock, W. A., Holling, C. S., & Gunderson, L. H. (2002). Why systems of people and nature are not just social systems. In L. H. Gunderson & C. S. Holling (Eds.), *Panarchy: Understanding transformations in human and natural systems* (pp. 103-119). Washington, DC: Island Press.

Whitehead, A. N., & Russell, B. (1927). *Principia Mathematica* (2nd ed. Vol. 1). Cambridge: Cambridge University Press.

Endnotes:

[1] For the purposes of this description 'nested' and 'non-nested' are used in the sense of definitional holarchies where a nested holon is conceptually 'contained' within holons of a higher level of organization (Koestler, 1967). Allen et al. (Allen, et al., 1999) elucidate the process for delineation of surfaces in ecological theory to form hierarchical nested structures through observation sets, with nestedness occurring by the process of observation. In panarchy theory, a panarchy is often described as comprising a 'nested set' of adaptive cycles, representing the relationship of entrainment (but not necessarily definitional containment) (Holling, et al., 2002). This paper explicitly examines the subtle distinctions between these three paradigms of practice, which use similar language in different systems of thought in approaches of definition, observation or exploration, each having their own unique advantages.

[2] Thomas Kuhn's (Kuhn, 1996) revolution was to re-describe the process of thought in the discoveries of normal science obscured by history's reconstructive re-telling. The pattern of progressions in our understanding, from newly unknowing, to progressive discovery, to a focus on anomalies, requiring different seeing, may lead us to reframe our perspectives in stages of evolutionary necessity. This cyclical unfolding of knowledge instigates, develops, exhausts and inspires new thinking. Thought entrained by such constraints may proceed occasionally (or perhaps periodically) to a revolution of worldviews. This process of transitions in paradigm is another example of the cyclic nature of the structure of thought at one unique and discrete level of observation.

[3] In this context, the sense of the word 'complex' is used in its hierarchical systems meaning, being that small scale changes potentially will have large scale impacts by reason of cross-scalar dependencies, such that a panarchy system is truly a complex system in being vulnerable to disturbances at any level.

[4] Many other studies support the application of ecological principles to the study of complex psychological systems. The structures of biological autopoiesis applied to mind (Thompson, 2007) and social autopoiesis applied to social perception of the environment (Luhmann, 1989) show how the development of mind is structurally coupled with the perception of environmental conditions. In the way that biological gradients provide resilience, cognitive boundaries are seen as essential for psychological integrity and a psychodynamic view of boundary permeability shows how the lack of psychological boundary affects the coherence of the internal self-sense determining psychological resiliency (La Llave & Commons, 1996). The concept of 'psychological niche' has been related to a 'poorness of fit' of children into parental expectations or standards, which creates stress and dissonance, leading to adverse coping responses and a lack of resiliency with the potential for the development of behavior disorders (Chess & Thomas, 1992). There is also longitudinal evidence of the positive effects of a child's early experiences in nature on moral development and caring, highlighting the developmental linkages between psychology and ecology (Kahn, 2006). Ecological psychology has shown how clinical behavior studies can benefit from understanding how situation affects the psychological responses of individuals (Barker, 1965, 1968; Schoggen, 1989). In environmental psychology it is noted that the psychological barriers and constraints to behavior change reflect individual psychological determinants, rather than social values or demographic forms (McKenzie-Mohr, Neiroff, Beers, & Desmarais, 1995; Russel & Ward, 1982). Community psychology as a distinct and evolving field in the study of social sustainability specifically examines our collective relationship to the environment in the form of social values (Kelly, 2006; Scheffer, Westley, Brock, & Holmgren, 2002; Schmuck & Schultz, 2002). However, while this represents remarkable and significant research, these studies primarily examine how human thought is altered in systemic relationship with the physical or sociological environment. The five component definitions of panarchy used in this paper are provided to make clear that an investigation into an 'ecology of thought' is very different to the investigation of the relationship of thought to the physical environment as an ecology. While benefit comes from understanding how thought is influenced by physical or social environments, the more intricate and determining mysteries will only be answered by inquiry into the environment of thought itself. For this to occur, a coherent discipline for the inquiry into the ecology of thought will be required, from which these many studies of the effects of variations in ecological and sociological influences on each of us, will make profoundly more sense.