Inclusional Sustainability: A Natural Way of Life

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Keywords

Ecological attunement; energy flow; evolutionary creativity; flow-geometry; intangible presence; natural inclusion; natural neighbourhood; natural systems; place-time; sustainable evolution

Introduction

The efficiency of all food and agricultural production depends ultimately on close attunement with the availability of sources of energy, whether in the open or under internally controlled conditions. Life on Earth has evolved through just such close attunement. If people are to enhance their sustainable practice, there may therefore be no better place to learn than from the wildlife about them. But, in order to do so, there is a need for a fundamental involution in how to understand the natural world and humanity's place within it.

As stated in the recent book, 'NaturesScope' (Rayner 2011a), for thousands of years people have tried to study, interpret and teach themselves *about* Nature from an inside-out point of view, through the lenses of telescopes, microscopes and binocular eyesight. A rigidly framed objective picture 'out there' is seen that does not include themselves, yet upon which is projected human imagery and psychology. This one-way view has brought humanity into opposition with its natural origins and one another. A different view, *from* Nature, needs to be evoked, which brings human beings and the world into empathic mutual relationship. This can enable people to enquire imaginatively and creatively into how to turn the narrowed down objective worldview around and see themselves from outside-in as energetic *inhabitants* of Nature.

In this contribution, personal experience of working with fungi and trees will be called upon to help show what needs to be taken into account if people are to develop more *energy*-efficient (*not* time-efficient!) and hence truly sustainable modes of production. There is much to be learned by reading the 'body language' of these growth forms.

Consider, for example, the 'sustainable growth' exhibited by the magpie ink cap, *Coprinus picaceus* in Figure 1, as its mycelium (a collective organization of branching cellular tubes

individually called hyphae) encounters an unforeseen array of energy-rich and energy-scarce circumstances. Is it possible to understand and learn how to apply to human productive practices the organizational principles underlying such fluidly receptive and responsive patterns? What kind of conceptual framework would help – indeed might the human predilection to impose abstract theoretical frameworks on natural processes be a 'learning difficulty'?

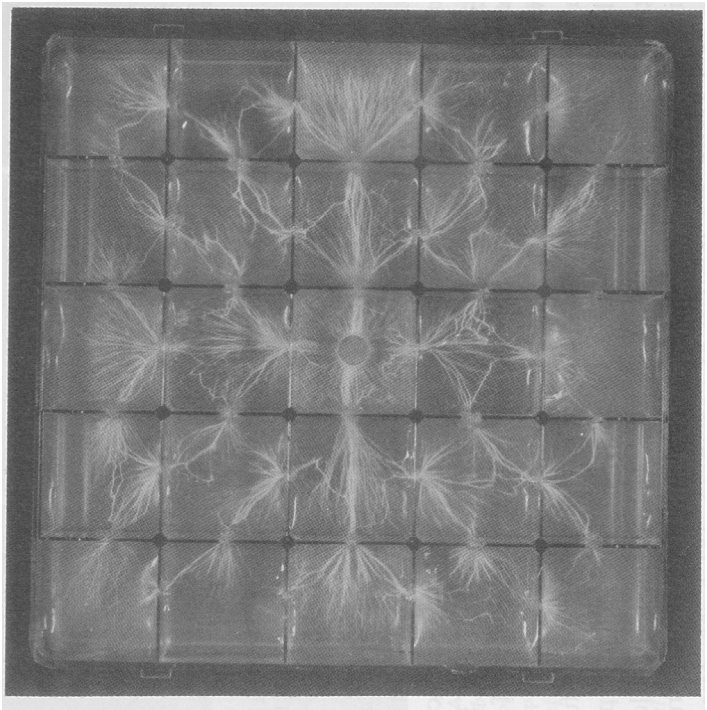

Fig. 1. 'Sustainable development' in abundance and scarcity, illustrated by mycelial growth of the magpie fungus, *Coprinus picaceus*, in a matrix of 25 2x2 cm plastic chambers filled alternately with high and low nutrient media. Holes have been cut in the partitions just above the level of the medium. The fungus has been inoculated into the central high nutrient chamber, whence it has produced alternating prolific and condensed patterns of development. Growth linking between chambers has been reinforced into persistent 'cables', whereas mycelium unable to extend further has been prone to degenerate. (Photograph reproduced by courtesy of Louise Owen and Erica Bower)

A Need for De-framing and Re-framing

"For once men have been made to realize the crippling mutilations imposed by an objectivist framework – once the veil of ambiguities covering up these mutilations has been definitely

> dissolved – many fresh minds will turn to the task of reinterpreting the world as it is, and as it then once more will be seen to be." Polanyi, 1958: 381

This contribution aims to highlight how the 'crippling mutilations imposed by an objectivist framework' continue to blight systems of agricultural production, and to suggest how a different philosophical approach may help people to develop more sustainable ways of attuning with their natural neighbourhood. The central point is that unsustainable practice arises from the attempt to impose methodologies based on systems of logic that can apply only to *inert* material systems onto *living*, evolutionary systems. The resulting incompatibilities produce deep conflicts of interest and inefficiencies of distribution that can only be resolved comprehensively by new thinking as well as new technology.

Since its arrival on the scene as a 'buzz word', there have been many efforts to frame the meaning of 'sustainability' within some definitive circumscription, fit for all purposes. From the point of view of a naturalist devoted to studying the world as it is, not within some arbitrarily convenient limits, these efforts are bemusing. For they belong to the very kind of theorizing that has led people down a path of unsustainable incompatibility with their natural neighborhood. *To be naturally sustainable simply means to be able to continue living*. To be able to continue living it is necessary to attune patterns of behavior and development with *variations in energy availability*. All the forms of wildlife on planet Earth, with the possible exception of the creature that calls itself *Homo sapiens* and those under its immediate domesticating influence, are expert at it. People can learn from them. But therein is the nub of human difficulty. If people are to learn from these natural life forms, it is necessary to empathize with them and study them as they are, not as people might psychologically project upon them or desire them to be if only they behaved properly. The fungi, that group of organisms from which it is perhaps possible to learn most about what it means to be naturally sustainable have famously been described by one exasperated scientist as 'a mutable and treacherous tribe'! That scientist might well have been dismayed, not enchanted, by the 'sloppy behavior' seen in Figure 1! Here is encountered the human desire for certainty and predictability, not the generous capacity to make allowances for changeable circumstances that is so vital to living in a sustainable way. Such desire has people try to impose an unnatural framework upon reality, with the intention of ordering it into obedient reproducibility but in reality engendering profound turbulence and conflict. This objectivist framework is deeply embedded in the definitive logic of *abstract rationality* that has held sway over human consciousness for millennia, setting people in opposition to one another and Nature as if all came from somewhere else in their own parallel universes. It has misguided people into believing that evolution is driven by a competitive 'struggle for existence' or selective 'survival of the fittest' instead of being implicit in the co-creative flow of 'the sustainability of the fitting' that has been called 'natural inclusion' (Rayner, 2006, 2010, 2011a,b).

Since publication of the book, 'Degrees of Freedom – Living in Dynamic Boundaries' (Rayner, 1997), personal scientific efforts to learn impartially *from* Nature through empathic observation, experimentation and reasoning have taken this contributor down a very different path from most other thinkers and scientists. This path has led to the awareness of 'natural inclusionality' that is described in 'NaturesScope' (Rayner, 2011a), which offers humanity a route to knowing what it really means to lead a sustainable way of life. This will be explored later in this chapter. But

beforehand it is necessary to reflect on some very basic concepts to do with human perceptions of physical reality.

Place-Time: Matter as a Configuration of Energy as a Configuration of Space

Energy is the currency of nature. The way that energy flows within and through natural boundaries shapes and mobilizes the cosmos, whether in the form of massy local bodies or massless radiation. So the story of modern physics implies.

But what *is* energy, and how might an understanding of natural energy flow contribute to human knowledge of the evolution and sustainability of organic life – including human life – on Earth? How can the occurrence and equivalence of two forms of expression of energy, in material bodies and electromagnetic radiation, be understood and reconciled? These questions have not been answered by standard modern physics, based as this is upon definitive logic and mathematics. But they are vital to a deeper understanding of natural identity and evolutionary diversity.

In classical Newtonian mechanics, 'energy' is understood in terms of the relationship between 'force', 'mass' and 'motion'. Here, 'mass' is a measure of the amount of matter in a body, which is also a measure of its linear inertia or extent to which it resists acceleration when subjected to a 'force'. 'Force' is the physical quantity that 'does work' either by changing the motion of a body, by imparting acceleration to it, or by deforming the body. The ability of a force to do 'work' is 'energy', of which there are two kinds. Massy bodies have 'kinetic energy' by virtue of their motion. When work is done against a restraining force, 'potential energy' is stored, ready to be converted into kinetic energy when a body resumes motion.

There are deep problems in the partiality of the logical premises underlying these definitions, which have not been solved by the advent either of relativity or of quantum mechanics. The default condition of Nature is regarded as stasis. Space is regarded merely as the distance over which mass, force and energy are stretched (or stretch themselves), such that they have variable density or frequency, and has no other influence beyond their limits. In this default condition, matter is inert and space passive. The very possibility of motion is therefore made ultimately dependent on some inscrutable external forceful agency or 'unmoved mover' to get it going. But if such agency can only be contained or applied locally, where is it? There is clearly something, or rather somewhere, missing from this classical description, which leads energy in the guise of mass and force paradoxically to be mentally confined within and excluded from the boundaries of discrete, completely quantifiable units – i.e. as atomic particles in material bodies, photons in electromagnetic radiation and phonons in heat.

What is missing from standard formulations of energy, according to natural inclusionality, is literally *everywhere*, without limit – the intangible receptive presence of space. With the dynamic inclusion of this non-local omnipresence within, throughout and beyond local form, movement and change become understood in terms of processes of *flow* as a continuous energetic reconfiguration of space, not as the travel of independent particles or waves *through* space. By the same token, massy bodies and electromagnetic radiation are understood as distinctive energetic configurations of space, neither solely 'particles' nor 'waves', but 'flow-forms' – dynamic localities in 'place-time' (e,g, Shakunle and Rayner, 2009; Rayner and Tattersall, 2010).

The difficulty that the objectivist framework of abstract rationality has with incorporating the intangible presence of space into energetic form is brought into sharp relief by the following statement:

"When a smaller box *s* is situated, relatively at rest, inside the hollow space of a larger box *S,* then the hollow space of *s* is a part of the hollow space of *S*, and the same "space", which contains both of them, belongs to each of the boxes. When *s* is in motion with respect to *S*, however, the concept is less simple. One is then inclined to think that *s* encloses always the same space, but a variable part of the space *S*. It then becomes necessary to apportion to each box its particular space, not thought of as bounded, and to assume that these two spaces are in motion with respect to each other." (Einstein, 1954)

Here is clearly portrayed the definitive assumption that space can be subdivided into discrete parts of *a* discrete whole. According to the logic of natural inclusionality*,* (Rayner 2004, 2006, 2010, 2011a,b), this premise is *inapplicable to Nature* where space *cannot be pluralized* into *discrete particularities* – it can only be distinguished into distinct, dynamically and permeably bounded regions. This is because a presence that has no resistance can neither be cut nor resisted by a tangible frame. It is inescapably present throughout and beyond the boundaries of tangible figures. A tangible frame is an inclusion of and is included in space but *the frame is not the space*. The tangible *frame can move* (or be moved) and be cut, *but not the space*. When the frame moves the space stays where it is: in relative terms by remaining still space *permeates freely* through the frame, the frame does not cut through the space. Moreover, if the frame is to move without being forced to do so by a force situated somewhere outside of it, it must have the capacity for movement within itself, i.e. the frame is itself a manifestation of energy, not inert structure – it is a variably fluid 'framing', not a permanent, absolutely rigid 'framework'. This tangible 'framing', or 'dynamic interfacing', has to be present for form to be distinguishable in a feature-full cosmos, but it can neither 'occupy' nor 'exclude' the space that it includes and is included in.

The dynamic relationship between distinct but mutually inclusive tangible (energetic) and intangible (spatial) presences is at the heart of 'natural inclusionality' both as a fundamental quality of Nature and way of reasoning about and from within this quality. All form is

distinguishable but not definable as variably viscous flow-form, an energetic inclusion of space throughout figure and figure in space.

Summarizing the Meaning and Implications of Natural Inclusionality

In general terms, natural inclusionality is a kind of awareness that helps us to appreciate our selves and other tangible forms as dynamic *inhabitants* of Nature, not discrete subjects and objects rigidly set apart from one another. This awareness comes with recognizing that *space* is a *limitless intangible presence* everywhere, which permeates throughout and beyond all tangible expressions of energy, whether in the form of radiation or massy bodies. *Space cannot be cut* and can neither resist nor be resisted by nor be removed from the presence and movement of tangible forms. Far from being just empty distance between, outside or occupied by discrete material objects or structures – as is assumed by the logic of **abstract rationality** – space is a *receptive* presence, vital for movement and communication. As natural dynamic inclusions of space, all forms are variably fluid *flow*-forms. Their boundaries are energetic configurations *of* space, not exclusions *from* space. When they move, they do not move *through* space; instead space *permeates through* them. With this awareness comes an appreciation of *self-identity as an inclusion of neighborhood* – a fluid inclusion, not a rigid exclusion of others' identities. This understanding of physical reality is such as to bring profound compassion for people and other life forms, and is a source of deep inspiration and creativity. It calls for an expansion of conventional theoretical reasoning to include more fluid, artistic and poetic forms of expression.

In more technical and philosophical terms, natural inclusionality is a new philosophy and fluid boundary logic of self-identity and ecological and evolutionary diversity and sustainability. It is intended to supersede the **abstract rationality** that has dominated human thought for millennia, based on definitive logic that can only apply to inert material systems that are unknown to exist anywhere in Nature. Whereas abstract rationality treats space as empty distance between, occupied by or outside completely definable tangible material structures or objects with discrete boundary limits, natural inclusionality recognizes space as a limitless, indivisible, receptive (non-resistive) 'intangible presence' vital for movement and communication. This allows all form to be understood as *flow*-form, distinctive but dynamically continuous, not singularly discrete. The *simple move from regarding intangible space and tangible boundaries as mutually exclusive sources of discontinuity and discrete definition to mutually inclusive sources of continuity and dynamic distinction* enables self-identity to be understood as a dynamic inclusion of neighborhood. Intangible space is included throughout and beyond all tangible figural forms as configurations of energy, whether as massy bodies or mass-less electromagnetic radiation. Fully to appreciate and communicate the significance of this move, it is necessary to widen the linguistic, mathematical and imaginative remit of conventional scientific argument and explication so as to include more poetic, fluid and artistic forms of expression.

The Relationship Between Natural Sustainability and Natural Inclusionality

To be entirely self-contained is to be an inert, hermetically closed structure with no capacity for take up or loss of energy between inner world and outer world. The nearest any life forms actually get to this condition is when they form survival capsules such as spores, seeds, pupae and cysts that carry them through periods of scarcity. This is what real biological 'survival' or 'preservation' entails. In such a dormant condition they are incapable of any active growth or relationship with others. But no sooner is any activity resumed that can support growth, so too is any life form's capacity to lose as well as take up energy through its necessarily permeable bodily boundaries and those of others in its vicinity.

It is therefore clear that the availability of sources of energy is the principal influence that governs the growth, organization and function of all forms of organic life as variably open systems. Any activity or pattern of development in which energy loss through permeable boundaries persistently exceeds energy acquisition will result in unsustainable deficit. On the other hand, any pattern of development that permanently prevents energy loss also prevents energy gain. For any living system to sustain itself, its primary need is therefore to be able to attune its activities and development to correspond with energy availability and hence with the local conditions of its habitat. This availability varies, both in amount and rate of supply due to seasonal and climatic fluctuations, and where and in what form it is located. It also changes due to the growth, death and decomposition of the systems themselves, which respectively deplete and replenish supplies as they come under one another's simultaneous mutual influence. For example, within a forest, Rayner (1998) fluidly described (rather than rigidly defined) a tree as "a solar powered fountain, its sprays supplied through wood-lined conduits and sealed in by bark until their final outburst in leaves…Within and upon its branching, enfolding, water-containing surfaces, and reaching out from there into air and soil are branching, enfolding, water-containing surfaces of finer scale, the mycelial networks of fungi…which provide a communications interface for energy transfer from neighbour to neighbour, from living to dead, and from dead to living".

Real life does not, therefore, inhabit an even playing field of energy, space and time. Instead it continually both changes and responds to changes in the contextual circumstances of its natural neighbourhood in an improvisational process of autocatalytic flow, which gives rise to evolutionary and ecological complexity and succession (Rayner, 1997; 2004). This process of 'natural inclusion' has been described as 'the co-creative, fluid dynamic transformation of all through all in receptive spatial context' (Rayner, 2006). Through it, an opening is made dynamically for an extraordinary diversity and complexity of interdependent forms and patterns of life to co-evolve over myriad nested temporal and spatial scales. The breathtaking variety that can be found in a crumb of soil, a patch of chalk grassland, a coral reef and a tropical forest comes into being under the guidance of no more and no less than the responses and contributions of its membership to natural energy flow in a natural 'sustainability of the fitting' (Rayner 2008, 2010; cf. Elstrup, 2009).

Figure 2 illustrates the general principles arising from observations of how living systems (except modern human cultures) attune their patterns of growth and development to variable availabilities of energy sources. As natural inclusional energetic inner-outer interfacings of continuous space, the boundaries of real organisms, populations and communities do not remain constant throughout their life span, but fluidly *vary* in *permeability*, *deformability* and *contiguity* (*connectivity*) (Rayner, 1997; cf. Elstrup, 2010). They change in dynamic relationship with the availability of energy predominantly assimilated from sunlight into organic compounds via the process of photosynthesis, and rendered into chemical form (adenosine triphosphate) via the oxidative-reductive reactions of respiration as a form of combustion. Moreover, these changes themselves entail alterations in boundary chemistry induced by and involving shifts in availability and production of oxidizing and reducing power (Rayner, 1997; Rayner et al, 1999).

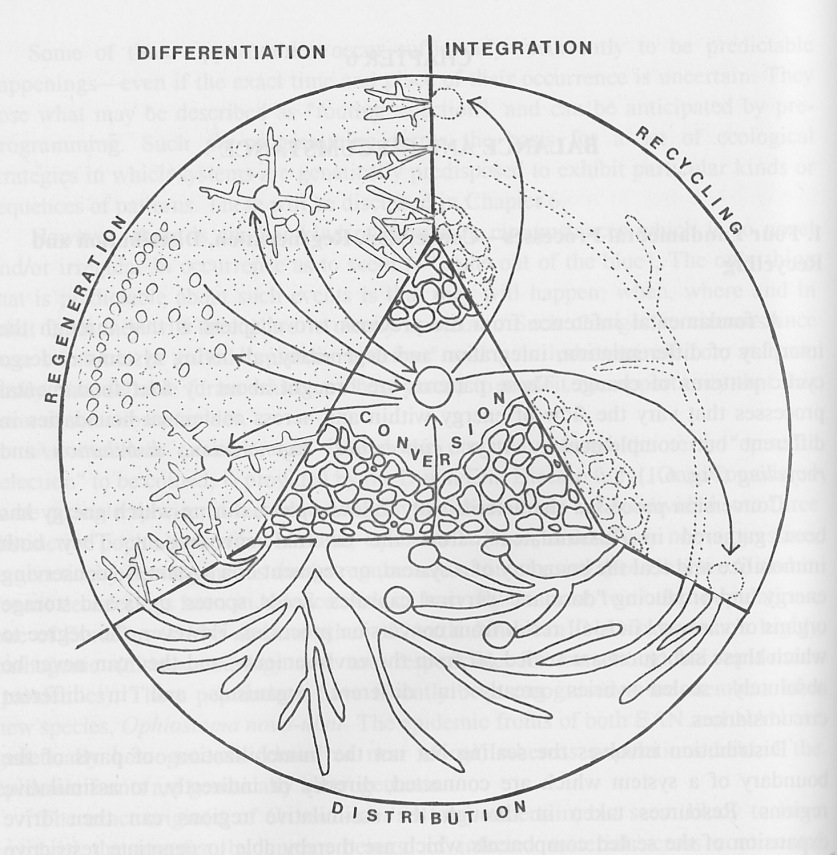

Fig. 2. The interplay between boundary-proliferating ('differentiation') and boundary-condensing ('integration') processes in energy-rich (stippled) and energy-restricted circumstances. This interplay enables energy to be assimilated (allowing regeneration and proliferation of boundaries), conserved (by conversion of boundaries into relatively impermeable form), explored for (through internal distribution of energy) and recycled (via redistribution/reconfiguration of boundaries) in spatial capsules, channels, branches and networks of life forms in dynamic attunement with their natural neighbourhood. Thin lines

indicate relatively more permeable boundaries, thick lines relatively impermeable boundaries and dotted lines degenerating boundaries. (From Rayner, 1997).

The ecological and evolutionary sustainability of natural life forms, from the cells and tissues in a human body to the trees in a forest depend upon close mutual attunement with (as distinct from unilateral adaptation to) the diversity, complementary nature and changeability of all within their neighbourhood, to which they themselves contribute. When energy supplies become scarce, sustainable living systems pool and redistribute internal resources within integrated structures and survival capsules – they do *not* compete to proliferate faster on the dwindling supplies than their neighbours. When supplies are abundant they proliferate and differentiate. Moreover, as is beautifully illustrated by the exploratory patterns of some kinds of fungi, this ability to attune their capacity to differentiate and integrate activity in dynamic relationship with energy availability allows life forms to locate and sustain supplies in heterogeneous habitats with extraordinary efficiency. As illustrated in Figs 1 and 3, they do this through a combination of all-round exploration and directional focus.

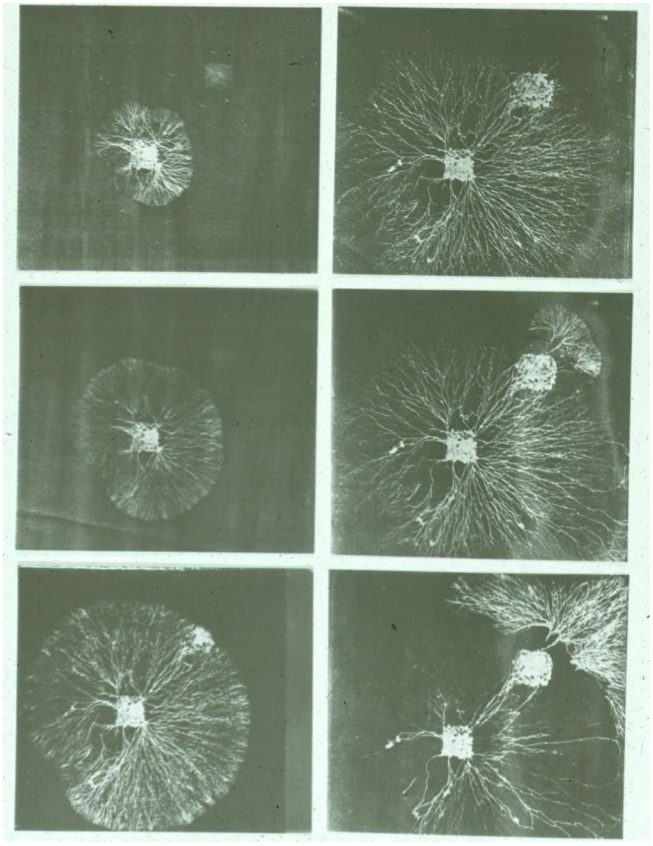

Fig. 3 'Fungal Foraging'. (From Dowson et al., 1986; see also Rayner, 1997).

Figure 3 shows how the mycelium of the wood-decaying fungus, *Hypholoma fasciculare*, finds an 'oasis in a desert', by fluid-dynamically spreading and narrowing its energetic focus. The fungus has been inoculated into a tray full of soil on a block of wood ('starter' food source), with an uncolonized wood block ('bait' food source) placed some distance away from it. Distinct

stages are shown in the radial spreading of the fungal colony from the inoculated wood block, followed by the redistribution and directional focusing of its energy following upon contact with the bait. As indicated in Figure 2, similar fluid dynamic patterns of gathering in, conservation of, exploration for and redistribution of energy supplies within variably connective channels and capsules of receptive space are found throughout the living world, from subcellular to ecosystem scales of organization

Sustainability, not *supremacy*, is therefore the path of evolutionary and ecological continuity. Natural energy flow is variably fluid, circulatory and redistributive along pressure gradients from higher concentration (relative 'abundance') to lower concentration (relative 'scarcity'), as illustrated, for example by atmospheric and ocean currents. The primary need for all life forms is not to seek competitive advantage through the unilateral accumulation of energy 'wealth' at the expense of their neighbourhood, but to sustain themselves and their offspring as variable channels for natural energy flow. They are more like members of a relay team – continually receiving, temporarily retaining and eventually passing along what sustains life – than a set of autonomous individuals striving to be first past the post. To succeed in this they have to be open to the energetic influence of their neighbourhood at the same time as sustaining the distinctiveness – but not discreteness (or separateness) – of their inner worlds from their outer worlds through their dynamic boundaries.

Any ecological or evolutionary or management model that treats an individual or group as a discrete, autonomous object or subject with the set objective of promulgating and preserving its self at all costs as sole survivor of a war of attrition is therefore partial and unsustainable in a changeable world of natural energy flow. Unfortunately, just such models are implicit in the objectivistic framing of natural energy flow that continues to underpin strategic planning for a desirable future and perceptions of what it means to be sustainable. People confuse *sustainability* with *self-preservation*, just as Darwin (1859) did when describing 'natural selection' as 'the preservation of favoured races in the struggle for life. Why?

Unsustainable Logic: Self-Dislocation From Neighbourhood

Notions of adversarial 'competition' and coercive 'co-operation', which respectively underlie individualistic 'capitalism' and collectivistic 'socialism', are predicated upon definitive logic that is incompatible with the cumulative energetic transformation of an evolving system (Rayner 2011). It is presupposed that individual or group entities can be defined independently from their spatial context and correspondingly that their 'future' can be fully defined by present or 'initial conditions'. As recognized by Bateson (1972), this narrows the focus of perception and purpose at the outset of enquiry into nature instead of in the process of discovery (cf. Figure 3) and can give rise to the familiar idea that undesirable present 'means' can be justified by desirable future 'ends'.

Human beings may be cognitively and culturally predisposed to make this presupposition through a combination of our inter-related capacities for categorization, sociality, abstract thought, tool and language use and awareness of mortality (Rayner and Jarvilehto, 2008; Rayner 2010; cf. Elstrup 2009, 2010). On the other hand, the imagination that comes alongside these capacities offers the creative potential to escape the restrictions imposed by purposive abstract objectivity through what is actually the more comprehensive worldview of natural inclusionality (Rayner 2010, 2011a,b).

As terrestrial, omnivorous, bipedal primates unable to digest cellulose but equipped with binocular vision and opposable thumbs that enable them to catch and grasp, people are predisposed to view the geometry of their natural neighborhood in an overly definitive way. They are prone to see the world in terms of what it can do for them and to them as detached observers or *abstracted 'ex*habitants', not how they are inextricably involved in it as *natural in*habitants. They perceive 'boundaries' as the limits of definable 'objects' and 'space' as 'nothing' – a gap or absence outside and between these objects (Rayner, 2004).

This perception of space and boundaries as definitively discontinuous *is incompatible with* the comprehension of continuity and change (Rayner, 2011; cf. Smith, 1997). If two adjacent locations in space and/or time are distinguished by a boundary, which one does the boundary belong to? If it belongs to both of them, how can the mutual exclusivity of definitive logic be satisfied, and where do both cease to be both and become either one or the other? If it belongs to neither, then where does one location end and the other begin and what *really* comes between them? In the case of a curved boundary, does it belong to whatever lies within it or to whatever lies without it? If two distinct locations are both contained within a larger location, are they mutually exclusive or co-existent? Upon such dilemmas rests the whole gamut of alternative propositional (either/or) and dialectical/transcendental logics (both/and in mutual opposition) that have been in conflict for millennia and continue to be so (e.g. see Valsiner, 2009). So too do the 'holons' - as 'Janus-faced' entities combining individual and collective aspects, and 'holarchies' - as nested arrays of holons, of Koestler (1976) in his 'Open Hierarchical Systems Theory' (Rayner et al., 1984; Wilber, 1996).

That it is nonetheless possible to avoid this perception is, however, evident from the indigenous cultures that sustain a much stronger sense of inclusion in Nature, aided by the preservation of oral, aural and nomadic traditions (e.g. Cairns and Harney, 2004; Taylor, 2005). According to Walker (2003), "Cross-cultural views of the self define individuality in terms of boundaries, locus of control and inclusiveness versus exclusiveness, or that which is intrinsic versus that which is extrinsic to the self (Heelas and Lock, 1981, Sampson, 1988). Cultures that emphasize firm boundaries and high personal control tend to view the self as exclusionary or 'self contained'. Fluid boundary, strong field control cultures, view the self as "ensembled," meaning that the self is inclusive of other individuals. While 'self contained' individualism is indigenous

to the United States and to the European countries from which its dominant ethnic groups draw their roots, 'ensembled' individualism is far more prevalent as a percentage of all known cultures (Sampson, 2000). Ensembled individualism is also indigenous to Aboriginal, Native American, Senoi and other cultures that are widely known to use dreams for social purposes."

The perception of completely definable objects separated by intervals of space as 'gaps of nothingness' sets the scene for the hard line logic of abstract rationality to become established in the foundations of our mathematical, scientific, theological, linguistic, governmental and economic endeavors. It also profoundly affects our perceptions of 'self' and 'self-interest'. The definitive supposition that 'one thing is not another thing, and, specifically, that 'one self cannot be another self' leads to what C.S. Lewis (1942) called 'the philosophy of Hell', in which 'to be means to be in competition'.

It is easy to see that this detached perception of nature and human nature in unnatural opposition could lead to profound human conflict and jealous possessiveness. With the continuous presence of space throughout and beyond all form erased from consideration, 'subjective self' and 'objective other' are brought into fear-full confrontation. Priorities are inverted from seeking sustainable relationship with others in a natural 'communion of diversity', to seeking cancerous dominion over other as the only certain route to 'self-preservation' (cf. Taylor, 2005). Sustaining 'Ego' becomes the focus of attention at the expense of the natural neighborhood upon which individual self-identity actually depends to sustain itself. Love and trust of others break down into xenophobia and avarice.

A question therefore arises. Is this abstraction humanly inevitable, or is there a way to develop a more natural and comprehensive perception of humanity's place in Nature? Can this abstraction actually be intellectually justified as a means of representation consistent with sensory experience (i.e. evidence) and that makes consistent sense? In a word, no, it cannot, because energy/matter cannot physically be cut away from space (Tesson, 2006; Rayner and Jarvilehto, 2008; Shakunle and Rayner, 2009; Rayner 2011a). If natural form was purely material, it could consist of no more than a dimensionless point with no shape or size. If natural form were purely spatial, it would be featureless. If nature consisted purely of solid, massy particles and space wasn't a natural presence, nothing could move. If space were just an infinite emptiness surrounding discrete objects, there would be no place to situate an external agency to move these objects around. If space wasn't within and throughout as well as around natural form, it wouldn't be possible for form to be distinguishable or to flow as liquid or gas or to have variable qualities of density, bounciness, flexibility and conductivity (Whitehead and Rayner, 2010).

Meanwhile, the dissociation of matter from space is embedded in the numerical and geometrical foundations of classical and modern mathematics. Here it may be recalled that Euclidean geometry is the abstract geometry of zero-dimensional (size-less) numerical points, one-

dimensional (breadth-less) lines, two-dimensional (depthless) planes and three-dimensional solids (self-contained volumes). Its figures are used to represent definitive tangible structure and yet can only *actually* represent the intangible presence in the core of tangible form because *it is impossible to reach zero without removing the tangible presence*. The same applies to the so-called 'non-Euclidean', Riemannian and Lobachevskian geometries of curved surfaces.

The scientifically inconvenient truth is hence that abstract Euclidian and non-Euclidean points, lines and planes/curved surfaces can consist *only* of intangible presence, *not* tangible presence! By the same token, it is impossible to drive or rotate a solid body from or around a solid fixed centre. The central 'still' point, axis or plane of symmetry of any bodily form can only consist of intangible presence, with correspondingly zero pressure.

In effect, conventional mathematics and its discontinuous underpinning logic thereby treat '1', as a 'unit of tangible presence', as if it is '0', a vanishing point of intangible presence. They literally attempt to construct 'one thing from nothing' and then to sum an infinite number of these one things up into an infinite 'whole' as a 'one' that is also 'many', whilst discounting the very presence that truly is infinite, at all scales.

This difficulty can only be resolved realistically by accepting that in Nature, tangible and intangible presences are *distinct but mutually inclusive*. This is the point recognized by the fluid geometry of natural inclusionality. Here, space and boundaries are regarded as *mutually inclusive* sources of continuity and dynamic distinction with *variable connectivity*, not *mutually exclusive* sources of discontinuity and discrete definition, as in Euclidean and non-Euclidean geometries. So far, the only mathematical formulation explicitly to accept and incorporate this natural inclusion of non-local space in and throughout local figural form is the 'transfigural mathematics' introduced in 1985 by Lere Shakunle (see, e.g. Shakunle, 1994; Shakunle & Rayner, 2008, 2009).

Natural inclusionality effectively transforms the *fixed frameworks* of Euclidean and non-Euclidean geometries into *fluid framings* of *omnipresent*, *non-local* intangible space *everywhere*, *within* (intra-), *throughout* (trans-), *between* (inter-) and *beyond* (extra-) local tangible energetic form (cf. Shakunle & Rayner, 2009). This opens the possibility of a dynamic, co-creative, mutually inclusive relationship between internally and externally situated non-resistive (and hence *receptive*) intangible spatial presence and locally situated, tangible energetic presence.

Variable Connectivity: The Sustainable Self-cultivation of Life

All that may therefore be needed to unlock human imagination and the world of real, live organisms and communities from the unnatural confinement imposed by abstract rationality is the simple understanding that space cannot be cut, occupied, confined or excluded. Space is a continuous presence throughout and beyond the boundaries of natural figures. By the same token, these boundaries are energetic interfacings between inner and outer realms, not fixed limits. This *simple move from regarding space and boundaries as sources of discontinuity and discrete definition to sources of continuity and dynamic distinction* is the ecological and evolutionary point of departure of 'natural inclusionality' from objective rationality.

The underlying logic of natural inclusionality can be described as 'the understanding of all form as flow-form, an energetic configuration of space throughout figure and figure in space', such that space, as a receptive (non-resistive) presence, is not assumed to be discontinuous (i.e. to stop at discrete boundary limits) (e.g. Rayner 2010a, b and c; Shakunle and Rayner, 2009). Correspondingly, it is possible to recognize the impossibility of defining or measuring anything in absolute numerical terms anywhere, because all form has both a *'figural'*, energetic inner-outer interfacing or dynamic boundary, which makes it distinct, and a *'transfigural'* (this term was first conceived by Lere Shakunle in 1985) – 'through the figure' – spatial reach that cannot be sliced or limited.

The continuous space throughout and beyond the figure pools it within the co-creative, influential neighbourhood of all others: local 'self' as an 'including middle' finds identity in its non-local neighbourhood as neighbourhood finds identity through its local 'self'. Without spatial continuity, figures are rendered into lifeless bodies, integral or fractional numbers and idealized geometric points, lines and solids. With space included, it is possible to escape the confinement and inconsistencies of the 'excluded middle', discrete boundary logic of 'one opposed to other' that has held human imagination to ransom for millennia. This enables the move to a more natural and comprehensive form of reasoning in the *fluid boundary logic* or *fluid transfigural logic* of each in the other's mutual influence. The real meanings of 'zero' and 'infinity' as *qualities of space* and sources of creativity, not abstract quantities of material, are brought into natural accounting systems, not excluded by abstract definition.

The following simple exercise might help illustrate the difference between the hard-line, space-cutting view of discontinuous models and fluid-line understanding of natural inclusionality. Draw an outline of two figures using a dotted line on a plain sheet of paper. The 'paper' infinitely stretched would represent what in the transfigural geometry developed by Lere Shakunle is called 'Omni-space' (Shakunle and Rayner, 2008b, 2009). The space within each figure represents 'Intra-Space', the space between figures 'Inter-space', the space beyond the figures 'Extra-space' and the space transcending the figures' permeable and dynamic boundaries 'Trans-Space'. The continuous non-local space everywhere (omni-space') is locally configured into distinctive, but *not discrete* regions. In the way that they have been drawn, the figures are not contiguous (connected), and so their 'intra-spaces' can only communicate through the 'inter-space' and 'trans-space' between and permeating their boundaries as *energetic interfacings* and

restraining influences (not *restrictive* material *definitions* or external *forces* – see later). Nonetheless, they inhabit the same limitless pool of omni-space everywhere. If the figures were now to be drawn closer together, so that their boundaries first connect and then coalesce at one or more points, their intra-space now becomes continuous (cf. Figure 4). On the other hand, if a pair of scissors is used to cut around the dotted lines, the figures will drop out of their spatial context as discontinuous individual entities. This 'dropping out' of context is what discontinuous models of reality effectively do – they treat boundaries as cut-out zones between discrete inner realms and outer realms, instead of dynamic relational interfacings through which these realms remain continuous through trans-space.

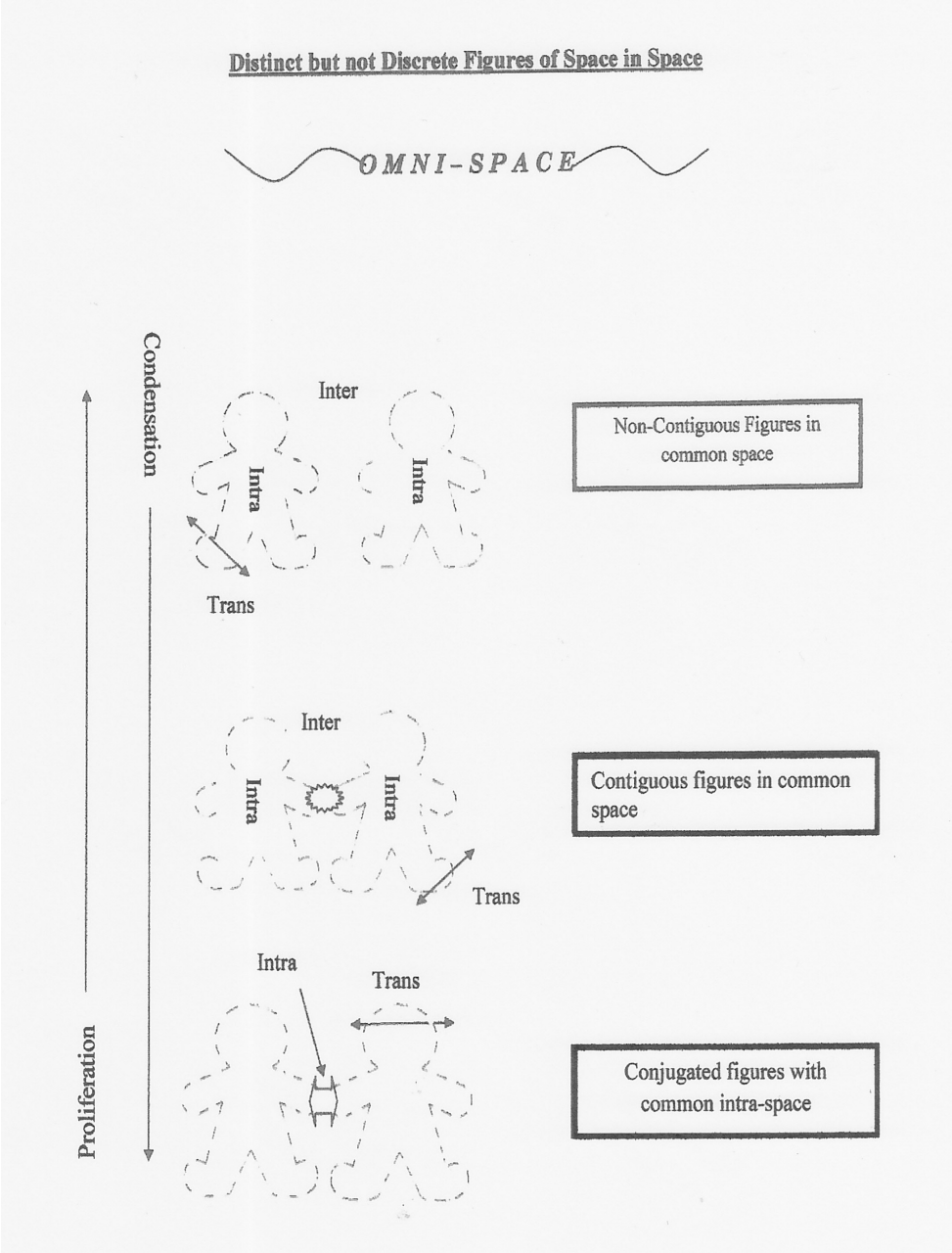

Fig 4. Distinct but not discrete figures of space in space (redrawn by Philip Tattersall from original pencil sketch by Alan Rayner, 2010).

Figure 4 illustrates the dynamic relationships between figural flow-forms as energetic configurations of space throughout figure and figure in space. It also serves to distinguish the natural inclusional dynamic relationship between distinct but not discrete flow-forms both from reductive schemas that cut off inner from outer spatial realms and from connective and holistic schemas where individual dynamic locality is eschewed from a seamless, purely figural whole or 'unity'. Since the cartoons can only represent an instantaneous 'slice' through the figures, the dotted lines shouldn't be taken to represent 'sieves' but more the seething 'fluid mosaic' that constitutes real biological membranes. A very simple example of what is represented in the cartoon can also be seen between surface-tense droplets of water condensing on a surface. As they expand and come into proximity their tensely curved inner-outer interfacings first touch and then coalesce in a visible rush as each flows reciprocally into the other and the tension of their boundaries is released.

A living illustration of the process of figural boundaries coming into proximity, contiguity and conjugation occurs during the process of hyphal fusion that is found in many fungi (e.g. Ainsworth and Rayner, 1986) and is shown in Figure 5. Here some fundamental differences between rationalistic and natural inclusional perceptions of connectivity and continuity emerge:

1. In rationalistic thought, continuity is *equated with* 'connectedness' because space is regarded as void, a source of discontinuity or disruptive gap between and around 'things' as discrete objects. Hence the only way of deriving continuity in this 'whole way of thinking', is either by totally excluding space and boundaries from form as a continuous line or network of width-less threads, or by totally conflating space with form in a seamless [distinction-less] whole. Such exclusion or conflation is neither consistent with evidence/experience nor does it make consistent sense.

2. In natural inclusional thought, space is a continuous omnipresence that cannot be cut, occupied, confined or excluded, and form is *dynamically continuous* through its energetic inclusion of space throughout figure and figure in space. Distinction and difference are hence accommodated in a natural fluid continuum, *without contradiction*. Local identity is recognised as a dynamic inclusion of non-local space in which all forms are pooled together (but not merged into complete unity) in natural communion as flow-forms.

3. Correspondingly, the treatment of continuity by objective rationality as the same as connectedness – as exemplified in conventional calculus, where continuity is approximated by connecting infinitesimal discontinuous units – is an idealized abstraction that is physically impossible. The very idea of complete 'whole units' existing anywhere, at any scale in Nature as an energetically open, fluid system does not make sense. The *fluidly variable connectivity* of natural inclusionality arises from the coming together (contiguity/inter-connectivity), fusion (confluence/intra-connectivity) and dissociation (individuation/differentiation) of energetic paths, corridors or channels of included space in labyrinthine branching systems and networks (i.e. as

shown in Fig. 2), *not* the 'ties that bind all into a web of one' (Rayner, 2004; Tesson, 2006; cf. Barabasi, 2002).

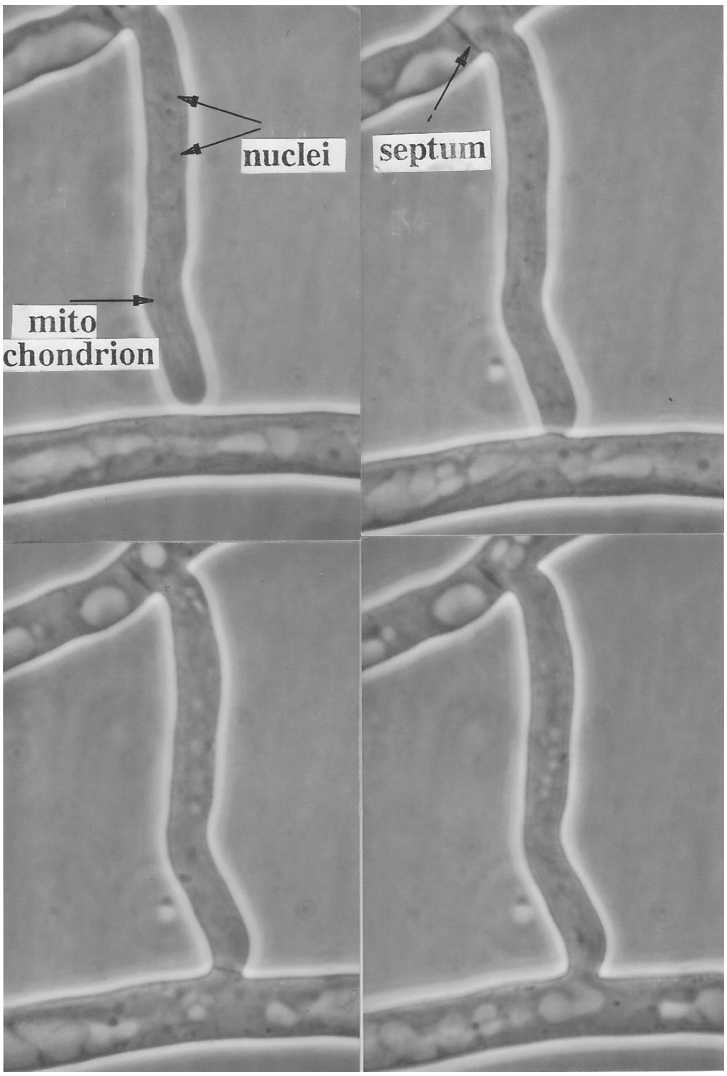

Fig. 5 Stages (from top left clockwise) in fusion between the protoplasm-filled cellular tubes (hyphae) within the mycelium of the basidiomycete fungus, *Phanerochaete velutina*. The tubes are internally partitioned into distinct compartments by septa, which have a door-like pore in their middle. As fusion occurs (third picture in the sequence) the cell walls and membranes around initially distinct tubes coalesce, so that their intracellular cytoplasm, which in its turn contains membrane bound organelles (nuclei and mitochondria) becomes continuous. A visible recoil can occur in the receptive hypha when the tubes coalesce. (Photographed by Dr A.M. Ainsworth).

Flow-Networking: Principles of Sustainable Environmental Management Through Natural Inclusion

The space-including processes of regeneration, degeneration, differentiation and integration illustrated in Figs 1-5 are very different from the purely tangible connectedness of modern network theory. They inform about how energy is assimilated, located, conserved and redistributed in real-world sustainable systems, as distinct from abstract mathematical models. This is the understanding that people need to incorporate into their agricultural and industrial praxis and systems of governance if they are to avoid continuing down the path to unsustainable hegemony. The implications of incorporating this natural inclusional understanding are radical. They demand nothing less than an upheaval in the ways of life to which people have become habituated through presuming to have dominion over Nature. This need not mean abandoning all that has been learned, and the creature comforts that have been fashioned through technological prowess. But it does mean an involution in attitude of mind, so that once more people allow themselves to be caring inhabitants of Nature, not its vain over-rulers. As this involution is made, there are a number of principles that can be learned from non-human life forms.

► Rather than being formed by stringing together a given set of initially independent entities, flow-networks *grow* into *place* through a combination of *self-differentiating* (boundary-maximizing) and *self-integrating* (boundary-minimizing) processes that configure and reconfigure space in dynamic correspondence with energy availability.

For example, fungal mycelia form when a spore germinates by first swelling symmetrically as it takes in water and nutrients across its bounding cell wall and membrane. The resulting structure then becomes *polarized*, hence breaking spherical symmetry and increasing surface area to volume ratio, through the emergence of a germ-tube or ‘hypha’ with a parabolic growing tip. As this tube elongates, its growth accelerates exponentially, as the absorptive surface increases, before attaining a more or less constant rate of extension, whence branches begin to emerge, each with their own parabolic growing tips. A *dendritic* (tree-like) system of hyphal branches develops, which radiates out in all directions. Eventually, in many fungi, as resources are depleted by the growing system, some of the branches begin to *fuse* or *anastomose* with one another, so converting the inner part of the system into a *network* of labyrinthine channels (as in Figure 5). During this process, the branches open up their external boundaries to one another, so that the inter-space initially *between* them becomes the continuum of intra-space *within* them. In other words, they ‘let go’ of their individuated self-identity ‘agenda’ in the process of coalescing by self-integration (cf. Figure 4). Within the integrated system, the branches do not disappear, but retain their form as connective channels of intra-space. The *nodes* in this system are the places from which the branches originally arose, rather than the loci of initially discrete entities. The branch-identities *are* the connective channels in the system, not the ‘knots’ or local centers through which network transactions are administratively controlled. At no stage in the evolution of the system have these identities been *fully* dislocated from one another or the limitless pool of common space in which they are immersed and of which they are dynamic inclusions.

► By *growing* into place, these dynamic systems exhibit *indeterminacy*, the potential for indefinite expansion and transformation within boundaries that vary in their *deformability*, *permeability* and *connectivity* depending on contextual circumstances. This contrasts with the *determinacy* assumed by many to apply to creatures like our individual selves, sentenced to death within a fixed frame of bodily space and time and so bustling through life as if there were no place else to care for, notwithstanding the continuum of social space.

Such indeterminacy brings scope for continual *improvisation*, *discovery* and *learning* through *co-creative evolutionary play* that is not fixed on a pre-determined course, but eases its own passage through a process of *autocatalytic flow* in which the flow of current lowers resistance to subsequent flow: sheep, wildebeest, ants and humans all exhibit this phenomenon as they create paths by following in one another's wake (Rayner, 1997). Some fungal mycelia making their way through ancient forest in this fashion are thought to cover up to square kilometres of ground and to be thousands of years old.

► By connecting their internal space *in parallel* rather than purely *in series* (as applies to dendritic systems, lacking anastomoses/cross links), flow-form networks greatly increase their conductivity and consequent capacity to store (i.e. 'memorize') and supply power at or to localities on their boundaries (cf Figures 1, 3).

In fungi, this increased capacity is what allows mycelial systems literally to 'mushroom' as well as to produce survival structures such as sclerotia (of which 'ergots' are a well known example) and rapidly extending cable-like aggregations - known as 'rhizomorphs' because of their root-like appearance and growth. Mycelial systems that lack or lose the ability to form anastomoses are prone to become dysfunctional and degenerate, proliferating numerous branches from local nodal sites in a way that looks very similar to some unrealistic 'maps' that have been made of the Internet using purely abstractive analytical techniques.

► Local, well connected centers in flow-form networks drain resources from the system, and inhibit its expansion. In fungi, fruit bodies and storage structures may form at such centers. In human organizations they have the potential to develop into exploitative growths and megalithic power structures.

► Degenerative processes in flow-form networks are vital as a means of preventing retention of power by core components of the system. For example, 'fairy rings', consisting of an annulus of spreading mycelium, result from the degeneration of the colony centre and release of its resources to supply the growing margin. In the absence of such degeneration, expansion of the system stalls. Death is vital to the possibility of continuing life: it feeds life and opens up new

possibilities for reconfiguration – it does not annihilate life in the way that the rationalistic view of space as an absence of presence may lead people to believe.

► The ability of flow-form networks to differentiate, integrate and degenerate, by varying the dynamic properties of their boundaries in tune with their circumstances and avoiding the wastage implicit in rationalistic 'cost-cutting', allows them to produce extraordinarily efficient organizations in highly heterogeneous situations. In fungi inhabiting the forest floor, for example, this ability allows them to make connections between local sources of nutrients in decaying wood, leaf litter and roots, to form an underground communicative infrastructure, which brings the lives and deaths of the trees into a common circulation (cf. Fig. 3).

So, altogether, these living flow networks are far more sensitively attuned to the ever-reconfiguring space that their channels embody, than the inflexible meshwork entrapments current (w)holistic abstractions represent.

How do these principles translate into management praxis? Perhaps some clue can be given by asking how as a forester or arboriculturalist, we might seek to manage a tree. First, imagine approaching a tree as though it is an isolated system, *dislocated from its neighborhood*. How is this approach likely to affect practice? Such an approach will inevitably lead to viewing the tree purely as though it is a mechanical object, whose performance is to be maximized against benchmark prescriptive standards or norms of productivity, dependability and perhaps aesthetic appeal. But in trying to maximize performance in terms of objective criteria, what aspects of the tree's natural, relational life of inner-outer attunement is likely to be overlooked and even damaged in the long run? Here are just a few thoughts.

(1) To promote productivity, fertilizer may be added or fast-growing varieties selected. But this may in the long run inhibit the tree's ability to form mycorrhizal partnerships with fungi, and promote the development of uniform stands of trees that literally 'overshoot' the capacity of their neighborhood to sustain them and so become subject to damage and spread of infection leading to their early demise.

(2) Alternatively mycorrhizal inoculum may be added. But this may lessen the diversity and efficacy of natural mycorrhizal communities, with potentially damaging consequences in the long run.

(3) By trying to eliminate fungi and decay that are thought to be a source of danger, vital accessories to the tree's dynamic function and damage the tree's protective boundaries may be removed.

(4) Similarly, by attempting to prune the tree ourselves, rather than allow natural degeneration to take its course, the tree's protective boundaries may be damaged.

(5) And by removing a tree's dynamic neighborhood through thinning and clearance, the conditions that it has grown up in may be radically altered - exposing it to the equivalent of 'culture shock'.

(6) By tidying up fallen debris a valuable resource may be removed.

Now, imagine approaching a tree as if attending a party within its receptive space and neighbourhood. What kind of attitude might be apt? Would one wish to be a gatecrasher, imposing on the hospitality of its host and making judgmental comments about the other guests? Would one seek to understand one's situation and attune with the needs and offerings of one's host, so both could feel at ease? Herein lies the fundamental difference between rationalistic and inclusional approaches to management and perceptions of perfection and imperfection - 'health' and 'disease'. So, what might an 'inclusional' approach to tree management involve? Just two general suggestions follow.

(1). Being alive to any tree's unique situation, its place in the ecosystem, the way it attunes with its neighborhood, the complex relationships that such attunement entails, and the ease with which these relationships can be destroyed by insensitive intervention. Correspondingly, thinking of a beautiful, healthy tree as one that is 'in place', attuned with its circumstances as a local or individual expression of its larger ecosystem context, by contrast with a 'dis-eased' tree as one that is 'dis-placed' from its natural relationship with its neighborhood. More often than not, in this context, it may be the intervention of human beings that is the 'true pathogen', blundering in like inept 'party poopers' and so creating the contextual conditions of imbalance that destabilize the complex, heterogeneous, inclusional system of the forest. Much of the 'remedial' work that is done to enhance the health and alleviate the disease of the trees people care for may actually therefore be to remedy the repercussions of their own actions.

(2). Valuing one's own learning experience, being prepared to share this with others and valuing others' unique experience, rather than simply following or desiring some 'one size fits all' doctrine, fad or short term 'fix'. Being more of a 'chef', following guidelines founded on basic understanding of dynamic process, than a 'cook' adhering strictly to recipe book instructions.

These suggestions might sound rather obvious and lacking any absolute, clear, fixed, authoritative direction. They might seem like not much more than one might gather about life's patterns and uncertainties from everyday experience as relational human beings - good *neighbours* using *all* our sentient faculties. It is to be hoped so!

Conclusion: What On Earth Is Sustainable?

A good question to ask; when all that's given; of incomparable value; seems to come at a price; worth more or worth less; as a set of commodities; on the supermarket shelf; of vacuum-packaged distress

Where what scores most regularly; is considered most consistently; to be the best; of those put to the test; to be singled out; for maximum uniform production; of an elite order; and preserved in a perpetual pickle

Whilst discarding the rest; of rampant variety; into a stultifying place; of squandered vitality

Placed under arrest; somewhere else; nowhere; where none can have grace; to give of their best; what they gratefully receive

Meanwhile, as our favorite selection reigns Supreme; it closes its hatches; against all oddness; in a harrowing victory; that spells desolation; for each and all; in a row standing stiffly on proud parade; amidst the fallen rank and filed; away for safe keeping

Because no one kind; can sustain itself; as a monoclonal antibody; of corporate ill health; in narrowing arteries; blocking the flow; betwixt heart and head

What is truly downright ugly; in the natural world; is the clot in the landscape; that claims for itself; all credit for wealth

Of human despair crying; never heard but trying; itself to the limit; within drab straight walls; that shut out the wildness; that burns to come in

A wildness whose life cannot deaden; and whose death can only enliven; the vital space; breathing in and out; the fresh air and water; flowing through channels; of pulsating arteries; sustaining supply from a pool; that empties as it fills; with no fear of drought; or stagnant disgrace

Rich in expression; of rampant variety; through irregular heartbeat; of present giving what passes; through central reception; into continual future

Where all that can be sustained; are sustained; accepting the invitation; to hold, protect and pass on; the capacity to flourish; in a pool that ripples and ruffles; amid spells of calm

To ask what on Earth is sustainable; is not the same; as to ask what's best; to preserve in isolation; as a keeper of deadness

But to ask what can keep going ; by giving what's given; its unique evanescence; to sustain the flow; of what's coming around; in perishable packaging; to have not to hold; for ever

From Rayner 2011a: 137-138

Summary

The inclusion of space in natural form brings varying degrees of fluidity to all living systems. It is vital to evolutionary creativity from sub-atomic to cosmic scales of natural energy flow. By contrast, the vain attempt to cut space by hard-line definition has underlain what have been called 'the crippling mutilations of the objectivist framework' that have dominated abstract human thought for millennia. Examples abound throughout the natural world of indeterminate forms and processes that do not and cannot conform to the expectations of definitive theoretical models. Here, the much-neglected Kingdom of the Fungi is used to illustrate the distinctive principles of the evolutionary process of 'natural inclusion' as the *co-creative, fluid dynamic transformation of all through all in receptive spatial context*. This process provides a much more comprehensive, logically consistent, realistic and less adversarial basis for understanding the dynamics of natural and human social formations than the preferential selection of discrete categories by a forceful agency. It offers scope for encouraging more empathic, sustainable and creative human life styles.

Cross-references

Agriculture and environmentalism; Agricultural Ethics; Biodioversity; Democracy, Sustainability, Food and Agriculture; Ecological Economics; Environmental Ethics.

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