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Towards a new paradigm – practical guidelines

To sum up our discussion so far, the ‘new’ paradigm involves bringing together today’s complexity-based (non-reductionist) science with a rediscovery of deep tradition. In this chapter we briefly discuss a few approaches which can concretise this.

The ‘tame’ and the ‘wild’

In Chapter 7 we described a wrong – i.e. colonial/supremacist – way to determine oneself in relation to ‘wild’ nature. So is there a good way?

In fact, our demarcation from the ‘wild’ is not an abolition of it but a dialogue with how it spontaneously works. The farmed area posits itself as a negation of the wild but, unlike colonialism or modernisation, far from supposing superiority, we should respect the wild, welcome the diversity and services it provides and, above all, learn from it in designing our own systems.

There is a strange ambiguity in the notion of ‘equilibrium’, which the systems literature is sometimes too opaque about. An interesting pathway into this question is the issue of spontaneous plants (‘weeds’). If the farm were indistinguishable from wildness, weeds would overtake it (Cabell and Oelofse, 2012). One way to conceptualise this is that any living entity has a boundary or ‘skin’ within which it maintains low entropy (c.f. Ho, 1998), and the boundaries of our plot are like this: if our farm was in ‘equilibrium’ with its environment in a thermodynamic sense, i.e. indistinguishable from it, it would cease to exist. For example, the nettle (*Urtica dioica*), while a very beneficial wild plant (serving as food, as an attractant for beneficial insects, as a source of fibre etc.)

might overwhelm our plot and, in fact, this would not be true wildness because, initially at least, it would lack diversity.

On the other hand, there does exist a meaning of equilibrium, or perhaps ‘poise’ would be a better term, which we definitely *do* want to have. This is part of the *criticality* we encountered in Chapter 6, a kind of ‘fulcrum’ where you can ‘move backwards and forwards’ (in Goodwin’s words, quoted in King, 1996) between order and chaos; there’s a connection between ‘edges’ in permaculture and the ‘edge of chaos’ in systems theory. We will return to the dialectics of equilibrium in Chapter 9, but the point for now is practical: the modernist negation of the ‘wild’ is to homogenise and simplify. The indigenous/sustainable demarcation is to create an edible forest which mimics the diversity produced by evolution of long historical time. We maintain this in a creative tension with the surrounding biodiversity, with which we’re not in thermodynamic equilibrium, but we are in *harmony*.

Diversity here refers not just to diversity of species, but to plant *height*, and depth of rooting. In the practical application of this approach, these factors can be explored through intercropping and agroforestry.

In such techniques, there are different ways in which we can handle the relationship with spontaneous plants (weeds). In the classic Native American intercropping system, they are *suppressed* (Bilalis, et al., 2010): thus, tall maize plants deprive them of light, beans out-compete climbing weeds, and the broad leaves of squash cover the ground. The other pathway to reducing weeds is simply to expand the definition of edible plants to embrace many of them into the category of vegetables! In the author’s allotment, we can include many self-seeded plants, which are either wild or self-seeding forms of cultivated strains, such as the wild hairy bittercress (*Cardamine hirsuta*), and land cress (*Barbarea verna*) which is a cultivated form which freely self-seeds. Because of the proximity of plots farmed by people originating from Jamaica, a semi-wild form of *Amaranthus viridis*, one of the sources of leaves known as callaloo, seeds itself freely, and we can introduce red orache (*Atriplex horensis rubra*) and then let it seed wherever. Rocket (*Eruca sativa*) is used in a similar way, along with the similar-tasting and ‘wilder’ form, *Diploaxis tenuifolia*.

This takes us to an important point, the relationship between agriculture and gathering. In a rigid interpretation, gathering – which forms an important element in deep tradition – might be dismissed as less relevant to cultivation. In reality, however, the frontier between the two is much less strict than is sometimes thought. Turning again to the pre-Roman practices reconstructed in P.J. Reynolds’ experiments in

England and Catalunya (Reynolds, 1985; Reynolds and Shaw, 1999), spontaneous plants – including Fat Hen (*Chenopodium album*) and wild oats (*Avena sterilis* and *Avena fatua*) – grew spontaneously in the field, greatly augmenting its nutritional output (and of course sparing the energy of weeding!). These systems were notable not just for their high food yield but for resilience: the forms of wheat which performed well, no matter how dire the conditions, were the more ancient (and closer to wild) forms, Emmer (*Triticum dicoccum*) and Einkorn (*Triticum monococcum*) (Reynolds and Shaw, 1999). The lesson is that – in contrast to modern approaches which unilaterally pursue yield volume by *narrowing the range of varieties* – the goals of yield and resilience can be fully harmonised, and must in fact be pursued in tandem; and for this, variety and variability are essential conditions.

The dialogue of human will with evolution

A key issue, again very relevant to how we relate to the ‘wild’ and to gathering, is the relationship of farming to evolution.

Partly, this means respect for *past* evolution: the plants on which we rely derive from strains whose immunities and robustness were honed over millennia. In modern strains, some characteristics have been ‘bred out’ so as to enhance food quality but we may still, when facing environmental challenges, need to re-access them. It is therefore crucial that ‘wild and weedy’ progenitors of cultivated crops be preserved (American Society of Agronomy, 2013). For instance, all apples in the world are probably descended from an original, *Malus sieversii*, found in Kazakhstan, where it is under threat (Fowler, 2014): we must retrieve it to access its evolved immunities which cultivated forms have lost. Thus, one of the methodologies which can contribute to the sustainability paradigm, Natural Systems Agriculture (NSA), ‘is predicated on an evolutionary-ecological view of the world in which the essentials for sustainable living have been sorted out and tested in nature’s ecosystems over millions of years... A primary feature of NSA is to sufficiently mimic the natural structure to be granted the function of its components.’ (Jackson, 2002, p.1).

On the other hand, it would be simplistic just to see evolution as a purely spontaneous, ‘wild’ process, counterposed to cultivation. In reality, we have inherited a nature whose evolutionary processes have, again over millennia, been ‘nudged’ by humanity. The central principle is nicely formulated by Clement and colleagues: ‘Plant domestication

is a long-term process in which natural selection interacts with human selection driving changes that improve usefulness to humans and adaptations to domesticated landscapes' (Clement, et al., 2015, p.2). It is likely that farming originated from gathering, via 'in situ' management, in which beneficial plants were 'left standing' while others around were cleared (Landon, 2008), which would obviously, over time, influence how they evolve. This undermines any notion of an agricultural 'revolution' as a complete negation of gathering.

So, in this way, evolved species bear a long-term imprint of interaction with society. The modern peanut (*Arachis hypogaea*) is revealed as a hybrid between two divergently evolved and widely separated ancestral forms, which were subsequently brought back together by the migration of early American populations (Carmona, 2016). There is also much swapping of DNA in nature (remarkably, eight per cent of 'human' DNA is borrowed from viruses) (University of Michigan, 2016) and this, too, is something we have learned to work with, again in a kind of interaction between natural and human selection. Thus, a recently-identified case concerns the sweet potato (*Ipomoea batatas*). The root which we harvest is shown to be a product of bacterial genes which inserted themselves into the plant's DNA (Kyndt, et al., 2015) and, although this genetic insertion occurred spontaneously, what is significant is that the bacterial genes are present *only* in cultivated sweet potato strains, not in closely related wild ones. This is evidence that this naturally transgenic form was selected and propagated by humans (Kyndt, et al., 2015). Grafting, an ancient technique, has also been shown to involve a transfer of DNA (Le Page, 2016a). So tradition was nudging the genome in quite sophisticated ways.

In this way, evolution shades off into agroforestry, which probably arose through forest-dwellers' ongoing modification of their habitat. It seems they achieved this partly by understanding the positive role, within ecosystem development, of *disturbance*. Another relevant contemporary methodology, Regenerative Organic Agriculture, addresses the same issue in its aim to take 'advantage of the natural tendencies of ecosystems to regenerate when disturbed.' (Rodale Institute, 2014). Traditionally, a particular focus was the role of fire. In nature, by keeping a check on plants which would otherwise overwhelm others, fire maintains diversity and, when humans seek to suppress it, the system becomes homogenised (Li and Waller, 2015). Traditional approaches embraced fire, modifying the forest to increase the proportion of certain naturally occurring food-producing species. Thus, recent research correlating the composition of forests

in the state of New York with the sites of precolonial Native American villages, reveals how their populations modified forests in ways which leave a lasting imprint today. Species which both yield nuts and are fire-tolerant occur in larger numbers than would be expected without intervention (Tulowiecki and Larsen, 2015). Similarly, while there is still debate on this, research on the Amazon suggests the extent to which, far from being pristine, it was quite intensively farmed prior to colonisation (Clement, et al., 2015). A recent study speaks of a ‘complex mosaic of fire regimes [...] consistent with existing models of anthropogenic pyrodiversity...’ (Liebmann, et al, 2016). It is important to note that interventions which modify forest composition do not necessarily lead to homogenisation. The result can be quite the contrary: thus, if we privilege fruit trees, this also has a positive impact on diversity of animal populations (Moore, et al., 2016).

While respecting the millennial legacies of evolution, we are also dealing with an *ongoing* process, since evolution, while partly very slow, can also be very quick. Some aspects are problematic for us, like the battle between antibiotics and bacterial resistance, and in a way this has its equivalent in farming: though we may use crop-rotation or sympathetic planting to confuse insect pests, the latter are evolutionarily selected to evade our ruses. Thus, ‘When we disturb the ecology with our agricultural landscape, there are going to be consequences – even with the most ecologically benign approaches, such as crop rotation’ (Seufferheld, 2015). We are therefore dealing with a dynamically changing natural order but can embrace this fact as part of our own evolutionary learning: just as evolution tests species, our farming systems are similarly tested and ameliorated. Seufferheld formulates this nicely: ‘Understanding the interplay of ecology and evolution will allow us to design more sustainable agricultural practices...’ (Seufferheld, 2015; c.f. also Chu, et al., 2015).

Seeds of oppression, seeds of hope

So what practical lessons can we draw from the above? An absolutely key issue for our food sustainability paradigm is plant breeding. In this respect, we may highlight two key requirements: (a) continuing to allow seeds to be tested against environmental challenge; and (b) farmer-based research. Today’s corporate seed agendas (which we address further in Chapter 10, in the context of imperialism) stand in opposition to both these requirements.

There is a duality in today's science. On the one hand a progressive movement – with which we can unite – offers to embrace complexity and self-organisation, bring us back/forward to dialectics and reunite with indigenous principles. On the other hand, genetic modification (GM) has re-invigorated the mad dominationist dreams which still linger, as a kind of 'background radiation' from the Big Bang of nascent capitalism and the Death of Nature.

The mainstream approach typically creates genetically uniform cultivars with an appropriate combination of traits, and then continues reproducing them *with as little change as possible*: this is known as 'stability', and forms the basis of legislation such as in the EU, which tends to repress small seed companies who sell traditional strains. This is an example of the futile quest for predictability through homogenisation. Yet, paradoxically, corporate agendas also require *variety* of germplasm as a basis for their experiments. Hence the role attached to genebanks, most notably the Global Seed Vault ('doomsday vault') in Svalbard, Norway, a massive frozen repository sponsored by the Gates Foundation (CGIAR, 2013). These seeds are (a) cut off from the evolutionary process and (b) *taken from* communities without any interaction with them (c.f. Goldenberg, 2015). The two issues are linked because only through farmer-based research is it fully possible to explore a dialogue with evolution; otherwise we deprive humanity of the *process* whereby food systems should ceaselessly develop in their constant interaction with the environment. As Robert Henry puts it in critiquing the genebank approach, 'we effectively stop evolution when we do that. By keeping the plants in the wild, they will continue to evolve with climate change' (Henry, 2015, p.27).

A practical alternative is the approach known as evolutionary plant breeding, which encourages strains to *change themselves* as they are selected by environmental pressures. This methodology would critique the mainstream at several levels, of which the following are perhaps the most important:

- [1] The issue of resilience: thus, '... the approach of creating uniform and genetically 'stable' cultivars that are deployed over large areas in monocultures is inappropriate for dealing with the current and predicted threats to agriculture. The response of these genetically uniform cultivars is not buffered against environmental fluctuations and novel stress factors when the direction and range of environmental changes are highly unpredictable.' (Döring, et al., 2011, p.1945).

- [2] The issue of input: the only way in which conventional pedigree strains perform well is in conjunction with heavy use of synthetic inputs to raise fertility and control weeds, pests and diseases (Phillips and Wolfe, 2005, p.245).
- [3] The issue of adaptability: as we saw in Chapter 5, micro-local specificity is the key to understanding soil ecosystems (c.f. Bardgett and van der Putten, 2014); thus, it is the very variability of non-standard strains which allows them to exploit particular niches. In an extremely interesting way, this argument also connects with the social argument for localism, in that ‘by creating locally or regionally unique crops with their own “terroir”, evolutionary breeding is in line with a re-connection between producer and consumer on a regional level...’ (Döring, et al., 2011, p.1960).

Thus, in the same way that entropy stimulates complexity or conflict stimulates co-operation, stress stimulates resilience. Grassroots, farmer-based research has always worked with evolutionary defences and immunities, and a fascinating example of the directions this can take today is the work of French peasant Pascal Poot, in Lodève (Hérault), who left school aged 7 (Schepman, 2015; 1001 Gardens, 2015). His farm’s soil is exceptionally poor and dry, yet his tomatoes are massively productive. He basically lets them strengthen themselves by battling harsh conditions, the key point being that this occurs *over successive generations* (he harvests seed as late as possible so that plants will have faced maximum stresses). It seems he doesn’t *select* the seed, which would be the more normal way farmers ‘nudge’ evolution, but rather just reproduces the traditional strains, so what changes is not the genome itself, but gene expression.

University-based science is coming to think on similar lines, the starting point for this argument being that ‘Plants can’t get up and run away when they’re being attacked by insects or harsh weather conditions. So they need mechanisms to rapidly respond to a stressful event – being eaten by a bug, for example – and then quickly transition back to ‘normal’ conditions when the stress level subsides’ (North Carolina State University, 2015). Typically this information is conveyed by the hormone ethylene. It is the transcription factors – proteins that control gene expression – which are responsible for emergent behaviours, governing the way cells respond to stresses (for example, Lin, et al., 2015). This makes perfect sense if we step outside a linear determinism, since genes possess many isoforms (which may run to hundreds

or even thousands) (c.f. Bolisetty, et al., 2015), and in this respect Dennis Noble interestingly employed an image of the ‘music of life’: rather than a one-way determinism from gene to organism, there are ‘Loops of interacting downward and upward causation...’ (Noble, 2006, p.51), controlling how genes are read. As if to confirm Noble’s musical analogy, research now finds that cells alternately activate and de-activate the proteins governing gene expression through a rhythmic pulsing (Lin, et al., 2015) (other examples of plants’ rhythmic sense will be discussed in Chapter 9). What Poot seems to demonstrate – and academic researchers are learning from him – is that some of these factors are heritable.

In all these ways, interaction with the environment is key. Most obviously, food systems must be resilient in *responding* to challenges – the adaptation issue. But, more profoundly, our food system can also *mitigate* environmental risk, and indeed has a responsibility to do so. This question forms the topic of our next chapter.