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Seedways

THE CIRCULATION, CONTROL AND CARE OF PLANTS IN A WARMING WORLD

Bengt G. Karlsson & Annika Rabo (eds)

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ABSTRACT

This is a book about seeds. It revolves around questions of why and how seeds matter today, as in the past. The focus is on human-seed relationships, and how seeds and plants co-evolve with humans and other living beings. Human history is fundamentally a multispecies story, and seeds thus function as a lens to trace relations and interdependencies between humans and plants. Through seeds we explore the cultural and sensorial or affective connections between people, plants, and places. Seeds are often used as metaphors or tropes of possibilities, of hope and aspirations that are inherent, yet not fully realized, in the present. Engaging with seeds also brings us to critical political questions about control over the material basis of our existence, that is, the main food crops. Accelerating climate change, the expansion of monocultural plantations, loss of biodiversity, and ruthless extraction of natural resources all point to increasingly difficult times ahead. Collecting and saving seeds has become a global concern to help face the uncertain and troubled future.

KEYWORDS

Seeds, plants, crops, agriculture, domestication, climate change, corporate power, conflict/war, symbols, ritual, and people-plant relations.

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ROY ELLEN

Seeds versus vegetative propagules as strategies for surviving the Anthropocene: Social profiles and biocultural consequences

There is a well-established observation that humans play an important part in the dispersal of plant seed and other propagative material, either inadvertently or deliberately (e.g. Hodkinson & Thompson 1997; Mack & Lonsdale 2001). In a paper published in 2011, Simon Platten and I expanded on this to demonstrate how forms of dispersal reflect different patterns of human interaction and relationship, and how the opposite may also be true: that patterns of human exchange modify the properties of plant germplasm subject to further co-evolutionary selection. While these patterns had been reported in the ethnobotanical literature for rural tropical and subtropical regions, there had been little work on comparable patterns for industrial and post-industrial Europe. In the paper, we illustrated the issues with reference to data on the management of germplasm in British allotments in East Kent and West London. We noted that despite official regulations restricting seed trade and dispersal, allotments (in the UK, community plots of land made available for individual, non-commercial gardening or growing of food plants) were a significant site for informal exchange, experimentation, and diversity production.

In this chapter I return to the relationship between kind of propagule (or disseminule) and social agency, but question the much-purported hegemony of seed as a mechanism and consider some forms of vegetative reproduction where the agency of plant and human cultivators converge. For it is not only seed that has a social life, but other plant parts that serve to reproduce vegetatively. In adopting this line of argument I move from the allotments of East Kent to the marginal Nuaulu and Kei swiddens of eastern Indonesia where I have undertaken most of my fieldwork since 1969. It must be said that although recreational East Kent allotment keepers outnumber Nuaulu (who in 2015 comprised something over 2,000 individuals), the biocultural consequences of their actions on the wider host population, though interesting, have very little impact on food intake and social resilience. By contrast, Nuaulu and Kei Islanders still maintain food sovereignty despite consuming increasing amounts of food purchased through the market, and despite a history of receptivity to new germplasm. It is instructive therefore to take a broader look at germplasm manipulation, to examine the trade-offs between different kinds of propagule, particularly between seeds and various forms of humanly-assisted vegetative reproduction, and undertake "counterwork" (see e.g. Fardon 2003) to re-assess some sloppy assumptions that underpin the idea that seed is supreme.

SEED AS A REPRODUCTIVE MECHANISM AND TROPE

Let us start with Henk Beetje's economical definition produced for a definitive publication produced by the Royal Botanic Gardens at Kew:

> seed, the structure produced from a fertilised ovule by which all seed plants reproduce, consisting of an embryo and usually a seed-coat, with endosperm; reproductive part of fruit; the integumented megasporangium (Beentje 2010, 105).

Seed has had a good press recently. As a form of dissemination and as natural capital it is conspicuously triumphant (Hanson 2015). There is excitement generated by the practice of seed exchange, concern expressed regarding seed "ownership", seed as cultural property and its commodification (van Dooren 2008). Entire industrial technologies and plant breeding programmes are based on seed (Kloppenburg 2004). Moreover, the concepts and practices of seed-saving (Phillips 2013) and even more seed-banking are accompanied by a great deal of scientific, political, and financial investment (Smith *et al.* 2003). Consider, for example the Kew Millennium Seed Bank at Wakehurst Place (Lewis-Jones 2019) and the Svalbard Global Seed Vault (Westengen *et al.* 2013). In the reconstruction of our evolutionary history a great deal of analytic weight has been placed on seed as the "fulcrum" of the first agricultural revolution separating nature from the social (Boyer 2014, 85). In plants that reproduce through seed, everything necessary for its success seems preserved within it: the plant in microcosm, a tiny capsule with a huge regenerative capacity. This is why seed as trope, or as concept metaphor, is so powerful in development, feminist (Shiva 1992), and environmentalist discourses, going back to the philosophical musings of Henry Thoreau (1917–1862; see e.g. Thoreau 1993) and beyond.

Not all seeds conform to the default stereotype of the small and robust entity you can keep in your top pocket, while the range of seed types (and certainly the fruits that encompass them) is much more varied than often popularly imagined in global debates about the valuation of nature (see e.g. Bell & Bryan 2008, 194–197; Hickey & King 2000, 173–186). Nevertheless, seeds as a whole are valued more than other forms of plant regeneration, such as suckers, and there is more talk of the conservation of seed than the conservation of stolons. Moreover, seed and pollen survive much better in archaeological and palaeoecological contexts, which may lead us to over-estimate their historical role. True, in terms of tropery, we find a rebellious challenge in the favoured image of the rhizome as used by Deleuze and Guattari (1980), and their various post-modernist and post-humanist acolytes, to represent a mode of knowledge and model of society that is non-hierarchic, network-like as opposed to generating linear arborescent hierarchies, and in the fungal mycelium and mycorrhizal analogies adopted by Tim Ingold (2011, 86) and Anna Tsing (Matsutake Worlds Research Group 2009) to understand the entanglements of social creativity. Nevertheless, seed metaphors as well as seed itself retain the upper hand in how most people, including neo-liberal agencies, think about life and regeneration more broadly. Such linguistic uses and the assumptions underpinning them are possibly reinforced by the undeniable preference for grain-based foods over root-based foods in the great historic Eurasian culinary traditions (Goody 1982), and the invariably low status accorded to roots, tubers, and palm starch. Thus, 19th-century Irish peasants ate potatoes because they could not afford bread, and many contemporary Indonesian smallholders eat cassava and sago when they cannot afford rice.

FORMS OF VEGETATIVE PLANT REPRODUCTION AND THEIR NEGLECT

There is little doubt that seeds are ideal material for commodification, and more than any other form of germplasm are amenable to the processes and potentials of industrial capitalism: in the way they can be produced, stored, packaged, and distributed. Propagules afforded through other diverse forms of vegetative reproduction do not lend themselves in the same way to this work of exchange and consumption. But this is hardly due to lack of variety. The common and effective forms of vegetative plant reproduction are arguably as numerous as the ingenuity with which botanists come up with typologies. In non-human systems we have: bulbs, runners, rhizomes, tubers, suckers, corms, offsets, stolons, plantlets, bulbils, turions, layers, hibernacula, adventitious buds, callus formation in root buds, and so on. To take two very different examples: clonal trees such as Californian coastal redwoods (*Sequoia sempervirens* (D.Don) Endl) sprout plantlets from the base of the trunk, while fallen trees of many species readily continue to grow by sprouting phototropic branches that become new trunks. One such case is hornbeam, *Carpinus betulus* L., showing vertical re-establishment in English woodland as illustrated by Oliver Rackham (2003, 438, figs. 27.1 & 27.12), that great pioneer in understanding the vegetal Anthropocene.

But certain forms of vegetative reproduction have become vastly more important, and greatly enhanced as a result of human management, such as through planting hops from rhizomes (*Fig. 1a*) in East Kent or (an example I shall develop further below) propagating sago from suckers in Indonesia. Some forms of vegetative reproduction are only possible with human intervention, such as stem cuttings, budding, and grafting. The significance of anthropic vegetation propagation in semi-managed tree landscapes can be seen in English woodland where ash, chestnut, and beech normally spread by sprouting new plants in ever-widening rings as a result of systematic coppicing. Similar examples (such as that of the coppice stool of *Acer rubrum* L., a native eastern North American species transplanted to southern English woodland) have been meticulously documented and interpreted by Rackham (2003, 434, fig. 26.15).

Beyond trees, we might note that grassland reproduces and expands extensively through stoloniferous or rhizomatic growth. Where humans have intervened to select and manage grasses to produce grain as food the propensity to reproduce vegetatively has been selected out, though there are now attempts to re-introduce it, as in the case

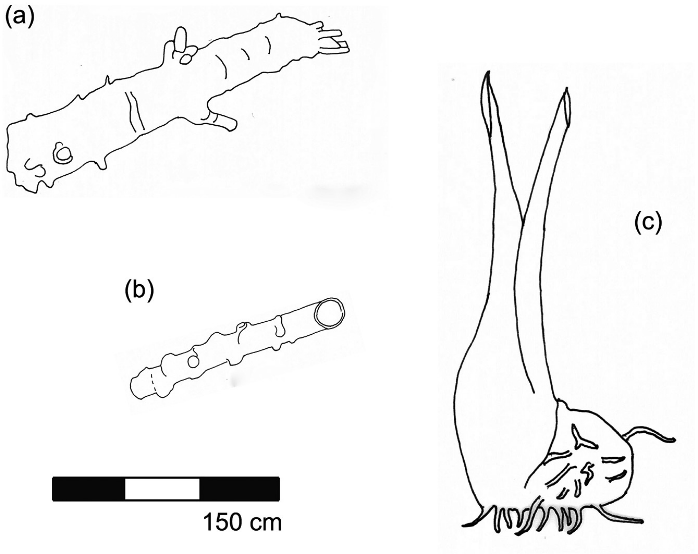

Fig. 1. (a) Hop (Humulus lupulus L.) rhizome: East Kent, (b) cassava (Manihot esculenta Crantz) stem cutting: Debut, Kei Kecil, Indonesia; and (c) sago (Metroxylon sagu Rottb.) sucker prepared for planting: Nuaulu, central Seram, Indonesia. Note the physical similarity between (a) and (b) despite the genetic distance between the two taxa, and the propagules being different plant organs. Line drawings from carpological specimens in the UKC Ethnobiology Laboratory collection: 2015-22-4. Approximate scale.

of rice (Kush 1997; Yoshida *et al.* 2016).[1] But our interest in the seed of grain crops is less as seed than as food, and some food grains we have produced are quite unsuitable as reproductive mechanisms. In other cases, social mechanisms prevent its use as seed, either by engineering out the physical possibility of effective sexual reproduction (as in so-called "terminator" seeds), or by employing commercial legal instruments such as gene patents (Stone 2018, 2602–2605). However, if we look at the ten most important food crops globally (Bates 1985; *Table 1* below), though the top three are seed reproducers, half of the species are mainly vegetative reproducers, the fourth and fifth most important being potato and cassava. The reason for this lies partly in some of the advantages of vegetative reproduction (such as the simplicity of immediately replanting stem-cuttings once cassava roots have been lifted); but also productivity factors, root and tuber crops, for example, producing twice as much useful dry matter as cereals (Flach & Rumawas 1996, 25).

Table 1. The ten most important staple food crops in global terms. Source: https://www.businessinsider.com/10-crops-that-feed-the-world-2011-9?IR=T [accessed 24 June 2019].

	Crop	Annual production/tons 2008
1	Maize	822,712,527
2	Wheat	689,945,712
3	Rice	685,013,374
4	Potatoes	314,140,107
5	Cassava	232,950,180
6	Soyabean	230,952,636
7	Sweet potato	110,128,298
8	Sorghum	65,534,273
9	Yams	51,728,233
10	Plantain	34,343,343

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[1] Other wild species in the genus *Oryza* are also perennial. While perennial *Oryza rufipogon* spreads vegetatively by above-ground stems (stolons), *O. longistaminata, O. officinalis, O. australiensis*, and *O. rhizomatis* spread by underground stems (rhizomes).

The triumph of seed is no doubt in large part due to its susceptibility to easy commodification, but its triumph as a trope while hardly unrelated, also requires that we consider other features. While it is easy to conceive of plant seed strategies, it is not so easy to envision, say, rhizome strategies. The fact that they are not so good to think with sometimes leads us to ignore or downplay the importance of other forms of vegetative reproduction, which are no less important than seed in feeding the world, certainly in its more peripheral areas. And this too is perhaps another reason for their neglect.

SOCIAL MECHANISMS OF VEGETATIVE DISPERSAL AND EXCHANGE

In assessing the extent and ways in which different forms of vegetative reproduction adopt a social profile we need to specify some relevant physical and behavioural qualities. Here are just a few, not necessarily mutually exclusive: size (obviously), woodiness, durability, ease of handling, ease of division, tolerance to temperature fluctuation, resistance to freezing, drying, moisture and to rough treatment, and storability. Bearing these qualities in mind, I shall focus here on just three types: bulbs, stem cuttings, and suckers.

BULBS

It is hardly surprising that the vegetative propagules most successfully circulated through the market are those morphologically and functionally similar to seed, and the obvious examples here are bulbs and corms. Consider the widely cited example of the so-called Dutch "tulip mania" of the 17th century (*Fig. 2*), in which bulbs took on virtually the same liquidity as currency. Although in 1637 the trade spiralled out of control in a classic early capitalist bubble, the market was in fact rationally organised and for the most part highly successful (Goldgar 2007). That it was so was in part due to the commodity being so readily transported over long distances, storable, diversified, circulated, commoditised, and subject to theft through "breaking" – that is through the simple separation of the bulb cloves. Of course, market mechanisms have been harnessed to disseminate other kinds of non-seed propagule, especially nowadays given the ingenuity of science-driven capitalism to utilise modern technologies of preservation and communication. But in developing countries non-seed propagules still rarely pass through the market. And even bulbs and corms are exceptional among the main food crops, restricted mainly to species used as relishes, such as onions and garlic.

Fig. 2. Double portrait by Michiel Janszoon van Mierevelt, of a husband and wife with tulip, tulib bulb, and shells, 1609. Public domain, Wikimedia Commons: source ArtDaily.org. Copyright 2000–2018, The Athenaeum.

STEM CUTTINGS

Far less amenable to market mechanisms, but nevertheless of considerable significance in large parts of the world is propagation through stem cuttings (*Fig. 1b*). The anthropological significance of this, especially for cassava, was first demonstrated by James Boster in work amongst the Aguaruna in the north-west Amazon. As with seeds, it is not the stem cuttings alone that are disseminated (the germplasm itself) but the associated knowledge, and in ways consistent with wider social norms and practices. This importantly includes division of labour by gender, depending on whether it is males or females who have the predominant role in farming. Boster (1986) was able to describe how cassava cultivar stem cuttings and knowledge moved between female cultivators along kinship lines.

But what is additionally interesting about cassava is that from the 16th century onwards it spread throughout the rest of the tropical world, and by the late 19th century was established in eastern Indonesia. In a comparative study of the Nuaulu and Kei islanders in 2009, Hermien Soselisa and I found similar patterns of transfer to those described by Boster for the Aguaruna, though with perhaps a less skewed gender distribution. What was additionally significant were the differences between Nuaulu and Kei. Nuaulu, living in humid tropical forest and traditionally reliant on sago palm for most carbohydrate, had relatively few cultivars, while in Kei, over 100 years of deforestation and consequent aridification had transformed the economy from one dependent on sago and other pre-Columbian cultigens to one in which cassava was king, and had been extensively diversified, especially in terms of the numbers of bitter landraces that performed better under arid conditions. Moreover, the shift from sago suckers to cassava stem cuttings was also a gender shift from entirely male control to predominantly female control of germplasm (Ellen & Soselisa 2012; Ellen *et al.* 2012; Soselisa & Ellen 2013).

SUCKERS

Compared to cuttings, bulbs and seeds, suckers – here exemplified by the sago palm *Metroxylon sagu* (Ellen 2006) – might seem unpromising material for social dissemination. Sago suckers (*Fig. 1c*) – shoots that are continuously branching off a stem at or below ground level – like the leaf sheaths that constitute the main stem, are mostly covered in thorns. There is just one variety that does not have thorns. Nevertheless, sago suckers are certainly tricky to handle, have to be carefully separated from the parent tree and usually wrapped in leaf sheath epidermis with the thorns pointing inside rather than outside, and secured tightly with a piece of rattan or liana. In this way they can be moved from place to place and planted in a convenient new location. Sago suckers move around Nuaulu villages between relatives, but are less likely to move further afield, to change hands for cash or barter, and therefore we might expect that their wider dissemination within a region is much slower. As long as the palms producing the suckers do not flower, fruit, and produce seedlings, the genetic composition of the clone will remain stable and there is some evidence that clonal stability has been achieved over many hundreds of years. As a trope, the sago palm, with its numerous suckers and phenotypic continuity over generations, is widely compared to patrilineal descent lines, the removal of suckers from a parent tree to clan segmentation, and the relationship between suckers from the same palm to siblinghood, a figurative language widely found amongst the sago-peoples of lowland Melanesia (e.g. Gell 1975, 144).

The resistance of the physicality of suckers and cuttings to the market can also be seen in advanced economies. Indeed, kinship and friendship are no less important for the dissemination of vegetative propagules amongst houseplant-keepers in East Kent than amongst Nuaulu sago extractors and Kei cassava farmers. In a study with Réka Komáromi (2013), we were able to show how householders reconstruct networks of kinship and friendship through their houseplants, in terms of what they had both given away and what they had acquired, and how certain forms of propagation were more amenable to social dissemination than others. Amongst allotment-keepers, raspberry canes (in some respects like sago suckers) move through friendship networks and those renting contiguous plots (Platten 2013). These provide a robust means of social storage, re-distribute both germplasm and knowledge diversity, and are a reservoir of variation as conditions change. As in traditional societies, most management knowledge rests in individuals, who transmit this through distributed kinship and friendship links.

In both the studies with Komáromi (Ellen and Komáromi 2013) and with Platten (Ellen and Platten 2011) we were able to show the importance of "tolerated taking", that is, movement of plant germplasm through the removal of cuttings (especially in private and public gardens) where no permission had been explicitly granted, but where there was widespread tolerance by owners of the practice, either because policing such low-level theft was considered not worth the effort, to avoid accusations of stinginess, or because a positive social value was placed on the spirit of generosity that acceptance reflected. The concept, which appears to have its origins in behavioural ecology (Blurton Jones 1987), might be seen as a more benign and socially acceptable instantiation of what Marshall Sahlins (1965) called "negative reciprocity". Empirically, it is clear that an enormous amount of germplasm circulates in this way, in all agricultural societies, in some cases with attempts to reduce it through social control. Under capitalism, and for seed, like many forms of informal circulation, tolerated taking or theft provides an additional hazard, in threatening standardisation of quality and undermining brand position in the market.

DISSEMINATION, TRANSMISSION, AND STORAGE

We can see that the redistribution of domesticate germplasm of any cultigen, and hence cultivar variations, is inevitably related to human movement, whether inadvertent or deliberate, but it also depends on evolved forms of plant reproduction and their different properties. To summarise, seed is the most resilient form of germplasm, and different forms of vegetative propagule vary greatly in their ability to move effectively through human systems (Ellen & Platten 2011). Moreover, although vegetative propagules can be selected for and managed to improve their efficiency, and technology applied to do so further, on balance it is usually more labour intensive than seed propagation and therefore more expensive for the farmer. For example, Carl Zimmerer (1991, 39) found that among Andean Aymara-speakers, maize seed was distributed much more frequently, easily, and widely than potato tubers. However, although seeds are highly convenient when it comes to transport, long-term survival, and dispersal, it is likely that some of the major vegetal successes – such as cassava, taro, and banana (triploid and sterile), spread through dissemination of vegetative propagules. Cassava, as we have noted, first made its way gradually to Southeast Asia as stem cuttings, both from West to East and from East and West, as slave food. Only in the 19th century was it taken seriously by Dutch colonial agricultural extension officers, who produced new varieties that they encouraged farmers in the East to plant. But once cassava was in, say, the Kei islands, it reproduced entirely through stem cuttings, and moved around the islands in that way.

In addition to ease of dissemination, storage potential is also a key difference between seed and most vegetative propagules. Seeds are easier to store than vegetative propagules, and most literature on plant storage concerns grains and pulses, directly destined for food rather than put aside for crop propagation, for which the environmental requirements are often different (Howard 2017). Under normal conditions, Baduy rice barns in upland west Java (Iskandar & Ellen 1999, 121) contain many more types of rice than are necessarily used in any one year, some bunches of which have been stored for up to 90 years and yet still maintain their viability. Under *ex situ* conditions we have, of course, the Millennium Seed Bank, the Svalbard Global Seed Vault, and exceptional examples of dormant prehistoric seed being resurrected (e.g. Yashina *et al.* 2012; and for cultigen seed, the example of a 2,000 BP date palm, mentioned by Hanson 2015, 85–89). By contrast, while the germplasm of many clonally reproducing crops cannot easily be stored *ex situ*, and the technical problems are much greater (partly due to higher moisture content: see e.g. Flach & Rumawas 1996, 25), it is transmitted instead through live-storage in fields, by periodically supplementing planted cultivars from wild stock (as with sago), or through social storage, either relying on others to plant cultivars or by keeping germplasm in constant circulation.

CLONAL AND SEED DIVERSITY

Finally, we need to take a look at cultivar diversity (Ellen 2020). It might be thought that seeds are better at producing useful diversity, though in a lot of national collections of domesticates this diversity is effectively located in the growing plants rather than the seed. For example, at the British national collection of fruit trees at Brogdale in Kent (Brogdale Horticultural Trust 1998), the varieties are maintained by grafts on rootstocks, and it is the grafts that are circulated, thus "by-passing" the seed stage (Boyer 2014, 98). This "by-passing" is critical to maintaining phenotypic clonal diversity, for where clones of – say – cassava or sago are left to flower, fruit, and disperse as new plants, the very virtues that farmers seek and actively manage (whether consumption virtues such as taste, or production virtues such as pest-resistance) will likely be lost. Looking at seeds *sensu stricto* in his Andean study Zimmerer (1991) found 21 cultivars per field for potato, but only 2.9 cultivars per field for maize. If we compare Nuaulu basic starch crops (*Table 2*), non-seed producing cultigens contain much more diversity than those reproducing by seed (compare taro, cassava, yam, banana, and sago with rice and maize). This pattern is reflected in nomenclatural data from other studies (*Table 3*), though Baduy rice diversity is exceptional at 89 landraces, as is rice in general.

Table 2. Numbers of locally named landraces for selected Nuaulu cultivated plants (modified from Ellen 2006).

Species	English name	No.
Musa x paradisiaca	banana and plantain	37
Dioscorea alata	greater or purple yam	11
Metroxylon sagu	sago palm	11
Manihot esculenta	cassava or manioc	11
Cocos nucifera	coconut palm	10
Capsicum annuum	chilli pepper	9
Colocasia esculenta	taro	9
Dioscorea esculenta	lesser yam	8
Areca catechu	betel palm	5

Table 3. Numbers of named landraces for selected domesticates in various study populations (modified from Ellen 2006).

Species	English name	Number of landraces	Location	Sources
Oryza sativa	rice	89	Baduy, West Java	Iskandar & Ellen 1999
Ensete ventricosum	Ethiopian banana	71	Ari, Ethiopia	Shigeta 1996, 236–239
Ipomoea batatas	sweet potato	64	Wola, New Guinea	Sillitoe 1983, 29
Manihot esculenta	cassava	50	Aguaruna, Peru	Boster 1984, 38–39
Pandanus brosimos, P. julianetti	screwpine	45	Wola, New Guinea	Sillitoe 1983, 45
Colocasia esculenta	taro	43	Wola, New Guinea	Sillitoe 1983, 37
Solanum tuberosum	Irish potato	30–40	Quechua, Peru	Brush 1991, 156
Cocos nucifera	coconut	14–17	Kerala, India	Thampan 2000
Zea mays	maize	12–17	Tzeltal, Mexico	Brush 1991, 158
Cocos nucifera	coconut	9–13	Solomons	Eyzaguirre & Batugal 1999
Saccharum officinarum	cane sugar	12	Wola, New Guinea	Sillitoe 1983, 84

Whether as seeds or vegetative propagules, high levels of diversity have the effect of buffering adverse short-term ecological conditions. As conditions change so traditional farmers such as the Baduy and Kei Islanders vary the proportion of different cultivars in their fields, and how groups of cultivars are arranged within a field. High levels of diversity are achieved through planting a wide range of cultivars in a given year, in the same field or over a number of fields. But as we have seen, in the case of seed crops diversity can be enhanced by long-term storage of germplasm, while diversity in clonally reproducing crops has in many cases to be in the form of live storage in the fields. While much selection and incorporation of individual cultivars in a local inventory is calculated and deliberate, it has been widely reported that many populations encourage variation for its own sake. There, is in other words, an “aesthetic of diversity”, reflected and supported through distinctive moral regimes (Ellen 2017). Thus, the maintenance of diversity itself can be a key factor in long-term adaptation. We can see this in the example of Baduy rice, but also in Nuaulu sago and in Kei cassava.

A major environmental hazard influencing diversification of crop cultivars has been aridification, accentuated through global warming and other biocultural features of the Anthropocene. One of the reasons why cassava spread so widely out of its area of endemism in north-west Amazonia was its flexibility as a crop, and particularly its tolerance of dry conditions. A key feature that makes this possible is high levels of HCN (hydrogen cyanide). This serves to combat competing pathogens and thus confers an advantage in dry zones. The range of HCN toxicity is wide in cassava, but in dry areas toxicity tends to be higher and the ecology selects for cultivars with high HCN concentration. Farmers in Africa, Indonesia, and elsewhere have learned to take advantage of this and deliberately favour high toxicity cultivars. Thus, in the Kei islands there are as many high toxicity cultivars (*enbal*) as low toxicity cultivars (*kasbi*) (Ellen & Soselisa 2012; Soselisa & Ellen 2013). In a comparative study of Kei and Nuaulu cassava diversity, Ellen, Soselisa and Wulandari (2012) used DNA evidence to show that the close genetic relatedness between most of the larger number of Kei cultivars and a distant genetic relatedness between all of the smaller number of Nuaulu cultivars, strongly indicated that Kei farmers were much more active in selecting propagative material than Nuaulu, who – living in a less arid area – were far less dependent on the crop.

THE BIOLOGICAL AND SOCIAL IMPLICATIONS OF NON-SEED PLANT REPRODUCTION

A seed is actually a risky form of reproduction compared with vegetative propagules – an r strategy rather than a K strategy (Pianka 1970) – in which survival of the genetic line is reliant on the production of huge quantities of replicators rather than heavy investment in just a few. With vegetative reproduction, all the hard embryological and maturational work has been done, and there is a much greater chance that a clone will grow to produce its own seeds or clones. For as long as variation within cloned cultigens is not sexually transmitted, the original genome is maintained, and so is available for future manipulation, unless the ability to flower has been completely lost, as sometimes happens. A stem clone contains all the same genetic information as a seed, but a crop when planted through clones will usually only reveal the characteristics of a particular phenotype of the individual parent plant. If the plant goes to seed there is no guarantee that it will reproduce in exactly the same form as the parent clone. This issue of predictability is one that Nuaulu sago cultivators face all the time, both a problem and an advantage, as the unpredictable reproductive outcomes of wild sago that has gone to seed are also opportunities for new and interesting clones. This same phenomenon is why, under capitalist market conditions, vegetative reproduction is problematic: the seed is not guaranteed to breed true. When particular clones become extinct there is no certainty that they will re-appear; if mature sexually reproduced cultivars become extinct we at least have their seed.

In botanical terms, a comparison of *Metroxylon sagu* (a slow-growing perennial), with say rice or maize (annuals) may seem invalid without a discussion of such matters as generation length and breeding systems. However, my starting point has been ethnobotanical: people's recognition and codification of diversity, and what they make of it, and what we might learn from it. Therefore, despite evident genetic variability within the species, cultigens such as sago, managed for their starch, diversify and form stable cultivars somewhat less than other cultigens. In vegetatively reproducing starch crops, such as taro (Matthews 2014), selection is for the most part of somatic mutations through continuous propagation, and with very high numbers of local named clonal cultivars. By comparison, the sago palm, which in anthropogenic contexts reproduces mainly by vegetative means, is disproportionately sustained as a reproductive strategy by human harvesting before fruiting and the deliberate transplanting of suckers, but has relatively fewer distinct cultivars. Grains such as rice and maize are selected mainly on the basis of sexual recombination. In the Andean study by Zimmerer (1991) potatoes appeared to be selected for diversity, while maize was selected for specific characters. Amongst Andean farmers, Zimmerer (1991) notes, potato selection tends to be for perceptual difference, while maize selection is for direct consumption and production traits.

THE SIGNIFICANCE OF CLONAL CROPS

In this chapter I have tried to make the case for the importance of vegetative plant propagation, both in colonising the world and in shaping the Anthropocene, and would suggest that these two processes are closely connected. The development and history of agriculture and food cultures in whole regions of the world is heavily influenced by the significance of clonal crops: Amazonia, Oceania, and Melanesia for a start. In vegetative reproduction there is no temporal break in the life cycle of the plant of the kind precipitated by seed dormancy. Instead, vegetative reproduction compresses the time taken to produce food by removing the seed stage, the plant becoming, as it were, a "'never-ending perennial" (Boyer 2014, 98–99). Vegetative propagation underpins much human production capacity, but also reveals how different social mechanisms assist this process. Tubers, roots, rhizomes, and bulbs, no less than seed, are implicated in intimate relations of biocultural mutualism with human social and technical practices.

I am of course being deliberately provocative here, and perhaps even "over-egging the pudding", since I broadly accept the hegemony of the seed narrative. But quite apart from redressing the balance in our interpretation of the science of plant reproduction and its impact on human lifeways and economy, it reminds us of the trap entailed in confusing the genetic with the biological (Ingold 1990; 2007; 2011, 9; also Palsson 2013), of assuming that the world around us is simply the unfolding of genetic determination, when in fact what we see and experience is the outcome of complex ontogenetic processes in which genes play an important but not an overwhelming part. Genes, like seeds, and like cells, are powerful tropes, each of which have successively and successfully captured our imagination. All are tiny entities that seem to contain within themselves everything we need, and are conveniently manipulable. We fall for the illusory supremacy of both gene and seed at our peril, as these disguise the very complexity of life processes necessary to adapt to rapidly changing conditions. We need to recognise that the agency in plants will simply seek to reproduce itself in the most efficient way, that it is unwise to always privilege Henk Beentje's "integumented megasporangium", and that we must not forget the vegetative propagules and their many virtues. We will need all the biocultural resources we have to survive the Anthropocene.

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