Chapter 2 - Care for the Commodity? The Work of Saving Succulents in the Laboratory

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Care for the Commodity? The work of saving succulents in the laboratory

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The work of saving species threatened with extinction is of critical importance. But what that work entails, who performs such work, and for whom this work is done has transformed and evolved alongside conservation as an academic discipline and scientific endeavor, a governmental and non-governmental industry, and more recently as a major financial enterprise (Braverman 2015; Dempsey 2018). The conservation of *plants*, however, with the very notable exception of agricultural crops, has not elicited the intense kind of global interest, financing, opportunity for capitalist accumulation, or at-times violent character (thankfully) such as that seen in the world of animal conservation (Duffy 2016; Margulies et al. 2019). As a small sliver of the plant kingdom, the cacti and succulents I focus on this chapter are experiencing a moment of phenomenal popularity with global consumers, both as household plants as well as in visual and iconographic forms, their images plastered across social media platforms, wallpaper, coffee mugs, and t-shirts, among other readymade consumer goods. The work of commodifying plant species for aesthetic consumption, and the work of plant conservation, however, are traditionally understood as distinct activities with divergent interests. In this chapter I focus on a space of vital overlap between them through species care work, to consider the work of caring for endangered plant species and the more-than-human laboratory labors this involves.

My attention turns to the shared work of plants and persons in a botanical garden laboratory setting, and a decades old project at the Botanical Gardens of The Huntington in Los Angeles County, California. The project, International Succulent Introductions (ISI), aims to reduce threats to endangered succulent plant species through their commodification—the mass reproduction of plants as 'lively commodities.' In cloning laboratory plants, ISI represents a market-oriented intervention into curbing illicit collection of wild plants by making cultivated specimens available for purchase. Drawing on notions of lively capital (Haraway 2008: 46), lively commodities are defined by Collard and Dempsey as "live commodities whose capitalist value is derived from their *status as living beings*" (2013: 2684, their emphasis). Through the setting of the laboratory and the work of laboratory laborers, the work of species care is extended to plants with the intent of offsetting pressure on these plants' wild relatives that are oftentimes restricted in habitat or naturally rare in number. In focusing on this laboratory setting and the maintenance and reproduction of endangered species, I became interested in these acts of commodification as a means to better understand the economy of saving plants and what it means to consider care of the species as "an alignment of interests and practices, applied across species boundaries … developed and promulgated through advances in genetic procedures and techniques" (Hartigan 2017: xiii). How might this laboratory work of species conservation be understood both as a matter of care and an effort of co-laboring between plants and persons?

In considering how plants are both made to work, but also fostered as species through the work of conservation care, thinking with Besky and Blanchette's (2019: 7) notion of "troubled ecologies" is useful, which "make the boundaries between subjects and objects blurry, while forcing those who subsist in them to grapple with the inadequacy of ingrained capitalist concepts and binaries such as work or nature". In a similar register, attending to the frictions at the heart of

this species care work aligns with the project of posthuman political ecologies, an effort of destabilizing taken-for-granted ontological 'givens' in analyses of environmental inequalities and power relations (Sundberg 2014; Margulies and Bersaglio 2018). As plant conservation work, the notion of more-than-human care extended through capitalist logics both complicates what it means to perform care work for nonhuman organisms and also who or what performs such work (Puig de la Bellacasa 2017). This chapter is a speculative effort to think with plants through the troubled ecological webs capitalism weaves through nature and vice versa (Moore 2015). Practices of succulent commodification interlace with 'caring for the collective' as biopolitical strategy aimed at the maintenance of populations (or species) deemed worthy of sustaining where the target for care are not individuals but broader categories of interest (Srinivasan 2014). Rather than strictly complementary practices, there is an emergent tension between the fostering of life and its commodification that materializes in the laboratory around the practice of 'saving species'. This tension finds resonance with other examples of appropriating nature in which new techniques devised to both monetize natural resources while also reducing natural resource degradation instead simultaneously maximize economies of both "growth and repair" (Fairhead et al. 2012: 242). Before tackling the subject of succulent propagation, in the next section I clarify the terms of more-than-human care work.

The work of species care

In the broadest sense, care encompasses activities and forms of attention directed towards the maintenance and sustenance of others, other things and others' interests. To clarify my usage of this terminology, I start with one of the most common definitions from Joan Tronto and Bernice Fisher:

> On the most general level, we suggest that caring be viewed as a *species activity that includes everything that we do to maintain, continue, and repair our 'world' so that we can live in it as well as possible.* That world includes our bodies, our selves, and our environment, all of which we seek to interweave in a complex, life-sustaining web, (Fisher and Tronto, 1991: 40, cited in Tronto 1993: 103, their emphasis)

While care is conventionally understood in everyday usage as inflected with empathy, concern, love, or affection, care is also detached, ambivalent, even violent; to care does not exist outside the cultural and political milieu of those engaged in the work of care, inclusive of the uneven power dynamics produced through and across histories of race, class, gender, and other forms of social difference (Puig de la Bellacasa 2011; Murphy 2015). As care has emerged as an important analytic, particularly within feminist geographies and (feminist) science and technology studies, Murphy (2015) urges deeper engagement with *unsettling* care, questioning care and caring that presumes only positive affects. I take this work of unsettling to mean both granting attention to and working against inequalities present in the work of care and the uneven social contexts within which care is pursued (Martin, Myers and Viseu 2015).

In turning to matters of the more-than-human in the context of care work, it signals a flourishing interdisciplinary area of scholarship concerned with developing language and theory to explore, analyze, and learn to be affected by the entangled and complex relations between bodies, individuals, collectives and earth system processes that co-fabricate the world (Whatmore 2002;

Greenhough 2014; Giraud 2019). Thinking with care in more-than-human registers, I became interested in a question posed by Puig de la Bellacasa (2017: 65), who asks: "for what worlds is care being done for?" Her question speaks to my interest in practices in which scientists within the conservation division of a botanical garden conduct care work for endangered species through the propagation and cloning of individual plants to sell over the internet. In whose interest do these practices of interspecies care occur? Does a rare species of aloe plant only known from two locations near a small village in the Mudug region of Somalia *care* if laboratory technicians in California produce hundreds of clones from a single individual of the species? What does it mean to extend care across species lines when those receiving care are collectively indifferent—as far as anyone knows—to such actions, but where individual lives are also arguably sacrificed or brought into existence for the care of the much more abstract concept of a *species or population*? I will fail to answer all these questions, as echoing Hartigan (2017: 217), "these dynamics of care become a good deal more complicated when they are enacted or exerted across species lines". Hartigan's choice of words is important as they tilt at agency, and beget yet another speculative question—how does one make determinations between *enactments* and *exertions* of care work, expressions with differing connotations of agency, force, and detachment in how work is pursued? Puig de la Bellacasa (2017: 7) again offers insight, suggesting the question to pursue – "how to care?" – transforms care from "a predetermined set of affective practices" into "an analytic or provocation." As a provocation then, the reproduction of rare plants in the laboratory is an avenue for considering both possibilities and limits to the work of conservation as care, attentive to the political economy of the more-than-human relations emergent through conservation work.

The laboratory is a particular site through which I consider the work of plants, but my interest in the lab extends beyond either the techniques or the economy of maintaining and reproducing plants. At the same time that the plants at the heart of this chapter were, through their entanglements with laboratory technicians, petri dishes, agar medium (the product of another plant), botanical gardens, and rare plant collectors transformed into living commodities, the human labor of reproducing them is also unambiguously intended an act of what John Hartigan Jr. (2017) calls 'care of the species'. Care of the species names the relationships forged as "forms of care as cross-species engagements", but specifically it turns on the work of caring for species rather than individual organisms (Hartigan 2017: 98). Hartigan (2017: 97) centers the plants, in this case, forms of maize, as the central focus of his ethnographic investigations, but with particular attention, drawing on the work of Foucault, to the meaning of the self in relation to the species, or namely "one species acting on and sculpting the self of another". But where Hartigan's work focuses on one of the worlds' most important food crops, here I am interested in the cultivation of species which do not serve the immediate sustenance of human life. Hartigan (2017: xiii-xv) notes this is an important expansion in the work of care from concern for agriculturally useful crops to species with innate 'biodiversity value' through the distinction between artificial and natural selection, writing that "Escalating efforts at conserving and cultivating biodiversity are extending such forms of care to species with little or no direct value for humans, blurring an important contrast with the domesticates we have transformed over millennia". In the case of the succulents I focus on in this chapter, these contrasts become blurrier still: because collector desire is incited by the possibility and availability of new species (or new phenotypic expressions), species care work and the sustaining of succulent biodiversity very much hold immediate value for the human subjects the ISI project engages with. Simply put, the more kinds of plants that exist, the more plants there are to plausibly collect.

The blurring of the 'natural' and 'domestic' Hartigan speaks to mirrors the troubled and blurred distinctions between the more-than-human care work of conserving species, and the work of cultivating lively commodities in the laboratory. As Hartigan (2017: 247) later adds on these distinctions between the work of caring for the "domesticated" versus "the untamed," he questions the ability to maintain such clear distinctions. I agree, arguing the work of cloning individual plants is not a purely innocent endeavor of perfect and indefinite genetic replication of species life. In particular, in the laboratory setting which I focus on, decisions are made about which individual plants should botanically represent the species as an epistemic category, but these decisions also determine how representations of species are economically appraised and valued by succulent collectors as living commodities for consumption. At the same time, as I discuss later in the chapter, plants too, through their physiological responses to the stresses of repeated clonal propagation, can resist the smooth and endless processes which render them into identical vegetal commodities (Shukin 2009). In coming to focus on the labors of plants and laboratory technicians working to propagate rare wild species, important connections also emerge between this work as species care and the growing emergence of seed banks, cryogenic freezing operations, and botanical gardens as sites where extinction operates as a speculative biocapital accumulation strategy (Helmreich 2008; Churlew 2017; Harrison 2017; Breithoff and Harrison 2020). While the activities I focus on in this chapter are not being pursued as a new form of bioaccumulation strategy, the plants situated at the heart of these endeavors nevertheless are shaped by capitalism and its logics.

Beyond articulating another rich example of the entangled lives within socionatures that make various accumulation strategies possible (Braun 2006), it is worth considering what is advanced more precisely by recognizing such entanglements of species life through acts of care work. Writing on the tensions of such articulations of entangled relationality, I am motivated by Giraud's recent (2019) assessment of the need to question whether recognition of relations begets more ethical response. Much of the literature on relational ethics presumes that revealing or articulating modes of relating generates affinities and greater capacity for interspecies intimacies (Giraud 2019: 2). This work therefore extends problematizing more-than-human relational ethics, questioning "the assumption that an ontology of relation and vitality can provide a route to a full more-than-human ethic" (Ginn 2014: 534). Attention to such indeterminacies and ambivalences in ethico-political registers is especially pertinent for thinking about more-than-human care work as an evolving set of laboring relations between persons and plants emergent through species care.

Botanical gardens as sites of species care work

The Huntington is one of the largest private research libraries in the world, an art museum, and collection of numerous botanical gardens located in Los Angeles County in San Marino, California.[1] The cactus and succulent 'living collection' of the Desert Garden is nearly 100 years old and is considered one of the most important succulent collections in the world, boasting over 2,000 different species of desert plants. As part of a larger research effort studying global

[1] The Huntington and its supporting endowment were formed through the amassed wealth of real estate and railroad tycoon Henry Edwards Huntington, who created the Huntington with his wife, Arabella Duval Huntington, the former wife of his deceased uncle and railroad business partner Collis P. Huntington.

succulent plant trade and conservation, In 2019 I spent a little over a week visiting the Botanical Research division of the Huntington to interview and spend time with cactus and succulent researchers, conservation practitioners, and garden staff to better understand the role of botanical gardens in succulent conservation work. Botanical gardens perform a vital function linking together the epistemological activities of knowing, describing, and archiving plants with the work of plant cultivation, care, and public education (Hartigan 2017: 217). Whom or what that care work serves has evolved over time; in previous centuries, botanical gardens were crucial (and problematic) sites of empire building and nation-making (McCracken 1997; Schiebinger 2004; Endersby 2008; Herbert 2012; Baber 2016). Over the past half century, and especially in the past few decades, botanical gardens have become more active sites of *ex-situ* conservation work. This *ex-situ* work is done in the name of preserving living biodiversity and involves working to maintain living collections, seeds, and plant genetic material for, among other things, their potential future value to repopulate degraded or destroyed ecosystems with rare or threatened species (Prance 2000; Heyd 2006; Hawkes et al. 2012).

Within this vein of thinking about the botanical garden as a site of ex-situ conservation, but also a space concerned with engaging the public, I wanted to learn more about a program run out of the Botanical Research division at The Huntington called International Succulent Introductions (ISI). ISI was first formed in 1958, and after operating out of various private commercial operations, it formally moved to the Huntington in 1989. ISI's mission is to "propagate and distribute new or rare succulents to collectors, nurseries and institutions. In keeping with sound conservation practices, field-collected plants are not sold" (The Huntington, no date). Clones of field collected plants or their progeny are sold, however, as a goal of ISI is to meet the demand of specialist collectors who might otherwise – so it is believed – take plants 'from habitat' (an expression used throughout the collecting and conservation community). ISI is unique for bringing together matters of plant conservation care with their commodification, as well as for the connections it makes between private collectors passionate about succulent plants and the threats plants may face from the activities of the very same community. I therefore conceive of the ISI as an intervention of species care work, and an attempt to mediate particular ways in which succulent collectors encounter and collect plants understood as either ethically 'good' or 'bad.' I must clarify my usage of, and slightly modify, Hartigan's (2017: 133) conceptualization of care of the species here, which he says "*aims toward knowledge production of species themselves*, in order to guide or direct their plasticity and cultivate their modes of diversity" (his emphasis). Here, the ISI is not an effort of knowledge production, but a set of tools and practices very much concerned with how to "maintain, continue, and repair" species by shaping human-plant encounters (Tronto 1993: 103). Embedded in this practice of caring for the species then is not only a moral claim to proper ways of caring, but also ethico-political determinations of what kinds of plants *within* a species are included in specific acts and attention of species care (and the work of care), and which are not.

It is for this reason – how the species as a matter of care for conservation both includes and excludes plants from acts of care based on their status as a 'wild' organism or not – that I situate this work as species care rather than care for plants, though the former does not preclude the latter. I understand 'species' as performed and enacted scientific classificatory constructs (Kirksey 2015). Presented in the form of a written binomial – a species is the joining of a Latin genus and species name as the indicator that a grouping of plants exists as a specific, immutable

type.[2] The species binomial works well within the logics of capitalism, as it orders and standardizes vegetal life in a structured and hierarchical form that belies the far more promiscuous and porous nature of plant life. Acknowledging this disjuncture between epistemological ideals of plant types and their ontological realities would complicate efforts of commodification and the production of species demand for consumers. This demand production is important because it taps into collector desire to possess representatives of species as well as type specimens, a botanical category described in greater detail in the next section. In the process of caring for the species, this care work differentiates between the species as an epistemological container for living organisms that very much exist in the world (even if they are represented quite poorly by the formal taxonomy that 'species' represents), and the organisms being grown in the laboratory through this care work as living representatives of the species. The species of conservation interest then is increasingly distanced from the actual work and plants in the laboratory, and the process of objectifying individual plants as lively commodities. Reiterating a position taken by Martin, Myers, and Viseu (2015: 627), care "circumscribes and cherishes some things, lives, or phenomena as its objects. In the process, it excludes others". One way to understand this differential species relationship between the plants of concern (wild plants – out there) and the plants being worked on (clonal propagules – in the lab) is to frame the endangered succulent plants living beyond the laboratory as the subjects of care, while those plants under replication in the laboratory are worked into commodified objects through whose reproduction care of the conservation subject is pursued. But in being worked on, these plants also work (metabolically) themselves, and it is ultimately this co-laboring of species that comprises species care work. Species care work is further complicated and temporally extended into the lives of plants through incorporating cryobiotechnologies as a technique capable of suspending life itself.

Tissue culture, cryopreservation, and the cycling of vegetal life in the lab

During an hour-long conversation in 2019 with the Huntington's Plant Conservation Specialist, we spoke over a cup of coffee on the conservation work of gardens. We touched on all matters of work and activity that takes place in the Botany division, and how the work of the garden is connected to concerns about the maintenance of wild life. Weaving across various thematic threads relating to trade, conservation, plant preservation and cryogenics, eventually we arrived at discussing the ISI as an activity bridging these topics. He explained the program's value: "Every year we offer plants that are either rare in cultivation or rare in the wild with the intent that people won't poach them from the wild if we give [the plants] to them first. We're targeting plants that we think are either new to the trade, or are uncommon. We mass propagate them artificially and then we try to satisfy the market" (Interview, January 28, 2019).

Prior to 2008, propagating plants for ISI focused on traditional methods of vegetal reproduction, such as taking plant cuttings, rooting them, growing them up, and cutting them again, a process he described as "a ten-year process. Whereas we were able to fast track that to 18 months or less through tissue culture. It was a time issue … As long as you keep a plant in what we call the multiplication phase, you can, theoretically, get as many plants as you want, you can stop it whenever you want" (Interview, January 28, 2019). Tissue culture in plants involves taking small

[2] The Linnaean taxonomic system using Latin binomials for species names has been widely critiqued for decades as an inadequate means of categorizing and classifying life, especially life beyond the animal. See, for instance, Ereshefsky (2000).

cuttings of meristematic plant tissue (called explants after excision) and then rearing them in a sterile growth medium (Figure 1). Meristematic plant cells have the ability to regenerate into any other plant cell and organize a complete organism, a cellular ability known as totipotency, a capacity much more restricted in animals. This means minuscule plant tissue cuttings can produce fully fledged plant clones in a matter of weeks, a process that, as noted above, can theoretically continue indefinitely. But more than providing time management advantages (reduction in necessary labor time to reproduce individual plants), reproduction of plants via tissue culture enables an additional avenue for plant reproduction when other methods of reproduction are not possible:

> Our tissue culture program was originally created as a propagation tool for plants that were difficult to propagate by other means, either it was a plant that was slow to produce flowers or didn't produce flowers, a plant where we only had a male or female, we didn't have both, and/or a plant that we knew was really hard to keep alive. These are candidates we looked at for using tissue culture to try to propagate them clonally. (Interview, January 28, 2019)

At the Huntington the scientists and technicians I interviewed explained the tissue culture program was an important phase of vegetal life in the lab linking the gardens' 'living collections' with mid- and long-term ex-situ preservation of species through plant cryopreservation – the process of storing desiccated plant tissue and seed at very low temperatures in liquid nitrogen cooled vessels. Cryopreservation is an evolving technology that extends biopolitical governing of life into blurrier thresholds of lively and not-so lively existence, and thus has also become a recent area of research interest for more critical scholars concerned about the biopolitics such practices produce or enable (Friedrich 2017; Radin and Kowal 2017). But while cryopreservation can serve as a practically indefinite form of storing value, coupled with other biotechnologies, it can also be applied to botanical and conservation problems that move plant life in and out of the varied biological temporalities and rhythms extreme cooling enables. As Friedrich (2017: 61) explains: "Prevented from aging and spoiling, cryogenic life is the result of the sociotechnical effort to detach organic matter from its natural life cycle."

The Huntington's Cryopreservation Research Botanist offers me a primer on cryogenics and botany one afternoon at her desk attached to the Huntington's tissue culture lab. We pore over powerpoint slides of the cryopreservation process on her computer screen, and she narrates the various figures and diagrams for me:

> So you collect a plant that might be wild collected, then you can keep it in a botanical garden, in an ex-situ collection, in a field collection. As I said before, that plant might die for different reasons. If you have the chance to have a backup collection – that is what actually the cryopreservation collections are – *they are living collections, but they are [also] backup collections*. They are not the only collection in the group for the plants. (Interview, 01/30/2019, her emphasis)

She shows me a figure illustrating how this process begins with either garden plants or wild specimens as sources of 'donor material'. This living material is then used to cycle explant material in and out of cryogenic preservation and tissue culture propagation, sending some of

those newly produced clones back into the cryogenic storage vessel, while sending the rest out to where they are needed. The destination might be the garden's outdoor collections to replace old or dying plants, other gardens or research centers, commercial entities or private collectors (such as through the ISI), and perhaps one day, she speculates, even into habitats where wild plants are no longer found. During our discussion, she makes sure to clarify we are not discussing "freezing" seeds or plant tissue through cryogenics, but "cooling" them. Freezing would imply ice crystal formation – a process that would be deadly to plant material as water expands when frozen and thus would cause plant cells to lyse. In cryopreservation, the water content of the plant material is first largely removed, and the plant tissue or seeds are treated with cryoprotectant chemicals to further shield them from freezing. She explained to me that in contrast to freezing plant material, cryopreservation is about the maintenance of life in suspended form for future use, unrestrained by the normal temporalities of plant time.

The role of cryopreservation at the garden mirrors similar efforts in zoos to cryopreserve endangered animal reproductive materials (Chrulew 2017); in fact, cryopreservation is much more well-established in humans and animals, and remains more experimental in plants. But unlike sperm and unfertilized eggs, cryopreserved plant matter is already existing life in suspension rather than only its future possibility. There is a distinction therefore between the way the botanist talks about the living status of plants in cryopreservation compared to its parallels for animal life. While this distinction is subtle, it speaks to the drastically different reproductive possibilities of plants and animals and how they might be put to work, and what these modes of reproducing life enable or disable in efforts to conserve them. Cryogenics enables a vital form of stable storage for plant life, suspending value in ultra-cooled plant tissue until its circulation is later desired (Banoub and Martin 2020). But which plants of a species enter cryopreservation, and which do not? Here the formulation of plant species as fixed botanical taxonomies, both by botanic gardens as well as avid collectors, is an epistemological concern determining how species care work in the botanic garden is pursued in relation to the value of certain plants. The botanist explains:

> The reason why do we do it [plant reproduction] clonal is just because we want to keep the *true-to-type plant*. So we want to keep the same plant. [For instance] If we want to plant it later in the garden … In the case of the agaves, and the species we are working with, many of them are type plants, as you might know, they're the plants that are used for the description of the species. So they have a botanical value. *It might not be a value for conservation itself, but it's a botanical value.* (Interview, 01/30/2019, my emphasis)

Her reference to 'type plants' here is important. 'Types' refer to a specific botanical specimen, an actual living or preserved plant, that serves as the reference plant for describing an entire species. Somewhere, every formally described plant species in the world has a type specimen comprised of preserved plant material affixed to an herbarium sheet with its description, location of origin, who collected and described the plant (often different people), among other essential data. In cloning types, cloning and cryogenic technologies are put to work to reproduce and store the individual organism that ties the species concept to a specific biological being. While the cryopreservation botanist points to the botanical value of these plants, as type specimen clones, these plants are also valued more highly by many collectors as 'the best' or 'true' representations of the species. Cryopreservation therefore also further enables a form of standardization and replication – at least in theory – of plants seen as more valuable than others of the species and

prioritized by the botanical garden and collectors alike as such. While this concern for species types and reproduction of 'true' or 'pure' species might seem to contradict previous statements made by others I interviewed about the conservation value of the ISI, the focus on type specimens is a space of concern for intervention because the private collectors they are producing plants for, and whose behavior they are seeking to modify, are specifically desirous of *collecting the species.* While there are many kinds of collectors motivated by various aspects of plant collections, many succulent collectors are equally concerned with the provenance and acquisition of plants that are representative of the type or closely affiliated with it through plants sharing the same provenance as the type's locality. Thus, although the cycling of clonal plant material in and out of cryopreservation and tissue culture may seem entirely removed from the lifeworlds of existing plants out in the world (the plants the program seeks to foster through their intervention), the production of these clones is very much linked to how the succulent collecting community constructs stable notions of species kinds, which in turn mediates their desires to possess and obtain wild-collected plants. Thus conceived, the work of conservation in the laboratory links together epistemologies of the species with forms of care work increasingly distanced from the plant lives for whom care work is pursued.

The multispecies work of cloning commodities

My time spent physically working with plants at the Huntington enabled a greater appreciation for species care work as a form of co-laboring. At the Huntington I was introduced to the basics of tissue culture propagation as well as more traditional propagation techniques such as grafting and taking succulent cuttings. I found cutting plants to be a generative task for theorizing about how different plant lives are valued through care work. In revisiting these practices, I wish to pay attention to what changes in the course of analysis if it is permitted that these plants in the lab are "working subjects, not just worked objects" (Haraway 2008: 57). It is in this speculative grey area between working subject and worked object that the labor of more-than-human care work clearly expresses both a relational endeavor of co-laboring between plants and persons, as well as an extension of species care by humans interested in the maintenance of species constructs, or classifications of a kind whose representations as species come to express forms of value.

One afternoon in one of the Huntington's succulent greenhouses I turned a pile of rat tail's cactus (*Discoactus flagelliformis*) stems about one meter long into a much larger pile of shorter cuttings. In the course of an hour I quintupled the number of cacti laid out before me. The only difficult part of the task was remembering to keep the new cuttings all facing the correct direction – new roots would only sprout from one end and growth would only occur in the other, so if I accidentally reversed them, they would die. The curator overseeing my small operation corrected me when I made this error. Unlike him, I was unable to easily discern up from down just by looking at the plants, and for several days after I worried whether I had accidentally switched any others around, subjecting them to a slow, upside down death by desiccation. As I became more confident in my cactus cutting, I became aware that the care I extended to the plant(s) seemed to decline as the pile of new cactus cuttings grew; what started out as careful surgery soon felt like repetitive and mechanistic chopping. Another day I was tasked with propagating a particular aloe hybrid named 'Wiley Coyote' (Figure 2). To my untrained eye, the process of splicing the plants under sterilized conditions was not only awkward and tedious, but ambiguous. I thought it would be clear when one aloe should become two or three. My lack of skill spelt uncertainty – should this explant become two or three clones? I was clumsy with the

scalpel and other tools, preoccupied with maintaining a sanitized laboratory space. Eventually I developed a rhythm in splicing the plants. In a matter of weeks the process would begin again. One to three, and so on, until there are hundreds of new aloes, all the clonal progeny of a single plant.

There are other clever techniques cactus collectors and conservators use for speeding up the propagation of cacti. One brutish method is to simply cut a large hole into the top of a cactus—in response to this injury, many types of cacti will respond by offsetting, or creating a slew of tiny new propagules, or pups, at the site of injury. I once watched an expert grower demonstrate this technique during a meeting of the Sheffield branch of the British Cactus and Succulent Society, an association I had joined in the course of my fieldwork. He took a pen knife, jabbed it into the center of a round cactus, gouged out the top, and said that's all it took, in a matter of months there would be half a dozen new cacti growing out from the top of the mother plant. These, like the progeny of tissue culture, would be clones. Deciding when a plant is no longer one but multiple starts to feel more slippery or uncertain at this juncture. What counts as an individual in the world of plants? To most growers, the only distinction between having one and many is the moment of excision of the pups from the mother plant into its own pot, its own kind of artifice of boundary-making in the vegetal worlds curated by collectors. It isn't a terribly profound question to consider whether to count a plant cut in half as one or two, but it does gesture towards the unsettling of clear distinctions between efforts to save species and vegetal commodification, and whom or what is engaged in species care work.

Despite the uneven dynamics of choice, agency, and power embedded in these acts of multispecies work, at the ISI the clonal cultivation of plants is a relational endeavor of sustaining plant life through variously inducing or encouraging plant reproduction and growth into desired forms. The use of tissue culture, alongside a variety of other reproductive tools and techniques the staff at the botanical garden utilize in the pursuit of species care, highlights an important and under-theorized facet of the work of plants in the commodification of life – the indeterminacy of plant cellular life and their diverse reproductive capabilities, especially when coaxed and activated by human-technical activity. In comparison to plants, animal reproduction appears remarkably limited – taking cuttings, pupping, selfing, tissue culture, and grafting, in addition to sexual reproduction between individual plants – all are means by which plant life (sometimes under human care, sometimes not) is sustained and expands (on the political ecologies of grafting see Fleming 2017). While the technologies themselves may remain more or less consistent in these pursuits, the cloning and propagation activities conducted in the laboratory value plants in remarkably different ways. At times the succulents being worked on in the lab are recipients of conservation care, a practice aimed at fostering and sustaining genetically diverse life through the suspended ex-situ preservation of individual plants. At other times, however, these activities of preservation and growth seem to actually diminish the vitality and valuing of plants as individual beings through processes rendering them as lively commodities. Vegetal standardization, mass replication, and the reduction of species diversity places emphasis on the valuing of plants as species types, or as *representatives* of endangered species rather than as individual plants. In the ISI lab, species care work thus conceived retains both a biopolitical shape fostering certain plant lives, while at the same time it reshapes others – often of the same species – into lively commodities through activities of purification and standardization. Within the same laboratory space this tension in how plant life is both valued and replicated is not only

maintained, but linked together through the shared and distinct desires of conservationists and collectors and the technological capabilities to make plants work. This tension between practices of conservation and commodification speaks to the 'troubled ecology' of species care work. Practices of cutting, propagating, grafting, and cloning, all practices intended to sustain and foster endangered or rare plant life, also lessen how conservationists value these same plants as individual subjects by literally working them into living objects in the name of species care.

Tissue culture and affiliated technologies not only accelerate the embodied capacities of succulent plants to reproduce, but also further their commodification through streamlining them as (seemingly) homogenous entities for mass market consumption. Tissue culture opens up additional means towards international commodification and trade that can be hindered by more traditional methods of vegetal reproduction. Where once the ISI was a truly international program, today only tissue culture plant materials are shipped internationally (to one commercial lab in Europe); full size plants are restricted to sales within the United States due to the complications and costs associated with complying with international species trade regulations under CITES, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (Interview, January 28, 2019). Because tissue culture successfully serves as 'proof' that a plant was artificially propagated (and thus, cannot be confused with a plant of possible wild origin or wild origin seed), tissue culture side-steps many of the complex regulations and certification requirements for selling and shipping plants internationally demanded by CITES. As laboratory grown plants, they are recognized as unambiguously artificial in origin and not of concern to the conservation of the species.

Not all succulents are suitable for tissue culture, however, which affects the speed with which mature plants can enter the marketplace. At the Huntington they focus more on agaves, aloes and other succulents compared to members of the cactus family, which reproduce less well under tissue culture. While certain types of plants are amenable to tissue culture due to their own evolutionary adaptations, others, such as cacti with their spines, areoles, wool, and rough microtopographies where bacteria or fungi live on plant bodies, are not. As the curator spoke, I scribbled in my notebook, "cactus resistance to commodification?", self-conscious of my overt adoption of agential language to describe how the biological and material existence of particular organisms shapes the possibilities for their transformation into commodified form. This perspective finds resonance with Youatt (2008: 394-395) who writes:

> Because nonhumans constitutionally (rather than intentionally) refuse to internalise the meanings of human language, they are able to resist becoming self-regulating subjects to a significant extent, relying instead on their own semiotic interpretations of the environment and acting accordingly: for example, through migrating, reproducing, consuming resources and filling ecological niches in unexpected ways biotic nonhumans are constantly challenging the normalising will of biopower.

As a constitutional refusal then, many cactus species resist vegetal commodification via tissue culture, while remaining amenable to other accelerated reproductive techniques such as grafting.

The practice of tissue culture both distances plants as matters of concern in relation to the species as a still evolving, genetically diverse grouping of plants, while simultaneously facilitating their transformation into carefully manipulated commodity-forms. Just as in other industries, here we see how practices of standardization and mass-replication through tissue culture accelerate plant

commodification by smoothing out the frictions erupting from biological heterogeneity within global supply chains. But let us consider this possibility of vegetal 'resistance to commodification' more seriously, as there are ways in which plants in the ISI lab *do* unsettle and trouble these clonal practices through specific responses to their environment and condition. Following Youatt's (2008) notion of constitutional refusal, I interpret ruptures in the smooth operating of tissue culture as plant resistance to efforts of total objectification. One site of resisting the reproductive work that enables their commodification is through phenotypic plasticity. Despite the promises of tissue culture as a means of indefinite and standardized vegetal reproduction, through the interplay of genetics and clonal techniques, 'errors' invariably emerge in the tissue culture laboratory, as small, random gene mutations occur in the proliferation of species, creating new phenotypic expressions:

> So, it happens, in tissue culture occasionally, actually with surprising frequency, that what you get out ends up looking a little bit different than what you put in. Maintaining genetic stability is the goal, of course, but things happen … Variegation tends to be a frequent result, but the tissues are being abused and manipulated so much that may be a factor in stimulating mutation." (Interview with Desert Gardens and Collections Curator, January 02, 2019)

As a metaphor, these phenotypic expressions rupture the 'theoretical' possibility for indefinite replication of individual plants as expressions of a 'true' species form – more than organic machines, plants are not infinitely reproducible *entirely*, and treating plants as living machines would represent a form of "bio-mechanical reductionism" of their vegetal vitality (Beldo 2017: 115). But these ruptures also hold possibility for further commodification: sometimes the resulting somatic mutations produce desirable aesthetic effects, similar to the work of cross-breeding hybrids, and they can lead to exceptionally lucrative new (and patentable) plant varietals. Thus even when plants' metabolic labors might be seen to go awry or 'resist' their indefinite duplication, their induced self-reproduction can become yet another new site for speculative biocapitalist accumulation (Marx, 1990 [1976]: 283-284).[3] This exemplifies the tension between plants as both subjects made to work in the ISI lab, and their position as worked objects as plants are transformed into streamlined commodities for global circulation and consumption.

As demonstrated through the case of the ISI program at The Huntington, the act of replicating plants through modern clonal techniques entwines matters of more-than-human care, species epistemologies, plant conservation, and vegetal commodification through species care work. In the laboratory, the particular reproductive capacities of plants are put to work in order to satisfy human desire as a means of pursuing their protection. But they do not always 'work' as well as human technicians would like, and they are not, in practice, always the infinitely replicable 'organic machines' that theory suggests. In many ways, the ISI, as an intervention, is a stop-gap measure within a very troubled ecology, one in which human pleasure, emotional experience, and affective relations are gained and sought through caring for plants, but as a kind of care work

[3] For a valuable discussion of metabolic labor of nonhuman life, see Beldo (2017: 119): "There is no reason to suppose, however, that labor needs to be deliberate or consciously directed to count as labor. Metabolism is a process yoked by capital that creates surplus value. It should not matter if it is microbes or cellular structures that labor instead of subjects."

that can reverberate with negative repercussions for plants. The botanists and technicians at the Huntington are therefore responding to a very immediate and real threat to species survival in increasingly fragmented and damaged landscapes, destruction which, perversely, can at times aid in making certain plants all the more desirable to passionate collectors by increasing their rarity. But while these intentions of species care work are benevolent, and may help reduce pressure on wild plant populations, the practice also reproduces notions of purified and static species categories in the valuing and fostering of certain vegetal life at the exclusion of others. In the laboratory, species as epistemological sites of care move ethical concern away from plants as vital beings worthy of consideration as subjects, and work to transform them into objectified commodities through exertions of species care work. Attention to the reproductive workings of plants through tissue culture is therefore an effort of careful political ecology (Hinchliffe, 2008), bringing the empirical specificity of vegetal vitalities in the laboratory as corporeal sites of care work to the fore. The plants at the center of this care work unsettle notions of mechanistic practices rendering them into objects, revealing plant capacities for exceeding the binaries of 'working subject' and 'worked object' that foreclose possibilities for interspecies caring beyond the commodity-form.

Figures

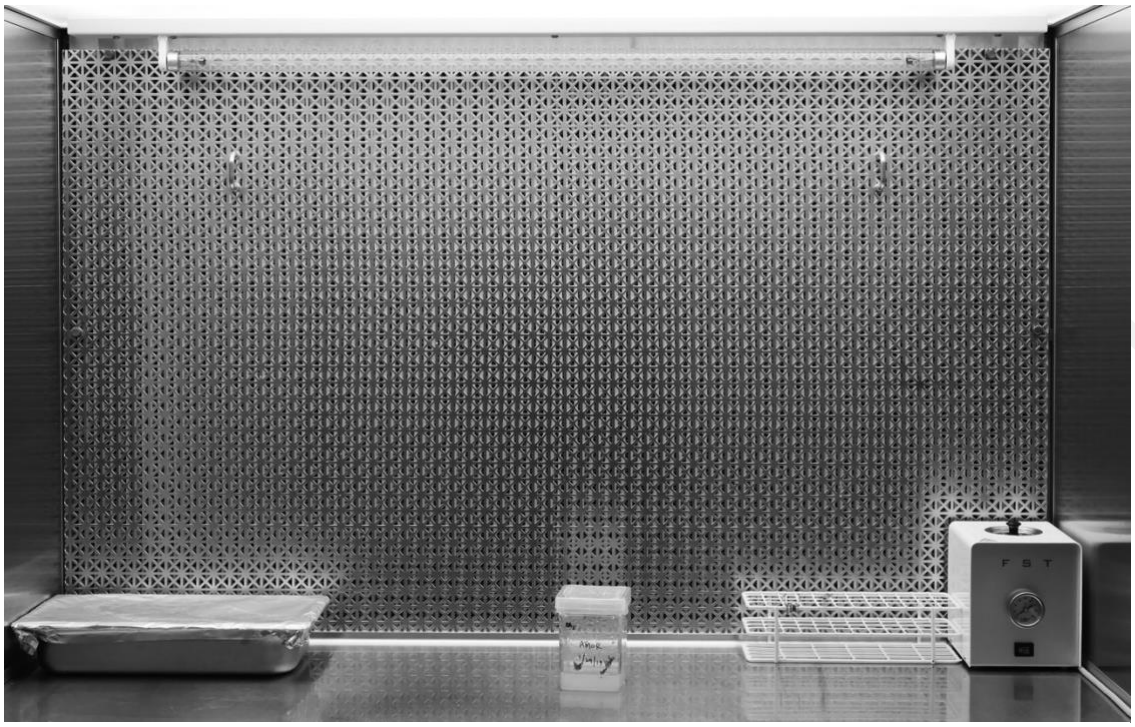

Figure 1. *Agave morani* tissue culture explants in sterile growth medium on laboratory bench prepared by the author. Photograph by the author.

Figure 2. Frame from motion picture film of aloe ‘Wiley Coyote’ micropropagation by the author.

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