The Rise of the Insect Industry
Sustainable Potential or Wasteful Accumulation

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Abstract In this paper I explore the relationship between insects, technoscience and sustainability culture made possible by recent developments in fabrication, micro-robotics, and design. I define the resulting scenario as "Insect Industry". This emerging agglomerate of practices and technological developments is comprised of practices and applications that promote, exploit and manipulate insects for their sustainable potentials. Among these practices is the flourishing of visionary micro-farming enclosures and experimental food-design, contributing to the urge to produce sustainable sources of food; the re-making of insects in micro-robotics; and the design of GM insects to help fight devastating diseases such as Dengue Fever. Although engaging with distinct fields of research and forms of creative entrepreneurship, these endeavors use very similar strategies and discursive patterns to promote innovation and sustainability, and the promise to fix the world. In illustrating a variety of examples in microrobotics, fabrication, and bioengineering, I ask: is this recent trend really marking the beginning of a new phase in sustainable innovation based on Humans/animals balanced coexistence or it rather constitutes another (maybe more acceptable or more palatable) form of exploitation of the non-human? Is this newly emerging "insect industry" obeying or rather contradicting the imperatives of economic growth and the principles of technological innovation supported by Western Culture?

Keywords: sustainable innovation; interspecies relation; anthropocentrism; biomimicry; solutionism.

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1. Introduction

In "Meeting the Universe Halfway", Karen Barad describes the brittlestar's remarkable nature as a "living, breathing, metamorphosing optical system" (Barad 2007, 370). The brittlestar has no brain, but behaves as if it had one; it has no eyes, yet its entire body is a constellation of tiny

eyes. This discovery has potentials to shake our traditional Cartesian constraints that prevent us from associating mind and performed entanglement of physical matter, and that force us to distinguish between intentionality and casual, unconscious agency. However, scientists preferred to interpret this phenomenon as "unusual" (Abraham 2001), and proceeded to describe this configuration using technological analogies and metaphors, a register that could reproduce the significance of this surprising discovery in a way that is easy-to-grasp and that could be unambiguously disseminated.

This example reveals the – inadvertent or voluntary – inability to think beyond preconceived ideas of the individual as self-contained (as opposed to the networked being manifested by the brittlestar's appearance and behavior), as unique (contrary to the brittlestar's multiplicity) and as sentient (contradicted by the brittlestar's apparent decision-making abilities even without the existence of a brain). How could it be otherwise possible to think of being (eyes) and doing (seeing) as one thing?

According to Barad, the excitement that followed the reporting of this story "has more to do with its potential applications than pure amazement at the ingenuity of this creature's bodily know-how" (Barad 2007, 373), as the brittlestar is compared to a digital camera that builds its vision pixel-by-pixel. Thus, it is not through a rethinking of the humanist episteme that scientists and observers have attempted to make sense of this bizarre creature, but through technological associations. On the one hand these technological analogies simplify and reify the complexity of the brittlestar and align it to traditional interpretations of the natural. On the other hand, they reveal an instrumental and anthropocentric approach that seems to be more devoted to the use of biomimetics to solve human questions (e.g., the construction of better optic devices and material design) than to the understanding of the new.

In other words, this line of thinking refuses to abandon the idea of human exceptionalism (Wolfe 2013), the position that human beings are the most important species in the planet, and the refusal to admit that the identity of the human species "is not unified or self-present, but thoroughly implicated in the phenomenology and ontology of other nonhuman species" (Chiew 2014, 54).

The insect industry is clearly a product of the resistance and the incapacity to think beyond human exceptionality. However, it does so indirectly, through the refusal to question (or the opportunist complacency with) the economic and technological systems upon which this human exceptionalism is based.

In the next pages, I zoom in on the specific nexus of sustainability culture and emerging technologies in the cooptation of insects. In particular, I propose examples based on a variety of technological innovations, whose analogous use of rhetoric and discursive approaches suggests that they be analyzed as part of the same trend. I define this trend "the insect industry".

Despite their different uses of technologies, these examples actively participate in the mechanisms of capitalist values of production and consumption, showing how the cooptation of insects in their endeavors hinders, rather than propose, any meaningful transformation to the current industrial/technological principles of growth. The very attachment of the insect industry to these principles – and its consequent reliance on technologies for its survival – proves to be a popular, yet momentous trend that might do nothing to solve the problems it has claimed to tackle. As ultimate result, despite its alleged forward-thinking, the insect industry is stuck with the good-old model of human exceptionalism.

2. Technology and the Living

The analogy between technology and the living brought us "a particular production of nature", as a condition of the "Postmodern World", whereby "Technological decontextualization is ordinary experience for hundreds of millions if not billions of human beings, as well as other organisms" (Haraway 1992, 297). In her Cyborg Manifesto, Haraway identifies this particular production in terms of "implosion of biologics and informatics", that is, as a way "of conceiving of us as communication systems, whether we are animate or inanimate, whether we are humans or animals... or machines of any kind" (Haraway 1989, 322). In a way, the description of the qualities of the brittlestar noted by Barad demonstrates this line of thinking, as scientists not only immediately compared the creature's eye-ness to tiny web cameras, but also appeared to be unable to tell the two items apart.

The non-human, the animal have been sources of inspiration and the subjects of imitation stemming from the acknowledgment of their abilities to run faster, to blend in and hide, to accomplish certain tasks in ways that humans deemed more "efficient". At the same time, they have been the subjects of (unintended or unrealized) exploitation. In fact, human aspiration to run faster, to fly, to see without being seen, to be more efficient have come with the assumption that these abilities could be one day turned to the service of mankind. Thus, non-human entities and animals were caught in a non-reciprocal relationship that located them, no matter what, on a lower scale.

Analogies and comparisons between mechanical objects and organisms, natural phenomena and engineering constructions have circulated at least since the XVI century, becoming widespread in the XVII century with the Scientific Revolution. As human faculties (e.g. the nervous system or human organs) were compared to the gears of clocks or the parts of mechanical instruments, so these very instruments drew inspiration from natural organisms and phenomena. For example, Leonardo da Vinci famously observed the flight of birds and examined the nature of air in order to build his flying machines, which culminated in the study *Codice*

sul Volo degli Uccelli (*Codex on the Flight of Birds*, 1505-06). Peter Galison reports how for Descartes, Galileo and Bacon, machines-objects analogies had important expository and explanatory roles, providing simple and compelling examples for dissemination among a wider public (Galison 1984). For instance, Descartes described the human nervous system as an engineering apparatus consisting of "water pipes" upon observing the mechanisms that animated the statues and the skilfully engineered fountains located in the royal gardens of Saint-Germain.

The recent rise of animal rights and countless studies in environmental science have suggested that the human and the non-human stand in a symbiotic relationship rather than in a subordinate one. The ontological turn in anthropology started to shift focus from "how humans and their worlds are portrayed" to "how they are thought to be"(Kirksey et al. 2014, 3), partially transforming the way in which we speak about, we relate to, and we use animals and natural resources. Ethnographers for instance no longer only explore human actors, but also interspecies relations, or how "the human has been formed and transformed amid encounters with multiple species of plants, animals, fungi, microbes" (Kirksey et al. 2014, 5).

Historically, insects have inspired the arts and the industrial sector, they have functioned as blueprints of behavioral, technological, and social models (as in the areas of biomimetics and biomimicry), and have been used as metaphors of class and social power, self, and the other (Siganos 1985; Hollingsworth 2005; Magnet 2013).

However, my interest lies in a more specific set of relationalities (or "intensities", to reference Parikka 2010) emerging from their material intersections with technoscience and its inherent discourses. Specifically, I wish to complicate the emphasis that recent texts in Media Studies and Animal Studies have placed on the mutual exchanges (unconscious and instrumental) occurring during human-animal encounters and between animals and technoscience (Haraway 2008; Parikka 2010; Wolfe 2013).

For instance, Donna Haraway conceptualizes the threads interfacing humans with animals (and insects) as a "becoming with," that is, as a "tapestry of shared being/becoming among critters (including humans)" (Haraway 2009, 118). This tapestry includes "unequal and ontologically multiple instrumental relationships", where different "responders are themselves co-constituted" (Haraway 2009, 116).

Cary Wolfe uses this notion to rethink the Posthuman as not being about the way in which "the human is transformed and eclipsed by various technological, informatics, and engineering developments rooted in the early Twentieth Century"(Wolfe, in Serres 2007), but about the processes unfolding through these uneven relations. This relational move, Parikka notes (2010), manifests at the material level as the capacities of human and animal bodies can no longer be detached from considerations of their technological framings. Thus, at least in some contexts, we can see a turn towards considering the non-human insect worth of our partial

respect, yet not before being properly anthropomorphised or made more human.

Although for these authors issues of conservation and sustainability in industrial societies are certainly important in modulating the intersections between the human, insects (or animal), and technologies, they only constitute two of the many aspects converging into such intersections. For Parikka, today's intensification of technoscientific research and innovations centered on insects is the product of a complex entanglement of technology "with a variety of animal bodies and nature" whereby insects have made the "cyborg as imagined since the 1980s in theory and fiction seem quite old-fashioned" (Parikka 2013, 108). However, he admits briefly, in this scenario the human is far from being taken off the picture.

The most recent wave of projects focusing on the intersection of insects and technologies tends to prioritize a new type of instrumental anthropocentrism that aggressively pursues insects through manipulation and re-fabrication in the name of a discourse – sustainability – presented as the pursue of the harmonious coexistence between, and balance of, humans and non-humans, yet still profoundly focused on the human. In fact, in many cases, insects are neither mere conceptual inspirations and technical models, nor organisms explicitly at the service of human goals (like in bee keeping or silkworm husbandry), but entities that have become physically built into these very technologies. In other words, insects become not only the subjects legitimating technologies, but also the entities that technologies will substitute, modify or keep alive in order to guarantee humans' economical wealth and everyday survival. This interpretation frames insects as both in symbiosis with, as well as subjected to technologies, an ambiguous relation reminiscent of the relation between sustainability culture and the capitalist system of values hosting it.

3. Exceptionalism and the Sustainable Paradigm

I ascribe the recent technological and entrepreneurial undertakings forming the insect industry to the dual conception of sustainability culture, which is often described as a "contradictory nexus of relations between production, ideology, state and society" (Parr 2009; see also Goodbun 2010). In fact, today's technological paradigms and the economic obligations of late capitalism play a substantial role in shaping (and clashing with) the sustainable content that these new practices claim to support. For instance, their commitment to ethics of conservation and waste reduction are challenged by practices supporting consumerism and accumulation (Harvey 2005; Sullivan 2013). Although the rhetoric and enthusiasm of these practices praise the potential environmental benefits of new technologies and industrial applications, these benefits are always tied to principles of ceaseless growth and obsolescence (Slade 2007; Burnett et al. 2009).

While applications merging insects and technology seem to acknowledge the coexistence and mutual dependence of insects (as animal/other), technologies, and the human, their mandate and goals are skewed towards the sole improvement of the human species. In other words, although the rhetoric that propels the insect industry seems to agree with recent Posthuman concerns regarding the role and the value of the non-human other for human existence, prompting a call to act quickly in order to preserve the world as we know it, its doing tells another story. In fact, these post-human concerns are generally contradicted by the prioritization of human needs at the expenses of ecological balance. Furthermore, the ambiguous interpretation of the word "sustainable" and "sustainability" appears to legitimize unchecked growth and surplus production, as well as maximization of financial gains.

In the first case, the idea of preservation and the call to responsibility that often characterize the industries and research facilities involved in insect fabrication, breeding and modification, is principally opportunist, preoccupied, to various degrees, and expressed in more or less blunt words, to reach the good of human species, rather than to attain a balance for the entire ecosystems. For instance, the fabrication of robotic insects as substitutes for the biological ones is primarily conceived as a solution to the possible disappearance of crops and goods vital to human healthy living. Normally, these endeavours make no provisions regarding the overall impact that the substitution of a biological insect for a robotic one will have on the entire ecosystem. Similarly, entomophagy advocates a transformation in the individuals' food habits to adopt the consumption of insects as a low impact alternative to resource-draining meat products. However, this transformation is sold to the individual through well-designed food and designer's insect farm enclosures promising keen consumers to breed their own insects in a "sanitized", "leakage-free" and "contact-free" environment. These invitations come with no warning about the danger of overproduction and no advise about how to dispose of insect waste, thus perpetuating the idea that not only insects are creatures that bear no function other than being at human's service, but that become acceptable and acquire value only when incorporated into design or technologies.

In the second case, the buzz world "sustainability" – uttered at any occasion in press releases and in advertising of insect-related technologies – is a debated term subject to very different interpretations. Sustainability pertains to the condition and the assessment of what is or can – potentially or realistically – be obtained through the modulation of the interrelations between human beings, nature and technological objects (McManus 1996; Robbins 2004).

While being widely discussed in the context of environmental politics, the notion of sustainability extends to the areas of economics, finance, and labor studies, often fitting existing or ideal belief systems. The multiplicity of applications of this term has turned it into a contested notion: in

fact, the meaning of what is "sustainable" is modulated differently according to competing discourses that prioritize either the environmental development of sustainability or sustainable development (McManus 1996, 49). The term "sustainability" seems to be arbitrarily attached, on the one hand, to words such as ecology or conservation; on the other hand, it is associated to growth or innovation.

It is by using development and growth as synonyms, McManus observes, that the notion often bypasses the wasting habits of ceaseless production and accumulation in the name of a "controlled use of material resources and better distributed costs and benefits in a more equitable manner than had previously occurred" (McManus 1996, 53). In turn, its use is justified in the context of a particular *apolitical* notion of ecology that claims, according to Robbins, that "ecological problems and crises throughout the world are the result of inadequate adoption and implementation of "modern" economic techniques of management, exploitation, and conservation" (Robbins 2004, 9). This way of thinking is driven by the belief that "economic growth (sometimes termed 'development') can occur alongside environmental conservation" (Robbins 2004, 10).

The ambiguous interpretation of the notion of sustainability makes the establishment of universal criteria for its understanding and application impossible: the term is then used to estimate and condemn various degrees of imbalance-causing activities such as the unregulated consumption and depletion of natural local resources or the overproduction of waste from particular activities (Sullivan 2013). Conversely, sustainability is used to estimate and praise the economic or labour benefits deriving from these very same activities. The resulting rationalization of human and non-human natures comes to "conform to an economic system that privileges price over other values, and profit-oriented market exchanges over the distributive and sustainable logics of other economic systems" (Sullivan 2013, 200).

This interpretation brings to a third aspect that qualifies the insect industry as a product of human exceptionalism rather than an attempt to re-think its main tenets: the development of insect-related products and design seems to be tied to ambivalent motivations. Behind its noble commitment to sustainability, it appears to use insects as a way to draw attention to, and magnify the reactions of awe and enthusiasm regarding the latest emerging technologies and scientific innovations, thus effectively mitigating or even silencing any concern or unwelcome criticism these technologies raise.

Quoting white papers and scientific data of reputable world organizations advocating the human consumption of insects (van Huis et al. 2013); condemning the imminent extinction of bees (Greenpeace 2015), or showing statistics about the mortality rates due to mosquito-born diseases (Brady et al. 2012), the insect industry has found an audience willing to listen. Enticed by their drive towards innovation and their sleek and ingenious design, these audiences are easily lured to buy into a classic

technological trap: the fact that technologies will fix the world. What the audiences are willing to forgive is the fact that these new products may be new, but do perpetuate the same economic imperatives that stand at the basis of Western Late Capitalist systems, namely, the idea that "Capitalism grows through investment and innovation in commodity production accompanied by necessary expansions of populations of producer-consumers" (Sullivan 2013).

A number of scholars have associated this type of rhetoric to the rather essentialist notions of "greenwashing" or "ecobranding", that is, how large multi-national corporations have assumed the appearance of a "green" ethos to further their corporate aims (Parr 2009). These terms are used to denounce false claims of sustainability promoted by corporations, multinationals and governments. However, I would like to propose a more nuanced interpretation. It appears that the insect industry is often driven by a genuine desire to improve dramatic situations. Where it falters, however, is in its belief in what Evgeny Morozov (2013) calls "solutionism", that is, to think that it is only by inventing increasingly advanced techniques and technologies that we might be able to solve the impending problems threatening our bees, our environment and our health. According to Morozov, solutionism is "An unhealthy preoccupation with sexy, monumental and narrow-minded solutions [...] to problems that are extremely complex, fluid and contentious [...]. Solutionism presumes rather than investigates the problem it is trying to solve, reaching for the answer before the questions have been fully asked" (Morozov 2014).

Thus, I want to desist from using the above terms as they often convey a degree of intentionality that not only does not describe accurately the nature of the insect industry, but also dismisses the nuanced relations between insects, technologies and sustainability culture.

4. Sustainable Ideas, Consumerist Desires: Entomophagy and Visionary Design

On April 2013, The Food and Agriculture Organization (FAO) issued a report documenting the detrimental consequences of the decrease of forest resources and the disappearance of farmland due to excessive cattle breeding. "Land is scarce and expanding the area devoted to farming is rarely a viable or sustainable option. Oceans are overfished and climate change and related water shortages could have profound implications for food production"(van Huis et al. 2013), the report announces. "To meet the food and nutrition challenges of today and tomorrow," it continues, "what we eat and how we produce it needs to be re-evaluated. Inefficiencies need to be rectified and food waste reduced. We need to find new ways of growing food" (van Huis et al. 2013, 14). A viable solution, ac-

cording to the author, is to embrace entomophagy (the consumption of insects) as a sustainable alternative to meat (van Huis 2013).

Although it has been a common practice in a number of countries in Africa, Asia, and the Americas, entomophagy was never assimilated by Western culture. On the contrary, it was rejected as a primitive and unpalatable culinary option: as insects "seem doubly other – other than humans and other than the animals that we eat as well" (Loo and Sellbach 2013, 13), they are also associated with colonial assumptions of primitivism and "un-civilized" behavior (Mullin 1999).

Early efforts sought to encourage the consumption of insects by promoting their nutritional properties such as their protein-rich content. As early as in the Nineteenth Century, Vincent Holt encouraged the consumption of insects by classifying them on a scale of palatability that distinguished between vegetarian insects (edible) and non-vegetarian insects (non-edible)(Holt 1992). However, these arguments didn't seem to be convincing enough, as general culturally-induced disgust and fears of literally becoming "what we eat" or, as Loo and Sellbach suggest, to become "what we eat *eats*" (Loo and Sellbach 2013, 15), continued to prevent the adoption of entomophagy.

Interestingly, the FAO report appeared to trigger a partial inversion of this trend, by shifting the issue from being just a choice dictated by taste and culture, to being a responsible decision in the name of sustainability; and by using scientific and technological innovation as means that would enable this transformation to happen. In fact, since its very beginning, the FAO report insists: "Insects offer a significant opportunity to merge traditional knowledge and modern science in both developed and developing countries" (van Huis et al. 2013, 25).

By mentioning the role of science as a key protagonist in the quest for a sustainable future, the report solicited a number of creative responses from sectors such as the culinary sciences, food design and packaging, industrial design and the DIY community. Generally, innovative design was identified as the key to achieve sustainability, as it could be used to successfully make insect consumption suitable to the Western palate. This strategy emerged in two distinct yet correlated sectors: food design and industrial design.

Food design start-up ENTO Box Ltd. (UK) aspires to introduce insects into the Western diet gradually, by presenting them in the form of aesthetically pleasant treats that *de facto* conceal the familiar shape of the insect while drawing attention on the clever and attractive design of its composition and package (ENTO Official website, n.d.). The company, whose name originates from an abbreviation of the word entomophagy and the popular Japanese lunch box going by the name of "bento", produces bite size, perfectly shaped and tastefully colourful pieces delicately arranged in an Asian-style tray. On their promotional webpage, ENTO claims to "overcome people's preconceptions and create a world where edible insect foods are an enjoyable, everyday reality". They continue:

"We do this because we love great food, designing exciting new experiences, and well, the world we live in" (ENTO Official website, n.d.).

By selling their products as innovative and exciting, and by cleverly concealing their main ingredient, not only is ENTO Ltd. bypassing the sense of disgust that often deters the potential customers from trying entomophagy, but is also tickling their curiosity, effectively turning the food into a novelty. ENTO's promotional videos cite data provided by the FAO report as well as studies highlighting the detrimental impact of cattle breeding on the environment and on farmland. By doing so, the company effectively markets its products to a crowd eager to contribute to making the world more sustainable, without however missing out on taste and without participating in any activity that would imply sacrifices or engaged action. Thus, the project of sustainability becomes secondary to food experience and enjoyment, as the customer is motivated by the consumerist desire to try a new product, rather than by awareness and by a wish to make a real contribution to the environment and to sustainability.

Following similar conceptual and promotional patterns, a number of DIY and high-end industrial design projects rose to popularity right after the FAO report was released. Among them, Katharina Unger's "Farm 432" (Unger, n.d.), Jakub Dzamba's crickets "Circle Chirp" bioreactor (Dzamba 2015a), and Mansour Ourasanah's "Lepsis" (Ourasanah 2012; Boyer 2015) employ ingenious industrial design to introduce entomophagy into the common household. Manifesting ethos and rhetoric comparable to the rising digital fabrication industry (Moilanen and Vadén 2013), these endeavors vow the dissemination of products that enable raising insects at home for personal consumption, that is, independently from the industrial intermediaries existing on the market.

The three designers propose that each household acquires an insect bioreactor, a vessel consisting of compartments which can be detached and separated, in order to ensure the development of each stage of the lifecycle of different insects (soldier flies, crickets, grasshoppers) from egg, to larvae, to pupae, to full grown adulthood. This method also facilitates the collection of the adult insect for human consumption while leaving behind its eggs, which will then hatch and continue a potentially never ending reproduction process. In all cases, each vessel is designed to assure a safe and sanitary environment for both insects and humans, requiring minimal management and space. According to these designers, the insect bioreactor is like an innovative kitchen appliance (like a yogurt incubator or a bread maker): having such vessel readily available at home would guarantee the owner autonomy, as he/she would be able to enjoy a continuous source of protein-rich food, while effortlessly contributing to sustainable culture.

Katarina Unger for instance suggests that owning an insect bioreactor (Figure 1) serves two functions: it "creates not only a more sustainable future of food production, but suggests new lifestyles and food cultures", enabling "people to turn against the dysfunctional system of current meat

production by growing their own protein source at home" (Unger, n.d.). Her idea for a black soldier fly bioreactor, she explains, originated from concerns regarding the overpopulation of our planet. Using FAO and similar reports, Unger points out that at this pace, by 2050, production of meat will have to increase by 50%, a goal that can't be reached as we will soon run out of crop fields dedicated to feeding meat-producing animals (van Huis et al. 2013).

Fig. 1 – Katharina Unger, *FARM 432 Insect Breeding*, bioreactor prototype.

Motivated by analogous concerns, architect Jakub Dzamba created a cricket domestic bioreactor (Figure 2) as part of a project for the future of farming in the third millennium, which he imagines will take place at home, thanks to easy-to-install cricket reactors made of re-cycled material. Cricket reactors, Dzamba claims, "are domestic modules, meant for household and office space, designed to house a population of 10,000 crickets, utilize local household biowaste, such as kitchen compost and yard waste as feed, and produce a regular supply of food-grade crickets"(Dzamba 2015a). As in the tradition of DIY makers and fabricators, he sells relatively cheap kits that the user can assemble at home. In this way, he hopes to fulfil his vision of "Third Millennium Farming".

Fig. 2 – Jakub Dzamba, *Household Cricket Reactor*, video still from http://thirdmillenniumfarming.com/-

Finally, Mansour Ourasanah proposes an elegantly designed grasshopper bioreactor (Figure 3) that can be adopted to avoid the environmental destruction and the potential scarcity of food that will likely occur in a few decades, should world consumption of meat and food waste increase at the current pace. For the US-based, Togo born designer, adopting entomophagy is neither a matter of taste, nor simply a choice, but an act of responsibility toward the environment and the product of an increasing awareness about what we eat, especially in the West.

It is easy to praise the commitment to ethics of conservation and waste reduction of the above three examples, as they emphasize the contribution that single users could make in creating a sustainable, zero-footprint and autonomous cycle of continuous production and consumption. Their focus on modifying our food consumption's habits by drawing attention to taste, positive futuristic scenarios, and visionary and clever design is, indeed, a persuasive strategy that works, especially in a society, like ours, unwilling to renounce comfort and privilege to embrace a more balanced, yet less satisfying lifestyle. After all, the bleak future predicted by the FAO report is a hypothesis that a limited number of people is willing, or prepared, to believe and to accept.

However, by adopting said strategies, these designers fail to address directly the transformative changes they seem to be hoping to obtain in their advertisements and promotional messages. In fact, their messages are mostly product-oriented, focusing on the contribution of the single individual, rather than the community; they exalt the design of the food over the food itself; and prioritize the ownership of the object-bioreactor

over the potential value of the insects – the latter being left in the background, only portrayed as the content of the bioreactor, rather than the main subject of interest. In other words, their messages appeals to the potential user as consumer, rather than as a person with responsibility, luring her/him with a product that can be purchased or built, rather than trying to foster her/his motivation and commitment.

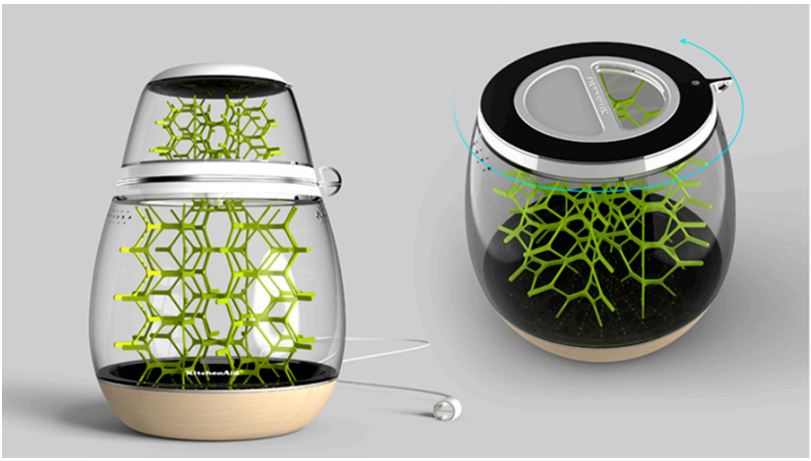

Fig. 3 – Mansour Ourasanah, Lepsis, *Insect Breeder*, from http://inhabitat-.com/mansour-ourasanah-designs-a-vessel-for-farming-edible-insects-at-home/lepsis-1/?extend=1.

Second, insects are used to draw attention on, and to enhance the quality and the beauty of design and sustainability as innovation, and as objects that can only achieve the status of food thanks to design. The way that the insects are subordinated to design relegates them to being a curiosity, not a primary interest. For instance, in describing her project, Unger observes how her bioreactor, "enables people to turn against the dysfunctional system of current meat production", but never mentions that a transformation would be only triggered through a shift in our eating habits. Furthermore, the designers collective behind ENTO emphasize the beauty and style of their well-packaged products, a way, they admit, to hide the insect content in an attempt to make it more palatable to the Westerner's sense of taste and expectations.

In addition, no thought is given to the overproduction that the adoption of these bioreactors would cause, nor the multiplication of consumer products, despite the genuine commitment to the environment and sustainability incorporated into their messages. For instance, Dzamba appears to think of the entomophagy revolution as a *fait accompli*: his pro-

motional website (Dzamba 2015b) pays special attention to reporting about the productivity of his bioreactor as opposed to the waste of land and resources produced by traditional meat (poultry, beef and pork), thus partially dismissing the uses of crickets in food.

In his video, Ourasanah describes the difficulty of Western culture to modify its lifestyle (Ourasanah 2012). Abundance and overproduction leads to the assumption that selecting what to eat is a choice, and not a necessity. In this scenario, transforming people's eating habits becomes a challenge if it is presented as a matter of commitment or as a decision implying some form of sacrifice. The examples described so far respond to this apparent impasse by using design as an incentive: the individual will accept the new habit because of its design, or because of the gadgets accompanying it. In some way, the use of design to lure the individual-as-consumer is a sign of resignation, deriving from the notion that no commitment to environmental causes and lifestyle changes can succeed, unless it is associated to practices that reproduce the models of consumerism and accumulation grounding our culture.

Thus, although one should acknowledge and even praise the enthusiasm for the potential environmental benefits of these ideas and the new technologies and industrial applications that the above projects generate, these benefits are always tied to principles of ceaseless growth, constant reliance on innovation and the production of increasingly new design, as well as obsolescence, as newer design models would probably be released as "improvements" in the future to supplant the original bioreactors.

The applications merging insects and technology acknowledge the coexistence and mutual dependence of insects (as animal/other), technologies, and the human. However the very focus on individual choice and on lifestyle clearly demonstrates how their mandate and goals not only are focused on the sole improvement of the human species, but they also tend to prioritize – for necessity or for choice – the technology and the innovative product over the insect that has inspired it.

5. The Quest for the Ultimate Solution

5.1. Disappearing Bees

On May 2013, in the wake of recent concerns regarding the widely documented decimation of bees, a press release from Harvard's School of Engineering introduced Robobees, a Micro Air Vehicles Project "inspired by biology" (Harvard School of Engineering and Applied Science, n.d.; Ma et al. 2013), consisting of a family of robotic insects which could be equipped, one day, with the ability to pollinate. According to the lab's press release, these state-of-the-art objects of micro-robotics could re-establish the ruptured ecological equilibrium left by the scientifically cor-

roborated and well-documented extinction of their biological relatives (Steffan-Dewenter et al. 2005; Wood 2009; Piore 2013).

The lab released a series of demo videos (Harvard University 2013), which were widely distributed online, and attracted the attention of the press, prompting questions of "whether particular forms of artificiality [...] were appropriate replacements for equivalent phenomena we have designated as natural" (Margolin 2002, 17); and whether the solution to the extinction of the bees could be found in the implementation of new technologies, or rather in the intensification of the battle for their preservation.

The issue has gathered both enthusiastic adopters, who regarded this technology as the new frontier in micro-robotics, and challengers, who questioned its ethics, accusing the Harvard's School of Engineering of opportunistically using an urgent environmental concern to obtain more media visibility and sympathy from the public; to conceal the real purposes lying behind such research, namely, the development of micro-robotics machines for military and surveillance purposes; and to advance a discourse encouraging the replacement of the natural and organic with the artificial and machinic.

Among the challengers, Greenpeace pointed the finger at the website of the Robobees project in its "Save the Bees" campaign, warning against the reliance on technologies to solve this environmental crisis and asking the question: "should we create a new world or save our own?" (Greenpeace 2015).

To raise awareness about the contentions that this project had prompted, in May 2014, a group of performers marched into the Micro-Robotic Lab at Harvard University. Reverend Billy, a performer known for his anti-corporate stunts as a pseudo-televangelist, led the group composed by the Church of Stop Shopping and Ethiopian-American activist Theodros Tamirat. Together, they had recently released an album voicing environmental concerns titled "Earthalujah" (Reverend Billy 2013). The group carried fruits and vegetables – all items available to human beings thanks to the labor of pollinators –which they offered to the Robobees, by laying the produce in front of a showcase where they were being displayed, chanting "These bees that are dying: we are asking you to place your genius, your research, your scientific know-how to save the honey bees" (Reverend Billy vs Robobees 2014).

Upon hearing the performers exhorting the scientists to redirect their research on saving the bees rather than replacing them, one of the scientists interviewed, candidly admitted that the purpose of the research had not at all emerged from a desire to replace the precious insects: "The story is that people are making small robots. That's an interesting technology that normally has lots and lots of uses. But now you want to sell that story, you want to get funding, you want to get coverage, so you have to tell a story. Hey! We are going to call them bees. Bees is a good story, but then if you call them only bees then Fox News gets upset, because you are

wasting money on bees, so you call them 'robot bees'" (Reverend Billy vs Robobees 2014).

Whether we examine the Robobees project from the perspective of the enthusiasts or the challengers, two aspects immediately emerge: first, the technology is both "producer and mediator of the bee as a specific scientific question" (Parikka 2013). In fact, the micro-robotics technology at the basis of Robobees is driven by the goal to imitate the bee (its flight, its size, its extraordinary ability to pollinate). In turn, it gains popularity thanks to the bee and its significance. In the case of the Robobees, the very relationship between technology and bees becomes the conjuncture around which technological and strategic decisions are made. What seems to stem from scientific data and public concerns about the alarming rates of decline of pollinators is conveniently coopted and used as a do-good motivation by the engineers at the Micro-Robotics Lab. In fact, by cleverly using the bees as its main subject, the lab temporary shifted the public attention away from some of the main sponsors of the project, namely the Navy, the Air Force and DARPA, whose goals are certainly more concerned with developing micro-surveillance devices for military uses, than with creating a new class of pollinators (Reverend Billy 2014).

It is micro-robotics and its promises that gain most traction, not the wellbeing of pollinators or the good of the environment. On the one hand, micro-robotics stands for innovation and improvement of human ingenuity, which is believed to enable us human beings to potentially master the functionality and complexity of nature. On the other hand, it constitutes a threat to nature. As we marvel at the shrinking in size of technologies and at their increasing precision at imitating nature, the extinction of the bee becomes of secondary importance. As Victor Margolin argues, the goal of technology in fact "is to improve upon nature to replace natural organisms and processes with artificial ones in order to increase overall social efficiency and profit" (Margolin 2002, 18).

According to Margolin, the reason behind this tendency is economical, that is "to spend more to produce economically valuable engineered species than to protect economically useless endangered ones" (Margolin 2002, 17). As the scientist interviewed after the Reverend Billy's action confirmed, building tiny robots and calling them Robobees guarantees more funding and visibility to the lab, than "merely" trying to protect the well-being of bees by using simpler and less sophisticated technologies and remedies.

Furthermore, bees are perceived as useful to the preservation of ecosystems and to human beings, since they make the production of most fruits and vegetables possible, by transporting pollen and seeds from place to place. While for Greenpeace and Reverend Billy bees are species to be revered and worth saving, for the scientists at the Micro Air Vehicles' lab they constitute an enough important species to be imitated. In all cases, there seems to be a shared interest in the ability of bees to pollinate, a quality crucial to the conservation of nature, which in turn is es-

sential to the human species.

This is an anthropocentric argument emerging even from the most well-meaning enterprises. In fact, the preservation of said quality, one may argue, can be pursued with or without bees, feeding in this way the urge to rely on technologies, rather than on other solutions. The preservation of the Earth, Margolin argues, "requires a profound shift in consciousness: a recovery of more ancient and traditional views that revere the profound connection of all beings in the web of life and a rethinking of the relation of both humanity and divinity to nature" (Margolin 2002, 19). However, this argument does not take into account the needs for human beings to survive our current economic climate, a system that advocates the use of technologies as a fix for personal gain, economic growth and material wealth, rather than for solutions that would strengthen the relationships between humans and the animal other (Fry 2008).

5.2. Proliferating Mosquitos

The conservation efforts of Greenpeace and the attempt at fabricating of the Micro Air Vehicles lab focused on saving and re-making a species destined to extinction. However, it is also worth considering how the opposite scenario – the attempt at exterminating an invasive species by means of innovative bioengineering techniques – manifests analogous rhetoric and rationales. Although using different technology and scientific knowledge, and addressing opposite issues, spread over extinction, the tendency to conform to the above joint economic/capitalist and anthropocentric principles can be also observed in the battle against mosquitoes.

Genetically Modified Organisms (or GMOs) are used in a variety of areas of research: bacteria are modified to produce insulin; transgenic seeds and plants are manipulated genetically for scientific research, to create new plants and crops; or for experimental medicine (e.g. gene therapy) (Newell 2003). However, they have been mostly criticized in regard to the production of food that went unregulated (or inadequately regulated) thanks to the complacency of the government and their relations with the biotech industry (Phillips and Isaac 1998). Public opinion regards the risks of GMO food on the human body as insufficiently studied, and deems the authorities unable to provide appropriate regulations that are both objective or reliable (Roff 2008).

Conversely, GMO plants (e.g. the Suntory blue rose) and animals (e.g. GFP Bunny, Glofish or transgenic mice for laboratory research purposes) have been welcomed somewhat differently. Whether produced for pleasure, entertainment or scholarly goals, these non-human creatures have elicited criticism and ethical questions, but they have never caused the same level of anxiety as GMO food. The worry caused by GMOs appears

to be directly proportional to their proximity to, and their ability to affect human personal liveliness and the human body: humans ingest food, and they are more likely to carry the future impact of GM produce on their physical health.

The case of GM mosquitoes as a solution to endemic diseases such as Dengue Fever or Malaria has been brought to public attention in a relatively recent article on the New Yorker which described the method developed by British biotechnology company Oxitec to modify the genetic structure of male *Aedes aegypti* mosquito, "essentially transforming it into a mutant capable of destroying its own species" (Specter 2012).

According to a number of studies, mosquito-borne diseases kill around 1 million people a year (most of them children) and affect more than 500 million people (Shah 2011). Currently, no effective cure has been found for Dengue Fever and Malaria, two diseases transmitted by mosquitos, and endemic in countries with tropical climate. With chemicals such as DDT becoming increasingly ineffective in destroying these insects, and climate change favoring their spread, finding new solutions has become an urgent problem. Most efforts have been dedicated to the extermination of these insects, arguing that their contribution to the ecology they inhabit is minimal.

The genetically engineered *Aedes Aegypti* mosquito, or OX513A, has already been used in successful trials in remote areas of Brazil, thanks to a collaboration between Moscamed, Oxitec (two biotech companies) and the University of São Paulo (Abumrad 2015). However, the steady spread of this species into the northern hemisphere and the increase of Dengue Fever cases in the South of the United States have convinced some local governments to initiate new trials and support from a portion of the population.

According to some sources, in 2009, Key West, Florida, suffered its first dengue outbreak in seventy-three years (Specter 2012). While there were fewer than thirty confirmed cases, as the population of the islands is limited, there was a main concern that this occurrence would damage its florid tourist industry.

The residents were faced with a dilemma: to rely on GM technologies to lower the mosquito population, or risk losing money and customers. Interestingly, the main concerns of the opponents to this trial were not about the existence of GM mosquitoes per se, but about the effects potentially caused if by any chance one of those GM mosquitoes accidentally bit a resident: would these mosquitoes affect the resident's DNA? The motivations behind choosing to welcome the trial and the types of concerns generated emphasize not only a reliance on technoscientific innovation as the only solution to a problem, but also its use to minimize commercial loss rather than human loss. In fact, as Michael S. Doyle, a resident of Key and an entomologist admits in an interview, "Part of our problem is the image of dengue. [...] A couple of hundred cases here could be devastating to the tourist economy" (Specter 2012).

I would also argue that using a state of the art innovative method to exterminate mosquitoes may be perceived more efficient and effective than traditional methods or non-technological solutions. In addition, the arguments in favor of the extermination of mosquitoes tend to be always skewed towards the conservation of humans and their economic well-being. No issues are raised about the contributions –if any—made by mosquitoes to the non-human ecology or the impact that their extermination would pose to said ecology. Given the bad reputation of mosquitoes, and the assumptions that this species only causes annoyances and damaging effects, the problem remain completely human focused.

5. Conclusion

The heterogeneous undertakings that constitute the insect industry appear to have enjoyed extensive media attention and popularity with the general public. However, despite their apparently well-meaning purposes and their admirable rhetoric, they do not appear to awaken any public responsibility towards the environmental challenges facing mankind in the next decades, or to generate a desire to contribute actively to leading a more sustainable and less wasteful existence. Rather, the insect industry appears to have benefited from both the subject (insects) and the technologies (state-of-the-art, innovative) they engage with.

In the examples I have described, designers, scientists and engineers successfully exploit the quality of insects as abject, yet enticing subjects, as creatures evoking "particular vicissitudes of our instincts formed early in childhood, which have acquired material properties of an external world of human and other than human forces" (Loo and Sellbach 2013, 20). In addition, they have accompanied this attention-grabbing subject with already popular emerging technologies. This move likely put them in a condition of advantage in regards to other designers and scientists working with similar technologies and innovative design, but engaging with less attention-grabbing and controversial subjects such as insects.

Thus, although the practices mentioned in this paper are apparently unrelated, since they engage with distinct fields of research and creative entrepreneurship, their emphasis on innovation and sustainability follows very similar discursive patterns and rhetorical strategies. As I mentioned early on, we should not dismiss these practices as yet another attempt at "greenwashing". In fact, in most cases, the choices to undertake insect-related projects originate from genuine concerns, or at least some awareness of the challenges posed by industrial overproduction, food waste and climate change.

Thus, the insect industry obeys and at the same time contradicts the imperatives of economic growth and the principles of technological innovation supported by Western culture. This tendency reveals a solutionist approach in its enthusiastic reliance in technologies, science, and design.

However, it also shows how considering alternative paths that go against this trust in technologies would be damaging to these designers and scientists' financial survival. Finally, as good intentions are trumped by pressing economic necessities, exceptionalism prevents us from seeing the relationships between humans and animal-others differently. As Sharon Kirsch notes "Man, like all other organized beings, is born, grows and perishes. But *Homo Sapiens* does not like to be "like". He can't imbibe it. So the thinkers of London and Paris encouraged Man [...] to mistake his proximity *to* other animals for dominion *over* them" (Kirsch 2008, 19).

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