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ORIGINAL PAPER

Animals and War: Anthropocentrism and Technoscience

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Abstract We are at the crux of a return of animals to the battlefield. Framed as an improvement over current limitations of biomimetic devices, couplings of microelectrical mechanical systems (MEMS) with insect bodies are currently being designed and created in laboratories, with funding from military agencies. Moving beyond the external attachment of computerized 'backpacks', MEMS are being implanted into larval stages to allow for living tissue to envelop otherwise fragile circuitry and electronics: the creation of bioelectronic interfaces. The weaponization of animals, with insect cyborgs as a first step—a foundation for the remaking of more complex species—is an anthropocentric solution to an anthropocentric problem. Speciesism is the normative context in which technoscientific discourse and such approaches to nanoscience and nanotechnology are situated. This is a network of actors and relationships within and across science and society. Animals are framed as mechanical devices that can be dis/enhanced for human ends. This paper engages with the remaking of species, the blurring of boundaries between mechanism and organism, and the implications of the effective disappearance of the animal as key sociotechnological challenges.

Keywords Animal-industrial complex · Anthropocentrism · Bioelectronics · Cyborgs · Speciesism · Technoscience

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> The use of animals in warfare is ugly enough without the further insult to their dignity involved in turning them into involuntary cyborgs
> James Meek [25]

Introduction

Building on Barbara Noske's identification of what she termed an animal-industrial complex—a set of economic, cultural and social relations and networks spanning agribusiness, governments and scientific bodies—this paper reflects on its intersection with the military-industrial complex. As Arianna Ferrari has noted with respect to apparent philosophical conundrums and the real exploitation of nonhuman animals, 'technologies are always embedded into a socio-economic context' ([12], p. 66). The pervasiveness of speciesism and prevalence of anthropocentrism are key assumptions embedded in technoscientific imaginings, research and use of other animals for military purposes.[1]

[1] The concept of speciesism was first coined by British psychologist Richard Ryder in 1970 and popularized by Peter Singer's [40] groundbreaking treatise Animal Liberation. As an ideology, speciesism is a socially constructed belief system. It enables human decisions and actions at the expense of members of other species and perpetuates anthropocentric assumptions about species superiority (i.e. speciesism functions in much the same way as racism).

The terminology 'other animals' is used throughout this paper to locate the values ascribed to nonhuman animals. Specifically, animals are constructed as other to enable the anthropocentric uses engaged with here, as well as more broadly.

In this paper, the notion of technoscience is used to refer to co-produced practices of science and technology as discourse. The sociopolitical context in which such discourse-practices are situated is located as central (if often nonconsidered) and performative. In this context, performative refers to technoscience as discourse (re)constituting the practices of technoscience itself.[2] In other words, discourse on science and technology (epistemologically and ontologically) reinforces, reinterprets and perpetuates specific understandings and knowledge production practices. More specifically, technologies (and technological discourse) developed for hybridization and the creation of cybernetic organisms—amalgams of the biological and (nano)technical—are foundational elements of the sociopolitical context this paper engages with. The focus is a resurgence in the use of other animals in war.

The notion of a military-industrial complex became popular after its use by former president Dwight D. Eisenhower during his January 17, 1961, farewell address, to refer to the increasingly pervasive relationships between politicians, armed forces and large corporate entities in the USA. Carl Boggs cites C. Wright Mills' *The Power Elite*, first published in 1956, as the 'most systematic and critical earlier recognition… [which] anticipated the dangers of U.S. militarism to a degree scarcely matched even in intellectual works written much later—at a time when the military-industrial complex was far more ensconced and menacing than when Mills was writing' ([3], p. xxii). Mills identified in the 'enlargement of all things military' and 'the increased traffic… between the military and the corporate realms… the great structural shift of modern American capitalism toward a permanent war economy' ([27], pp. 200, 215). Of note, in the afterward to the 'new edition' of *The Power Elite*, Alan Wolfe describes Mills' 'understanding of capitalism… as not radical enough' (ibid, p. 369).

Alongside Mills, Wolfe's writing was a product of his time—it could similarly be described as not radical enough. The dramatic rise in the use of pilotless drones and battlefield robotics—an evolution in approach to asymmetrical risk-free warfare—emerged shortly after publication in 2000. The events of 9/11, the dramatic increase in US military expenditure and militarism more broadly, the invasions of Iraq and Afghanistan, political costs of military (human) causalities, and a capitalization on increases in available funding for military and potentially military-related research—and associated military contracts—were all aspects of the context in which the 'robotics revolution' emerged. Peter W. Singer outlines the revolution as encompassing ground-based warbots designed for bomb disposal to pilotless drones for use in surveillance and targeted killing programmes. The impacts and influence these will and have had on warfare, and associated research into next generation robotics, are the cornerstone of the revolution. Of note for this paper, an unpublished chapter titled 'Man's Best Friend? The history and future of animals in warfare' (omitted from the published version) provides a brief insight into other animals as technoscientific developments[3]:

> Of all the strange changes happening in war in the 21st century, one of the most odd has to be the return of animals to the battlefield [41].

In what would appear to be formal, publicly visible, recognition of this shift, on April 1, 2014, the US Defense Advanced Research Projects Agency (DARPA)—a branch of the US Department of Defense (DoD)—publicly announced a new division, the 'Biological Technologies Office'. The aim of the office is to investigate how biological science could be further mobilized to inform and integrate research developments into military technologies. The press release opened with 'New technology office will merge biology, engineering, and computer science to harness the power of natural systems for national security'. The formal launch presented the biological sciences as the cornerstone of future military research:

> Starting today, biology takes its place among the core sciences that represent the future of defense technology [9].

Reference to 'today' as the commence date is of note. Other animals have been used in warfare for as long as humans have been waging war against each other (see [35]). Even more specifically, DARPA has sought and funded research proposals into the use of animal cyborgs—hybrid biological-mechanical systems—at least as far back as 2006.

David Nibert argues that (other) animal agriculture was a precursor to, and essential for, 'the amassing of military power' and associated 'large-scale violence and

[2] See Butler [6].

[3] Peter W. Singer, personal communication, 29 March 2011

warfare [coming] into existence' ([28], pp. 5, 22). Other animals have been integrated into human warfare in a dearth of ways, including as transport, weapons platforms, weapons in themselves, and surveillance. In many ways, the introduction and proliferation of drones, the central focus of what P. W. Singer labels the robotics revolution, are bioinspired robots: what amounts to biomimesis or biomimicry.

Matthias Franz and Hanspeter Mallot, in their overview of the field, provide the following definition:

> We consider an approach as biomimetic if the authors try to implement a mechanism described in the biological literature, and explicitly refer to the biological inspiration of their approach ([14], p. 134)

P. W. Singer's reference to 'strange changes' refers to the 'how', central to other animals being incorporated and reintroduced onto the contemporary battlefield. There are significant shifts in the ways other animals are being (re)imagined as tools and weapons of war. Moving a step beyond biomimicry, he notes 'war is not just about hardware and software, it is also now involving what some researchers call "wetware" [41].' This next generation of other animals as weapons, as tools of war, is being envisioned, researched and evaluated. What is encompassed in this new wave of technoscientific discourse are 'true cyborgs: creatures that involve, to greater or lesser degrees, the integration of cybernetic mechanisms with living organisms' ([52], p. 292). One outcome is an emergent 'excessive abstraction of what is meant by "the cyborg" [and one] that risks losing sight of the actual practices of technoscience as they impact upon [other] animals' ([11], p. 162). In many ways, as this paper will show, this is a key feature of the military-animal industrial complex. A subsequent and interrelated implication is that of the relational affects-effects on understandings of what it means to be human.

A Selective History of Other Animals and Human Wars

The military use of other animals has a long history. It is in their use—notwithstanding accounts of individuals as brave and heroic—that we can locate anthropocentric and speciesist attitudes and assumptions. Other animals have and continue to be routinely used in a rather disposable fashion. They have been forced into roles supporting humans, including transporting them and their equipment, as unwitting weapons, and in a variety of ways related to both. These roles have at times been as means of augmentation, at others of replacement, for humans—be it for menial, dangerous or otherwise undesirable tasks and activities.

It is the more horrific, and the more ludicrous actual and proposed uses of other animals in recent history, that a resurgence of military interest in the potential for other animals in warfare is most clear. One of the more well-known examples is that of tank dogs in WWII. Russian solders trained dogs using starvation to seek out food under tanks. Before release on battlefields, explosives were strapped to the bodies of these unwitting suicide bombers. When the individual reached a suitable target vehicle, the explosives were remotely detonated ([44], p. 23).

As horrific, or even unconscionable, as the example of tank dogs may be, their use/exploitation was exceeded by the Office of Strategic Services' (OSS)—the predecessor of the Central Intelligence Agency—'imaginative' testing. For example, in an early attempt at 'smart' bombs, for use against ocean going targets, it was hypothesized that cats could provide an effective guidance system. A combination of assumptions was mobilized to justify such an hypothesis: cats always land on their feet and seek to avoid water. This led to the idea that cats would guide themselves, and the bomb they were strapped to, onto the decks of vessels below to avoid landing in water. Test carried out proved less successful than anticipated ([16], p. 206).

Subsequently, a number of species have been used in bomb detection roles, on both land and sea. These include more widely known examples such as dogs, a number of rodent species (i.e. rats and ferrets), and aquatic animals including dolphins, sea lions and orcas. The cost of training and equipping these individuals is juxtaposed with the level of danger of the roles they are deployed for. It is worth noting that they do not necessarily follow their 'orders'.[4] In replacing human soldiers, what this becomes is 'a search for anthropocentric solutions to an anthropocentric problem' ([1], p. 28). The potential loss of human life is replaced with potential loss of the live(s) of other animals.

[4] A recent example is that of Flipper, one of 75 dolphins used for mine detection during the 2003 invasion of Iraq. Flipper went 'AWOL'. Alongside the specific capabilities for which the use of dolphins was based—a 99.8 % effective detection rate—their intelligence proved a challenge as they figured 'out how to game the [reward-based] system' of their deployment (see [41]).

What some might consider as extreme examples aside, links between more common uses of other animals (in war and otherwise) and the evolution of the technologies used for military purposes have been made explicit. DARPA's original description of early biological-mechanical projects, linking history to present-future, had the stated aim as being

> to develop technology that provides more control over insect locomotion, just as saddles and horseshoes are needed for horse locomotion control (cited in [11], p. 167).

The formal, public establishment of the Biological Technologies Office in April 2014 clearly signalled how other animals are seen, with their positioning being integral to shaping future directions of militarisation and warfare.

Industrial Complexes

Military spending in the USA, as a percentage of gross domestic product (GDP) and world share, is indicative of the influence of the military-industrial complex across the socioeconomic/political spectrum. State military institutions and private corporations engaged in research, testing and production of weaponized technologies have become economic and political powerhouses—to the point where they directly influence domestic and foreign policies.

The Stockholm International Peace Research Institute (SIPRI) has monitored military expenditure since 1967. The institute provides a database of records from 1988 to 2013, as an indicator of economic resources devoted to military expenditure, 'economic, political and security drivers and their implications for global peace, security and development' [45]. In 2012, as with previous years, US expenditure of US$682b far exceeded all other countries. Comprising 39 % of global expenditure, it is more than that of the remaining countries in the top ten combined—and more than four times that of China, ranked second [32].[5]

[5] Of note, in 2012, global military spending fell by 0.5 % in real terms. Whereas, this was the first decrease since 1998, it was still higher in real terms than the peak near the end of the cold war.

Military expenditure in the USA fell by 6 %, comprising 69 % more than that of 2001. By way of contrast, military expenditure in Russia increased 16 % and China 7.5 %.

The permanent war economy of the military-industrial complex comprises an 'intricate and vast web of political, bureaucratic, social and international, as well as economic, institutions and processes'. The functions and scope of the complex—across corporate profit-driven industries, research institutions and domestic systems of employment, production and consumption—'converge with a variety of social, cultural, political, and international phenomena'. For example, 'military norms and priorities… influence the realms of education, politics, science, technology, the media, even popular culture' ([3], p. 23). Mills described this as the firmly planting of military metaphysics 'among the population at large' ([27], p. 219).

Wolfe's analysis of the 1990s identified opposition to militarism as curtailing the influence of the military and military-industrial complex on 'both foreign and domestic policy making'. Whereas he did (or could?) not predict the events of 9/11 and capitalization by the military-industrial complex, he did note that strategists were working to plan military interventions 'in ways that avoid the use of American troops' (ibid, pp. 374–375). The proliferation of biomimetic drones and the return of other animals to the battlefield are two ways in which such plans are being realized. Preventing injury and loss of (human soldier) life are routinely mobilized as a basis for this. Anthropocentrism is a key element of the latter, and the context in which current technological research and innovation is embedded.

DARPA is a centrepiece of the military-industrial complex and driving force behind military-related research and innovation—including the use of other animals. It 'operates as a venture capital firm for the Pentagon, awarding grants to companies and research institutions to develop war-fighting technology' [10]. Donald Rumsfeld located the role of DARPA in the broader context of neoliberalism and the permanent war economy, as Secretary of Defense, in 2002:

> we must transform not only our armed forces, but also the Department that serves them by encouraging a culture of creativity and intelligent risk taking. We must promote a more entrepreneurial approach to developing military capabilities, one that encourages people, all people, to be proactive and not reactive, to behave somewhat less like bureaucrats and more like venture capitalists; one that does not wait for threats to emerge and be "validated," but rather anticipates them before

> they emerge and develops new capabilities that can dissuade and deter those nascent threats [34].

The revolving door identified by Mills was entrenched in legislation and adopted successfully by DARPA, and 'now characterizes the development of 21st-century, future-oriented military technology in the United States' ([11], p. 158). DARPA has played a key role in influencing academia via a complex web of research and other funding, particularly the availability of substantive, ongoing research funds and the chance of a successful application. It is also driving military innovations, including the use of other animals, through setting briefs and funding contracts more broadly (see [42], pp. 171–176). In particular, 'DARPA is taking a lead in neuroscience and neurotechnology research' ([26], p. 26). The (public) formalization of such research in the Biological Technologies Office is the most recent example.

The use of other animals for human ends is a common element of human societies—past and present. In *Animal Oppression and Human Violence*, Nibert argues that, counter to positivist accounts of the virtues of the exploitation of other animals for human society, such practices have 'undermined the development of a just and peaceful world' and were a 'precondition for and have engendered large-scale violence' across our own, and targeted towards other, species (2013, p. 2). He goes further: alongside being a precursor to, and essential for, the amassing of military power, large-scale violence and warfare was promoted by agricultural practice—protecting existing land and colonization and control of new pastoral regions.

The notion of an animal-industrial complex was first introduced by Barbara Noske in 1989 [29]. Richard Twine, in attempting to re/present and redefine the importance of the concept, and 'the myriad complexity of the multiple relations, actors, technologies and identities' ([50], p. 15), has offered 'an initial basic and succinct definition':

> a partly opaque and multiple set of networks and relationships between the corporate (agricultural) sector, governments, and public and private science. With economic, cultural, social and affective dimensions it encompasses an extensive range of practices, technologies, images, identities and markets (ibid, p. 23).

Direct parallels emerge here with the processes identified by Mills and others with respect to the military industrial complex. Specifically, the ascendancy of military metaphysics can be considered in a number of ways synonymous to the ontologizing-deontologizing of other animals. They are socially constructed and positioned (i.e. ontologized) as unquestioningly usable for human ends in that this is where their value lies. Simultaneously, they are positioned as absent referents and disappeared (i.e. deontologized) and 'have no individuality, no uniqueness, no specificity, and no particularity' ([1], p. 34). In short, other animals are ontologized and deontologized as objects.

Such a shifting of the status of other animals was a precursor and requirement for increasingly industrialized agricultural practices. Ferrari has identified the dearth of such assumptions in her contribution to a *NanoEthics* symposium on other animal disenhancement [51], specifically in response to the notion that disenhancement presents a philosophical conundrum. In particular, the instrumentalization of other animals is a key foundation for the context in which technology is looked to for 'solutions' to the harm inflicted on other animals. For example, 'only in the context of exploitation… do contradictions between improvement of welfare and disenhancement of capabilities make sense' ([13], p. 66). It is only in such a sociopolitical context of a human-other animal divide (i.e. an unquestioned logic of domination) that disenhancement can be considered a philosophical conundrum. This is technoscience as performative. Technological solutions are a fait accompli only when the use of other animals for human ends is not questioned and taken for granted (ibid).[6]

Central to Noske's development of the concept of the animal-industrial complex, sharing similarities to Mill's enunciation of an emerging permanent war economy, was an adoption of Taylorism, the scientific management of labor, in the (factory) farming sector. The specific aim was to transform practices to produce capitalist-economically efficient (i.e. profit generating) processes. Such management required animals to be objects, not subjects, in a cultural milieu of carnism: an ideological system that situates the exploitation of other animals as natural, appropriate, ethical and even necessary for human existence [20]:

> Conditions of factory farming, said to be improved owing to reforms, are in fact worse by most standards—more crowded, more painful,

[6] See also Twine [49] and Adams [1].

> more disease-ridden, more drug saturated even than at the time of Upton Sinclair's classic *The Jungle* (published in 1906) ([4], p. 76).

In this context, we can locate the symposium on other animal disenhancement referred to above: the original work by Thompson [47], Palmer's [30] reply, and the works contained in the subsequent special issue of *NanoEthics*—Ferrari [13], Hadley [15], Henschke [17] and Hongladarom [18]. Whereas all authors identified ethical issues with disenhancement, Ferrari was alone in explicitly challenging anthropocentric and speciesist assumptions central to the technoscientific discourse of disenhancement: questioning the exploitation of other animals for human ends. A focus on suffering strategically renders such questioning nonconsidered.[7] What is explored centres on an anthropocentric notion of a win-win scenario ([13], p. 73).

The ideological assumptions and sociopolitical context from which the animal-industrial complex emerged are central to the (re)introduction of other animals to the battlefield. The unquestioning acceptance of the ontologizing-deontologizing of certain species, alongside a relational anthropocentric positioning of their roles in saving human lives, is a key feature of the intersection of the military- and animal-industrial complexes.[8] To state another way, the (re)introduction of dis/enhanced other animals onto battlefields:

> embod[ies] a seductive vision of wartime and peacetime 'governance' that is cheaper, easier, and less costly: wars without [human] bodies, blood, or human suffering ([52], p. 293).

In simple terms, this enables a removal of soldiers from the front line, comprising a form of causality-averse warfare. The potential loss of human life is replaced with the lives of other animals.[9]

The 'Remaking' of Species

A key element in the construction of the human-other animal dualism is the process of othering (see [36], pp. 2–3). Other animals are positioned individually, as species and across species, as absent referents. Subjects are made into objects through an anthropocentric deontologizing (see [1], p. 29). The process is rooted in a 'logic which reproduces the human-animal divide and the characterization of "the" animal as "the" other through a hierarchy of beings along particular cognitive abilities' ([13], p. 72).

The process is both anthropocentric and speciesist. It is anthropocentric in that traits considered of human value are central. It is speciesist given how these traits are prioritized in the construction of hierarchy, and subsequent (different) values are afforded along species lines (see [40]). Such values are contextual and ever-shifting. By way of example, insects are viewed quite differently, as are cows, to species such as dogs and cats, whales and dolphins (in the west).

The potential of insects as tools and weapons of war is at the cutting edge of military technoscience, of biotechnology, neurotechnology and neuroscience. As biologically 'simpler' organisms, they are the focus of early research and testing, laying the groundwork for future systematic body manipulation and remaking of other more biologically 'complex' species.

Proposed and actual research on the use of other animals is framed in specific terms, clearly locating the sociopolitical context of technoscientific discourse. As Dodd notes,

> For readers unfamiliar with DoD [US Department of Defense] documents but well-acquainted with contemporary critical literature about animals, the language will appear abrupt and notably devoid of ethical considerations; this is representative of the ways in which such projects tend to be described within the military-industrial community ([11], p. 159).

The language Dodd refers to is clear in DARPA's first information brief seeking proposals for 'controlled biological systems' ([24], p. 537):

> The Defense Advanced Research Projects Agency (DARPA) is soliciting research proposals in the area of Hybrid Insect MEMS [micro electrical mechanical systems, HI-MEMS]. Proposed

[7] For an engagement with strategic ignorance, in a different context, see Sullivan and Tuana [46].

[8] ([11], p. 161) describes the convergence as a 'military-industrial, corporate-academic milieu'. I have engaged with this elsewhere as a military-animal industrial complex [36].

[9] The implications extend beyond other animals. As an evolution of asymmetrical, risk-free, war, such a vast imbalance of risk fundamentally undermines the just war doctrine and the principles of laws of war (see [21]).

> research should investigate innovative approaches that enable revolutionary advances in science, devices or systems. Specifically excluded is research, which primarily results in evolutionary improvement upon existing state-of-the-art.
> DARPA seeks innovative proposals to develop technology to create insect-cyborgs, possibly enabled by intimately integrating microsystems within insects, during their early stages of metamorphoses. The healing processes from one metamorphic stage to the next stage are expected to yield more reliable bio-electromechanical interface to insects, as compared to adhesively bonded systems to adult insects. Once these platforms are integrated, various microsystem payloads can be mounted on the platforms with the goal of controlling insect locomotion, sense local environment, and scavenge power. Multidisciplinary teams of engineers, physicists, and biologists are expected to work together to develop new technologies utilizing insect biology, while developing foundations for the new field of insect cyborg engineering [23].

Implicit is the augmentation and amplification of the biological with nanotechnology, to "integrate living and nonliving components for novel device applications". In other words, the (further) instrumentalization of life for military ends ([24], p. 537). Whereas the biological is clearly a key 'component', and supersedes current human technologies (including biomimesis: attempts to copy, and seek design influence from, biological systems for military and other purposes), there is both an absence of any ethical considerations and reference to the biological as more than an object. The individual animals are absent referents, reduced to mere biological stages, evolutionary traits and components with specific and significant military potential. Such potential is currently beyond the scope of cutting-edge (nonbiological) MEMS. Further, it is clearly assumed that the biological, the natural, can be improved in an unquestioned anthropocentric sense. The desired potential to 'scavenge', as a key goal of the HI-MEMS programme, is aptly described by Charles Zerner as parasitic: another example of humanity sucking the life out of a militarized nature for anthropocentric ends ([52], p. 300). As dystopian as Zerner's metaphor may be, we can recall Nibert's identification of animal agriculture as a precursor and essential for militarism and a precondition for the engendering of large-scale societal violence [28].

The creation of 'smart' insects, or cybugs, is part of what Zerner describes as the design of 'stealth nature'. A stealth nature is 'a nature that surveils, that itself is hidden in plain site, camouflaged by and through its everyday form' ([52], p. 317). An interesting juxtaposition emerges. The qualities of particular species, in many ways superior to human abilities in the specific context of militarism and human warfare, are deemed useful. Weaponization of other animals renders the constructed 'hierarchy of beings' unquestioned. By way of example, 'in order to create a cyborg, one must begin by conceptualising the organism as a kind of machine', as technology ([11], p. 155). It is through seeing an animal as machine-like that we are able to view it as (in some ways) superior without destabilizing humanity's self-appointed position of mastery.

In 'Ecologies of empire: on the new uses of the honeybee', Jake Kosek confronts the history of the 'modern honeybee… through the labyrinth of the military-industrial complex'. In particular, he focuses on how it 'has been remade as a military technology and strategic resource for the battlefield' ([22], p. 651). For example, through their deployment 'as efficient and effective homeland security detective devices' (Stealthy Insect Sensor Project Team, quoted in ibid, p. 656).

A 1944 article in *Popular Science* described the honeybee as 'far more important to both war industry and our food supply than most people realize' ([43], p. 98.). An underlying theme, central to current approaches to remaking, the militarisation of other species, was clearly stated:

> Though nature has produced few animals as remarkable as these industrious little insects, entomologists and geneticists have found the means to improve on its handiwork (ibid, p. 98).

The explicit statement of improving on nature, what we can consider as both enhancement and disenhancement (dis/enhancement) in an anthropocentric context, is framed as a 'partnership of science and nature': the customizing of other species to human ends. Such language (as an example of the pervasiveness of technoscientific discourse) are clear in DARPA's 2006 request for HI-MEMS research proposals and the 2014 media release announcing the formation of the Biological Technologies Office.

Enhancement and disenhancement are ideologically loaded terms, in this context rooted in anthropocentrism. Research proposals and projects for military use of other

animals can be considered, as a necessity, to embody both. For example, the 'first thrust' of DARPA's Controlled Biological Systems Program in 'exploiting [biological] activities and behaviors' has been illustrated as 'the power of having insects that home in on explosives rather than their natural behavior of tracking sex pheromones or food sources' [2]. In this example, disenhancement would be a suppression of natural behaviours. Enhancement comprises the coercive supplanting, superseding or replacement of these natural behaviours with a desired ability of detecting explosives. The second thrust comprises direct control through 'biointerfaces', with the third working at the 'whole organism level'. In short

> the Controlled Biological Systems program is an example of a set of efforts integrating biological knowledge with the ability to interface microsystems to the biological organisms and understanding and exploiting the information technology of nature (ibid).

Kosek's ethnographic study—which afforded him access to bioengineers, military strategists, mathematicians and private military contractors—was situated at an intersection and juxtaposition of a post-9/11 security state and researchers expressing an eagerness to share excitement about the perceived possibilities and potentials of their research. It provided insights into views on other species, echoing and contrasting with the nature-science marriage envisioned in 1944.

For researchers involved in one DARPA-funded Bio-Revolution project, 'the bee was simply a mechanical device, and the project viewed more as an engineering problem than an instance of intimate interspecies interaction' ([22], p. 661). DARPA's Controlled Biological and Biomimetic Systems (CBBS) Program was clear in its intent: it solicited proposals seeking to

> exploit the unique capabilities of living systems [to] explore new technical capabilities through the use of living or biomimetic platforms or devices… The fabrication of working devices or systems could require the construction of unique interfaces, tags, or materials that monitor, influence, control, and or fuse sensory or mechanical movement in living or biomimetic systems… The program will explore the control of biological systems or subsystems as real-time animal sentinels [8].

The CBBS Program 'represented DARPA's commitment to superseding the biology of animal bodies in order to have them serve (often vaguely defined) military objectives' ([11], p. 160).

The language of improvement is clear in a number of DARPA-funded projects. The problem is identified as performance shortcomings of purely (biomimetic) mechanical micro air vehicles (MAVs) [37]. For example, 'none of these systems has yet reached the flexibility and navigation performance of bees or ants, let alone migrating birds or fish' ([14], p. 133). The implanting of MEMS into insects identified as a means to overcome these, and the 'interest' in such research is based around finding ways to 'combine the advantageous features of insects—small size, effective energy storage, navigation ability—with the benefits of MEMS and electronics—sensing, actuation and information processing' ([48], p. 39). Another study introduces its aim through contrasting the limitations of biomimetic designs with that of millennia of evolutionary adaptation:

> Insect micro air vehicles represent a promising alternative to traditional small scale aircraft because they combine the enhanced energy storage and maneuverability of living insects with the controllability offered by micro- electromechanical systems ([7], p. 345).

In building on a literature review of research findings as to the biological superiority of insects over biomimetic (mechanical) designs, and a lack of success in attempts to 'train and control' individuals, the authors identified that 'the development of systems that take advantage of the energy storage and flight capabilities of living insects with the precise control enabled by modern MEMS technology' afforded significant potential to address these 'design' challenges (ibid, p. 345). Of note, the research investigated the use of electrical and chemical enhancements: the implanting of microelectrical mechanical and drug delivery systems—a double dis/enhancement of sorts. The latter being designed to modulate 'flight output power by administering a neurotransmitter dose to the central nervous system' (ibid, p. 345). Specifically, 'a system that harnesses the maneuverability offered by the electrical approach with the speed control and physiological access enabled by chemistry could increase the number of achievable flight routines' (ibid, p. 346).

For participants on a different DARPA-funded project, embedded MEMS designed to control movement were

implanted into bees and other insects in the early stages of metamorphosis. The aim was to create 'tightly coupled machine-insect interfaces'—a hybrid fusion of the biological and the mechanical, also central to the examples above ([22], p. 661). A stipulated benefit is an increase in the potential robustness of the hybrid cyborg device. Rather than fragile surgically bolted-on apparatus—often referred to as 'backpacks', living tissue envelops and protects MEMS circuitry and electronics. Other animals are remade, merging what was previously considered science fiction into technoscientific discourse and practice. Subsequent research proposes harnessing enough energy from the insect and its movements to power the sensors, probes and transceivers [19].

Approaches to such dis/enhancement as an engineering problem firmly locate the sociopolitical context of other animals in society, as well as a clear component of the military-animal industrial complex. Dodd has identified that such views are pervasive. Military research is situated in 'a world in which contemporary scientists… explicitly seek to control the life phenomena of animals in order to bring about effects that cannot be expected in nature'. In line with the views expressed in *Popular Science* (at the height of World War II), renewed research into the insertion of other animals into contemporary warfare is rooted in an ambivalence towards their lives, and 'one that can accommodate the exploitation of [other animal] bodies as resources in the service of military agendas' ([11], pp. 153–154). More specifically:

> In the eyes of the U.S. Department of Defense and its many research teams, insects are nothing more than 'mechanical little animals,' and it is this perspective that permits the "coupling" of microelectromechanical systems with insect bodies (ibid, p. 155).

At the 2008 Micro Electrical Mechanical Systems (MEMS) conference, the first directly controlled flight of a cyborg *Manduca sexta* moth was reported. Authors of the study 'demonstrated a reliable hybrid tissue-electronics interface' through the use of Early Metamorphosis Insertion Technology (EMIT). During a series of tests, 'probe based microsystem platform[s]' were surgically implanted into individual moths at the pupal stage, with muscle growing around these devices as the moths 'healed'. A success rate of 90 % was achieved, 'pav[ing] the way for future engineering approaches to utilize the bioelectronic interfaces especially for realizing insect cyborgs' [5]. At the 2009 conference,

> the first-ever wireless flight control microsystem using a small RF receiver mounted on a live beetle and an RF transmitter operated from a base station [was presented]. Flight initiation and cessation were accomplished by neural stimulation of both optic lobes while turns in free flight were elicited by muscular stimulation of basalar flight muscle on either side [37].

As with other DARPA-funded research, what resulted was considered an engineering solution to an engineering problem. Dodd notes that 'it is difficult to avoid reading this account… as something like a description of a very expensive "science toy" built from a kind of hobby kit' ([11], p. 65). [10]Indicative of such attitudes, in a video interview about the engineered beetle cyborgs, Michel Maharbiz—one of the project researchers—jovially states that 'it sounds like a helicopter when it flies, it's pretty cute' [39].

As these examples illustrate, species are being reimagined and remade. The context in which technologies are embedded is changing, as are the implications. Kosek maps what he has identified as 'the changing contours of apiary ecology under U.S. empire' as it 'dwells in a shifting biopolitical terrain, where nature and culture are being reconfigured, where humans and nonhumans are being remade by discourses and material practices in the war on terror' ([22], p. 653). Of note here, as Michael Parenti stated in a May 2007 lecture, 'the most insidious oppressions are those that so insinuate themselves into the fabric of our lives and into the recesses of our minds that we don't even realize they are acting upon us'. In the context of the militarization of the natural world, 'the nature and boundaries of the human have become a central part of the war on terror… What it means to be human is a product of the shifting cartography of what it is to be animal' ([22], p. 670). This is the current context, the discursive terrain of technoscience with respect to other animals.

[10] The notion of other animals as components of hobby kits is exemplified in a controversial yet successfully crowd-funded (2013) project in which a smartphone is used to control electrodes implanted in cockroaches: The RoboRoach: control a living insect from your smartphone! (see [33], [38]).

Conclusion: Anthropocentric Solutions to an Anthropocentric Problem

In concluding his analysis of stealth nature and the weaponization of other animals, Zerner asks:

> If the realm of the human is made, in part, by differentiation from the animal, then how does and will the constitution of a weaponized other affect our idea of the human? What happens when the other (the animal), against which the human is continually defined, is radically remade through weaponization and cyborgization?… it is time to examine redefinitions of the idea of humanity and the social ([52], p. 318).

The anthropocentric focus of Zerner's reflection[11] identifies key challenges to come given current unquestioned assumptions and trends in technoscientific discourse centred on the construction, positioning and reconstruction-remaking of other animals. Parenti's [31] take on the most insidious oppressions—the pervasiveness of unmarked exploitation—can be similarly located. What is important here are the blurring of boundaries between 'mechanism and organism' as a key element of the (military) instrumentalization of life and its centrality to speciesism more broadly ([52], p. 317). Species are being remade to fit militaristic and anthropocentric notions.

Paralleling what Mills identified in *The Power Elite*—an acceptance and embrace of 'military metaphysics' as 'the only reality, that is to say, the necessity of our time' ([27], p. 202)—research into the use of other animals in warfare, based on current technoscientific discourse, will be increasingly positioned as an essential element of the military-industrial complex. How we proceed in responding to other animal positionings and current remakings in technoscientific developments will have a significant effect-affect. In focusing on the human impacts, the redefinitions of humanity and the social as Zerner highlights, are we merely seeking out, willfully or ignorantly, anthropocentric solutions to anthropocentric problems? As Ferrari, seemingly singularly, noted in the symposium on other animal disenhancement, such an approach is in many ways 'an extension of the system and mentality that produced and produces such suffering in the first place' ([13], p. 75). It is a means of coping with the human effects of human problems imposed on other animals and detracts from the assumptions embedded in technoscientific discourse—rooted in societal assumptions more broadly. To put it simply, 'the [other] animal itself virtually disappears' in the relationships of the military-animal industrial complex ([11], p. 166).

[11] For example, in seeking to distance himself from being labeled as a technophobe, Zerner lauds the potential for insect-cyborgs to prevent (human) nuclear accidents and undertake (human) medical procedures (ibid, p. 319).

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