

"With *Insect Media* Jussi Parikka offers a theory of media that challenges our traditional views of the natural and the artificial. Parikka not only understands insects through the lens of media and mediation, he also unearths an insect logic at the heart of our contemporary fascination with networks, swarming, and intelligent agents. Such a project requires the ability to interweave cultural theory with a deep understanding of the sciences—something for which Parikka is well suited. Most important, *Insect Media* reminds us of the nonhuman aspect of media, communication, intelligence. *Insect Media* is a book that is sure to create a buzz."

—EUGENE THACKER, AUTHOR OF *AFTER LIFE*

In *Insect Media*, Jussi Parikka analyzes how insect forms of social organization—swarms, hives, webs, and distributed intelligence—have been used to structure modern media technologies and the network society, providing a radical new perspective on the interconnection of biology and technology. Through close engagement with the pioneering work of insect ethologists (including Jakob von Uexküll and Karl von Frisch), posthumanist philosophers, media theorists, and contemporary filmmakers and artists, Parikka develops an insect theory of media—one that conceptualizes modern media as more than the products of individual human actors, social interests, or technological determinants. Challenging anthropocentric approaches to contemporary science and culture, *Insect Media* reveals the possibilities that insects and other nonhuman animals offer for rethinking media, the conflation of biology and technology, and our understanding of, and interaction with, contemporary digital culture.

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INSECT MEDIA

An Archaeology of Animals and Technologies

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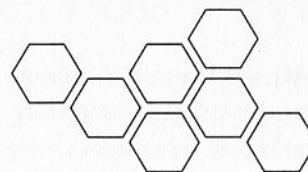
T e c h n o l o g y

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INTRODUCTION

Insects in the Age of Technology

... cultural and technical phenomena providing a fertile soil, a good soup, for the development of insects, bacteria, germs, or even particles. The industrial age defined as the age of insects. . . .

—Gilles Deleuze and Félix Guattari, *A Thousand Plateaus*

There is an entire genealogy to be written from the point of view of the challenge posed by insect coordination, by “swarm intelligence.” Again and again, poetic, philosophical, and biological studies ask the same question: how does this “intelligent,” global organization emerge from a myriad of local, “dumb” interactions?

—Alex Galloway and Eugene Thacker, *The Exploit*

FROM CYBORGS TO INSECTS

First, a practical exercise. Pick up an entomology book; something such as Thomas Eisner's *For the Love of Insects* from a couple of years back will do fine, or an older book from the nineteenth century, like John Lubbock's *On the Senses, Instincts, and Intelligence of Animals with Special Reference to Insects* (1888) suits the purpose as well. However, do not read the book as a description of the biology of those tiny insects or solely as an excavation of the microcosmic worlds of entomology. Instead, if you approach it as media theory, it reveals a whole new world of sensations, perceptions, movements, stratagems, and patterns of organization that work much beyond the confines of the human world.

Of course, in a way this has already been done. Some years ago the

American research agency DARPA (the Defense Advanced Research Projects Agency), in the past responsible for various high-tech army gadgets, revealed information about its aspirations to fabricate cyborg insects. DARPA was criticized and ridiculed quite soon because of this imaginative, to say the least, plan of harnessing these simple forms of life as part of the most developed military machine the world has ever seen. The idea was to insert electronic devices into insect pupae. The so-called MEMS (microelectromechanical systems) system was designed to smoothen as part of the body structure of the animal during later metamorphoses. The cyborg insect could be then controlled and used as a spy tool for army covert operations. Who would suspect a lone moth or a bumblebee?¹

The connection between insects and high-tech war was not altogether new. Some years earlier, in the midst of fears of terrorists and cyberhackers, swarms were identified as future models of conflict: "from ants and bees and wolf packs, to ancient Parthians and medieval Mongols."² Insect organization was creeping into the most high-tech area of the contemporary world, the U.S. military, which was making use of ideas of nonlinearity, small tactical units, and network-oriented models of action. Not only the military was picking up entomology books; insects were being discussed in various other fields of media, communication, and digital design and theory as well. In visual systems, insects' compound eyes represented a powerful example of biologically inspired computation. Biomimetics was opening up a new field in engineering naturelike behavior such as locomotion, navigation, and vision.³ Insects' wide field of view was attracting a great deal of research interest from players developing medical, industrial, and military applications.⁴ Artists such as Garnet Hertz (designer of a cockroach-controlled robot), Toshio Iwai ("Music Insects"), and Mira Calix (a composer working with insect sounds) were engaging with similar questions as well, using insects to think through high-tech creation. Experimental video works such as the bizarre narrative of David Blair's online film *Wax, or The Discovery of Television among the Bees* (1991) ties together military development, insects, and high-tech telecommunications media.⁵

Suddenly the cyborg as imagined since the 1980s in theory and fiction seemed quite old-fashioned. This shift was not altogether dismissing the human being and its perceptive and cognitive capabilities: the

two-handed and -legged brainy animal was seen to demonstrate distinct powers in visual (recognizing edges, seeing contrasts, differentiating between dimensional entities) and tactile (the hand) faculties. Yet a much less brainy entity, the insect, was a powerful new kind of model for designing artificial agents that expressed complex behavior, not through pre-programming and centralization but through autonomy, emergence, and distributed functioning.⁶ Since the 1980s, such terms as swarms, distributed intelligence, and insect models of organization have infiltrated both the design of digital technologies and cultural theoretical analysis of such media systems. Yet, as researchers commented, "The most talented roboticist in the world is not going to come close to what a cockroach can do."⁷

One of the most discussed contexts for such a cultural and scientific reorientation in terms of design practices and plans was artificial intelligence (AI) research. New ideas in cognitive science seemed to offer the most convincing explanations of the potential for tapping into the simple architectures already developed by nature. "Intelligence is overrated," such research paradigms seemed implicitly to suggest. The approach, which focused on the redundancy of numerous "dumb" machines, emphasized that

1. there is no need for planning;
2. no need for central representation;
3. our traditional ways of modeling the world for the actors are impractical and unnecessary;
4. we should pay more close attention to biology and evolution;
5. One should focus on building real, concrete solutions, not merely theoretical models.⁸

In robotics, MIT professor Rodney Brooks noted in the late 1980s that artificial agents do not have to resemble or act like humans; there are much more efficient ways of doing complex tasks than by modeling intelligent machines. Brooks designed insectlike robots, and in his 1989 paper "Fast, Cheap, and Out of Control," coauthored by Anita Flynn, he introduced the idea of using insectlike mobots as space exploration agents instead of large "intelligent" ones.⁹ Douglas Hofstadter had already used

the notion of the ant colony to pave the way for a rethinking of cognition as distributed "mass communication" between miniagents,¹⁰ but Brooks deployed a similar insect metaphor: no central command but massive parallelism and cooperation.

Such research in "new AI" had many parallels in the emerging artificial life sciences, which, however, dealt mostly with software. The approaches were kicked off by researchers such as Christopher Langton. In that context, and in the midst of the emerging digital software culture of the 1980s, the field of programming also gained much from the scientific theories of artificial life. In software and network processes, simple but interconnected agents had been planned since the 1960s. Nowadays everybody knows viruses and worms by name, but the fact that we are thinking them in terms of parallel processing and artificial life is often less emphasized. Yet such program types, which span computer boundaries as "parasite computing," are exemplary of software that acts in a manner reminiscent of insect colonies: individually dumb, but highly efficient when coupled with their environment. The ideas of distributing artificial actors into insectlike colonies of part functions and parallel processing represented a move toward situatedness but also embodiment: robots are in the world, and their actions are enabled and controlled by the very present environment. This could be seen as signaling a kind of ethological turn in creating artificial agents, because such ideas were reminiscent of those of animal ethologists such as Jakob von Uexküll's in work from the 1920s: artificial actors are embedded in a perceptual world, which implies that what we perceive is what we are, and animals and artificial agents are defined by the capabilities of perception, sensation, and orientation in their environment.¹¹

The ethological and ecological interests spread quickly to cultural and media theory as well, with writers embracing swarms and termites as relevant to leftist politics (Hardt and Negri), insects as figures important for material feminism (Braidotti), and notions such as packs and "nonanthropomorphic intelligence" as key terms for a biophilosophy of the contemporary network culture (Thacker).¹²

Strange Sensations of Insect Media

The aim of *Insect Media* is to dig into this field of insects and media and cultural theory that seems to have emerged during recent decades. Yet,

because I am infected with a historical obsession, my aim is to dig deeper. It might be more coherent to offer an analysis of the interconnections of such models, concepts, and diagrams of insects, viroids, and media since the 1980s, but my contention is that it proves fruitful to stretch this analysis on a wider temporal scale and begin with an analysis of animal worlds of the nineteenth century. In other words, the fascination with simple forms of life such as insects, viruses, and the like has been interfaced with media design and theory for years now, but nineteenth-century entomology, and various other cultural discourses and practices since then, have hailed the powers of insects as media in themselves, capable of weird affect worlds, strange sensations, and uncanny potentials that cannot immediately be pinpointed in terms of a register of known possibilities. Hence the task of the book is twofold: first, to look at media as insects and see what kinds of theoretical modulations we can come up with if we extend further the recent decades of obsession with insectlike models of media, and second, to analyze the archaeology of the recent figurations in terms of "insects as media," a cultural historical theme that can be catalyzed into media theoretical implications as well.

My aim is not to write a linear history of insects and media but to offer some key case studies, all of which address a transposition between insects (and other simple forms of life) and media technologies. The translations among different modern sciences (biology, entomology, technology) are coupled with a philosophically tuned cultural analysis that offers new ways to think of the bestiality of media technologies as intensive potentials. So when I refer to a work of "translation," it is not to awaken ideas of the metaphoricity of technology but to point to how specific figures such as "insects" are continuously distributed across a social field not merely as denotations of a special class of icky animals but as carriers of intensities (potentials) and modes of aesthetic, political, economic, and technological thought. Translation, then, is not a linguistic operation without residue but a transposition,¹³ and a much more active operation on levels of nondiscursive media production, as becomes especially evident when approaching the end of the twentieth century and the use of insect models of organization in computer science and digital culture.

In a parallel move, the book implicitly questions the definition of media in itself. In fact, the notion of media is broadened from technologies and uses of mass communication to various processes that are often

not even mentioned in media studies textbooks. Yet faculties of transmission, recording, and connecting can be found in various places. Stones and geological formations are recordings of the slow passing of time and the turbulence of matter-energy. Plants and animals constitute their being through various modes of transmission and coupling with their environment. They contract the forces of the cosmos into environmental relations, couplings, which is perhaps not a reflective (human) relation but is still a lived one of relations actual and virtual (potential).¹⁴ Media, then, in this book, are not only a technology, a political agenda, or an exclusively human theme. Media are a contraction of forces of the world into specific resonating milieus: internal milieus with their resonance, external milieus affording their rhythms as part of that resonance. An animal has to find a common tune with its environment, and a technology has to work through rhythmic relations with other force fields such as politics and economics. In this context, sensations, percepts, and affects become the primary vectors through which entities are co-created at the same time as their environmental relations.

In other words, there is a whole cosmology of media technologies that spans much more of time than the human historical approach suggests. In this sense, insects and animals provide an interesting case of how to widen the possibilities to think media and technological culture. They are contractions of the world and organizations into environmental relations and milieus. This is not meant to be read as a sociobiological celebration of the superiority of nature as a deterministic machine to which we should adapt. Nature is not a model to be followed but a toolbox or a storehouse of invention, as has been voiced since the nineteenth century in the context of biology but also that of experimental work in technological discourses.

A MEDIA ARCHAEOLOGICAL TWIST

This idea of focusing on the joint history of media and nature can be seen as a kind of twisted media archaeology.¹⁵ It does not try to excavate lost histories of present technologies but rather, by its temporal realigning, looks for conceptual cuts through which to open up new agendas of research and analysis. In my take, this methodological clue leads to a rethinking of the various senses and rationalities inherent in

techno-logy and bio-logy. *Bestial media archaeology*, as addressed in this book, is a means by which to look at the immanent conditions of possibility of the current insect theme in media design and theory; to question the supposed newness of the coupling of (seemingly) simple animal behavior with media technologies; to look for the longer duration of this phenomenon; to present important case studies of this history of insect media that do not merely represent the past of this specific "idea" but offer important philosophical interventions into how we habitually think about media, technology, and the conjoining and differences of animal and nonorganic life. The chapters that follow demonstrate how insects have been short-circuited as part of philosophical, engineering, and scientific concerns regarding media systems since the nineteenth century.

Examples from nineteenth-century popular discourse are illustrative. In 1897 the *New York Times* addressed spiders as "builders, engineers and weavers" and also as the "original inventors of a system of telegraphy." For such Victorian writers, spiders' webs offered themselves as ingenious communication systems that do not merely signal according to a binary setting (something has hit the web or has not hit the web) but transmit information regarding the "general character and weight of any object touching it."¹⁶ Similar accounts have abounded since the mid-nineteenth century. Insects sense, move, build, communicate, and even create art in various ways that raised wonder and awe, for example, in U.S. popular culture. An apt example of the nineteenth-century insect mania is the story about the "cricket mania" of a young lady who collected and trained crickets as musical instruments:

200 crickets in a wirework-house, filled with ferns and shells, which she called a "fernery." The constant rubbing of the wings of these insects, producing the sounds so familiar to thousands everywhere seemed to be the finest music to her ears. She admitted at once that she had a mania for capturing crickets.¹⁷

In the nineteenth century, insects infiltrated popular culture as fashion figures—literally, as in the case of the beetle dresses and insect hats of the Victorian era (especially between the 1850s and the 1880s).¹⁸ In popular entomology books such as the classic *An Introduction to Entomology; or, Elements of the Natural History of Insects: Comprising an Account of Noxious and Useful Insects, of Their Metamorphoses, Food,*

Stratagems, Habitations, Societies, Motions, Noises, Hybernation, Instinct, etc. etc. (originally four volumes, 1815–1826), insects are approached as engineers, architects, and tinkers of the microscopic world. They are marveled at due to their powers of affect, sensing, and motion—for instance, their ability to fly, for which they were appropriated as models of the aspiring branch of motion engineering, as were spiders (which were back then counted as insects):

What will you say, if I tell you that these webs (at least many of them) are airballoons and that the aeronauts are not “lovers who may bestride the gossamer / That idles in the wanton summer air / And yet not fall,” but spiders, who, long before Montgolfier, nay, ever since the creation, have been in the habit of sailing through the fields of ether in these air-light chariots.¹⁹

In another passage of the book, spiders are referred to as having electric capabilities, with the authors arguing that “there is a mode . . . in which some geometric spiders shoot and direct their threads, and fly upon them; by which it appears that as they dart them out they guide them as if by magic, emitting at the same time a stream of air, . . . or possibly some subtile electric fluid.”²⁰

Modern media were constantly present in the animal world and in the physiological research of animal bodies, understood as wire systems.²¹ It is no wonder, then, that the famous entomologist J. H. Fabre speculated in 1911 whether moths, too—the great peacock moths, to be exact—were capable of wireless telegraphy, of “Hertzian vibrations of the ether.”²² Though Fabre quickly came to the conclusion that the curious communication of the moths did not result from modulating electric or magnetic waves, the mere fact that he considered such a link is worth mentioning.

Despite various examples, in most histories and theories of media the centrality of the human being has persisted since the early nineteenth century. Media technologies have, since their early modern roots, been perceived as crucial components in the emerging power structures of the nation-state and capitalist business, which has contributed to the need to view technologies as centrally run and controlled by and subject to top-down functional goals. Yet in recent years of technological “evolution,” other things have been underlined, namely, a move toward invertebrate

animals. According to Steven Shaviro, the nineteenth-century biological organic metaphors were based on the seemingly well-structured “vertebrate body plans,” whereas those of our postmodern age are more closely related to the lives of insects and, for example, arthropods in their ability to generate distributed, experimental, and metamorphosing organizations.²³ Yet the division is not so clear-cut, and there is a neglected history to be excavated: to a certain extent, a history of “postmodern technology” had already started in the nineteenth century with pioneering discourses on insect technics. The nineteenth- and twentieth-century history of media was already filled with such “hidden themes” of alternative media. Within the majoritarian joining of technology–state–human being we find cracks and varia: the early modern media sphere incorporated in its phases of emergence a panorama of ideas and views of media and technology (even though, one should note, the term “media” is much younger in its present usage) in which processes of transmission, calculation, and storage were not restricted to forms of technical media that we would normally understand by the term (twentieth-century mass media from cinema and radio to television and network media such as the Internet).

To follow Akira Mizuta Lippit, the intertwining of animals and technology was an inherent part of the modernization and emergence of technical media at the end of the nineteenth century. The disappearance of animals from urban cultures of technical media was paralleled by the appearance of animals in various discourses, from media (e.g., cinema) to modern subjectivity (e.g., psychoanalysis). As Lippit notes, from metonymies of nature animals became embedded in the new industrial environment, where

the idioms and histories of numerous technological innovations from the steam engine to quantum mechanics bear the traces of an incorporated animality. James Watt and later Henry Ford, Thomas Edison, Alexander Graham Bell, Walt Disney, and Erwin Schrödinger, among other key figures in the industrial and aesthetic shifts of the late nineteenth and early twentieth centuries, found uses for animal spirits in developing their respective machines, creating in the process a series of fantastic hybrids.²⁴

Siegfried Zielinski’s anachronological approach has tried to delineate media history that has run away from its institutional and conventional

definitions to neglected, “minor” phenomena; similarly, Jeffrey Sconce, for example, has mapped the anomalies haunting the normalized understanding of media since the nineteenth century, demonstrating how media mediate not merely between humans but also, on the imaginary media level, between ghosts and the living.²⁵ Again, the media archaeological method has proved apt as a cartography of media culture beyond the usual confines of technology and human intentions to encompass a variety of not only sources used but also analytical perspectives not confined to a narrow focus on actual technologies and their histories. Such work has already been done in the field of media archaeology, especially in mapping the histories of “imaginary media.”²⁶

In addition to scholarly contributions, recent decades of media art have also succeeded in deterritorializing media practices from a narrow understanding based on technologies to a wider and more innovative distribution—to organic, chemical, and other alternative platforms, where not only the established forms of transmission of perception count but also the realization that basically anything can become a medium—a realization that easily shakes our understanding of contemporary but also past media. Exemplary are the ideas proposed by former Mongrel art group members Harwood, Wright, and Yokokoji to consider the ecology as a medium in itself. The Cross Talk proposal explains ecosystems as communication networks, platforms of alternative agencies and sensoriums, in a fashion that subsequently also radicalizes the idea of “free” media. Exhibitions such as Bug City (2006) in Canada were as exemplary in discussing the insect question as crucial to modernity and postmodernity. Such exhibitions are good educations in the “becoming-insect” of contemporary culture and how to enter the swarm logic that seems to characterize network culture: we “enter the swarm” when using the bit torrent protocol, we are told, as much as when we enter the swarm space, whether visual or aural, in swarm art installations that introduce the move from static design to dynamic spaces and interaction with such processes.²⁷ A recent installation, Timo Kahlen’s 2008 *Swarm* piece, is a good example of the way a sound object turns the whole space where it is placed into a vibratory, lived space with bee sounds that are modulated and recomposed.

Biomedial art pieces might often work through the centrality of the algorithmic, which creates “natural forms” in digital environments. How-

ever, at least as interesting is how they are able to reframe life in its wet materiality.²⁸ Genetic algorithms express complex processes that resemble Karl Blossfeldt’s photographic art from the 1920s depicting “natural forms.” Instead of just representing, digital media were creating forms in the 1990s of interest to evolutionary algorithms and have been followed by various biomedial projects that cross the boundary of digitality and the fleshy bodies of animality. In any case, the more interesting experiments not only showed the phenomenological resemblances in nature and art(ifice) but engaged in a more radical redistribution of the presumed division. This “art for animals,” as Matthew Fuller has called it, does not represent or depict animals as objects but targets animals as audiences: it is “work that makes a direct address to the perceptual world of one or more non-human animal species.”²⁹ Technologies and techniques of seeing, hearing, and transmission can be found in the most surprising places.

In the context of *Insect Media*, Zielinski’s suggestion regarding the fundamental inhumanity of media is important. The earlier idea of technology as an organ stretching from the human being has been demonstrated as dysfunctional, as has the straightforward translation of the organic as the technological in the era of the computer: “Technology is not human; in a specific sense, it is deeply inhuman. The best, fully functioning technology can be created only in opposition to the traditional image of what is human and living, seldom as its extension or expansion.”³⁰ I take this as referring to the impetus to steer clear of easy-going metaphors and look for another, a more fundamental level, of molecular movements, intensities, which characterize potentials for media. This follows an earlier critical task of reorientation expressed by Friedrich Nietzsche, in which the human being and the valuation of consciousness as the highest level of evolution were questioned.³¹ This anthropomorphic dream, or prejudice, tended to form trees of thought and progress in which the cognitive man was the primary reference point. There is an urgent need for a cartography of potential forces of inhuman kinds that question evolutionary trees and exhibit alternative logics of thought, organization, and sensation.³²

This can also be understood as the immanent theme that runs throughout modernity and the animal–technology relationship, where animals seem to suggest a mode of communication and media beyond those

of the human language. As Lippit argues, animals suggested, from the Darwinian revolution to Freudian psychoanalysis and in the midst of "the advances of the optical and technological media," a new understanding of technics beyond that of symbolic human communication.³³ This realization is something that should further be added to a methodological approach to animal technics.

Next, I will address the question of media as a milieu of intensive capabilities, an ethology, and hence illuminate more specifically the theoretical contexts of this book.

MEDIA ETHOLOGY

One might object that it's all nice and interesting, this talk about animals and biology, but remains irrelevant to the world of media technologies: it is in vain to transport biological models into the world of technology, which, in the age of digital computing, is more mathematical than biological. Yet mine is not a metaphoric suggestion but one committed to approaching media technologies not as a fixed substance but as a realm of affects, potentials, and energetics. It is my contention that contemporary analysis of media should furthermore underline the need to rethink the material basis of contemporary media condition and produce much more complex intuitions that take into account a certain "activity of matter," nonhuman forces expressing themselves as part of this media assemblage of modernity.

Coupling biology and technology and relying on concepts adopted from biology in cultural explanations have had their fair share of felicitous criticism in recent years. For example, Anna Munster and Geert Lovink note that we should argue "against biologism." Networks, for example, do not "grow" in the manner of teleological plants, nor do they "emerge"; contagions, memes, and epidemics are in constant danger of being pressed into metaphorical use by marketing departments that use them instead of providing a specific view of what goes on in networks and other cybernetic systems.³⁴ This relates to the question, What do we actually talk about when we address animals, insects, and media technologies? Do we think of them as predefined, discrete forms of reality in which natural beings are separated from cultural substance (and seen only through our discursive lenses)? Or would there be a chance for a view

in which we would not have to assume a preparatory division but could approach things as intensive molecular flows, in which, for example, the notion of "media" was only the end result of connections, articulations of flows, affects, speeds, densities, discourses, and practices (namely, assemblages)?³⁵ Could we see media as a contracting of sensations into a certain field of consistency—whether called an environment or a media ecology? In other words, could we not (only) ask how nature is evident in our media cultures but what in media technology is already present in nature?³⁶ That seems to be the implicit question that various models of swarms and such projects as Craig Reynolds's 1980s work with boids pose: how can we reframe the natural to make it into a viable dynamic machine for the technological?

Whereas since the boom of network media in the 1990s there has been a constant danger of inflating the use of cultural theoretical concepts, there is also another danger in loose metaphors. By using analogy as a method of explanation, we often try to see one phenomenon in the use of some other, usually a familiar one. Take viruses. A computer virus might be explained as being "like" a biological virus, capturing the cells of the host, using them to spread its own code, and making new viruses (perhaps also killing the host). Despite the reasonable-sounding "analysis," the problem is that there is so much baggage that comes along with metaphors, and in the case of biological metaphors, it tends to "naturalize" a cybernetic construction. The phenomena are placed on an explanatory grid that has already stabilized the relations of nodes. What are neglected are the intensive processes of individuation out of which more stable formations emerge. In this sense, we should be interested not only in the actualized technological objects, animal beings or their combinations, but in approaching them as carriers of potentials, forces of individuation, expressions of "what bodies can do." Similarly, when I analyze literary examples or insect figures in popular cultural objects, I do not approach them primarily as metaphors but as relays in the wider structuration of the biopolitical regime of the technical media age.

In this context, Gilles Deleuze and Félix Guattari, who were reluctant themselves to think in terms of "media" (discarding it as a realm of communication), can offer media theoretical clues. Their neomaterialist ideas have been continued and developed by many other writers also mentioned in this book, such as Eugene Thacker, Alex Galloway, Tiziana

Terranova, Matthew Fuller, Elizabeth Grosz, John Johnston, Manuel DeLanda, Luciana Parisi, Rosi Braidotti, and Brian Massumi. In this context, this book approaches the translations and transpositions of insects and biology with technology and media in terms of the following three key terms: intensity, assemblage, and diagram.

Intensity

As an alternative to years of the hegemony of the signifier, the linguistic turn, and the various types of cultural constructionism that have placed "meaning" in its linguistic form as the key object of cultural studies, various new approaches have emerged. Within cultural studies, Lawrence Grossberg was among the first to address the shortcomings of meaning and draw from Deleuze, Guattari, and Spinoza for a more material approach tuned to affect. Indeed, *affect* is one of the key words used in thinking beyond both the signifier and the body as only an individualized entity and to grasp the interconnected nature of bodies of various kinds.³⁷ In what has been coined "material feminism,"³⁸ different strategies to counter the primacy of the linguistic have been proposed in order to adequately theorize the nonhuman and the intensity of the material. The list could go on, including Bruno Latour's theories of nonhuman networks, Langdon Winner's takes on science and technology studies, German "materialist" media theories from those of Kittler to those of more recent writers such as Wolfgang Ernst, notions of abstract materialism suggested by Luciana Parisi and other writers, or, for example, the critique of hylomorphism.³⁹

Neomaterialist cultural analysis, in the context of this book, is an approach that tries to acknowledge the specificity of the material. The differential creativity of the material stems from a radicality of difference that is not only difference within a genus, a third general concept, as the Aristotelian tradition supposes (for there to be a difference, there must first be something common). Difference, in such a case, is in danger of residing merely on the actual level of already defined entities of the world. Instead, difference becomes an ontogenetic—and consequently heterogenetic—force.⁴⁰

A differing force of creation, a becoming, an intensity creates what we perceive. The perceived takes place only through events in which both the subject and the object are formed. This is the intensity inherent in

Deleuze's thought and also in more recent formulations of neomaterialism: to see the divisible, the extensive, the named merely as a result of forces of intensive differentiation. The focus on the intensive does not mean that extensions are not real. On the contrary, they are very much real, imposing themselves, but only as one possible mode of being, on temporary end results in the intensive processes of individuation.⁴¹ Differentiated entities tend to hide their history of differentiation, which in a way undermines the creative processuality of the world.⁴²

The focus on intensities, in addition to being an ontological statement, refers to the crucial methodological need to understand the creative forces of the world. These forces mold our lived relations, which increasingly are characterized by the milieu of technology and nonhuman technological actors but also by new modulations of nature in the form of biodigital technologies, nanotechnologies, and biological computation, for example.⁴³

In general, a new materialism addresses a micropolitics of matter, the nondiscursive manipulation of energetic material flows that have been captured in the bioproduction of modern media culture since the nineteenth century. This means there is a need to stay in tune with the ethics and politics of life and subrepresentational processes. As Braidotti writes, there is a whole history of thinking animals in terms of energetics and potentials, often reduced to a technological-industrial mode. Paraphrasing Braidotti, the idea of animals as machines is not reducible to the philosophical claim that both lack souls but to think both as workers and producers, like "an industrial production plant."⁴⁴ Raw material for production, but also producers, animals are much more than they are captured to be.

Thus biopower, the key theme of the book, is to be grasped not merely as the capture of life as the *object* of power, which Foucault analyzed meticulously in terms of the biological features of human populations. Instead, as Braidotti suggests, life is intensive, creative, and infinite in the Spinozan take, in which life became a subject as well. It is an agency that in its intensive creativity is coming up with new solutions and ways of engaging with the world. This viewpoint differs to some extent from the recent Heideggerian emphasis on life and biopolitics suggested by Giorgio Agamben, in which death is the continuous zero point and horizon of life. Beyond what Braidotti calls a narcissistic viewpoint that

promotes loss and melancholia, a Spinozian version looks at life as something that surpasses the individual and is a nonpersonal force of creativity that contracts individuals as its attributes.⁴⁵ In Braidotti's take, life is the double articulation of *bios* (politics and discourse) and *zoe* (nonhuman intensity), a continuous intensive creation that is also continuously articulated on a social level of power and knowledge that, increasingly during modernity, has been a level of technical media: from technologies of the image and the cinema to games, software, and networks.

Assemblages

Seemingly stable bodies are always formed of intensive flows and their molecular connections. Bodies are not merely predefined organs and functions; they form as part of the environment in which they are embedded.⁴⁶ Gilbert Simondon talks about individuation and the (in)formative role of environmental milieus in this metastability of transductive relations; Deleuze and Guattari insist that we must get away from closed models of bodies and organisms and look at how bodies are continuously articulated with their outsiders.⁴⁷

Another way to take into account the ontological intensity of the world is to focus on the intensive qualities of beings, their capacities. In a mode of thought that also draws from Simondon's emphasis on individuation, this suggests a cartographical mapping of the qualitative modes of creation of forms of life defined not (only) by their stabilized forms of organization but by their potentials for experience, sensation, and becoming. Recently an increasing number of media theorists have drawn from Simondon, including Mark Hansen. For Hansen, too, Simondon offers a way to step further from social constructivism that stems from what Hansen describes as an externalist account of the body toward an ontology of the originary technicity of bodies.⁴⁸ Biological and technological bodies are not natural kinds, but they carry tendencies toward various relations, percepts, and affects.⁴⁹ Such points are later elaborated in this book not only in contexts of philosophy but, for example, through the "cybernetic zoology" of the 1950s and 1960s, including Karl von Frisch's research into bee dancing and W. Grey Walter's cybernetic turtles. These various discursive and technological constructions can be seen as enviroing and affective assemblages that operate through relating and responding to the fluctuations of their milieus.

This is where ethology becomes media theory. Such an ethological perspective (referring to Jakob von Uexküll) of the world leads us to evaluate bodies not according to their innate, morphological essences but as expressions of certain movements, sensations, and interactions with their environments. These are always intensive potentials, not pre-determined qualities, which underlines an experimental empiricism.⁵⁰ Assemblages are compositions, affects, and passages in a state of becoming and a relationality that is the stuff of experience. No assemblage stems from a prescribed relation hidden inside it, as if it were a seed; rather, an assemblage comes from the folding of the inside and the outside. An assemblage, whether classified as technology, animal, or a human being, is a product of the connecting relations, and what can become technological is not decided *before* the relations are entered into, something that Simondon refers to as the transductive relation. In other words, assemblages are always constituted by a relationality, but this does not mean a complete external constructivism but an ontogenesis of transindividual individuation. All relations are enabled by a pre-individual reality of potentials and virtuality, and this transindividual element that beings share is what affords collective assemblings as well.⁵¹

Affects are always in transit and hence contain an element of virtuality. Jean-François Lyotard refers to the "affect-phrases" of animals that do not fit into the communicative and discursive logic of human language but cut through it, opening up another, alternative, way of relating and communicating.⁵² Animals are beyond language but not mute. They are stratified by but not reducible to the human signifying practices and hence offer a fruitful way of approaching affects. Beyond language, however, animals such as insects map territories, contract forces, fold their bodies, and establish relations. This is what I find a crucial point in the field of animal studies and posthumanism as well: we must not get stuck with the question concerning language and the defining differences (usually in terms of language) that remove the animal from the cultural. Instead we should map the differing modalities of expression of animal bodies that point toward asignifying semiotics. Animal studies joins forces with media theory of a nonhuman kind. Reproduction of culture takes as much into account those semiotics of intensive bodily interactions and fluctuations as it does the linguistic acts and discourses; indeed, it is increasingly urgent to recognize the different genealogy of

thought that helps us to realize this regime of asignifying semiotics and nonlinguistic individuation that draws more from Spinoza, Bergson, Whitehead, Simondon, and Deleuze-Guattari than from Plato, Descartes, Hegel, and Heidegger or even Derrida.⁵³

The asignifying regime of signs can be related to the notion of affect. Affects are not possessed by anyone, but blocs of them constitute individuals.⁵⁴ Affects are transitions, gateways, and passages between dimensions. As an artistic endeavor, however, affects are reducible not to human art but to art as creation, the art of relations, from animals to technics of various other kinds. This affinity with the primacy of affects (as indexes of relationality) is what distinguishes this project from some much-discussed positions in animal studies. Much of the agenda has been set in relation to the Western metaphysical tradition in which the intensity of the animal has been undermined by a lack of language of the beast. Even though writers such as Jacques Derrida have succeeded in pointing toward the “heterogeneous multiplicity” in the animal itself, it is more often writers coming from Deleuzian or Whiteheadian traditions who have been able to grasp the vibrant materiality of the animality.⁵⁵

In other words, mine is a kind of a milieu approach to the world and, in the context of this book, to media technologies. Also, media can be defined as assembled of various bodies interacting, of intensive relations. Media can be seen as an assemblage of various forces, from human potential to technological interactions and powers to economic forces at play, experimental aesthetic forces, conceptual philosophical modulations. Media contract forces, but also act as a passage and a mode of intensification that affords sensations, percepts, and thoughts. An assemblage is not, then, only a collection of already existing elements (technology taking the animal as its model, for example) but is in itself a mode of cutting flows. It consists of much more elementary things such as speeds and slowness, affects (potentials to connect) and qualities—a mode more akin to becoming than expressing a solid being (the becoming animal of technology, the becoming technical of the insect).⁵⁶

The assemblage approach underlines a nonrepresentational cultural analysis. Becomings and machinic conjunctions are not about imitation and representation of forms or actors.⁵⁷ Instead they move on a plane of immanence that traverses the stable forms. An insect becoming media or a network becoming an insect swarm is not an imitation but a molecular

expression of the affects that the assemblage is capable of. Suddenly, in a certain territorial situation, coupled to its environment, an insect might be seen as a modern media technology (the entomological translation of insects in terms of telegraphs, for example), or a network agency might be modeled as animal packs or insect swarms self-organizing in a certain environment. The questions of naturality or artificiality are bracketed, and the focus is placed on the nonrepresentational environment and the machinic assemblage in which the entities act.

In other words, media can be approached as intensive capabilities that are constitutive of worlds.⁵⁸ Also, animals live in and of media: their world is by definition formed of the constant interactional sensing, movement, and memory of their surroundings, much as the media environment in which we live is constituted of our ethological bodies interacting with bodies technological, political, and economic. Or, to put it a bit differently: we do not so much *have* media as we *are* media and *of* media; media are brains that contract forces of the cosmos, cast a plane over the chaos. Deleuze and Guattari wrote the seminal book *What Is Philosophy?* but someone should address the topic *What Are Media?* in a manner as extensive and original. What is the specific plane that media contracts, or is there even one? Do media work through elements from science, art, and philosophy, a crisscrossing of various modes of dealing with chaos? Furthermore, it is not clear that we can find the answer in books on philosophy, but perhaps we can find it in such works of fiction as the film *Teknolust* by Lynn Hershman-Leeson (analyzed in chapter 7).

Diagrammatics

Even though in this book I am continuously underlining the importance of an intensive focus on the plane of immanence on which particular bodies, organisms, and other stratifications (technologies, animal species, human characteristics) are formed, this is supplemented by a historical view. Any assemblage works on various spatial and temporal scales and hence as an “ecology” of a kind. In addition to their openness to new connections, there are what Manuel Delanda calls “universal singularities” that are the space of potential, of virtuality, which limits what any assemblage (body) can do (a diagram). Potentials are always articulated in and through specific historical situations. As will become evident in the book, the intensity of affects, whether animal, human, or media

technological, is constantly captured as part of the productive machinery of media technological modernity. To be sure, this is what technoscience has been about: rationalizing modes of action, capturing the movement and interaction of bodies, controlling the future by standardizing the otherwise fluctuating animal affects. This relates to Michel Foucault's interest in analyzing the techniques of the spatialization and channeling of bodies and the creation of new diagrammatic maps that are not stable, closed structures but ways of distributing singularities: virtual elements that define the borders of a diagram and limit the turns and directions into which it can actualize.

Following Delanda's terms, diagrammatics can be understood, however, not only as a parasitical capture but as a tracking of the intensive singularities of body diagrams. These are spaces of possibilities or topologies of potential singularities that are the potential modes of actualization of a certain body plan. During evolution, vertebrates, crustaceans, and insects, for example, have developed and followed a certain diagrammatic space of possibility that defines (not as preexisting possibilities but as virtualities that need to be actualized in intensive, embodied processes) what a specific animal is capable of.⁵⁹ An animal phylum has a certain topology, a space of possibility, and a key feature of this book is its analysis of why technological modernity has gradually taken such an interest in the singularities of primitive life, especially insects. For me, this is also a historical question, which explains the focus on modern times. Insects have been discussed for a long time; the philosophers in ancient Greece were already contributing to the topic in various texts. But in order to question more specifically the biopolitics of technical modernity and technical media, I want to limit my book to developments not earlier than the birth of modern entomology and modern media.

In one crucial mode, the translation of animals into media has been part of the science of physiology in diagrams of translation par excellence that have created media technological sensations and perceptions severed from the observing, perceiving subject. As argued by several writers, the sciences of sensation and physiology contributed to the emerging technological media culture of the nineteenth century, which was keen on rationalizing procedures of perception, communication, and organization.⁶⁰ Animals, too, and even such seemingly irrelevant "dumb" forms of life as insects, were already then being translated through scien-

tific research into constituents of media technologies and a conceptual opening to nonhuman affects as the potentialities of a media to come. The articulations of insects-media-technology were part of a larger diagrammatic field of excavation of the principles of (animal) life.

Hence diagrammatics refers to a mode of analyzing, defining, and reproducing animal affectivity (which spreads from the human sensorium measured as psychophysical quantities to insect organization and sensation) and distributing it from strict scientific contexts across a broad social field. Starting in the nineteenth century, insects spread from fashion garments to popular fiction in the form of amazing stories of alien insects with horrific capabilities. Of course, the diagramming is not unidirectional, from science to popular culture, but exists as a continuous feedback loop. This is why the book mixes such a variety of source materials, from the sciences of entomology and computers to, for example, media art and surrealism, popular science fiction, techniques of digital cinema, and concepts of late twentieth-century feminism. This is how diagrams always work: through mixing and transporting practices and discourses.

FROM ANIMAL AFFECT TO TECHNOLOGY

Referring to the title of the book—*Insect Media*—I wish to underline that I do not intend to write a whole history or a universal theory of media from the viewpoints of these small animals. The book works through transversal case studies that address issues I see as especially important in the present context of the insect media of network culture. The topics are chosen to represent a transversal link between various levels of knowledge production and culture. In other words, the chapters move from science (entomology and biology) to technical media, from popular culture to avant-garde arts, and touch various media from cinema to music, software, and literature. They act as condensation points for transversal networks of scientific discourses, popular cultural clues, and media theoretical notions. Hence they draw from a heterogeneous source base and work to illustrate through empirical examples the potentials in emphasizing the transdisciplinary relations of "the insect question."

Think of the first half of the book as a media archaeological parallel to the 1996 film *Microcosmos*. Through a magnifying cinematic lens, insect

life is revealed to consist of industrious workers and factories, weird capacities and potentials, complex systems. The themes stretch from scientific research and biology to science fiction, the physiology of movement and perception, avant-garde aesthetics, and the non-Cartesian philosophy of the early twentieth century. The notion of media as technics is not reducible to technology as we normally understand it (tools and machines used by humans or technological systems ontologically different from living organisms). It is much closer to Simondon's idea of technicity as the "transformations and correlations that characterize technical objects."⁶¹ A primary characteristic of insects, metamorphosis, is transported to the heart of technics, and technics becomes an issue of affects, relations, and transformations, not a particular substance.

The first chapter addresses the enthusiasm in insect analysis from entomology to popular culture and the philosophy of the nineteenth century. Moving from the early entomological classic of Kirby and Spence to *Alice in Wonderland* and *The Population of an Old Pear-Tree; or, Stories of Insect Life*, the chapter maps the fabulations of the insect world as a microcosmos of new movements, actions, and perceptions. These intensive potentials were tracked in the physiological research of, for example, Etienne-Jules Marey but also continued in Henri Bergson's biophilosophy. There the characteristic mode of life of insects, instinct, is contrasted with that of the intelligent tool-making animals. Despite this realization, the primitive insect is revealed as an alternative kind of technical assemblage, a technics of insects and nature in which the tools are not yet differentiated from the body of the animal. In a way, the chapter can be thought of as providing a "response" to Donna Haraway's call for a nonanthropological way of understanding reality beyond the human-centered notion of "culture" or the sociological emphasis on human groups—the need to turn toward animal societies, which also "have been extensively employed in rationalization and naturalization of the oppressive orders of domination in the human body politic"⁶² and hence are a crucial part of the biopower of the contemporary technological world.

Chapter 2 continues the idea of natural technics in the context of architecture and organization. The idea of seeing insects and animals as builders, architects, and geometers was widely discussed in the latter

half of the nineteenth century and was also seen in the context of the early modernist architecture of the early twentieth century. For example, the comb structures of bees seemed to express a meticulous order, a theme that was widely used to underline the rigid and hierarchic social systems of insects. Yet in addition, a whole other contrasting theme should not be neglected, that of swarming and self-organizing systems. This idea gained much interest in the context of research into emergent systems, as with C. Lloyd Morgan, and here insects can offer indispensable lessons in the nonhierarchical modes of organization of network society, as Eugene Thacker has suggested.

Chapter 3 focuses on the work of the early ethological pioneer Jakob von Uexküll. His research into the affect and perceptive worlds of insects is a radical continuation (and also overturning) of Kantian philosophy and attracted much attention in philosophical discourse of the twentieth century from Heidegger to Deleuze and on to Agamben. The chapter analyses his ideas of animal perception and underlines the issue of temporality as a way to understand the variations and potential openness in perception. Ethological research works as a double of the 1920s and 1930s avant-garde discourse of technological (mostly cinematic) perception as radical anti-Cartesian probing.

The next chapter continues along the routes paved by the avant-garde. The early surrealist movement was very interested in insects, and the chapter uses the research of Roger Caillois into the spatial worlds of insects as an opening to discuss the metamorphosis of space, temporality, and devouring mimicry. Later adopted by Lacan in his theories of the mirror stage, the early surrealist discourses give a hint of how to move beyond the phenomenal affect worlds of the human being toward animality as a mythical but also intensive force. As Caillois's work on play and imitation has been adopted as part of game studies, what would a more elaborated "insect approach" to worlds of gaming and play look like, something that would again challenge the anthropomorphic way of looking at the genealogy of technics and evolution?

Mediated by a short theoretical intermezzo, the second half of the book focuses on post-World War II discourse relating to media as insects. The aim of this part is to articulate how insects and animal affects were directly addressed in technological contexts from research into the

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cybernetic loops between machines and animals, the perception qualities of machines and animals, the simulations of swarm behavior and semiintelligent systems, and, in recent years, media art from the feminist film *Teknolust* by Lynn Hershman-Leeson to some other key examples. The second half of the book tracks the technological synthesis of the affective qualities of animal and insect life, a contracting of the intensive ecological potential of animals as they were understood in the cybernetic and digital discourses of recent decades. A simulation of movement, perception, swarming, and even evolution amounted to a new kind of approach between biological and technological beings in which the intensive life of the hybrids was discussed not only in terms of cyborgs but increasingly in those of insectlike distributed systems.

In this context, chapter 5 moves from cybernetics to a related set of questions developed by researchers of animal perception. Cybernetics has been identified by a plethora of cultural theorists and historians as the crucial mode of interfacing animal affects and technological systems, with a special emphasis on, for example, Norbert Wiener's work. However, the ideas offered by Gilbert Simondon in his writings from the 1950s and 1960s offer a much more intensive and embodied understanding of information, communication, and individuation. In this context, the chapter discusses Karl von Frisch's research into bee dancing and communication in the 1950s as well as briefly reviewing the "cybernetic zoology" of W. Grey Walter with his robotic tortoise. The chapter addresses the need for an embodied understanding of communication that is promoted through the concepts of assemblage, individuation, and transduction.

Similar themes are continued in chapter 6, which analyzes new techniques of computer-generated imaging that spread from computer science and visualizing experiments (e.g., in artificial life research) to mainstream New Hollywood cinema. Addressing the theme of insects in 1980s and 1990s cinematic culture, the chapter thematizes the culture of the visual as a culture of calculation based on insect models of automated systems. The visual creations, "biomorphs," that were an example of nature's computational power harnessed to create complex forms in Richard Dawkins's work, provide the key example to connect the computational powers of nature to the swarms and flocks on the vi-

sual screen. However, to address the shortcomings of the neo-Darwinist discourse in digital culture, the chapter turns to the swarm algorithms developed by Craig Reynolds. In the 1980s, his "boids" figures emerged as key modes of programming collective behavior, and the chapter uses the idea of boids to address ethologies of software.

Chapter 7 continues along cinematic lines but engages with the film *Teknolust* (2002). It presents an alternative cinematic account of biotechnologies in contemporary culture through the lives of three self-reproducing automata. The automata break free from the home lab of bioscientist Rosetta (Tilda Swinton) and embark on a life of their own, trespassing the boundaries between worlds of computer-generated habitat and the analog world outside computers. The chapter analyzes the figurations of sex, sexuality, and reproduction in *Teknolust*, which presents a refreshing account of the biopower of contemporary digital culture. In the context of feminist sexual difference, Braidotti has been keenly promoting figurations of insects and animals as efficient philosophical concepts of nomadic cultural analysis. Such alien forms of affects and sensations offer a challenge to normalized figurations of the male body as the normalized mold of being. Insects, among other figures, creep into the supposedly intact but in fact crack-filled phantasm of the body of late modernity, revealing the distributed and assembled nature of any body taken to be natural. Insects, then, are a parallel mode of becoming in terms of bodily metamorphoses but also as carriers of nomadic, energetic thought that turn from an emphasis on metaphors and meaning to one on metamorphoses and temporal bodies.⁶³ We are constantly penetrated and accompanied by a panorama of nonhuman forces and "mutations of desire" (Parisi), something that the figure of the cyborgs perhaps tried to convey but of which more recent variations closer to animals have been more pertinent examples, as is also argued by Elizabeth Grosz. In this context, *Teknolust* demonstrates the new forms of subjectivity imagined and glued as part of the intimacy between female agency and new technologies.

The concluding epilogue draws together themes discussed earlier and addresses recent (new) media artworks in which the theme of insects is analyzed. Seeing insects as a powerful mode of distributed intelligence, harnessing nature and experimenting with nonhuman modes of

sensation, such insect media can also be seen as philosophical thought experiments. The epilogue also addresses some themes of new media art in recent media philosophy, for example, Mark Hansen's writings.

In closing, a few words of clarification. Insects are not the only phylum of animals I analyze in this book, but they provide a generic opening for my interests in this "bestial" media archaeology of animal affects. Why insects? Not only have animals been of media historical importance in general; insects can be seen as "the privileged case study,"⁶⁴ as Eugene Thacker notes: they are paradigmatic examples of the many, the emerging swarm order that questions notions of sovereignty, life, and organization that are so crucial for current articulations of politics, networks, and technology. If the human has been the starting point in most accounts of Western political philosophy (and also the philosophy of organization), insects provide a crucial difference within that mode of thought. Of course "insects" is a huge category that comprises in its modern definition a subclass of arthropods of more than 900,000 species from dragonflies to bees, grasshoppers to moths, flies to ants, bugs to praying mantises. This book tends to focus on just a few selected ones that have been dear to popular culture and designers of technology: bees, ants, wasps, spiders, and a few other examples, which exhibit a curious creative relationship with the world. Although the twentieth century has had its fair share of reductive accounts that see various "minuscule forms of life"—whether behavioral traits of social insects (sociobiology) or genes, for example—as the defining stuff of life, this book defines this "stuff" only through relations of externality and change and hence is far from suggesting that everything is already defined and set for us by and in nature.

In addition, there is a curious, nearly ephemeral side to insects. They are probably furthest from the image of domesticated animals that have been contained and rationalized as part of the pet culture of modern society.⁶⁵ Yet, as noted throughout the book, insects have also gradually been made part of the diagrammatics of the contemporary media condition as uncanny models of sensation and organization. However, they remain radically nonhuman: as often presented in science fiction, insects are from outer space; they remain alien to human life. They present a curious threat but perhaps also a possibility of a future nonhuman

life. In the communist-fearing United States of the 1950s, insects were models of the cold other, this time seen through the lenses of cold war politics. For David Cronenberg, the connection and fear were more intimate: perhaps insects are already inside us, perhaps there is an uncanny animality within us. In his remake of the 1958 Kurt Neumann film *The Fly*, Cronenberg's 1980s vision presented the metamorphosis of the protagonist, Seth Brundle, as stemming from the molecular level. Despite the monstrous change, Brundle himself sees it as merely expressing the dormant continuity between the animal and the human: "I'm an insect who dreamt he was a man, and loved it. But now the dream is over, and the insect is awake." The molecular metamorphosis expresses itself on the level of affects and percepts, the way the Brundle-fly relates to his/its environment. What distinguishes this new hybrid from humans are its new strengths, energy, body hair, perceptual capabilities, and sexual appetite.⁶⁶ Cronenberg's film can be seen as a cartography of human and insect affects. The medium of film continues the work of the microscope in examining the worlds of animality. However, whereas the microscope was embedded in the scientific practices of recording, analyzing, and reproducing the motions, percepts, and capabilities of the animal, Cronenberg's project is much more poetic and works in terms of an ecosophy: a catalysis of animal forces for the society of technical media and a mapping of singularities of the new forces stemming from the assemblages of technics.⁶⁷

Swarms, metamorphoses, and weird sensations are easily produced by digital technologies of imaging, but this theme is not reducible to technological possibilities. Hence, there is also a philosophical side to these simple animals, constantly present in this book as well. The insect becomes a philosophical figure for a cultural analysis of the nonhuman basics of media technological modernity, labeled not by the conscious unity of Man but by the swarming, distributed intelligence of insects, collective agents, and uncanny potentials of the "autonomy of affect."⁶⁸

of bodies and their sensoriums to new diagrams of tapping into and capturing such bodies in technocapitalist projects. It is defined by this complexity, and by the media ecological relationality that demands an insectlike compound vision system and the alternative senses of the cultural analyst as well, to be able to take into account the various planes on which the notion of insect media is organized and distributed but also finds its lines of flight. As tracked throughout this book, insects are not only the theme of the book but also the subjects of a body of thought that emerges from various sources, some explicitly, some implicitly present here: Michel Serres's notions concerning parasites, animals, and theories of information; Deleuze and Guattari's biophilosophy; Foucault's analysis of the regimes of power and the body; Simondon's way of thinking the living as a process of individuation; and the ideas of various more recent theorists, from Rosi Braidotti to Eugene Thacker, who have helped to bridge gaps between "wetware" and "techware" approaches to post-humanism. The way some insects are defined by metamorphosis connects them to a conceptual agenda of cultural analysis and media archaeology keen on developing conceptual tools to open up "universes of virtuality"²⁷ and ecosophic cartographies that are less about interpretation than about creating potentials for "assemblages of enunciation capable of capturing the points of singularity of a situation."²⁸ In this case, the singularity resides in ethological relations, metamorphosis, and bodily intensities and potentials of communication that are not captured from an anthropomorphic perspective. Incidentally, these points are what connect contemporary network culture and the much older techniques of environing that we find in animals such as insects.

NOTES

INTRODUCTION

1. See the project homepage for DARPA: <http://www.darpa.mil/> (accessed April 10, 2009). For another example of insect robotics, see "Robots Scale New Heights," *BBC Online*, July 8, 2008, <http://news.bbc.co.uk/> (accessed April 10, 2009).
2. John Arquilla and David Ronfeldt, "Swarming and Future Conflict," *RAND National Defense Institute Document Briefings* 311 (2000), <http://www.rand.org/> (accessed April 10, 2009).
3. For a short summary of insect robotics, see, for instance, "The Buzz about Insect Robots," *Nova: Science in the News*, <http://www.science.org.au/nova/084/084key.htm> (accessed April 10, 2009).
4. Ki-Hun Jeong, Jaeyoun Kim, and Luke P. Lee, "Biologically Inspired Artificial Compound Eyes," *Science* 312 (April 2006): 557-61. For example, compound eyes were already being discussed at the end of the nineteenth century. See, for example, R. T. Lewis et al., "On the Use of the Compound Eyes of Insects," *Science* 20 (December 2, 1892): 314-15.
5. David Blair, *Waxweb*, <http://jefferson.village.virginia.edu/wax/> (accessed February 24, 2009).
6. Eric Bonabeau, Marco Dorigo, and Guy Theraulaz, *Swarm Intelligence: From Natural to Artificial Systems* (New York: Oxford University Press, 1999), xi. See James Gleick, "Why Can't a Robot Be More Like a Man?" *New York Times*, December 11, 1988.

7. "Sci/Tech Cockroaches: World Champion Side-Steppers," *BBC News*, February 17, 1999, <http://news.bbc.co.uk/> (accessed April 10, 2009).

8. Rodney A. Brooks and Anita M. Flynn, "Fast, Cheap and Out of Control: A Robot Invasion of the Solar System," *Journal of the British Interplanetary Society* 42 (1989): 479.

9. *Ibid.*, 478–85.

10. John Johnston, *The Allure of Machinic Life: Cybernetics, Artificial Life, and the New AI* (Cambridge, Mass.: MIT Press, 2008), 340.

11. John Johnston, "A Future for Autonomous Agents: Machinic Merkwel-ten and Artificial Evolution," *Configurations* 10 (2002): 490–92. A short note on sensation and perception: perception can be understood as the mapped and coordinated regime of the body "being in the world," whereas sensation is the element that exceeds that. Sensation is the element of becoming that cannot be pinpointed to one register or organ. See Elizabeth Grosz, *Chaos, Territory, Art, Deleuze and the Framing of the Earth* (New York: Columbia University Press, 2008), 72. Sensation is the element of virtuality and creativity that feeds perception, which underlines that the two are continuously tied together, informing each other.

12. Eugene Thacker, "Biophilosophy for the Twenty-first Century," in *Critical Digital Studies: A Reader*, ed. Arthur Kroker and Marilouise Kroker (Toronto: University of Toronto Press, 2008), 132–42; Michael Hardt and Antonio Negri, *Multitude: War and Democracy in the Age of Empire* (New York: Penguin Press, 2004), 91–93; Rosi Braidotti, *Metamorphoses: Towards a Materialist Theory of Becoming* (Cambridge, England: Polity, 2002). On early social theory and insects, see Diane M. Rodgers, *Debugging the Link between Social Theory and Social Insects* (Baton Rouge: Louisiana State University Press, 2008).

13. See Pasi Väliaho, "Bodies Outside In: On Cinematic Organ Projection," *Parallax* 14, no. 2 (2008): 8–9.

14. See Gilles Deleuze and Félix Guattari, *What Is Philosophy?* trans. Graham Burchell and Hugh Tomlinson (London: Verso, 1994), 212–13.

15. Media archaeology as a term and as a method has more or less been attached to research by Erkki Huhtamo and Siegfried Zielinski, as well as several approaches trying to open up cinema history into a more multimedial understanding, like that of Thomas Elsaesser, but also in recent years the materialist media archaeology of Wolfgang Ernst. Ernst continues Friedrich Kittler's agenda to approach technical media in terms of their technological capacities to record and transmit beyond the human senses. On media archaeology, see Erkki Huhtamo and Jussi Parikka, eds., *Media Archaeologies* (Berkeley: University of California Press, 2011). See the introduction for an archaeology of media archaeology.

16. "Studies of the Spider," *New York Times*, May 9, 1897. See also, for ex-

ample, this book from the nineteenth century: Eliçagaray, *Beautés et merveilles de la nature et des arts*, 3rd ed. (Paris: Philippart, n.d.), which lists among the marvels of artifice and nature both technological and animal wonders, for example, bees and other insects. We should note, however, that according to present understanding spiders are not insects but part of a different subclass of arthropods, namely arachnids.

17. "Two Hundred Crickets," *New York Times*, May 29, 1880.

18. Michelle Tolini, "Beetle Abominations and Birds on Bonnets: Zoological Fantasy in Late-Nineteenth-Century Dress," *Nineteenth-Century Art Worldwide: A Journal of Nineteenth-Century Visual Culture* 1, no. 1 (2002), <http://www.19thc-artworldwide.org> (accessed February 11, 2009).

19. William Kirby and William Spence, *An Introduction to Entomology*, vol. 2 (London: Elibron Classics, 2005), 270, facsimile of the 1843 edition; orig. 1815–1826.

20. *Ibid.*, 272.

21. See Laura Otis, *Networking: Communicating with Bodies and Machines in the Nineteenth Century* (Ann Arbor: University of Michigan Press, 2001).

22. J. H. Fabre, *Social Life in the Insect World*, trans. Bernard Miall (Harmondsworth, England: Penguin Books, 1937), 151.

23. Steven Shavero, *Doom Patrols: A Theoretical Fiction about Postmodernism* (New York: Serpent's Tail, 1996), <http://www.dhlgren.com/Doom/ch11.html> (accessed January 22, 2009).

24. Akira Mizuta Lippit, *Electric Animal: Toward a Rhetoric of Wildlife* (Minneapolis: University of Minnesota Press, 2000), 187.

25. See Jeffrey Sconce, *Haunted Media: Electronic Presence from Telegraphy to Television* (Durham, N.C.: Duke University Press, 2000).

26. Eric Kluitenberg, ed., *Book of Imaginary Media: Excavating the Dream of the Ultimate Communication Medium* (Rotterdam: NAI Publishers, 2006).

27. See, for example, Christian Jacob and Gerald Hushlak, "Evolutionary and Swarm Design in Science, Art, and Music," in *The Art of Artificial Evolution*, ed. Juan Romero and Penousal Machado (Berlin: Springer, 2008), 145–66.

28. See Monika Bakke, "Zoe-philic Desires: Wet Media Art and Beyond," *Parallax* 14, no. 48, July–September 2008, 21–34.

29. Matthew Fuller, "Art for Animals," in *Deleuze/Guattari and Ecology*, ed. Bernd Herzogenrath (Basingstoke, England: Palgrave, 2008), 267.

30. Zielinski, *Deep Time of the Media: Toward an Archaeology of Hearing and Seeing by Technical Means*, trans. Gloria Custance (Cambridge, Mass.: MIT Press, 2006), 6.

31. Keith Ansell-Pearson, *Viroid Life: Perspectives on Nietzsche and the Trans-human Condition* (London: Routledge, 1997), 162. Ansell-Pearson writes that

consciousness is merely "one means by which the powers of life unfold and extend." Beyond such human, oh so human enterprises, for example, Bergson posited his idea that life comes up with various solutions to problems it encounters. These are analyzed in chapters 1 and 2, among others.

32. This can also be related to Michel Serres's approach to the posthuman. It is less about a figure that comes after the human than about a mode of rethinking key notions at the core of agencies such as unity and rationality. See Michel Serres, *The Parasite*, trans. Lawrence R. Schehr, with a new introduction by Cary Wolfe (Minneapolis: University of Minnesota Press, 2007). See also Wolfe's introduction, in which this idea is elaborated. In addition, see Robert Esposito's point about Nietzsche, which underlines a similar approach, in *Bios: Biopolitics and Philosophy*, trans. Timothy Campbell (Minneapolis: University of Minnesota Press, 2008), 101–9.

33. Lippit, *Electric Animal*, 2.

34. Anna Munster and Geert Lovink, "Theses on Distributed Aesthetics, or What a Network Is Not," *Fibreculture*, no. 7, <http://journal.fibreculture.org> (accessed February 11, 2009).

35. See J. Macgregor Wise, "Assemblage," in *Gilles Deleuze: Key Concepts*, ed. Charles J. Stivale (Chesham, England: Acumen, 2005), 77–87.

36. Cf. Gilles Deleuze and Félix Guattari, *A Thousand Plateaus*, trans. Brian Massumi (Minneapolis: University of Minnesota Press, 1987), 309.

37. See, for instance, Patricia Ticineto Clough with Jean Halley, eds., *The Affective Turn: Theorizing the Social* (Durham, N.C.: Duke University Press, 2007).

38. Stacy Alaimo and Susan Hekman, eds., *Material Feminisms* (Bloomington: Indiana University Press, 2008).

39. See, for instance, Manuel DeLanda, "Deleuze, Diagrams and the Open-Ended Becoming of the World," in *Becomings: Explorations in Time, Memory and Futures*, ed. Elizabeth Grosz (Ithaca, N.Y.: Cornell University Press, 1999). In general, see also Cary Wolfe, *Critical Environments: Postmodern Theory and the Pragmatics of the "Outside"* (Minneapolis: University of Minnesota Press, 1998).

40. Karen Barad refers to "things"-in-phenomena to bypass the things/phenomena dualism. The world is for Barad a process of dynamic flows and mattering from which "differential agential" positions emerge and suggest post-humanist notions of matter in a state of "congealing an agency." Barad, "Post-humanist Performativity: Toward an Understanding of How Matter Comes to Matter," in *Material Feminisms*, ed. Stacy Alaimo and Susan Hekman (Bloomington: Indiana University Press, 2008), 139.

41. As Constantin Boundas explains, we need not fear that Deleuze's ontology is dualist: "virtual intensity exists nowhere else but in the extended that it constitutes." Intensity is not identical to the extended terms, nor does it re-

semble them, but is rather the creative difference, force as a creative relation. Boundas, "Intensity," in *The Deleuze Dictionary*, ed. Adrian Parr (Edinburgh: Edinburgh University Press, 2005), 131.

42. Peter Hallward, *Deleuze and the Philosophy of Creation* (London: Verso, 2006), 11–18.

43. For some, such as Elizabeth Grosz, a rethinking of the connections of modern biology (such as Darwinism) and cultural theory is a crucial requisite for new concepts and practices of the body as an open-ended system that functions "with other huge systems it cannot control, through which it can access and acquire its abilities and capacities." Elizabeth Grosz, *The Nick of Time: Politics, Evolution, and the Untimely* (Durham, N.C.: Duke University Press, 2004), 3. Others, such as DeLanda, frame their "new materialism" more closely through a physics of self-organization.

44. Braidotti, *Metamorphoses*, 126.

45. Rosi Braidotti, *Transpositions: On Nomadic Ethics* (Cambridge, England: Polity, 2006), 38–40. However, passages from Foucault's later lectures suggest a way to incorporate this openness to the "natural running of things" as part of his theories of biopower. As he outlines, already early on a certain breach in the disciplinary apparatus of the police provided the need not only to impose objective regulations on the socially crucial issues from grain to safety but to find a way of flexible regulation: "So a regulation based upon and in accordance with the course of things themselves must replace a regulation by police authority." Michel Foucault, *Security, Territory, Population: Lectures at the Collège de France 1977–1978*, trans. Graham Burchell (Basingstoke, England: Palgrave Macmillan, 2007), 344. This relates in general to the sketching of the logic of security as one of intervening in the natural course of things—an alternative logic to that of discipline.

46. Also, nonorganic life "evolves," differentiates, and resonates with its adjoining milieus in order to further develop new assemblages and territories. Assemblages work through cutting flows and selecting from milieus (which can be external or internal). As J. Macgregor Wise notes, the elements of an assemblage are not just things but processes: qualities, speeds, and lines—and hence temporal becomings and milieus resonate as rhythms ("Assemblage," 78).

47. For sure, their biophilosophy has encountered severe criticism from writers such as Mark B. N. Hansen, who has pointed how their approach fetishizes the molecular becoming at the expense of organization. Mark B. N. Hansen, "Becoming as Creative Involution? Contextualizing Deleuze and Guattari's Biophilosophy," *Postmodern Culture* 11, no. 1 (September 2000): 22–23. Hansen hopes to flag the different modes of engaging with the body to which contemporary biology and complexity thinking adhere as well as the different

modes of thinking the body in some cognitive theories. Instead, writes Hansen, Deleuze and Guattari address a philosophical mode of conceptualizing bodies as ethological systems of relationality.

48. Mark B. N. Hansen, *Bodies in Code: Interfaces with Digital Media* (New York: Routledge, 2006), 13.

49. I am indebted throughout the book to Bergson, whose thinking is well summed by John Mullarkey, who writes that "organisms should not be regarded as natural kinds but as collections or nexuses of different tendencies, for no species, genus or kingdom uniquely possesses any one characteristic." Mullarkey, *Bergson and Philosophy* (Edinburgh: Edinburgh University Press, 1999), 65.

50. In Deleuze and Guattari's words: "We know nothing about a body until we know what it can do, in other words, what its affects are, how they can or cannot enter into composition with other affects, with the affects of another body, either to destroy that body or to be destroyed by it, either to exchange actions and passions with it or to join with it in composing a more powerful body." Deleuze and Guattari, *A Thousand Plateaus*, 257. Hallward, *Deleuze and the Philosophy of Creation*, 19.

51. Hansen, *Bodies in Code*, 86–87. On the computational assemblage, see Johnston, *The Allure of Machinic Life*.

52. Lippit, *Electric Animal*, 49.

53. See Luciana Parisi, "For a Schizogenesis of Sexual Difference," *Identities: Journal for Politics, Gender and Culture* 3, no. 1 (Summer 2004): 67–93.

54. Deleuze and Guattari, *What Is Philosophy?* 164.

55. Here, as Matthew Calarco explains, Deleuze and Haraway have much to offer with their ontological stances. Matthew Calarco, *Zoographies: The Question of the Animal from Heidegger to Derrida* (New York: Columbia University Press), 141. See also Cary Wolfe, ed., *Zoologies: The Question of the Animal* (Minneapolis: University of Minnesota Press, 2003). More specifically, Haraway distances herself from both Derrida and Deleuze-Guattari in her recent *When Species Meet* (Minneapolis: University of Minnesota Press, 2008), 31. Her focus on the multiplicity inherent in "companion species" eventually extends into a Whiteheadian ontology of events and, more specifically, draws from Lynn Margulis's idea that every solid organism is always an ecosystem in its own right. Without going into a discussion of her disagreement with the aforementioned thinkers, I find this ecological realization resonating with the affect-relationality, a politics of ecology, that I am trying to express through the following chapters.

56. Cf. Wise, "Assemblage," 84.

57. Ansell-Pearson, *Viroid Life*, 180–81.

58. Keith Ansell Pearson notes a resonating theme in his reading of Deleuze

and Guattari and von Uexküll. Prior to having functionally determined that organisms are closed units, we have the intensive molecular level of nonorganic life in which the "form" of matter is immanent to it. This immanent view of reality (of humans, animals, technologies, etc.) bypasses the dichotomies of form and matter, subject and objects, and taps into flows constituting stable entities. Beyond subjects and objects, or form and matter, there are "forces, densities, and intensities. . . . In short, this is to arrive at 'the immense mechanosphere' beyond the opposition of nature and artifice (technics, assemblages) in which the 'cosmicization of forces' is harnessed." Ansell-Pearson, *Viroid Life*, 120. This is a mode of intensive abstract or spiritual materialism in which everything remains immanent to material instances yet irreducible to any actualized entity. Every actuality, or graspable "thing," is surrounded by its potential for change, movement, sensation, and becoming. Here Ansell-Pearson is contrasting a machinic view of reality with Heidegger's notion of how "the animal is poor in the world." For Heidegger, echoing Hegel, the animal in its lack of recognition of itself is doomed to a life of mere repetition short of potentiality. Only self-recognizing beings can have a history, and hence a potentially nondetermined future. As Ansell-Pearson notes, Heidegger's reading, marked by "bad biology," fails to take into account the "affective relationships between heterogeneous bodies" and is in danger of operating on mere molar concepts and at the level of predefined organisms (Man, Technology, Nature). Instead, with von Uexküll we have the possibility to bypass such rigid terms.

59. See Manuel Delanda, "Deleuze and the Use of the Genetic Algorithm in Architecture," online essay, n.d., <http://www.cddc.vt.edu/host/delanda/> (accessed April 10, 2009).

60. See, for example, Jonathan Crary, *Suspensions of Perception: Attention, Spectacle, and Modern Culture* (Cambridge, Mass.: MIT Press, 2001). See also Otis, *Networking*. For a brilliant analysis of the parallel evolution of the biological sciences and informatics, see Johnston's *The Allure of Machinic Life*.

61. Adrian Mackenzie, *Transductions: Bodies and Machines at Speed* (London: Continuum, 2002), 25 n. 2.

62. Donna J. Haraway, *Simians, Cyborgs, and Women: The Reinvention of Nature* (New York: Routledge, 1991), 11.

63. See Rosi Braidotti, *Metamorphoses*, 117–53. See also Braidotti, "Of Bugs and Women: Irigaray and Deleuze on the Becoming-Woman," in *Engaging with Irigaray*, ed. Carolyn Burke, Naomi Schor, and Margaret Whitford (New York: Columbia University Press, 1994), 111–37.

64. Thacker, "Biophilosophy for the Twenty-first Century."

65. Cf. Donna J. Haraway's defense of the culture of canines in her *When Species Meet*.

66. Steven Connor, *Fly* (London: Reaktion Books, 2006), 163.

67. On ecosophy, see Félix Guattari, *Chaosmosis: An Ethico-Aesthetic Paradigm*, trans. Paul Bains and Julian Pefanis (Bloomington: Indiana University Press, 1995).

68. I use the idea of autonomous affect to refer to the facts that (a) affects are not inclusively of the human and (b) they are pre-individual events. See Paul Bains, "Subjectless Subjectivities," in *A Shock to Thought: Expression after Deleuze and Guattari*, ed. Brian Massumi (London: Routledge, 2002), 101–16; Brian Massumi, *Parables for the Virtual: Movement, Affect, Sensation* (Durham, N.C.: Duke University Press, 2002).

1. NINETEENTH-CENTURY INSECT TECHNICS

1. Cf. Mieke Bal, *Travelling Concepts in the Humanities: A Rough Guide* (Toronto: University of Toronto Press, 2002).

2. William Kirby and William Spence, *An Introduction to Entomology; or, Elements of the Natural History of Insects*, 4 vols., unabridged facsimile of the 1843 edition (London: Elibron, 2005), 1:7.

3. *Ibid.*, 9.

4. Kirby and Spence, *Entomology*, 1:14.

5. An early example was Reverend William Gould's 1747 *An Account of English Ants*, in which ants were raised up as idols of modern pious society. The order of nature paralleled that of divine creation and remained influential long after the presumed Darwinian secular turn. Charlotte Sleight, *Ant* (London: Reaktion Books, 2003), 64–68.

6. Étienne-Louis Geoffroy, *Histoire abrégée des insectes, dans laquelle ces animaux sont rangés suivant un ordre méthodique*, tome 1 (Paris: C. Volland, 1799), iii.

7. Quoted in "Say's American Entomology," *North American Review* 21, no. 48 (July 1825).

8. J. J. Bourassé, *Esquisses entomologiques; ou, histoire naturelle des insectes plus remarquables* (Tours: A. Mame, 1842), 1–2. Also, William Paley's early nineteenth-century text *Natural Theology—or Evidences of the Existence and Attributes of the Deity Collected from the Appearances of Nature* (1802) argued a similar point, that intelligent design was to be thanked for the complex technics of nature. See chapter 6 for a continuation of this discussion.

9. Kevin Murray, "Glass Angels and Data Insects," in *International Symposium on Electronic Art*, Chicago, October 22–27, 1997, <http://kitez.com/texts/isea.html> (accessed January 10, 2009).

10. Charles Darwin, *Origin of Species*, ed. with an introduction and notes by

Gillian Beer (Oxford: Oxford University Press, 1996), 395. Some commentators have argued, however, that Darwin gives natural selection an anthropomorphic face, a theme that stems from Darwin's keen interest in artificial breeding. Here Darwin's rhetoric is seen to be translating the power of the breeder into natural selection. Instead of a theological view of a divine breeder, Darwin introduces the technological idea of a machinery of evolution, a version that suited his social context of thriving industrialization. See John F. Cornell, "Analogy and Technology in Darwin's Vision of Nature," *Journal of the History of Biology* 17, no. 3 (Fall 1984): 303–44. For an alternative view, which I find more interesting for its emphasis on experimentality, see Hans-Jörg Rheinberger and Peter McLaughlin, "Darwin's Experimental Natural History," *Journal of the History of Biology* 17, no. 3 (Fall 1984): 345–68. These authors criticize the view that Darwin saw natural selection merely as analogous to artificial breeding and try to find a richer view in which the human being is not detached from nature but also subject to its forces. Here artificial breeding is perhaps more accurately seen as a tracking of the tendencies inherent in nature. It was actually Arthur Russel Wallace, in his ideas of variations in nature, who proposed a view of humans as conscious actors who could turn nature to their ends, emphasizing the supremacy man enjoys over matter. See Rheinberger and McLaughlin, "Darwin's Experimental Natural History," 355 n. 23.

11. Kirby and Spence, *Entomology*, 1:85–86. Of course, anthropomorphizing insect and animal behavior was a continuous theme throughout the nineteenth century (as it is now). Often it was connected to a desire to somehow make sense of otherwise meaningless-appearing devastation by insects. Locusts and the like were a continuous threat, especially in the United States. Consider, for example, this depiction of crop-destroying army worms from 1880: "Encouraged by this official recognition [by the Agricultural Bureau], the army-worm has begun a most energetic campaign, and is displaying a degree of enterprise and a knowledge of strategy and tactics that are extremely creditable." "The Army-Worm," *New York Times*, June 14, 1880.

12. Kirby and Spence, *Entomology*, 1:120.

13. *Ibid.*, 2:330.

14. Michelle Tolini, "Beetle Abominations" and "Birds on Bonnets: Zoological Fantasy in Late-Nineteenth-Century Dress," *Nineteenth-Century Art Worldwide—A Journal of Nineteenth-Century Visual Culture* 1, no. 1 (Spring 2002), <http://19thc-artworldwide.org/> (accessed April 24, 2009). In addition, Richard Marsh's novel *The Beetle* from 1897 introduced a horrifying insect figure that connected archaic mythic creatures and rites to contemporary London mysteries.

15. Steven Connor, *Fly* (London: Reaktion Books, 2006), 82–83.