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Alien vs. Predator

Presentation to the Danish Association for Science and Technology Studies annual meetings, June 6, 2008

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The informal style of this paper reflects the fact that it was a talk.

Let me begin right away with my point. Researchers must love their material to produce good research. Science studies researchers must get inside the science, learning to appreciate it with the passion of an insider. This is the mainly unrealized gift of anthropology to science studies. Immersion produces insight. Reifying theory as a higher life form gets in the way of love. Theory is a tool kit. We need to love our tools as they help us make things, not for themselves.

A few weeks ago, I passed several wall-sized posters advertising the DVD release of what I understand to be a very bad science-fiction movie called Alien vs. Predator. I haven't seen the movie. But the posters caught my attention; I peered at them trying to make out what the monsters looked like. I picked my title hoping to catch your attention and hoping you might be curious to see my monsters. I also hoped that by staging a war between great theorists, I might be able to have it both ways. I might *both* be able to keep your interest by talking theory *and* get you a little curious about the obscure object of my research love, a wild mushroom called matsutake. Matsutake have a spicy aroma that is valued in Japan; a handful of the best quality mushrooms can cost hundreds-to-thousands of US dollars. The mushrooms are picked in forests around the northern hemisphere for export to Japan. I'll embarrass myself by trying to say their Danish name: doft riddlehat. To get you to listen to a talk on mushrooms, I thought it best to take us into theory—and perhaps even reified theory of a "battle of the worlds" sort.

My Predator is Bruno Latour's Actor-Network Theory or A-N-T as in ANT. Latour offers us the humble and endearing social insect, the ant, to orient our thinking about his theory, and I thought it would be fun to have an ant playing the insect-like Predator. Let me start by saying I think actor-network theory is a brilliant idea. In particular, it gets around stereotypes about the nature of human agency as dependent upon will or intention. For Latour, it is the actor-network, that is, the web of humans and nonhumans joined together in association, that exerts agency, not the will. Nonhumans are as much a part of agential action as humans. This has been a foundational move for a science studies that takes its nonhumans seriously.

In establishing the agency of actor-networks, Latour gives his ant a magical weapon: the refusal of context. The abilities of this weapon are best developed in his book *Reassembling the Social*, in which Latour extends his insights about science studies to reform sociology as a whole.[1] The book is an extended rant against the concept of context, which Latour sees as a perverse imposition of sociologists. Context puts our objects of study into a system of parts and wholes. Latour argues, and here I agree, that context can suffocate the analysis, explaining away the very phenomena about which we want to learn. Instead, he advises us to follow the actors to see how they assemble networks. He offers a flat analysis, the ant's work of tracking close to the ground, refusing the "leap" to a magical third dimension of context. In refusing context, the ant is able to traverse space and time in new ways. Instead of imposing pre-set units, the ant searches out the locally situated features of the global and the globally extending elements of the local. The ant defeats its enemies, the critical sociologists, by means of its special weapon, "refusing context."

[1] Latour, Bruno. 2005. *Reassembling the social*. Oxford: Oxford University Press.

What happens, however, when the ant faces a disorienting new opponent, the Alien? My Alien is anthropologist Marilyn Strathern. Strathern has focused her research on Papua New Guinea and its surrounding islands, a part of the world called Melanesia. In contrast to Latour's refusal of discussion of parts and wholes, Strathern is obsessed with parts and wholes. What are the parts of persons?, she asks, considering how Melanesians think of their embodied personhood not as forming a united individual but rather as disparate bundles of social relations. What are the parts of societies?, she asks, tracing gift exchanges in which social units are assembled and dissolved. What are the parts of time?, she asks, looking at mounds of yams piled up to measure pasts and futures. Strathern has a lot to say about Melanesian particularities. But she is surprisingly uninterested in cultural taxonomy, the cataloguing of cultural traits. Instead, she uses her questions to reflect on her own forms of analysis. How is it even possible, she asks, to use culturally particular theoretical tools to study radically incommensurate worlds? Her answer is an unceasing back-and-forth between ethnographic and theoretical framings, such that parts and wholes from each are constantly startled by mutual juxtaposition. The result is not the smug satisfaction Latour attributes to reflexive and critical sociology, his familiar enemy. Instead, Strathern's research figure is constantly disoriented by the hall of mirrors in which she places herself. Disorientation through juxtaposition is her magical weapon, which she calls the "ethnographic effect." The ethnographic effect is one way of doing context, but not the one against which Latour's ant is armed. Strathern continually tosses us patterns of parts and wholes, but to increase instability rather than close off analysis.

The Alien can use her weapon against the ant, disorienting it through finding that it has been using context all along despite Latour's denials. The problem begins with the actors. How do we know who they are? Don't we have to be able to identify them in order to follow them? Latour's answer is figuration. We identify the actors because we recognize them as figures. Figuration is a wonderful concept. But figuration, a concept best developed in literary criticism, requires our attention to semiotic worlds. These worlds are arrangements of parts and wholes; figures are *parts* within such worlds. Aha!, says the Alien, here are parts and wholes. But the ant retorts that this is not "context" because it does not *explain* the social situation. These are parts and wholes that facilitate a flat analysis, tracking actor-networks. Yet, replies the Alien, what else is context?

The battle is engaged. Because this is still the opening credits before the action rolls I can resort to what movie critics call a "spoiler" and tell you who wins. To do so I need another term from literary criticism: "worlding," the process of making and claiming worlds. Again, I define worlds for our purposes as arrangements of parts and wholes, and the worlding that interests me is not just textual but an aspect of social practice more generally. Worlds have an awkward relationship to real life; postcolonial literary critics speak of Orientalist "worldings" in which Western thinkers impose their logic of parts and wholes on an imagined East. Worldings do not need to be pernicious, however. Some worldings are better than others. But none are a final resting place for social action. Worlds need not be solidly coherent or long lasting. They need not make good on their promises. Nor need they push all other worlds out. I will argue that worlding is *both* a Stathernian "ethnographic effect" *and* a necessary part of the Latourian route to actor-networks. The battle conceives an Alien-Predator hybrid, which I am told also happens in the movie. This hybrid can guide us to love our material more than we love theory alone.

Let the action begin. In the opening scene, the Predator ant visits one of the sacred origin places of actor-network theory: Michel Callon's "Some elements of a sociology of translation: domestication of the scallops and the fishermen of St. Brieuc Bay."[2] I hope this is a

[2] Callon, Michel. 1986 "Some Elements of a Sociology of Translation: Domestication of the Scallops and the Fishermen of St Brieuc Bay," in John Law, ed., *Power, Action and Belief: A New Sociology of Knowledge*. London: Routledge & Kegan Paul, pp. 196-233.

reference we have in common so you can picture the scene. Callon tells of three French scientists who address the potential loss of the scallops' fishery of St. Brieuc Bay by applying a model they learned on a trip to Japan. Japanese resource managers, they found, have encouraged and protected scallops through allowing their larvae to anchor on collector lines. The three French scientists hope to use this model to advance the interests of scallops, fishermen, and science in St. Brieuc Bay. Callon shows how the three scientists are successful at first in forming the alliance that has come to be called an "actor-network." Later their work suffers from a series of betrayals in which first the scallops and then the fishermen refuse to cooperate.

Callon's article is a classic for good reasons. Yet it is haunted by a mysterious presence: the Japanese scientists and scallops hovering in the background. Why didn't they make Callon's list of relevant actors? Did the three French scientists somehow neglect to consult Japanese scientists in constructing their project? Given that they knew the Japanese scientists were farther along in building knowledge about scallops, wouldn't the Frenchmen have made them integral to their project? Since so much hinged on relationships between French and Japanese scallops, wouldn't they also have wanted to arrange a meeting among the scallops? If not, what *world* were they protecting?

There also seems to me to be a problem of terms. Did the Japanese think they were "domesticating" scallops—or was this just the awkward and mismatched translation of the French scientists? The concept of domestication requires a pre-existing separation between domestic and wild, a distinction with a long legacy in French sociality but without such a clear precedent in Japan. Were the Japanese, perhaps, engaged in a different project of bringing humans and nonhumans into alignment? And in what ways, then, did the French scientists mangle or dismiss the work of their Japanese colleagues?

Enter the Alien: the haunting presence of the Other in Callon's determinations. It is difficult to know how much of these gaps and omissions derive from the worldings of the French scientists and how much from Callon's own worldings. In either case, Japanese scientists, science, and scallops have left the arena of action, dismissed as irrelevant to the alliances that matter. Surely this is a matter of someone's judgment of parts and wholes. Can the ant continue to refuse context, or will the Alien prevail?

The scene shifts to the world of matsutake mushrooms.[3] The matsutake complex is a group of species of the genus *Tricholoma*, which grow in symbiotic relationship with trees in forests across the northern hemisphere. The rise of the Japanese economy in the 1970s stimulated matsutake picking in many countries for export to Japan. The high value of the mushrooms brought them to the attention of forest managers and scientists, and matsutake science, once mainly limited to Japan, has now proliferated in many picking areas. My research has taken me between Japan and Oregon, in the U.S. Pacific Northwest, where matsutake picking and matsutake science are both lively.

As with Callon's Frenchmen and scallops, U.S. matsutake scientists in Oregon recognize that Japanese scientists have a longer history studying matsutake than they do. During the build up to research in Oregon, which began in the late 1980s, some effort went into having Japanese articles translated into English. Rather to my surprise, Oregon scientists then proceeded to ignore these articles, inventing their own matsutake science as if *de novo*. When I discussed this issue with scientists in Oregon, they tended to shrug off the matter or even to deny the gap completely. If pressed, they allowed that the Japanese articles were disappointing. Yet these dismissals were not well-worked-out policy statements; they were offered to me as asides, without the status of science.

[3] My research forms part of the Matsutake Worlds Research Group, which includes Timothy Choy, Lieba Faier, Miyako Inoue, Michael Hathaway, and Shiho Satsuka. My research in Oregon takes place in collaboration with anthropologist Hjorleifur Jonsson and with the assistance of UC Santa Cruz undergraduates Lue Vang and David Pheng.

The situation was even more confusing in Japan. The Japanese matsutake scientists I spoke with were clear that they belonged to a cosmopolitan scientific community and were fully responsive to international scientific standards. The differences that mattered among scientists, they explained, were not national differences but instead disciplinary differences, such that training as an ecologist, a botanist, or a bacteriologist might shape divergent research questions. Yet when I asked them about particular American publications, they had never read them. Their matsutake science did not require these articles. The only way American matsutake scientists came to their attention was as colleagues through whom travel and international conferences could be arranged.

What about the mushrooms? The differences between matsutake mushrooms in Japan and Oregon have been the topic of considerable study. Here it seems we might escape the shifting bog of assumptions, denials, and innuendos for the firmer terrain of Latour's "matters of concern"—that is "facts" with the work involved in making them still visible. Yet here, too, there is trouble for following actor-networks. It happens that the handiest method for studying the differences among nonhuman organisms is itself, like ANT, a denier of the need for the discussion of parts and wholes. As with ANT, this means that worlding takes place in the margins, where the analyst can't really see it less examine it as science.

With scientists and mushrooms, then, I introduce two modes in which consequential worlding might take place within science *without the Predator noticing*. First, my scientists deny national difference despite the fact that it is apparent in their practices. Might this be one kind of worlding? Second, might another kind of worlding be involved in studying mushrooms through a method that segregates species, yet requires multi-species worlds to interpret its results? These questions signal two modes of indirect, under-recognized worlding. They help us to understand why scientists—and those who study them—might not think about worlding even as they engage in it. Each of these two modes does double duty in my analysis. On the one hand, they are the terrain on which the Predator and the Alien each aims to demonstrate their respective magical weapons. The ant tracks how actor-networks are assembled; the Alien disorients us with part-whole juxtapositions. On the other hand, they are allegories for each of the two theories. They show us how actor-network theory necessarily incorporates parts and wholes even in excluding their consideration from its analysis. They require the Alien to track networks as well as throw worlds at us. In each case, the contest is generated by the haunting presence of parts and wholes in Callon's analysis of scallops. For the battle between the Alien and the Predator, such ghosts are the scented trail.

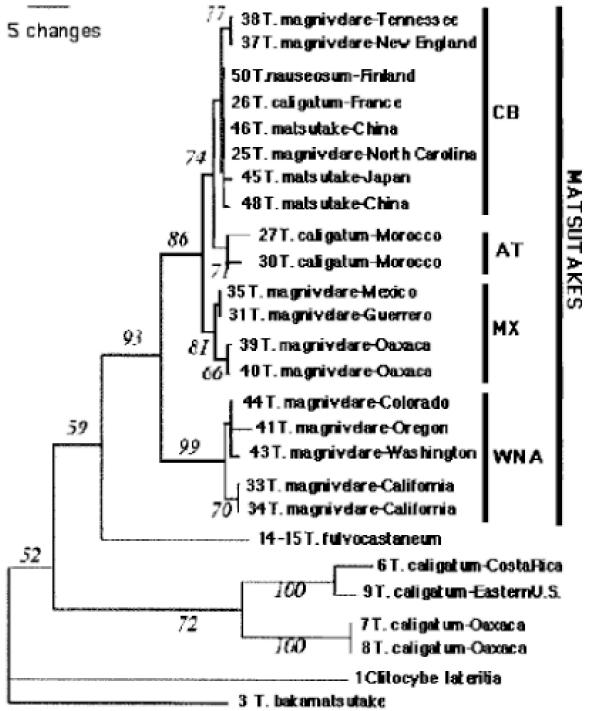
Part One: marginal worldings

Let me orient you with an illustration [slide 1]: Here are some Japanese matsutake. [slide 2] Here is a white variety from North America. [slide 3] Here is one scientist's map of matsutake distributions. [*Dear reader: You don't need these slides to understand the talk, and so I have omitted them.]*

Phylogeography is the study of the evolutionary history of geographical populations. Phylogeography offers a lively historical agency to nonhuman organisms, showing their origins and movements over eon-stretching time scales. Phylogeography works by comparing sequences of DNA taken from populations in different places and reading evolutionary history into the comparison. There is something to love here for both the Alien and the Predator. Like Strathern, phylogeographers want to know about diversity and its distribution around the earth. Like Latour, phylogeographers are interested in how things become associated. Furthermore, like the ant, they have committed themselves to a "flat" analysis without three-dimensional impositions. Instead of beginning with holistic ecological communities, the researchers go straight to their "actors": base pair sequences on a stretch of matsutake DNA. The researchers mobilize these actors in polymerase chain reactions through which

the actors "express" themselves to the scientists. These expressions can then be brought into common parliament by the scientists, who draw from their association a family tree.

Acting on the advice of the Predator, lets go straight to a concrete instantiation.



Slide 4

[Slide 4] This figure compares DNA sequences from matsutake mushrooms taken from several geographical locations.[4] Here, the

[4] Chapela, Ignacio and Matteo Garbelotto, 2004. "Phylogeography and evolution in matsutake and close allies inferred by analyses of ITS sequences and AFLPs," *Mycologia* 96(4): 730-741.

ant can find a web of associations including both Japanese and Oregon matsutake! But unless you have a background in biology, it is unlikely that you can make sense of this list. I couldn't. You may be able to make out that T. stands for Tricholoma, and that these are different matsutakes, labeled by location. But what is the purpose of this list, what do those connecting lines mean, and where is the science in all this? Disorientation is the Alien's favorite ground. The Alien hurls parts and wholes, allowing figures to emerge from the mist.

Worlding exercise 1. Phylogeography is an example of the comparative method, a method that simultaneously shaped the formation of anthropology, linguistics, and biology in the 19th century. What if we used parallels across the disciplines to explain phylogeography? Might we learn something about their respective figurations?

Since this sort of comparative method is no longer much practiced in anthropology, consider the related terrain of historical linguistics. In this field, the analyst uses the comparative method by assembling a potential list of cognate words [slide 5].[5]

Sanskrit	Avestan	Greek	Latin	Gothic	English
pita		pater	pater	fadar	father
padam		poda	pedem	fotu	foot
bhratar		phrater	frater	brothar	brother
bharami	barami	phero	fero	baira	bear
jivah	jivo		wiwos	qius	quick ('living')
sanah	hano	henee	senex	sinista	senile
virah		viro	wir	wair	were(wolf)('man')

Slide 5

The next step is to establish sound correspondences among these potential cognates, and to consider how one sound might have chan-

[5] Kathleen Hubbard, "Everything you ever wanted to know about Proto-Indo-European (and the comparative method), but were afraid to ask!" http://www.utexas.edu/depts/classics/documents/PIE.html

ged to another. This allows the analyst to construct proto-phonemes, that is word sounds that could have characterized the common ancestors of the words in the first list [slide 6].[6] Here, the asterisks identify the word as part of the analyst's evolutionary reconstruction.

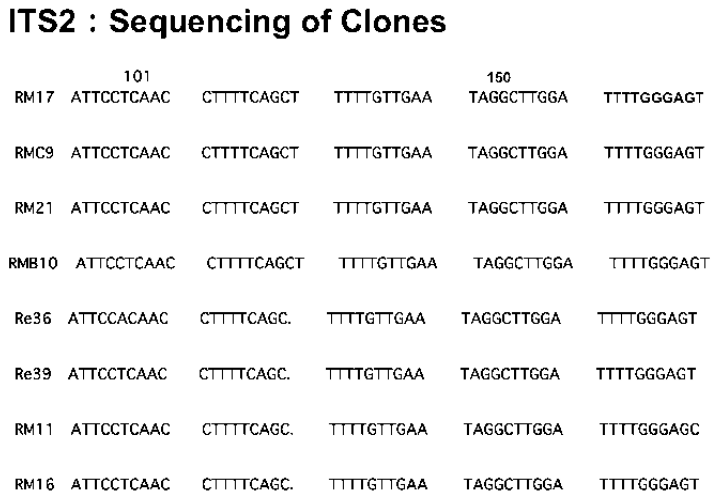
*pə̀ter-	father
*ped-	foot
*bhrater-	brother
*bher-	carry
*gwei-	live
*sen-	old
*wi-ro-	man

Slide 6

These proto-phonemes are thought of as elements of an ancient language that could have evolved into the variety of modern words seen on the original list.

Phylogeographies work very similarly. Since DNA base pair sequences are represented as letters, DNA sequences look a lot like words. To use the comparative method, the matsutake phylogeographer sequences a given stretch of DNA from related kinds of matsutake. The result looks rather like a list of cognate words [slide 7]. This list is laid out 90 degrees askew from the linguistics list, so that the related samples (akin to languages) are on the left side, and the "words" or stretches of DNA extend horizontally to the right instead of in columns.

[6] ibid



Slide 7

Just as in historical linguistics, the next step is to look for changes in what are represented in each case as letters, that is, sounds in linguistics and base pairs in biology. In phylogeography, the number of changes in base pairs indicates a greater evolutionary distance. If one assumes that base pairs mutate around the same rate, then this difference is also an indication of time, through which samples can be compared to each other as having more or less distant common ancestors.

[Slide 5: *Return to figure on page 12*] Perhaps this excursion allows us to return to the phylogeography figure with a new appreciation. In this chart, the length of the horizontal line to the left of the sample name indicates how many base pairs it differs from those to which it is connected. The authors of the diagram concede that there would have been other ways to rank and order these samples, but they have used statistical trials to put this diagram together as the most parsimonious ordering.

Worlding exercise 2. Phylogeography carries with it the historical legacies of other instances of the comparative method. That's why

it's more than just mildly amusing to learn to understand it through historical linguistics. What might we learn by thinking about phylogeography through the experience of anthropology?

19th century anthropologists reconstructed evolutionary histories of culture from the evidence of present-day practices. Marriage practices, rituals, or kinship rules could each be compared to such customs among other groups; from their degree of difference the analyst would construct the common ancestor from which each evolved. Evolutionary trees could then be drawn.

By the end of the 19th century, however, anthropologists had reacted against the comparative method. For American anthropology, the key intervention was Franz Boas' paper, "The limitations of the comparative method of anthropology." Boas railed against the comparative method. He writes, "The comparative method, notwithstanding all that has been said and written in its praise, has been remarkably barren of definite results, and I believe it will not become fruitful until we renounce the vain endeavor to construct a uniform systematic history of the evolution of culture…"[7] American cultural anthropology was founded by following Boas. Evolutionary explanations were expelled from the center, which was occupied instead by attention to parts and wholes.

Boas stressed that the comparative method was not empirically grounded, and American anthropologists still describe the method as "speculative." What was speculative about it? The customs being compared were as accurate as reports of the time. What contemporary readers find doubtful is the evolutionary ordering that was imposed upon differences of custom. This ordering rested on assumptions about *worlds* in which some customs could be classified as "savage," at the bottom of the human evolutionary tree, while others were slightly higher as "barbarian," and others yet were "civilized." In other words, the comparison of customs did rest on an

[7] Boas, Franz. 1940 [1896] "The limitations of the comparative method of anthropology," In Race, Language and Culture, New York: The Free Press. Pp. 270-280.

ordering of parts and wholes, but this worlding project now seems to us as purely a product of the European colonial imagination. The many 20th century attempts to revive the comparative method, for example as "controlled comparison," each try to rid it of colonial worlding while maintaining its imagined scientific rigor. And the reason revivalists see a rigorous method here, from which colonial worlding can be peeled off, is that the science is seen to reside in the comparison itself, with the worlding as a marginal afterthought for interpretation of the results.

19th century evolutionary biology used the comparative method to reconstruct similarly "speculative" histories through comparing the morphology of organisms. As in anthropology, the morphological measurements were fine within the standards of the time. But contemporary biologists looking back find all kinds of unacceptable worldings—for example, Lamarckism—at the margins of the method; yet these controlled evolutionary storylines.

20th century advances in genetics and then genomics have revamped the comparative method in biology. Instead of comparing morphologies, biologists now compare sequences of DNA base pairs. Yet the method itself is the same. And—most importantly for my argument—the importance of marginal worldings to tell the evolutionary story remains. Let me return to phylogeography. To turn the results we saw into an evolutionary story requires a whole new set of exercises. In the article from which the figure was taken, these new exercises are marked by a new section, following "Results," called "Discussion." In the Discussion, lots of other species, not tested in the experiment, show up. Most of these are host trees with which matsutake is associated in various forest environments. Suddenly we have multi-species worlds—arrangements of parts and wholes—not just stretches of DNA. And these multi-species worlds are the necessary ingredients of the evolutionary story the researchers are able to tell. It seems, they argue, that matsutake originally evolved with broadleaf trees and only afterwards moved to an association with conifers. In Japan, matsutake have come to associate

only with conifers, but in western North America, matsutake still associate with both broadleaves and conifers. This suggests that those Oregon matsutake have an ancestral status to the Japanese ones.

At last, we have a real story, and an exciting one! But it has taken ecological worlding to get us from the results of the comparative method to an evolutionary story. In this way, phylogeography shows the same vulnerabilities as 19th century evolutionary anthropology. Informed as they are by a stack of evolutionary studies involving host trees as well as fungi, we can hope phylogeographers' worldings are better than colonial taxonomies. But the status of these worlding practices outside the scientific method employed in the research is the same. Worlding makes the story possible, but from the margins.

Worlding exercise 3. What does this have to do with the Alien and the Predator? ANT is not the comparative method. The only thing the two have in common is their refusal of context as an aspect of the research method. The method of phylogeography excises ecological context, treating each species' DNA on its own. As a result, the mobilization of ecological worlds takes place outside what is identified as method. Ecological worlding makes scientific storytelling possible but it cannot itself be recognized as part of the science that produced those specific results. This comment is not a criticism of phylogeography research. I have offered it to help me think through ANT as well as my own research methods.

This is a damaging allegory for the Predator. ANT disallows discussion of parts and wholes. But because it requires the researcher to identify actor figurations, some kind of worlding is necessary. In the exercises here, I cannot recognize phylogenetic figuration without putting it in some universe of parts and wholes. As long as this worlding is allowed only to occupy the margins of the research, it produces trouble, such as the unexplained exclusion of Japanese scallops and scientists from Callon's analysis.

It seems that the Alien is winning: Worlding is happening even where it is denied. But the Predator has another resource: the force of nonhuman agency. Phylogeographies are not just metaphors; they tap the characteristics and potencies of actually existing mushrooms. Through the ant's willingness to trace actor-networks, the mushrooms repulse deconstruction as idle storytelling. But can the ant do its work of tracing networks without this storytelling? It seems that the battle must continue.

Part Two: implicit worlding

Let me return to the scientists in Japan and Oregon who deny difference but don't engage. How might they advance the battle between the Predator and the Alien? These are not phylogeographers but field scientists concerned with resource management, like those among Callon's scallops. They want to make sure the mushrooms thrive despite their commercial harvest; their goal is to forge actor-networks that include mushrooms, pickers, and scientists. The Predator seems to be on advantageous, familiar ground. But why then is the scene haunted by invisible foreign scientists?[8]

Following the ant's methods, let's ask the scientists about what they do. Yet, I fear, their tellings will transport us into the Alien's disorienting parts and wholes.

Worlding exercise 4. Most Oregon matsutake scientists are hosted and/or funded by the U.S. Forest Service. The first thing they tend to explain to you is the relationship of their research to the long-term agendas of the U.S. Forest Service. From the first, they explain, the Forest Service has aimed to balance the use and protection of natural resources; this gives rise to management for *sustainability*. The goal of matsutake research in the U.S. Pacific Northwest is to promote the sustainability of matsutake.

[8] This part of my talk draws heavily on the article I co-authored with Shiho Satsuka, "Diverging understandings of forest management in matsutake science," forthcoming, *Economic Botany*.

The U.S. Forest Service was founded in the early 20th century in dialogue with timber and grazing industries in the American west. In response to what emergent foresters saw as the waste and destruction of unregulated logging and grazing, they promoted a "conservation" aimed at protecting natural resources for future users. They developed what they called "sustainable yield," that is, forestry in which the regrowth of trees could replace cut timber. From the first, government forestry emerged in tense and tender ties with loggers, and many compromises were made in the formulation and practice of scientific rules imagined as promoting sustainable yields. Whether the rules or the practices were the problem is still much under debate. In any case, by the 1980s, Oregon forests—a central location of U.S. Forest Service management—were in bad shape. Meanwhile, an environmental movement had grown up to promote a completely different vision of conservation, one in which nonhuman species should be preserved for *themselves*, rather than for future human industry. According to the new environmentalists, forests should be conserved as sites of biodiversity and ecosystem health, rather than as tree farms. The environmental movement won some key legislative battles, and the U.S. Forest Service language of sustainability was stretched to include sustainable ecological function as well as sustainable yield. Whether this expansion could make sustainability anything other than an impossible contradiction has been fought in many battles, in and out of court. Attention to "non-timber forest products" such as matsutake seemed auspicious in this climate: They promised an economic use for forests, but one that did not require cutting down trees.

Configured as they were within this drama, matsutake could not escape sustainability management. Nor was it likely that concepts of sustainability would be imported from Japan. To communicate with the U.S. Forest Service, matsutake scientists needed to use a language the Forest Service could understand. Thus, sustainability put matsutake in dialogue with timber. This dialogue had important corollaries for research practices. First, the most important goal has been to measure human impact, and the key site in which to measure this impact has been the harvest itself—as with trees in logging. Oregon scientists became obsessed with whether harvesters were destroying their own resource. A good deal of research went into the question of harvesting techniques, to see if some were worse than others. Second, timber-sized *scales* were the focus of attention. Oregon scientists asked questions about stands of trees ("atoms" of timber management) and landscapes as timber "systems." To achieve these scales, Oregon scientists needed statistical sampling methods through which particular observations could be generalized. They thus used randomly directed strip plots to monitor fungal productivity, despite the fact this ignored fungal patch dynamics. They used computer programs to generate landscape-scale management packages for timber managers. And, third, the preferred method of research was *monitoring*. Monitoring measures sustainability at timber scales, and this became the major task of Oregon matsutake science.

So far, I have followed what I was told by Oregon scientists and what I read in their publications. Let me turn to what their Japanese colleagues say about what they do.

Worlding exercise 5. Japanese matsutake scientists are also worried about the decline of matsutake, but rather than identifying this decline as a result of too much human impact, as in the United States, they identify the problem as too little human impact. This is because matsutake in Japan grow in forests understood as anthropogenic in their very nature. Japanese matsutake are creatures of *satoyama* village forests, in which peasant coppicing of broadleaf trees for firewood creates the structure of the forest. Peasants also raked fallen leaves and litter for fertilizer, and gathered shrubs, grass, and herbs for fodder for their animals. The process created open forests with nutrient-poor soils; Japanese red pine invades such places as a pioneer species of disturbed areas. Matsutake grows with red pine. The decline of matsutake is understood by Japanese scientists as a result of peasant inattention to village

forests. The turn to fossil fuels since World War II halted firewood collection, allowing broadleaf trees to take over, shading out the pines. To promote matsutake, scientists suggest a renewed peasant-type forest management, in which broadleaf trees are thinned or cut back to allow the regrowth of pine—and matsutake.

As in Oregon, the research of Japanese matsutake scientists addresses a larger social and ecological agenda. Satoyama forests are an object of affection and concern from several directions. They are considered sites of great beauty, stimulating attention to the particular character of each season. Some see satoyama as the source of Japanese artistic inspiration. They are also thought of as sites of traditional harmony between humans and nature, and thus places for nature education and the transmission of values from elders to the young. Japanese matsutake scientists contribute to a larger effort to revitalize satoyama for multifaceted environmental, aesthetic and socially associative goals.

The projects of Japanese matsutake scientists are advised by the need to improve the conditions of matsutake cultivation. Such efforts can take place in a laboratory, where matsutake mycelia can be raised under controlled conditions. They can also take place in a forest, where the effects of gardening practices at multiple scales can be studied—from micro-ecologies connecting soil bacteria, fungi, and roots to the patterns of soil or sunlight in variously managed forests. But cultivation is not "domestication." One influential scientist describes matsutake as a product of "unintended cultivation," an oxymoron from the perspective of those committed to segregations between domestic and wild. Matsutake flourishes where human management practices have been conducive to the growth of red pine. To continue or intensify ecosystems management does not change the not-fully-tamed status of matsutake, which one Kyoto greengrocer described as "a gift from the gods." To cultivate the forest adjusts human-nonhuman relationships without subjecting nonhumans to domestication, that is, membership in the human family.

Worlding exercise 6. It seems we have stepped into two quite different arrangements. Consider first the problem of incompatible scales. Japanese scientists map historical configurations of fungi and trees. U.S. scientists ignore historical configurations entirely to generate statistical probabilities that might inform management at timber-sized scales. The results of each research exercise whiz past the other without any communication. Then there is the problem of U.S. commitment to concepts of "industrial" on the one hand, and "wild" on the other. Industrial forests need sustainable yields; wild forests need sustainable ecosystems. The concept of "sustainability" is starting to look rather culturally specific, rather than being the universal science its supporters claim it to be. Japanese scientists don't ask about sustainability because village forests are neither wild nor industrial. Instead, they manage satoyama forests through aesthetics, education, and harmony with nature, concepts U.S. scientists would dismiss as unscientific. Yet sustainability is similarly unscientific in Japan.

There is much more to say, but let us return to the Predator and the Alien. Again, the Alien at first seems to be winning. We cannot understand the figurations of our actors without engaging with parts and wholes. Even where they do not include each other as significant figures, the worlds they spin are revealing for what they leave out. This is where the Alien's talent shows itself: Juxtaposing arrangements of parts and wholes reveals hidden figurations that inform the research process.

Yet, once again, it is the steadiness of the Predator that keeps us on the trail. Japanese and Oregon science are not just fantasy worlds. They are materially placed—and connected by all kinds of travels and technologies. Their interconnection looks particularly concrete when each attempts to advise management policies in less powerful matsutake areas, such as southwest China. In China, Oregon scientists push sustainability; Japanese scientists manage satoyama. Their competition involves them in material struggles over law, scientific resources, and forestry practices. To trace these

struggles, we cannot do without the Predator's tool, the careful following of trails of the ant. But this is an ant that needs to be armed with worlding abilities, to both recognize the constant array of worldings of the actors and to compose its own worldings through juxtaposition, just like the Alien.

I have arrived at the Alien-Predator hybrid, born from the battle of worlds. It is only this hybrid that can both follow the train *and* recognize its figures creatively. Rather than generating a fiercer warrior, as I suspect happens in the movie, my hybrid is a curious baby. Grabbing at everything uncritically as its plaything, it renews our own sense of wonder. And this is where we can follow it into love of our materials.

In fact, both Strathern and Latour are known for their playful voraciousness when it comes to curiosity. Both want to grab at *everything* as data, refusing to limit their analyses to known quantities. This is why we look to each of them for new ideas. With such godparents, a child who can both play with parts and wholes *and* follow chains of association should stimulate even more creativity. We would have the ethnographic effect, with its disorientation and engagement, and actor-networks to bring nonhumans and multiple scales into our purview. The thicker the puzzles, the more our child is curious. Thin sociologies of the techniques or lives of scientists can't hold its interest. It wants to know all the details; you can't get at either worlds or networks without being able to do the science yourself. Debates between theorists are only of interest to the child if the debates themselves open up substantive issues of how to do not just science studies but science itself. Why does any of this matter?, the child wants to know. The stakes are in the material itself—in my case, in the mushrooms.

So let me leave you with one final mushroom question of some consequence: If we are concerned with the continued flourishing of matsutake species, should we put matsutake on the CITES international list of endangered species—as some have proposed? I have shown how this question takes us in and out of worlding projects in which the global distribution of matsutake requires attention to multi-species ecologies as well as species history. We cannot know species, or their population histories, without multi-species parts and wholes. In turn, these multi-species ecologies are only known through the worlding projects of resource managers who work to align humans and nonhumans in disparate ways. Is matsutake endangered by overharvesting or by neglect? To list matsutake as endangered by harvesters advances one project of worlding, one knot of actor-networks, as it marginalizes others. In my judgment, and I do care, matsutake is *not* an endangered species, and attempts to list it are a reflex of imperial science. To arrive at this judgment, I need both worlds—parts and wholes—and actor-networks. Bruno Latour and Marilyn Strathern both help me arrive at this judgment. But I need an eclectic toolbox—and the deep immersion of love.