Reading forests, Kyoto Prefecture. Matsutake science in the field. The diagram is a map of host tree–matsutake relations over time. Through precise site specification and continuous observation, Japanese matsutake science investigates ecologies of encounter. U.S. scientists have tended to dismiss this research as "description."

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Science as Translation

As with capitalism, it is useful to consider science a translation machine. It is machinic because a phalanx of teachers, technicians, and peer reviewers stands ready to chop off excess parts and to hammer those that remain into their proper places. It is translational because its insights are drawn from diverse ways of life. Most scholars have studied the translational features of science only as they contribute to the machinic ones.[1] Translation helps them watch the elements of science come together into a unified system of knowledge and practice. There has been less attention to the messy process of translation as jarring juxtaposition and miscommunication. In part this is because science studies has only too rarely been willing to stray outside of that imagined entity, the West. Science studies needs postcolonial theory to extend itself beyond the common sense of this self-imposed box. In postcolonial theory, translation shows us misfits as well as joins.[2] Thus Shiho Satsuka watches *nature* emerge in just this kind of mixed-up, unresolved translation. In transnational practices for interpreting nature, she shows, shared training can go hand and hand with the eruption of difference.[3]

Translation in this sense creates patches of incoherence and incompatibility in science. To the extent that there are separate bodies of research, review, and reading, such patches may persist despite crosscutting forms of training and communication. These patches are neither closed nor isolated; they shift with new materials.[4] Their distinctiveness is not prior logic but an effect of the convergence. Watching them returns me to the open-ended gatherings I am calling assemblages. Here layered, inconsistent, and jumbled ontologies form even within the domain of the machine. Matsutake science and forestry are vivid examples; this chapter explores messy translation and the formation of knowledge patches through it.

To begin with, if science is an international enterprise, why might there be *national* matsutake sciences? The answer requires attention to the infrastructure of science, which segregates even as it draws together. Matsutake science is national to the extent that it is tied to state-sponsored forestry institutes. Forestry emerged as a science of state governance and continues a close relationship. Even in its cosmopolitan reach, forestry is national. Already, we are on the road to divergent assemblages. But the situation is even more peculiar. Why has established research had so little influence across national borders? Why are the gaps so great, despite common training, international conferences, and public-domain publication? The answers here begin with the exclusion of Japan from North American and European common sense. Matsutake science and forestry are well established in Japan. Everywhere else, they are new, emerging with the commercialization of matsutake. One might expect that Japanese matsutake science would be the mother tradition that inspires new science elsewhere. Except in Korea, this is not the case.[5] Scientists in matsutake-exporting countries are busy inventing their own matsutake sciences. This is not the universal science we are taught to expect. Following its uneven development shows us science as postcolonial translation.

Alternative performances of "nature" are at stake. Consider their different takes on human disturbance. Drawing from satoyama research, Japanese scientists argue that matsutake forests are threatened by too little human disturbance. Abandoned village forests shade out pines, losing matsutake. In contrast, in the United States, scientists argue that matsutake forests are threatened by too much human disturbance.

Reckless harvesting kills off species. This is not a debate: despite the fact that both groups of scientists circulate internationally, there has been almost no communication about these positions. Furthermore, scientists in Japan and in the United States tend to use contrasting investigative strategies—particularly on issues of site selection and scale. This removes the possibility of direct comparisons across their respective results. In this process, segregated patches of knowledge and research practice are formed.

That divergences matter is particularly evident when alternative sciences arrive in the same place. In China, matsutake science and forestry are caught between Japanese and U.S. trajectories. In the matsutake forests of China's northeast, Japanese scientists have sturdy collaborations with Chinese counterparts.[6] But in Yunnan, U.S. experts in conservation and development have arrived in droves, and matsutake science has been drawn into their sphere of influence. Chinese scholars see their job as catching up with "international," that is, English-language science. As one young scientist explained, the young and ambitious never read Japanese sources because out-of-date older scholars who have no command of English can read them. U.S. approaches have had the power to set policy in Yunnan: Yunnan matsutake have been entered on the CITES list of endangered species; regulations against uncontrolled pickers and picking have been drawn up.[7] Yet Yunnan's forests are nothing like U.S. matsutake forests. As I argued in chapter 13, they have affinities to Japan's satoyama. American experts do not recognize the landscape dynamics of such forests. But I am jumping ahead of myself. How did Japanese and U.S. knowledge patches develop, and then spread?

Modern matsutake science began in Japan in the early twentieth century; after World War II its champion was Kyoto University's Minoru Hamada.[8] Dr. Hamada saw how matsutake could enlarge science through its position at key intersections between applied and basic research—and between vernacular and expert knowledge. Matsutake's economic value generated government and private support; it also opened barely explored biological research trajectories involving interspecies interactions. To explore those interactions, Dr. Hamada was willing to listen to peasant experience. For example, he used the folk term *shiro* ("castle," "white," or "plant bed") to refer to the mycelial mats—indeed, white, defense-oriented growth beds—in which matsutake fungus grows. He

learned from peasant knowledge about shiro, including early attempts to cultivate the fungus.[9] Meanwhile, he explored the implications of the shiro's interspecies relationships with trees, even as it raised philosophical questions. Might we think, he asked, of mutualisms as a form of love?[10]

Dr. Hamada's students—and their students—spread and deepened matsutake research. One, Makoto Ogawa, initiated a program for matsutake research in prefectural forestry offices across Japan. Prefectural forest researchers addressed applied questions with simple equipment and field-based methods; they kept the dialogue between vernacular and expert knowledge lively and productive.[11] Even university- and institute-based researchers in this legacy have continued to address farmers, writing popular books and field manuals as well as professional articles.[12] At the heart of their questions is the decline of matsutake since the 1970s—and the possibility of reversing this decline. On the one hand, they have worked to cultivate matsutake in the laboratory; on the other, they have explored the conditions most conducive to its growth in forests. Thus some have become involved with initiatives to save Japan's satoyama forests. Matsutake cannot flourish in Japan without revitalizing pine forests.

Thinking of matsutake in relation to the decline of satoyama led the researchers of this school to emphasize matsutake's relationality, not only with other species but also with the nonliving environment.[13] Researchers investigated the plants, slopes, soils, light, bacteria, and other fungi in matsutake environments. Matsutake is never seen as self-contained, but always in relation—and thus site specific. To promote matsutake, these researchers advise attention to the site—and to a regime of human disturbance to favor pine. In neglected forests, *more* disturbance is needed. One pair of researchers called this the "orchard method."[14] Through favoring pine, matsutake becomes a hoped-for weed.

Meanwhile, both private companies and university-based researchers have been busy trying to cultivate matsutake in laboratories. As long as prices remain high, what a prize that would be! For a decade starting in the mid-1990s, Kazuo Suzuki gathered a high-profile research team at the University of Tokyo to investigate the conditions of matsutake cultivation. The Suzuki lab brought in international postdoctoral fellows, adding to the cosmopolitanism of Japanese matsutake science. This re-

search turned away from field-based methods to explore biochemistry and genomic studies. Results have not so far included successful cultivation of mushrooms.[15] However, many insights have been gained, especially about fungus-tree relations: relations remain central here. At one point, Dr. Suzuki brought mature pine trees into his laboratory, constructing basement cages in which root symbioses could be observed and measured in detail.

Why hasn't this research been influential in the United States? The separation between U.S. and Japanese approaches to matsutake science was not ingrained from the start. When matsutake first came to the attention of forestry researchers in the U.S. Pacific Northwest in the 1980s, they set out to find out about it—from Japanese research.[16] Central Washington University's David Hosford went to Japan to work with Hiroyuki Ohara, who had trained with Dr. Hamada. Dr. Hosford also had a number of scientific articles translated from Japanese. His work resulted in an extraordinary publication, coauthored with American colleagues: *Ecology and Management of the Commercially Harvested American Matsutake*.[17] The publication is as close to Japanese research as anything published in the United States. The opening summarizes the history of matsutake in Japan, and it proceeds to Japanese-style research in Washington State, which Dr. Ohara helped supervise. It even describes site-specific vegetation patterns in U.S. matsutake areas. However, it also includes a caveat: "American foresters . . . are likely to view the Japanese methods for enhancing matsutake production in a different context . . . [because] forest management goals differ greatly."[18] This caveat turned out to be fateful. All subsequent U.S. Forest Service research on matsutake takes Japanese studies into account only by citing Hosford.

What was the block? One Pacific Northwest researcher told me that Japanese studies are not very useful because they are "descriptive." In untangling what "descriptive" might mean, and what is wrong with it, the cultural and historical specificity of U.S. forestry research comes into focus. Descriptive means site-specific, that is, attuned to indeterminate encounters and thus nonscalable. U.S. forestry researchers are under pressure to develop analyses compatible with the scalable management of timber trees. This requires that matsutake studies scale up to timber. Site selection in Japanese research follows patches of fungal growth, not timber grids.

Forest Service–sponsored matsutake research has addressed one big question: Can matsutake as an economic product be managed sustainably?[19] This question takes shape within the history of Forest Service efforts at timber management. In this history, nontimber forest products cannot be seen unless they make themselves compatible with timber. Thus the stand—the unit of manageable timber—is the basic landscape unit U.S. foresters can see.[20] The fungal patch ecologies studied by Japanese scientists just do not register on this grid. The scale of U.S. forestry research on matsutake is adjusted accordingly. Some studies use random transects to sample matsutake on a scale that is compatible with timber stands.[21] Others build models through which fungal patches can be scaled up.[22] These studies devise monitoring techniques to make matsutake visible on the scale of timber's rationalization.

One of the key questions of U.S. matsutake research concerns pickers: Are pickers destroying their resource? This question draws from U.S. forestry history, with its central query: Are loggers destroying their resource? This legacy suggested research on pickers' techniques. As with loggers, the point of impact is imagined as the harvest. Studies have found that raking the ground lessens future mushroom production; if mushrooms are gently removed, future production is unharmed.[23] Pickers must be trained to harvest properly. The effect of other forms of human disturbance on mushroom harvests—e.g., thinning, fire suppression, or silviculture—has not been studied; it does not jump to the minds of researchers worried about overharvesting. This is U.S. sustainability: a defense against greed-based popular destruction.

In contrast to Japan, in the U.S. foresters are concerned about dangerous human disturbance. Too much, not too little human activity destroys the forest. By chance, "raking" is symbolic of disturbance in both sciences—but with opposite valences. Raking destroys matsutake forests in the U.S. by disturbing underground fungal bodies. Raking makes productive matsutake forests in Japan by uncovering mineral soil for pine. These are very different forests, with different challenges. Advocacy for pine is unnecessary in the conifer forests of the U.S. Pacific Northwest (although opening the national forests to citizens' thinning groups might be great). The contrast, however, raises issues other than which approach is right: it shows the productivity of basic questions and as-

sumptions. Cosmopolitan science is made in emerging patches of research, which grow into or reject each other in varied encounters.

Returning to Yunnan, the influence of U.S. approaches should now be clearer. This would be prime country in which to ask about relations between matsutake, oaks-and-pines, and people: How might people sustain oak-pine forests for matsutake? Instead, researchers imagine matsutake, American style, as a self-contained, scalable product, whose accounting requires no attention to relations with other species. The questions that follow about sustainability ask not about relational forests but about picker practices: Are pickers destroying their own resource? When researchers ask villagers about declines in matsutake harvests, they do not ask about forests. The question of decline is addressed as if mushrooms inhabited the landscape alone.[24] This is the American question, the question learned from the experience of rationalizing timber in the hopes of saving it from greedy loggers. But mushroom pickers are not loggers.[25]

Despite the hegemony of American frameworks among scientists, there are audiences for Japanese matsutake research in Yunnan. Matsutake export businesses have ties to Japan because that is where the mushrooms go. Furthermore, Japanese science explores how humans can manage forests to increase the yield of matsutake mushrooms. In contrast, Americans explore how the mushroom harvest should be regulated to keep harvesters from destroying their resource. Japanese forest management promises more mushrooms for the market; American science promises fewer. Yunnan matsutake businesses have reason to prefer the Japanese paradigm. When a prominent Japanese scientist had his book on matsutake management translated into Chinese, it was the matsutake business association in Yunnan, not the scientists, who translated it, and even after its translation, the scientists did not know about it.[26]

All of this brings me to the first international matsutake studies conference held in Kunming in September 2011. The Yunnan matsutake business association organized it in concert with a team of Japanese scientists. Also in attendance were a group of North Korean matsutake scientists—and the North American–based Matsutake Worlds Research Group. Communication was made difficult by the fact that translators were provided only for the ceremonial opening session, and even then

the translators were overwhelmed by discussion in an unfamiliar field. The rest of the conference was supposed to be in English, but participants struggled with that standard. Still, language was only part of the problem. We each had completely different ideas about the point of matsutake studies. Most of the Chinese participants hoped to promote Chinese matsutake, and so they spoke of cultural values, new processing techniques, and efforts by the government to protect the mushroom. The Japanese participants, in contrast, were excited by the opportunity to see non-Japanese varieties of matsutake, which might have better potential for cultivation. (Some Chinese objected; they didn't want to be data.) The North Koreans begged for copies of international scientific articles, blocked to them at home. And dancing around this were the North American anthropologists, with our metacommentary on science and society.

We had different agendas. Yet in two days of joint fieldwork before the papers, we watched each other watching the forest. It was an amazing opportunity to see several kinds of science-in-action performed simultaneously. Chinese participants witnessed to the diversity of the forest's fungal life and the newly cordial relations between peasants and international experts. Japanese scholars savored the rare chance to work with foreign fungus–host tree relations. North Koreans were eager to learn new techniques. No one thought this meeting was unproductive. We practiced arts of listening: the recognition of differences as the beginning of work together.

There were also silences. Consider who did not attend. U.S. Forest Service research had been curtailed several years before by cuts in federal funding; no U.S. foresters would be sent. Just across town, a Chinese research institution boasted several matsutake researchers, and they also were not in attendance. This was a different crowd, assembled by Chinese businesses and Japanese scientists. In the confused translations and missing persons of meetings such as this, gaps and patches are maintained.

Sometimes individuals make a difference in translating across patches, fertilizing new developments. The Kunming meeting emerged only because of the efforts of an individual. As a child, Yang Huiling met a Japanese anthropologist studying her Bai community in Yunnan. She went to study in Japan and became involved in the matsutake trade. She facil-

itated the ties with Japanese scientists that made the Kunming meeting possible. Bringing together research traditions, she had the opportunity to begin a new patch formation.

Cosmopolitan science is composed of patches—and is richer for it. Yet individuals and events sometimes make a difference. Like mushroom spores, they may germinate in unexpected places, reshaping patch geographies.