THE RISE AND GOVERNANCE OF 'HIMALAYAN GOLD': TRANSFORMATIONS IN THE CATERPILLAR FUNGUS COMMONS OF TIBETAN YUNNAN, CHINA

by

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The Rise and Governance of 'Himalayan Gold':

Transformations in the Caterpillar Fungus Commons in Tibetan Yunnan

Thesis directed by Associate Professor Emily T. Yeh

Contemporary Tibetan livelihoods across the Tibetan Plateau depend extensively on profits earned through caterpillar fungus (*Ophiocordyceps sinensis*) harvesting. Caterpillar fungus is a rare fungus that is internationally valued in traditional Chinese medicine (TCM), Western medicine and biomedical research. The income harvesters earn in the short six-week harvesting season accounts for 40-80% of their annual cash income, making "Himalayan Gold" the single most important constituent of rural Tibetan economies. Market price for caterpillar fungus has increased by a factor of ten in the past decade and two-fold in the past four years. As market demand for and derived income from caterpillar fungus continue to rise, so too does the number of harvesters across collecting areas. To date it remains uncertain how harvesting potentially influences future caterpillar fungus populations and there are few economic alternatives for a similar scale of cash income for collectors in the neoliberalizing geographies of western China.

Emphasizing a political ecological approach and based in three case studies in Tibetan Yunnan, this dissertation has examined: (i) how the nonhuman dimensions of caterpillar fungus production influence the forms its commodity chains take, by influencing who and what places are incorporated into and excluded from its production; (ii) how the rise of the caterpillar fungus market has influenced the Tibetan social relations of production; (iii) whether harvesting communities have developed governance arrangements in their caterpillar fungus commons with the rise of the fungal economy.

This dissertation shows how the biophysical and ecological specificities of caterpillar fungus growth influence who and what places are involved in the harvesting economy, and how and when it is produced, which points to the ways nature variegates the production of caterpillar fungus. It also describes how unlike other caterpillar fungus production areas, the fungal market in Yunnan is still deeply embedded in social relations that enable and constrain how the market takes form in the lives of its producers. Lastly, it shows that local governance arrangements in Yunnan have emerged, but that they are maintained and destroyed in articulation with China's political economic context. Research methods include: participant observation, focus groups, interviews, and ecological methods.

This dissertation is dedicated to
Jenn S. Dinaburg
Dear friend and colleague
(1980-2012)

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INTRODUCTION

During the past two decades, a parasitic fungus known as caterpillar fungus (*Ophiocordyceps sinensis*) has risen to unprecedented heights in the Chinese economy. Known as "Himalayan Gold" in some places of its production (Gould 2007), the fungus has become one of the most expensive traditional Chinese medicines and a choice commodity of exchange between Chinese government officials and wealthy businessmen in China's unique *guanxi* economy. Less than 20 years ago, a gram of caterpillar fungus was worth but a fraction of a US dollar, but by early 2012, the retail price for caterpillar fungus among its major importers in Beijing, Shanghai and Guangzhou had increased more than 100-fold and was valued at more than $111 USD per gram – more than the price of gold by gram weight equivalence.[1] With an exchange value surpassing gold, caterpillar fungus has now even emerged on the Chinese stock exchange. According to a *Wall Street Journal* journalist, some wealthy Chinese investors are "looking for help in strange places" to find profitable returns on their investments (McMahon 2012). As stocks have fallen, real-estate markets have leveled, and bank deposits have yielded minimal returns in China, caterpillar fungus has risen from the rubble as China's "new gold" and an investment worth making.

Thousands of miles west of the stock exchange of China's eastern seaboard, the caterpillar fungus economy has also risen to great heights in an entirely different set of social, cultural, political and ecological relationships. Each spring, thousands of Tibetans travel from their villages to the high alpine grasslands of the Tibetan Plateau to search for and produce the

[1] Want China Times: http://www.wantchinatimes.com/newssubclasscnt.aspx?id=20120207000020&cid=1503, accessed May 24, 2013.

caterpillar fungus commodity. Yeh and Lama (2013) recently described this seasonal mass migration of people from urban areas and villages to the rural grasslands as the paradoxical reversal of China's usual flow of 'floating' populations to urban areas. During the collecting season, Tibetan time-space relations revolve significantly around caterpillar fungus production, creating the phenomenon Lama (2007) has described as "crowded mountains, empty towns," where all but the very young and very old reside in the high alpine grasslands during May and June each year. Those who are collecting the fungus live in high alpine camps for the duration of the season, and in some areas – such as those described in this dissertation -- the camps are replete with pool hall, barbeque shacks, restaurants, movie theaters and teahouses. The emergence of these secondary businesses and clusters of huts in the camps illustrate the ways the practice of collecting caterpillar fungus builds on and continuously produces social relations, making it a significant feature in the social lives of most pastoral and semi-pastoral Tibetans throughout the Tibetan Plateau.

In Tibetan, caterpillar fungus is called *yartsa gunbu*, or "summer-grass winter-worm," which reflects Tibetan understandings of 'nature's production' of the valued fungus. In the grasslands at elevations of 4200 meters (approximately 14000 feet) and greater, the caterpillar fungus commodity is visible to collectors as a small, darkish "blade of grass." It is usually less than five centimeters tall and three millimeters in width, and highly inconspicuous within its sea of similar alpine vegetation. In addition to being small and difficult for harvesters to see in the grasslands, caterpillar fungus is sparsely distributed, which makes the practice of producing it require hours, if not days, of crawling across the grasslands searching for the small fruiting body. Currently, collectors in Yunnan usually find zero to eight fungi in an eight to ten-hour harvesting day, which means "collecting" caterpillar fungus is more accurately described as the act of searching for caterpillar fungus, which better conveys the reality that the hours harvesters invest in searching for the fungus do not result in a proportional or guaranteed economic benefit.

Once a collector finds a caterpillar fungus individual, she uses a stick or a small hoe-like tool to carefully dig down and around the blade of "summer grass" to excavate the remaining portion of the prized commodity: the body of the host larva that the parasitic fungus attached to, grew within, killed and emerged from. After a harvester collects the "summer-grass winter-worm" complex in its joined form, with the fungal fruiting body and larval body still attached, she places it in a small container (a dried noodle bag, a plastic gum container, a cigarette package, etc.) or tucks it in a fold of clothing or a pocket for safe-keeping until she can sell it to a caterpillar fungus buyer. When freshly harvested, the joined larva-fungus is usually 10 centimeters in length. The fungus is most valued in its joined form, and as later discussed, harvesters are careful not to break the joined form while collecting and handling the commodity.

In Yunnan's Diqing Prefecture, the region where this research is based, local buyers (*xiao laoban*, or "little bosses" in Chinese)[2] hike up to the high alpine grasslands and buy caterpillar fungus from collectors throughout the harvesting day. In some areas, local buyers sit and wait for collectors at a point near the harvesting camps to buy at the end of the harvesting day, and in other areas the buyers hike to and around the collecting areas. The local buyers generally stay up in the camps for a week to ten days at a time, depending on how long it takes them to purchase enough caterpillar fungus to fill a shoulder bag, briefcase or a duffel bag, or spend all of their money, whichever comes first. After their buying stays in the camps are finished, local buyers transport the commodity in bulk down from the mountain camps to the next major town or city, where they sell their fungi in bulk to medicine stores or larger-scale buyers who travel to the area

[2] Here I use the term "local buyers" to describe those buyers who are generally from the same township as collectors and who move fluidly between the role of collector and buyer during the day and harvesting season. These buyers are distinct from the buyers who are not harvesters and who are from other provinces.

during the harvesting season to buy caterpillar fungus for their medicine stores throughout China. Local buyers usually take several buying trips to the mountains during the collecting season, exchanging cash for fungi and fungi for cash, until the collecting season ends towards the end of June or until they have sold their purchases for the year.

With the rise of China's cash economy during the 1980s due to Deng Xiaoping's economic reforms, the price of caterpillar fungus and other related commodities have risen steadily during the past three decades. According to Lama (2007, 33), the price for caterpillar fungus rose by a factor of 10 from the mid-1990s to the mid-2000s, increasing from 2000 RMB for one *jin* (half of a kilogram) in 1997 to 20,000 RMB per *jin* in 2006 in some parts of China. In Yunnan during 2009 and 2011, high quality caterpillar fungus sold for 40,000 to 60,000 RMB per *jin* in medicine shops, and caterpillar fungus sold for more than 350,000 RMB per *jin* in high end medicine shops in Beijing.

For harvesters in Yunnan, the price for caterpillar fungus peaked in 2008, when they could earn 50-100 RMB for a single high quality caterpillar fungus individual. This meant that finding just one caterpillar fungus in a day provided more income than a day's labor working road or building construction at the time. During the six-week harvesting season, caterpillar fungus harvesters earn 40-80% of their annual cash income (Winkler 2004), making caterpillar fungus the cornerstone of the contemporary rural Tibetan economy. Due to this economic opportunity, the rapid rise in the caterpillar fungus economy in recent decades has caused an increase in the number of collectors throughout the fungus' range of occurrence. Some harvesting areas, like Qinghai's Golok Prefecture and Nepal's Dolpa district, are now characterized by an influx of thousands of nonlocal harvesters during the collecting season (Shrestha and Bawa 2013; Sulek 2011). In Golok, some residents who control access to caterpillar fungus collecting areas have started charging exorbitant rents from harvesters who travel to the region during the collecting season (Sulek 2011). Other harvesting areas, like those in Diqing, are not characterized by such a dramatic influx of 'outsiders' during the harvesting season, but rather by modest population increases in recent years due to the fact that households send more family members up to the collecting areas in order to generate more income. The emptying of the household during the collecting season, where most able-bodied individuals travel to the high alpine grasslands and harvesting camps for the duration of the season, has shifted a new level of labor burden to elders who remain in the home. As I discuss in Chapter 3, elders' contributions to household (re)production enables and constrains the extent to which families can participate in the collection of caterpillar fungus.

As the caterpillar fungus economy has gained momentum among collectors, buyers and consumers in the past decade, harvesters have become aware of a *per capita* decline in the amount of caterpillar fungus they find during a collecting season. In Diqing, most harvesters attribute the decline to the increased number of collectors and drier spring conditions. These narratives and reasons for a *per capita* decline are emerging in other collecting areas as well, as recently noted by Shrestha and Bawa (2013) in Nepal's Dolpa region. Some conservation scientists have interpreted harvesters' narratives and perceptions of *per capita* declines to be indicators of an *overall* decline in caterpillar fungus populations (ibid.), but in this dissertation I suggest that such interpretations are premature and as yet scientifically unverified. A *per capita* decline in the amount of caterpillar fungus collected could indicate an overall decline if the total number of harvesters remains constant, but given the increase in the number of collectors across harvesting areas in the past decade, it is misleading and potentially inaccurate to interpret *per capita* declines as indicative of overall declines. Further, it remains scientifically uncertain how harvesting potentially influences caterpillar fungus reproduction, thus it is similarly misleading to claim -- as Shrestha and Bawa (2013) have -- that caterpillar fungus populations are in decline due to trade-induced overharvesting. As I discuss in Chapter 2, the timing and practice of collecting caterpillar fungus may not impact fungal reproduction in the way they are often assumed to, and broader biophysical factors – such as climate change or larva population fluctuations -- might be influencing overall caterpillar fungus population fluctuations.

Shrestha and Bawa's (2013) claim that caterpillar fungus is in 'rapid decline' due to trade-induced overharvesting is not an exceptional understanding of harvester-fungus interactions among those conservation scientists examining aspects of the sustainability of caterpillar fungus collecting in Bhutan (Cannon et al. 2009; Cannon 2011), China (Winkler 2008; Weckerle et al. 2010), and Nepal (Shrestha and Bawa 2013). When I first began this research in 2007, I, too, concluded after preliminary research that the timing and intensity of caterpillar fungus collecting were indicative of an impending resource decline. This dissertation, however, based on my continued research on caterpillar fungus, critically challenges the ways the ecological narrative of a trade-induced resource decline is so readily accepted among conservation-minded scientists who are studying the caterpillar fungus. There are significant gaps in the scientific understanding of both caterpillar fungus growth and harvesters' impacts on fungal reproduction, as I discuss in Chapter 2, which indicate that the assumed impact of harvesting on caterpillar fungus resources is not substantiated or accurate. As a readily-accepted truth, I suggest that the story of a "trade-induced" or "human-induced" caterpillar fungus decline is a powerful environmental narrative, and a 'received wisdom'-in-the-making (Fairhead and Leach 1995; 1996). Examining whether understandings of environmental change are 'received wisdoms' requires close attention to the linkages between science and society, and how "environmental laws" or "truths" are produced, corroborated and then used to legitimize policies or resource governance strategies. As Forsyth (2003) has discussed, examining these linkages is crucial for ensuring that scientific understandings of environmental change are both biophysically accurate and socially relevant. Two potential downfalls of what Forsyth calls "unreconstructed" environmental science – or science that has not been examined in relation to its social and political influences – are the undermining of "its ability to address the underlying biophysical causes of perceived environmental problems" and its potential production of environmental policies that "unfairly penalize many land users – especially in developing countries – and that may even increase environmental degradation and poverty by threatening livelihoods" (Forsyth 2003, 2).

As 'received wisdom,' the linkage and assumed causal relationship between harvesters and caterpillar fungus decline is emerging as a taken-for-granted truth, or an unchallenged *a priori* assumption about what is going on, that takes much more scientific evidence to overturn or disprove than it does to reinforce. For the caterpillar fungus economy, this 'received wisdom' requires reflective and critical (re)examination because establishing causality (i.e. stating that a harvester's actions are causing an overall decline in a resource population) draws boundaries around what or who is important and determines which courses of action (management) are both possible and appropriate in order to address the 'problem.' Once received wisdoms like these are accepted and taken up among scientists because they "reflect culturally and historically specific representations of 'the environment'" (Mearns and Leach 1996, 11) – or once a resource is assumed to be in decline due to trade-induced overharvesting – data that could be interpreted in multiple ways is narrowly interpreted in ways that reinforce narratives of decline. For example, under the *a priori* assumption that harvesters are causing a decline in caterpillar fungus populations, narratives of *per capita* declines in caterpillar fungus among harvesters that are elicited through interviews could be readily interpreted as data that supports and reinforces an understanding or deep-seated notion that the resource is in overall decline, as has been done by Shrestha and Bawa (2013). Such interpretations rest on neo-Malthusian and Hardin-inspired theories that regard human misuse of resources, overpopulation and economic rationality as fundamental drivers of environmental degradation. If such theories were not taken as starting points for caterpillar fungus research, however, the fact that harvesters are both experiencing and perceiving a *per capita* decline in the amount of caterpillar fungus they find each year could lead to further examinations of how broader factors, like climate change or ecological shifts in host-parasite relationships, are influencing caterpillar fungus growth and why such perceptions of scarcity are emerging among harvesters.

While this dissertation does not explicitly examine the ways climate change and shifts in host-fungus dynamics are potentially influencing caterpillar fungus populations, as I discuss in Chapters 2 and 3, harvesters' perceptions and experiences of a *per capita* decline in caterpillar fungus are salient at this time (and thus readily elicited through interviews) because the amount of caterpillar fungus harvesters find now is interpreted in relation to historical narratives of caterpillar fungus abundance -- when there were very few harvesters and caterpillar fungus was found in greater quantities by individuals -- *and* the pressing realization that collecting the fungus is currently their major source of cash income in a neoliberalizing political-economic context. Political ecologists like Louise Fortmann (1995) have shown how stories and historical narratives significantly influence how environmental claims are produced and contested in resource geographies, and here I expand on these insights to show how an awareness of caterpillar fungus scarcity among harvesters is produced in relation to elders' stories of historical abundance and reinforced through their lived experiences, where there are few economic and culturally-valued alternatives for generating household cash income.

The discussion in Chapters 2 and 3 thus pushes narratives of *per capita* decline beyond their immediate interpretation – or reinforcement of an understanding that the caterpillar fungus economy is another ‘tragic’ case of trade-induced overharvesting – towards deeper analysis of how and why perceptions and experiences of collecting caterpillar fungus are historically and political economically situated. This shifting of interpretation reflects an analytical shift from an *apolitical ecological* approach to the fungal economy – where human-fungus interactions are solely biological, similar to predator-prey relations -- to a *political ecological* approach, where human interactions with resources are social, cultural and political.

Employing a political ecology approach to the caterpillar fungus economy also means expanding analyses in ways that further account for how the biophysical characteristics of caterpillar fungus play an important but under-examined role in the fungal economy. As I discuss in Chapter 2, the *asexual* reproductive pathways of caterpillar fungus has largely been marginalized by scientists examining the caterpillar fungus, even though it is potentially one of the most important dimensions of understanding how and whether harvesting influences fungal viability, and is thus a key dimension of understanding caterpillar fungus sustainability. Similarly, Himalayan climatic trends in recent decades, most notably the decrease in spring precipitation (Shrestha 2012), and host population fluctuations (unrelated to harvesting) might have major influences on caterpillar fungus populations that remain as-yet unknown and under-examined. Foreclosing alternative hypotheses and failing to examine multiple variables in a complex system like the caterpillar fungus economy leads to weaker and perhaps inaccurate scientific understanding of what is going on, and perpetuates the production of certain forms of science that are defined by characteristic questions and approaches to environmental studies. By challenging the taken-for-granted truths that are emerging around the caterpillar fungus economy, this discussion builds on "critical" political ecology engagements with environmental science that seek to "avoid the replication of inadequate science, and to enable the production of more biophysically accurate, and socially relevant science" (Forsyth 2003, 2). In doing so, this dissertation is not intended to be "brownlash," or anti-science (Forsyth 2003, 20), but rather contributes a critical (re)constructive critique of the kinds of conservation science that are emerging around caterpillar fungus in order to foster the production of environmental explanations that adequately acknowledge the complexities of the biophysical and the socio-political dimensions of the fungal economy.

Shifting conservation science analyses and interpretations of harvester-caterpillar fungus relationships from an apolitical approach to a political ecology approach is critical at this time because conservation science-policy boundaries are currently being explored to devise 'sustainable' caterpillar fungus governance strategies (Kuniyal and Sundriyal 2013; Shrestha and Bawa 2013; Winkler 2013; Shrestha et al. 2010; Zhang et al. 2012; Cannon 2011; Snouffer 2013). As political ecologists have long shown, inaccurate assumptions and misinterpretations of human-resource relationships – both mobilized through asymmetrical power relations -- can lead to unintended or adverse governance outcomes (Neumann 1992; 1997; Carney 1993; Turner 1993; Schroeder 1997; Fairhead and Leach 1995; 1996). Using a political ecology approach, this dissertation draws attention to the ways that complex social, cultural, economic, and political factors influence how and why harvesters collect caterpillar fungus, and the ways harvesting communities are governing access to caterpillar fungus collecting areas. Contrary to the Hardin-inspired assumptions among some conservation scientists that there are currently *no rules* governing access to caterpillar fungus throughout collecting areas – which are reflected in their discussions for the need for local institutions and education (Kuniyal and Sundriyal 2013; Shrestha and Bawa 2013; Winkler 2013; Shrestha et al. 2010; Zhang et al. 2012; Cannon 2011; Snouffer 2013) -- harvesters in Yunnan have created and continue to create governance arrangements that limit access to their shared caterpillar fungus resources based on collectors' village-of-origin.

In Chapter 4, I describe governance processes for three harvesting areas in Diqing. As I show, the current governance arrangements in Diqing build on China's village-based pastoral reforms from the 1980s, which devolved control over the previously state-owned high alpine grasslands to natural or administrative villages so that villagers could use the grasslands in common for livestock grazing. Those high alpine grasslands that were over 14,000 feet elevation, generally summer pastures in Diqing, have become important caterpillar fungus production areas since the rise of the fungal economy. When possible, villages have strengthened their village-based claims to their grasslands as the fungal economy has risen by creating rules that limit access to them, and the villagers determine the specific characteristics of the arrangements each year.

In exploring the emergence and change over time of governance arrangements in Diqing this dissertation contributes to the growing body of scholarship on common-pool resources, or "the commons," that has drawn attention to the ways common-pool resources can be collectively and cooperatively governed by local communities (Wade 1987; Bromley 1992; Ostrom 1990; McCay and Acheson 1987). Commons scholars have produced a coherent and powerful refutation of Hardin's 'tragedy of the commons' model by overturning his major assumption that in the absence of government or individual property rights, there were no property rights at all.

Through myriad case studies, commons scholars have shown how through communication and collaboration, communities can self-organize and produce community-based governance institutions to govern their shared resources in potentially sustainable ways.

Building on the commons literature that has examined the kinds of institutions that make collective resource governance possible (Wade 1987; Bromley 1992; Ostrom 1990; McCay and Acheson 1987), this dissertation specifically engages recent geographical commons scholarship that examines how resource use and governance in the commons are constituted by more than just the motivations and desires of individual economic actors (Nightingale 2011; Martin 2006) -- and how the commons are "more than just a container of resources for appropriation" (St. Martin 2006) – by examining how cooperative governance is mediated by a host of social, cultural, political and economic factors. In Chapters 3 and 4, I discuss how harvesters' participation in the fungal economy is motivated by income opportunity, but also constrained and enabled by their membership within their household, and valued because of their affinity for the landscapes and the practice of collecting caterpillar fungus as compared to other available labor opportunities (road and building construction). Additionally, this dissertation illustrates how it is not only local capacities to communicate and cooperate that influence how and why governance arrangements develop and persist, but also the extent to which the state enables and reinforces local communities' control over their shared resources.

Caterpillar fungus collecting is thus a practice mediated by economic, political, social and cultural factors, and collecting areas and camps are significant sites for the ongoing production of social relations. The rise of the caterpillar fungus economy is rooted in China's economic reforms of the 1980s that created a space within which Tibetans can produce and govern caterpillar fungus in ways that enable them to economically negotiate Yunnan's rapidly neoliberalizing contexts, but under the control of a strong and pervasive Chinese state. As I discuss in Chapter 3, caterpillar fungus collecting is a unique form of 'freedom' for collectors: an opportunity by which to earn cash income, which can be used to purchase material goods and thus enable the continued neoliberalization of the region, and also a form of 'resistance' to the forms of work that are being created in the rapidly developing geographies of western China. As a source of income and a practice, collecting caterpillar fungus has become a major feature of the social and ecological lives of rural Tibetans in neoliberalizing China.

With these larger directions and purposes of the dissertation in mind, what follows is a brief overview of why and how caterpillar fungus is valued as a commodity in the current Chinese medicine market.[3]

The Commodification of "Himalayan Gold"

Caterpillar fungus is highly valued in traditional Chinese medicine and increasingly the international biomedical research industry. Within traditional Chinese medicine, caterpillar fungus (*dongchong xiacao* in Chinese, which translates as "winter worm summer grass") is categorized as a "warm" medicinal substance, and is commonly administered in tonic form to replenish kidney, liver and immune function, and to help against respiratory disease, fatigue, night sweating, arrhythmias and other heart diseases, hyposexuality, hyperglycemia, hyperlipidemia and renal failure (Zhu et al. 1998). Recent biomedical research has revealed that its polysaccharide fractions modulate immune activity and inhibit tumor growth (Buenz et al. 2005; Zhang et al. 2005). The latter characteristics are of growing interest in international cancer

[3] This dissertation focuses on the production and governance of caterpillar fungus, so the following will be the only description of how and why caterpillar fungus is being produced in the way it is today. See Yeh and Lama (2013) and Lama (2007) for descriptions of the cultural and political economic dimensions of the caterpillar fungus commodity chain.

research for exploring novel agents for radiation mitigation to improve the outcome of current radiation treatment due to its demonstrated capacity to improve nuclear transcription processes (Petrova et al. 2008), accelerate leukocyte recovery (Xun et al. 2008), and suppress tumor growth (Yoshikawa et al. 2006; 2007).

The rapid commodification of caterpillar fungus during the past two decades is due to the culmination of many factors. Deng Xiaoping's economic reforms that began during the late 1970s have played a paramount role in structuring China's now flourishing market economy, and through this, engendered the rapid rise of the caterpillar fungus economy both within China and internationally. Deng's reforms opened up China to foreign trade and investment (but with strict state control), increased the commodification of goods like caterpillar fungus and people in the form of wage labor, facilitated market-based pricing for most goods, and devolved centralized governance to townships and localities (Harvey 2005). With a focus on development, the reforms contributed to a widening of a gap between the rich and the poor, and the rising wealth along China's eastern seaboard engendered a rise in consumer interest in and capacity to purchase luxury goods like caterpillar fungus.

Within China's broader context of economic growth and expansion, particular facets of the caterpillar fungus commodity have contributed to its rise as a uniquely desirable product. In his recent anthropological commodity chain analysis of caterpillar fungus, Kunga Lama notes that "Tibet sells," and that Tibetan commodities are novel to consumers because the "myth of Tibet" captures consumer interest (Lama 2007, 49). For many of China's urban citizens, Tibet and the "West" conjure associations of wildness and vast expanses of open space, which cater to a consumer appeal for products from distant and exotic places (Yeh and Lama 2013). Two caterpillar fungus product companies announced a merger in 2009 that enabled them to launch the "Potala Palace" brand of caterpillar fungus as the "No. 1 brand in the Mainland China."[4] Here, the Potala Palace, one of the most important symbolic sites for Tibetans, was leveraged as a symbol and a way to bind caterpillar fungus to its 'Tibetanness' -- and thus its exotic appeal – to facilitate consumption among its mainly east-coast markets.

In relation to its medicinal efficacy, caterpillar fungus has become appealing for a variety of (wealthy) consumers. Caterpillar fungus supposedly started gaining Chinese and international attention as a medicinal product after two major ignition points: the World Games of 1993 and the Severe Acute Respiratory Syndrome (SARS) epidemic of 2003 (Lama 2007, 47-49). In 1993, three Chinese female runners broke records in the 1,500 m, 3,000 m and 10,000m events, after which their coach publically attributed their successes to their consumption of caterpillar fungus as part of their training diets. This testimonial is often claimed to have sparked a flurry of interest in caterpillar fungus and its consumption, but the coach made the remark in response to accusations at the time that the Chinese athletes were using steroids or other performance enhancing drugs (Steinkraus and Whitfield 1994), and their training regime was also said to have included deer penis and turtle blood (Demick 2008). From the testimony, however, several studies have examined its athletic performance effects and have found that there is no appreciable effects on aerobic capacity and endurance exercise performance (Earnest et al. 2004; Williams 2006).[5]

Another ignition point in the caterpillar fungus economy was the SARS outbreak of 2003, which drew another wave of attention towards caterpillar fungus (Lama 2007). SARS -- the symptoms of which include a cough, difficulty breathing and a fever -- was identified by World

[4] From *Sinocast*, June 15, 2007, "Along Tibet, Meibong Cordyceps to build up No. 1 Aweto Brand," http://findarticles.com/p/articles/mi_hb5562/is_200706/ai_n22745370, accessed July 20, 2007.
[5] Daniel Winkler, who has been engaged in various kinds of caterpillar fungus research since the 1990s, has also discussed the sensationalized discussions of its athletic performance-enhancing effects on his blog, http://mushroaming.com/blogs/cordyceps. See the 11/26/12 entry for specifics.

Health Organization (WHO) physician Dr. Carlo Urbani as a new disease in 2003. It was diagnosed in a 48-year old businessman who had traveled from China's Guangdong province through Hong Kong to Hanoi, Vietnam. Both the businessman and the doctor died from the illness, and during its global outbreak in 2003, it caused an estimated 8,000 cases of illness and 750 deaths. That year, the price of caterpillar fungus doubled from 4,000 *yuan* per *jin* (500 g) to 8,000–10,000 *yuan* per *jin* in the Tibet Autonomous Region (Lama 2007, 47). Studies continue to examine the medical efficacy of caterpillar fungus treatment among patients who suffer from lung fibrosis, which was commonly found in patients who died from SARS during the outbreak. Recent lab based and clinical trials suggest that caterpillar fungus is beneficial for relieving lung fibrosis (Chen et al. 2012).

Caterpillar fungus' association as a respiratory treatment during the SARS primed it for enrollment into medical regimes to combat the rise in respiratory illnesses that are associated with China's economic development practices and their environmental effects. A traditional Chinese medicine storeowner in Beijing said in 2007 that most of her clients buy caterpillar fungus to treat asthma. Thirty to forty percent of China's territory, especially the southwest, is suffering from acid rain and respiratory diseases caused by poor air quality, which is not surprising since China is currently the world's largest producer and consumer of coal, the emissions of which are environmentally destructive and are known to cause an array of respiratory illnesses (Liu et al. 2008). Asthma is but one of many secondary effects of poor air quality, and the number of asthmatic children and adults is increasing. It was estimated that from 2001 to 2006, the number of asthma cases in China increased by 40 percent and incidence rates are more acute in larger cities and among children (Watts 2006).

A recent study indicates that one of caterpillar fungus's active chemicals -- cordycepin -- is highly effective at inhibiting inflammation responses like asthma (Kondrashov et al. 2012). The details of cordycepin were highlighted in a recent *National Geographic* article that described how caterpillar fungus is a "worm worth its weight in gold" (Demick 2008). These kinds of studies, international attention, and China's continued maladies related to traffic congestion and economic development strategies will likely continue to reinforce interest in the caterpillar fungus for its medicinal qualities, but its exorbitant price as a commodity makes it a medicinal option only for the very wealthy.

The high price of caterpillar fungus stems from its rarity and wild-harvested production, which together make it a highly prestigious and valued commodity in China's gift economy. In China's culture of gift exchange, known as *guanxi* ("connection" or "relation") exchange, gifts are exchanged in order to cement social bonds or gesture wishes to establish them, and are often used to secure professional or political relationships or favors. *Guanxi* practices are resilient and they continuously adapt and adjust to new institutional arrangements as capitalism proliferates throughout China (Yang 2002). In general, rare and highly valued goods are used for *guanxi* exchanges. In the past, household items were preferred for *guanxi* exchanges; however these items are now no longer rare or sought after in China's contemporary arena of consumerism and production, and thus they are no longer considered significant gestures of exchange. Due to its rarity and economic value, caterpillar fungus has become an appealing choice. Most traditional Chinese medicine stores sell ornamental packages and gift boxes of caterpillar fungus, which range from 200–4,000 USD, that are purchased by wealthy Chinese as gifts for persons of notable rank. Such *guanxi* exchanges are increasingly valued in China's transitioning political and economic contexts where business arrangements among private entrepreneurs, between private entrepreneurs and state managers, or between entrepreneurs and officials — especially local officials — are secured through gift exchange (Yang 2002). In Yunnan's Deqin County, a government official explained in 2007 that nearly 25 percent of the locally harvested caterpillar fungus was purchased within Deqin for gifts to local or visiting government officials. China's business and development ventures will likely continue to position caterpillar fungus centrally in its *guanxi* economy.

With its rapid rise and incredible value in the Chinese economy, it is only reasonable to assume that it is just a matter of time -- if it hasn't already happened -- before caterpillar fungus is artificially produced. Despite decades of effort by Chinese and international biomedical scientists, however, the wild-harvested form of caterpillar fungus cannot be artificially produced. This means its supply to traders and consumers is both enabled and constrained by the social and natural relations of its production and governance in the high alpine grasslands of the Tibetan Plateau, which have not been examined to date but are the focus of this dissertation.

This dissertation research was conducted across four harvesting areas in Yunnan's Diqing Prefecture, an area undergoing rapid social and ecological transformations relating to statist development schemes designed to increase culture and nature-based tourism in the region (Yeh and Coggins 2014). These tourism-focused transformations of the region are part of China's broader development goals and interventions in its 'western' regions, which are collectively known as *Xibu Da Kaifa*, or the "Great Western Development Initiative." What follows is an overview of Diqing Prefecture and the development interventions underway in the region, which sheds light on how claims over nature and people are actively being produced and contested throughout the region, having everything to do with access to and control over caterpillar fungus.

Region and Site Description

The ethnically Tibetan region of Yunnan's Diqing Tibetan Autonomous Prefecture, where this work is grounded, is a dynamic stage on which to examine the intersections of the ongoing statist economic development transformations of the 'west' and the everyday lived experiences of semi-pastoral Tibetans who are navigating the political economic context of neoliberalizing China. As one of "China's many Tibets" (Hillman 2010), Diqing Prefecture is undergoing major economic development transformations as part of the "Great Western Development" initiative, which was designed to enroll the 'backwards' regions of China into its national economy[6] and address the blatant disparity between China's eastern seaboard and its western hinterlands (Goodman 2004).

The "Great Western Development" initiative was set in motion in 2000 for several reasons. First, discontent started to emerge around the widening economic gap between China's thriving eastern seaboard and its western and central hinterlands. In the 1990s, a group of analysts and scholars drew attention to the various indications that the coastal east had exploited the western regions during its growth phase, and they produced a series of demands for compensation and policy shifts that were more favorable to the interior (Yang 2002, 438). Second, during the late 1990s, the East Asian crisis weakened demand for Chinese exports, which raised state awareness of the fact that the consumption of manufactured goods in the central and western regions was far below that of the coastal region. This made central and western China a potentially large but then incapable consumer market that could shore up its

[6] In 1988 Deng Xiaoping explained, "the coastal areas, which comprise a vast region with a population of 200 million, should accelerate their opening to the outside world, and we should help them develop rapidly first; afterward they can promote the development of the interior" (Lai 2002). After pursuing coastal development for two decades, the economic gap between China's eastern and central/western regions has widened to an unstable degree and now the central government has turned its 'gaze' westward to actualize its promised interior development.

crippled economy (Yang 2002, 442). Third, China's entry into the World Trade Organization likely prompted state efforts to increase the productive capacity of the west so it could compete with foreign firms (ibid.).

Developing the 'west' – which includes Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang, Sichuan, Chongqing, Guizhou, Guangxi, Yunnan, Inner Mongolia and Tibet -- requires the central government to build the necessary infrastructure and stimulate job growth. The first endeavor required state-led investments in the region, or what Yeh and Coggins (2014) have called the expansion in the "hardware" of development, namely road networks, air travel and airports, hydropower generation, and telecommunication systems. Tactics for stimulating job growth included promoting the growth of the non-state economy, especially rural enterprises and foreign-direct investment (FDI); improving the performances of State-Owned Enterprises (SOEs) in the western and central regions, which were losing money at the time; and generally jumpstarting the economy in the interior regions (Yang 2002, 437). Promoting growth of the non-state economy has required diligent work by the central government to increase what Yeh and Coggins (2014) call its "soft power" in the region, or the technique of governance that engenders the formation of neoliberal subjects by enabling transnational and local cooperation in the development of the region's natural and cultural landscapes.

As part of the broader western development initiative, Diqing Prefecture has had a unique model of tourism-focused development that has capitalized on the biological and ethnic diversity that characterize the region. Though timber was an important source of income for the prefecture during the 1980s and early 1990s, by the mid-1990s, timber revenues began to decline in Diqing due to trade liberalization and increasing competition from Southeast Asia (Hillman 2010). Nature and culture-based tourism was an especially feasible option for Diqing's growth model given the success and established domestic tourism traffic that was already flocking to the towns of Lijiang and Dali to its south (Hillman 2010). When state revenues started pouring into the west, the Prefecture combined state-based investments, subsidies, grants, and soft loans from provincial authorities, and eventually made tourism a primary source of regional GDP. By 2007, approximately 3.2 billion RMB of Diqing's regional GDP of 4.4 billion RMB was tourism-based (Hillman 2010, 274).

Diqing's political economic context of development and tourism has produced uneven geographies. To date, most state investments and transitions relating to the "Great Western Development" initiative in most Tibetan areas of the west have been concentrated on infrastructure projects and state administration, which generally benefits minority elites with access to state jobs and droves of migrant laborers with access to construction, tailoring, food production or other service jobs (Hillman 2008; Fischer 2005). These kinds of technological and industry-focused investments produce highly heterogeneous landscapes, where some communities and places are subject to rapid material transformations while others are not. Diqing's cultural and natural tourism-led development strategy is said to deliver more inclusive growth than most other models where there are just fiscal transfers from above [7] (Hillman 2010, 274), though it still fails to directly benefit the majority of rural Tibetans in the form of new labor opportunities, [8] as they are either too remote to access new job markets or simply lack the skills to be considered for them (Hillman 2008). What this means is that the caterpillar fungus economy is tremendously important to Diqing Tibetans and whoever has access to and

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[7] Diqing has seen a large expansion in its private sector, which accounts for half of its GDP, where tourism has created opportunities for many Tibetan small businesses and traders with options for interest-free loans (Hillman 2010, p. 274).

[8] While some households certainly do have individuals engaging directly with tourism-related opportunities in the area –working at hotels, restaurants or driving – these are not very common.

ownership of collecting areas is economically advantaged in the rapidly expanding cash economy.

Study Sites

This research was conducted across four harvesting areas and their respective natural villages, which I refer to as Adong, Dongwa, Shusong and Yangla in this dissertation. All of the sites are located within Yunnan's Diqing Prefecture (see Figure 1.1), which consists of three counties: Deqin County, Shangrila County and Weixi County. This research was conducted in both Shangrila County and Deqin County. Shangrila County was previously known as Zhongdian County -- and Gyalthang among Tibetans (the name means 'victory plain' in Tibetan) -- but was renamed to Shangrila (*Xiang ge lila*) in December 2001 after the local government received permission and an endorsement from China's Civil Administration Department to rename it as such (Kolas 2008). The name "Shangri-La" is from James Hilton's novel *Lost Horizon*, written in 1933, where Shangri-La is a mystical and harmonious place in which the storyline is based. The name change was initiated to expand tourism in the region, which was a successful maneuver. The renaming sparked a wave of desired media attention and a rapid growth in the regional tourism industry followed soon after, which also spurred a growth in market demand for Tibetan cultural products (Kolas 2008).

Figure 1.1 Map of four study sites, Adong, Dongwa, Shusong and Yangla, in Diqing Prefecture in Yunnan Province. Map Source: Jamon Van Den Hoek

Adong

Adong village (阿东村, pinyin: *A Dong Cun*) (28.7967 N, 98.6598 E) is an administrative village within Shengping town (升平镇, pinyin: *Sheng Ping Zhen*) in Deqin County, and is comprised of 16 natural villages or groups, each of which has approximately 30 households. According to a village leader in 2011, there are approximately 2,249 people in the entire Adong administrative village, with approximately 700-800 harvesters across all of the different harvesting areas. Adong administrative village is comprised of Lower, Middle and Upper Adong, the names of which refer to their relative position along the major river running through the villages. Lower Adong is a major grape-growing area, and as a result, caterpillar fungus collecting is not as much of a priority as it is for Middle and Upper Adong residents. My household interviews were based across two natural villages in Middle Adong, but for greater clarity in this discussion, I will refer to my research findings and observations for both the camps and the two natural villages as "Adong."

Adong is located northeast of Shengping town (colloquially often referred to as Deqin), reachable by either a two-hour local bus ride or a five to six hour hike along an old trade trail over the mountain pass that separates the two. As described in Chapter 4, each natural village in Adong has its own caterpillar fungus harvesting area, which makes the collecting areas and their harvesting camps sparsely populated even by Yunnan standards. I visited two different harvesting camps during this research, both of which had approximately 40-60 harvesters at various times.

Dongwa

Dongwa Township (东旺乡, pinyin: *Dong Wang Xiang*) (28.3475 N, 99.4121 E) is located within Shangri-la County and consists of five administrative villages: Zhongxin, Xinlian, Shangyou, Yuejin and, Shengli. Each administrative village consists of approximately 12 natural villages. This research was conducted across two natural villages within Zhongxin administrative village, but for clarity in this discussion I refer to these cases as "Dongwa" in this discussion, which is the Tibetan name for the area.

Dongwa's township seat is not located along any major tourism routes in Shangri-la County, and is reachable by a nine-hour bus ride along a partially paved road. The township seat seemingly exists to house the Public Security Bureau offices and the Township government offices, which are the largest buildings in the township and are surrounded by a high concrete compound wall. The rest of the township seat is a dusty single-lane road, lined with two local hotels, three restaurants, and two general stores. The township seat is located next to the Dongwa River, and across the river from the seat is a small natural village. Though Dongwa villagers can buy necessities in the township, Shangri-la is the nearest major town.

As discussed in Chapter 4, three of Dongwa's five administrative villages have allocated caterpillar fungus collecting areas, which are used and accessed by all of the natural villages through a system of rules. Dongwa's camps are much more populated than Adong's, and Zhongxin's camp has an average of 400 harvesters.

Shusong

Shusong village (书松村*,* pinyin: *Shu Song Cun,*）(N 28 23.074, E 99 00.272) is an administrative village within Benzilan Town (*Ben Zi Lan Zhen)*,[9] in Deqin County, which includes 13 natural villages within its administrative territory. As with the other sites, I conducted research across two natural villages within Shusong, but will refer to them collectively as "Shusong" in this dissertation.

Unlike Adong and Dongwa, Shusong is located on the major tourism corridor between Shangri-la and Shengping, or the connection between the two major sites of "China's Tibet" tour of Diqing Prefecture. Both Shusong village and its harvesting areas are located immediately alongside the National Highway 214 (*Guodao* 214, referred to as G214 in this dissertation), which is currently undergoing a major expansion as part of the "Great Western Development"

[9] Benzilan Town is comprised of five administrative villages total, including Benzilan, Shusong, Yeri, Duotong, and Dari.

and significantly influences the social and ecological dimensions of life in Shusong, as I will discuss.

Shusong's harvesting area is located within *Baimaxueshan* Nature Reserve, which brings with it a whole host of governance and tourism-related factors that are not found in either Adong or Dongwa's harvesting areas (as discussed in Chapter 4). Shusong has two major roadside harvesting camps, and there are estimated to be approximately 200-300 harvesters in the areas each season.

Yangla

Yangla Township（羊拉乡, pinyin: *Yang La Xiang*) is located in Shangrila County, and is comprised of four administrative villages: Jiagong, Guiwa, Yangla and Maoxiang. I conducted research in one natural village and its harvesting area within the township, which I refer to as "Yangla" in this discussion.

Yangla is located approximately 10 hours north of Shangri-la along a partially paved road, and is located close to the Sichuan-Yunnan border. Yangla is said to have a major copper mine, but the mine was not visible or a significant aspect of people's daily lives when I was in their harvesting areas in 2009. The harvesting camp I visited in 2009 had approximately 60 people using the area, all of whom were from the same natural village.

Field Research

This dissertation is based on field research that I conducted across Dongwa, Adong, and Shusong's caterpillar fungus harvesting areas and their respective villages from 2007 to 2011, and in Yangla during 2009.[10] Since my research sought to understand how caterpillar fungus production and governance operate in the daily lives of harvesters in the camps and collecting areas, most of my research took place during the collecting season from May to July each year. In 2009 I lived in Shangrila, Yunnan, for the duration of the year, and conducted household interviews during the fall and winter, from September to December.

Research Assistance

Each season I traveled to the high alpine grasslands for research, I hired a field assistant and translator to help me communicate with harvesters, buyers, village leaders, government officials and nature reserve staff. Though I studied Mandarin Chinese to an intermediate level at the University of California-Santa Cruz and the University of Colorado at Boulder, and participated in an intensive Standard Tibetan language program at the University of Virginia, the harvesters I was working among spoke different subdialects of Kham Tibetan, which I was not able to understand or study in the US. Though younger generations of harvesters are quite proficient in Chinese, many of the elders were not, so conducting interviews solely in Chinese would have limited whom I could talk with, and in general, I preferred to conduct interviews in Tibetan. I chose to hire female field assistants because their companionship while conducting the research made sleeping and living arrangements easier.

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[10] I expanded the sites to include Yangla because I was engaged in a collaborative project at the time with a molecular biologist, Kathryn Bushley. I collected 75 samples at each site that she used for genetic analyses, with the hope of building a genetic sequencing bank that would contribute to future research examining the reproductive mechanisms of caterpillar fungus. I conducted focus groups, informal interviews and participant observation, transects and household interviews in Yangla in 2009, but since I did not have a multi-year understanding of governance and changes over time, I do not include Yangla in the discussion on governance (Chapter 4).

Access and local relationships

In Yunnan, harvesting camps are generally located about a six to 13-hour hike up into the mountains from the lower river-valley villages. Travel to different harvesting camps requires not only permission from the local government official and natural village leaders, but also knowledge of the area and about which trails to follow up out of the villages towards the high grasslands. Most of the mountains surrounding villages are laced with various trails leading to fuel wood, timber, medicinal plants, or fungi collecting spots, or those that have been created by goatherds or other livestock traveling to and from grazing areas. My travel to the camps thus required assistance from villagers who were willing to allow me to join them as they traveled up to their harvesting area. As I describe in Chapter 4, many families send a household member back to the village at various points during the caterpillar fungus-collecting season to check on and maintain household labor needs. This meant that no matter what time I reached a village during the collecting season, I could usually find at least one if not several people who were planning to return to the harvesting camps a day or so after my arrival. During each field trip to Dongwa, Adong and Shusong, I was able to find an individual or a family who were willing to have me join them as they traveled to their collecting areas, and in all cases, stay with them and their family throughout the time in the camps. These individuals were important sources of knowledge and points of orientation within harvesting communities.

Methods

From 2007-2011, I used several methods both in the harvesting camps and in villages to understand different dimensions of the production and governance of caterpillar fungus. Within the harvesting camps and harvesting areas, I employed participant observation, informal interviews with harvesters and buyers, focus groups with harvesters in the camps; banded ecological transects; and a catch-per-unit-effort harvester tracking method. In villages and townships, I employed semi-structured interviews with local village leaders, government officials, and nature reserve managers and household interviews.

Participant observation and informal interviews

Participant observation of the daily lives of harvesters consisted of a tremendous amount of hiking and was physically strenuous. At the end of each field season I was always deeply impressed by the strength, resilience and fortitude with which Tibetans make a living in the mountainous geographies of Yunnan. As I discuss Chapter 3, many Tibetans value the practice of harvesting caterpillar fungus because of the income, their affinity for the grasslands and because it's more "free" than other kinds of labor, like road or building construction. However, make no mistake that living at 14,000 feet elevation (where most of the camps are located) and hiking up to 16,000 feet elevation on a daily basis, for up to sixty days in a row, is physically demanding and exhausting. Combined with sun exposure, frigid winds, cold nights, and limited food, harvesting caterpillar fungus is a form of labor that most people would have a very difficult time doing. The fact that Tibetan harvesters both normalize and prefer it as a form of labor is a testament to their strength.

A usual harvesting day consisted of the following: we would generally wake at 7am, rinse our faces with boiled water, have a quick breakfast of *tsampa* and yak butter tea, and depart camp before 8am. Most camps have a set of major trails that lead from the camp to a particular region of meadows, and travel along these main paths was generally quite quick. In some cases, we traveled up these main trails in a current of yak and *dzo* that were being moved up to the higher pastures for grazing during the day. In these cases the walk was surrounded by the clamor of bells and hooves on ground. Tibetans tie bells around the necks of their grazing livestock so they are heard when not visible: horses have the highest-toned bells that chime as they move, yak and *dzo* bells are deeper, and often produce a hollow clanking sound.

The main trail leading from the camp often dissipated as we climbed to the higher meadows and collecting areas, at which point everyone would slow from a walk to a stroll, to a stroll/crouch, and then a finally a crawl as they began their day's search for the small brown blade of "grass." When they harvest, people search for the fungus continuously. Even if they stop to take a break or move locations by walking, harvesters' eyes are always fixed on the textures of the grasslands. On one break in Dongwa, several of us sat on a grass bluff overlooking a deep drop off to valleys below and snow-mountain peaks across, when one man yelped excitedly and leapt nearly three feet downslope and across another companion who was sitting beside a rock. He had spotted the small fruiting body from several feet away as he sat, and several of the others laughed because it was less than a foot away from one collector who was sitting right beside it and didn't see it. As the man collected it, others' eyes scanned slowly around the area.

Lunch was usually at around 12 or 1pm, a time when everyone took a break from harvesting and sat in the round to share any food we had between us. Usual lunch fare was *mantou* (steamed buns make of wheat flour) or *baba* (a large, round, flat Tibetan wheat-based bread), with any additional things people had, such as chunks of red sugar, chilies, and very rarely slices of cooked salted pork fat. On sunny, calm days, people often rest a bit after lunch and surrender to the inevitable sleepiness that often accompanies time at higher elevations. Moving around above 15,000 feet elevation makes you both physically tired and also incredibly sleepy if you are sitting in a warm bath of sunlight. It was rather comical at times to see the handful of people stretched out on top of a rolling hill, as if they had all fallen from the sky to their respective landing places of slumber: some lying like straight arrows on their backs with their hats over their faces, others curled on their sides, and others lying on their stomachs as if soaring across the grasslands.

During the harvesting days, I visited with harvesters and conducted *informal interviews* to learn about their relationships with one another, how their experiences with harvesting had changed over time, where they find caterpillar fungus in the grasslands, how they learned how to collect it, etc. Informal interviews were useful for gathering and clarifying the nuances of caterpillar fungus production and governance, because they allowed for candid responses to things that come up during the day or topics that might not be thought of as questions to include in a semi-structured interview. For example, when hiking up to a particular area with a group of harvesters, one individual pointed over to a rock that was silhouetted on the slope to our left and said, "see that rock over there, it used to be much higher up the mountain, and the snow used to always be all the way down there." The permanent snowfield he remembered had receded about 30 feet up the mountain. These kinds of narratives enabled me to follow up on other perceptions and registers of other environmental changes, such as trends in snowfall, and how caterpillar fungus abundances change with the broader environmental changes. These kinds of exchanges are among the strengths of ethnographic research methods, which enable memories and unanticipated, impromptu stories to texture the understandings we gain about various topics, which is particularly important for analyzing how and why resource economies like caterpillar fungus are situated in the social lives of harvesters.

In general, people harvest until about five or six pm and then return to the camps for the evenings. Life in the camps in the evenings centered around making a fire, preparing food for yak, horses and *dzo* if families are watching their animals in the camps,[11] preparing dinner for themselves and then sleep. Two to three families generally share huts, and men and women sleep on benches that are built into the sidewalls under piles of quilts they bring up to the camps from the village. The huts have a central open fire pit in them if they don't have a wood stove, and people usually sit, eat and visit around the fire when they are in the camps.

Focus groups

The evening camp routines, where people are at home preparing food, eating and visiting around the fire, provided a good opportunity to do focus groups. Inspired by Geraldine Pratt's (2002) discussion of the value of focus groups as a way to observe the social process of knowledge and meaning generation, and how location and sitedness matter for the process, I conducted three focus groups in Adong, two in Shusong and three in Dongwa in 2009. My questions broadly asked about the history of caterpillar fungus collecting in different areas, perceptions and experiences of changes in the fungal market, and who has access to caterpillar fungus collecting areas and when governance arrangements emerged. When conducting the focus groups, my field assistant asked the questions and I observed how people reacted to the questions and took notes throughout. Paying attention to how people react to questions sheds light on what kinds of issues are important. For example, groups were usually quite serious when we asked them if they had any concerns about the future of caterpillar fungus, because as they often

[11] During the day while people harvest caterpillar fungus, herds of their livestock (yak and *dzo*) are also up in the high grasslands grazing, though usually they don't go as high as people do when collecting caterpillar fungus. In the mornings, when people leave the camps and hike up to the higher pastures to collect, they drive the herds up to the pastures with them, and similarly bring them back down to the camps in the evening. During the day, caterpillar fungus harvesters don't monitor their livestock closely.

recited, caterpillar fungus is their most important source of income. Through the focus groups, I noticed how respectful people were to elders when they spoke, and how closely people listened when the older harvesters shared stories about how collecting caterpillar fungus was when they were younger and how they would hike up to the collecting areas in the morning, and fill large market baskets with caterpillar fungus by lunch. The evident awe and smiles of disbelief among many of the younger harvesters suggested how significantly the stories of historical abundance influence the perceptions of harvesters today, who might harvest 10 hours and still not find any. Pratt's discussion of the transformative dimensions of focus groups also draws reflexive attention to the ways the research process itself contributes to the formation of new social relations: by drawing together a group of people who share the practice of collecting caterpillar fungus, and talking about what it means in their lives and in the lives of elders, the practice becomes imbued with new meanings and understandings among the participants.

Pratt (2002) discussed how the location and *sitedness* of focus groups makes a difference for how focus groups as a method play out. With this in mind, I chose to conduct focus groups within the harvesting areas and during the harvesting seasons to enable the focus group to take place as an event while caterpillar fungus governance and production were actively being negotiated within a set of social relations and field of concerns.

Banded (strip) Transects

During summer 2009, I conducted banded transects to purposively sample caterpillar fungus abundance per unit area across Yangla, Dongwa and Adong, in harvesting patches that harvesters defined as ideal harvesting areas at that particular time of year. I chose not to conduct transects in Shusong because it was the end of the harvesting season and people were noticeably getting ready to return to their village and thus it felt like it was too intrusive to request harvesters' participation in the transects at that time. In total, I conducted three sets of banded transects in Dongwa and in Yangla and two sets of transects in Adong, totaling eight sets of banded transects.

Methodologically, I chose banded/strip transects rather than line-intercept transects or a combination of randomly placed quadrats and line transects (both of which are commonly used to assess vegetation abundance) because they more accurately aligned with how harvesters search for caterpillar fungus. In line-intersect transects, only individuals that are located on the line are counted, and I felt that there was a high likelihood that line transects wouldn't overlap with caterpillar fungus individuals and it felt contrived and banal to ask harvesters to search for caterpillar fungus is such a constrained and choreographed way. Harvesters, who had trained eyes and had honed their most effective harvesting strategies over many years, had the greatest ability to 'read' the landscape for caterpillar fungus individuals and produce meaningful registers of its distribution.

Based on participant observation with harvesters in 2008 and careful observations of how harvesters search for caterpillar fungus, I opted for banded transects, which are a strip as opposed to a line, where any caterpillar fungus individuals located in the strip are counted towards total abundance calculations. I chose the width of the strip for the banded transects based on my estimates of what the natural 'spotting distance' and search pattern was for harvesters. It was important to me to tailor the choice of the method to the actual practice of harvesting so harvesters' participation in the method wasn't too onerous or time and energy intensive, and so it validated and capitalized on their practice-based knowledge and skills. Doing so made the method a more accurate and meaningful way to produce count data. Since harvesters generally crawl or crouch while collecting, I estimated a harvester's average spotting distance to be about one meter, or the length of one's arm. The width of the transect was thus 2m, so an individual could harvest along the center line of the transect and look on and on either side of the line up to their usual spotting distance, which covered an area of 2m in width. The transects were 20 m in length and were placed at 10 m intervals moving upslope and perpendicular to the slope.

When placing transects, I asked harvesters to select a "good" harvesting patch that they would otherwise be searching at that time of year based on their insights about where and when it would be ideal to collect. After they selected a particular area to harvest, which generally consisted of a section of a mountain slope, I began the transects at the base of the area and placed the first band perpendicular to the slope. After placing the first line, I placed a second one 10 meters upslope, parallel to the first, and repeated this leapfrogging transect placement until the harvesters themselves said that the transects had covered the entire swath of the patch. The end of the harvesting area usually correlated with physical transitions, such as transitions from grassland to scree or a leveling off in the slope.[12] For each line, I recorded elevation at 0 m, 5 m, 10 m, 15 m, and 20 m-intervals along the previously marked transect line. Since it was illegal for foreign researchers to operate a GPS unit in Yunnan at the time of my research, my field assistant Cao Wu Mei recorded GPS locations at the ends of each transects line, at 0m and 20m.

In each harvesting area, I asked the same two harvesters to search all of the transect lines. Having the same two individuals search the lines was a way to increase consistency across the different transects. I asked the harvesters to alternate their start order to make sure one wasn't always following behind the other.

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[12] In Yangla, harvesters said in one area that they harvest on the slope but didn't ever find fungus in a particular area after it leveled off.

In addition to searching within the bands, the harvesters also generally searched in between the lines as they moved upslope. In most cases, fungal individuals were found between the transects, the number of which was recorded but not included in the total density calculations presented in Chapter 2.

To compensate harvesters for their efforts and time, I paid all participants an amount equivalent to finding four regular caterpillar fungus individuals at the time (100 *yuan* in 2009). In addition, I paid a higher rate than the going purchasing price for any individuals they found in the transects. For example, when buyers were offering 25 *yuan* per piece, I offered 35 *yuan,* which was a way for me to additionally compensate for their time and effort investments. The findings from this method are discussed in Chapter 2.

Catch-per-unit-effort (CPUE) and time/space log

During 2008, I employed a method that I adapted from catch-per-unit-effort (CPUE) analysis, which is a method commonly employed in fisheries research as a way to estimate overall population size or population variation trends. The method is useful when "effort" can be assumed to remain constant, which in a harvesting situation broadly means that there has not been any major change in the technology that is used. This assumption is a major simplification for any harvesting situation, because "effort" also varies based on desires and interests among other things, as discussed in Chapter 3. With this in mind, according to the method, an increase in CPUE generally indicates population growth while a negative CPUE indicates a decline (Vickers 1991).

Puertas and Bodmer (2004) tested whether CPUE was an effective tool to assess wildlife population trends among hunting communities in northern Peru, comparing their findings and trends with line transect data, and found that it was a useful population-change detector because it does not interfere with the activities of local populations in the same way transects do. In terms of community-based management, CPUE methods -- which involve hunters' direct observation and logs -- are useful because they both involve the community and can be used by a community as a way to monitor change, which can then inform their own governance strategies (Puertas and Bodmer 2004). Puertas and Bodmer examined the hunters' logs and 4200 person-days of hunting and found that CPUE was reliable as a comparative index of population abundance, but that a limitation of the method for examining hunting-induced population changes was that it only worked well for economically important species -- mammals that are hunted and sold for income or are of high subsistence value -- which were hunted whenever they were encountered, which meant "effort" was constant. Non-preferred species were usually only killed close to the settlement and not with every encounter, meaning effort was not consistent.

For caterpillar fungus harvesting – and for all forms of harvesting -- it is both reasonable and problematic to assume that effort is constant across all harvesters and for the duration of their time spent searching. As discussed in Chapter 2 and 4, harvesters have different skills, desires and motivations for harvesting, which makes "effort" variable and contingent upon many factors. However, in general, there is only one way to harvest -- by crawling and searching -- which means there is no major technological difference between harvesters' effort. Though CPUE is an imperfect proxy for abundance and abundance changes, it is a potentially valuable way to assess abundance changes over time because people can hunt or harvest as they want and do as long as their total time and "catch" are recorded.

I trialed a variation of the method in 2008 and used three Garmin GPS Forerunners -- which are wristband-GPS units that are often used by hikers and runners to gather total distance, time and elevation measures – to create time/distance harvesting logs, which recorded total time, distance covered and "catch" for three harvesters on two different harvesting days, and two harvesters the third day, producing eight total observations. These data are discussed in Chapter 2 as time/space logs only.

Semi-structured interviews

To understand governance as a political process and a practice, and the ways in which ideas of rules are or are not upheld in the daily lives of harvesters, I conducted semi-structured interviews with village leaders, government officials, the PSB and nature reserve officers. These interviews were useful for understanding the formal representations of how governance operated in the high alpine grasslands, who is in charge, where different rules came from and at which scales they are negotiated and enforced.

Whenever I arrived in a township or administrative village from which I was going to base my research, I first made an effort to meet with the local PSB and government officials to make sure they knew I was in the area and that I had formal research clearance. I was instructed to do this by all of my funding organizations and my Chinese host researcher, and I know it was a practice that notified authorities of where I was, as well as a necessary safety precaution from the US Consulate's perspective.

When I was able to find government officials or higher level PSB officers in their offices, these formal meetings provided me with a unique opportunity to learn the formal caterpillar fungus governance arrangements, that is, the role of the state in caterpillar fungus governance. I often found, however, that officials were not in their offices. Their absence paralleled the narratives I gathered across diverse conversations that caterpillar fungus governance in Yunnan is village-based. In all villages, I was able to conduct interviews with the natural village leaders each year. I conducted interviews with *Baimaxueshan* Nature Reserve officers in their Shengping office during 2008 and 2011. The findings from these methods are discussed in Chapter 3.

Semi-structured household interviews

During Fall 2009, I conducted semi-structured household interviews in Adong, Dongwa and Shusong. I trialed the interview guide in Muding village in Yangla Township, which is another significant region of caterpillar fungus production in Yunnan. I had originally intended to conduct these semi-structured interviews with harvesters in the camps, but soon realized that the social nature, tight living quarters and busy days made the camps an inappropriate place to conduct such personal and rather time-intensive interviews. During the summer harvesting season, I asked multiple people at each camp questions about the timing of their various household activities to determine a time during the year when people would be in the village and not too burdened by interviews. Based on their responses I determined that the fall was a good time to conduct household interviews because most people were home after having harvested their corn. I had initially traveled to Shusong to begin the interviews, but realized that everyone was in the middle of harvesting their corn, so I ended up going to Adong first and returned to Shusong after.

Methodologically, household interviews are useful when questions are about household information that respondents might not feel comfortable disclosing in a public setting. Since several of my questions examined household incomes and expenses, it was appropriate to ask them in a private setting. Households were selected using convenience sampling, rather than randomized or stratified sampling, because many people were often in and out of their homes during the day and I interviewed those that were in their homes. My questions sought to understand how harvesting caterpillar fungus mattered in the household economy, and since most families send one or more individuals up to harvest, it was not necessary to only interview harvesters, as was the case in the summer. I sampled over 30% of the number of households across two natural villages in each area (approximately 60 households): in Adong, I conducted 24 household interviews; in Shusong, I conducted 21 household interviews; and in Dongwa, I conducted 19 household interviews.

Chapter One

Theoretical Framework

Introduction and Structure of the Dissertation

In recent years, the caterpillar fungus economy has gained significant attention from the popular media and press due to the rise of social conflicts in some areas and the increased realization of how significantly harvesters' livelihoods are anchored on the wild-harvested fungal economy (Finkel 2012; Cui 2012; McMahon 2012; Snouffer 2013). Popular discussions of the caterpillar fungus economy are often framed with concerns and speculations about what will happen *when* the caterpillar fungus economy crashes, based in the assumption that a "rush" like the caterpillar fungus economy can only persist for so long. This same assumption is pervasive among conservation scientists studying aspects of caterpillar fungus sustainability who readily assume that the increase in the number of harvesters in past decades and the practice of harvesting are negatively impacting caterpillar fungus populations (Winkler 2008; Cannon et al. 2009; Weckerle et al. 2010; Shrestha and Bawa 2013).

While the legacies of boom-bust cycles for natural resources like cod, whales, ivory, and timber illustrate that trade-induced resource declines have and do continue to occur across diverse resource geographies, in this dissertation I challenge the relevance of 'tragic' and neo-Malthusian theories for understanding the caterpillar fungus economy. Using political ecology and science studies approaches to the study of science-society-environment relationships, I argue that applying these reductionist frameworks to the complexities of human-fungus relationships in the caterpillar fungus economy potentially obfuscates other important drivers of social and environmental transformation in the region and may produce unintended consequences for those who are targeted as conservation subjects.

I support this overall argument in several ways. First, drawing from foundational political ecology literature that revealed how development-focused environmental explanations of 'degradation' failed to accurately describe actual human uses of and effects on resources (Leach and Mearns 1995; 1996) and provide alternative explanations for how and why 'degradation' was occurring (Blaikie 1995; Hecht 1995), I analyze how both state practices and political economic contexts give rise to and influence caterpillar fungus resource geographies. Examining resource politics in this way builds on the understanding that resource harvesting practices and patterns are not just proximately produced, but emerge at the crossroads of local and non-local forces, such as market forces and access and shifting political economic contexts (e.g. Turner 1993). With this in mind, I question the conventional wisdom of who should be blamed for 'degradation' in the caterpillar fungus economy and why. As I discuss, standard conservation approaches to caterpillar fungus focus mainly on the proximate harvester-fungus interactions to explain 'degradation' – positing, for example, that trade-induced overharvesting is causing an overall caterpillar fungus decline – which leaves broader explanatory factors, such as Chinese consumer demand for the fungus and the rapidly expanding cash economy in western China unexamined. These ideas thus challenge the 'received wisdom' (Leach and Mearns 1996) in-the-making for caterpillar fungus, which calls for careful consideration of how non-proximate factors produce and influence the caterpillar fungus economy, or the 'conservation problem.' In particular, this dissertation examines how the changing political economic context of Tibetan Yunnan influences harvesters' values, social relations, and access to caterpillar fungus influence resource use practices and patterns.

Challenging the conventional wisdom of who should be blamed for 'degradation' and why in this way also means questioning taken-for-assumptions about human-resource interactions. With respect to the caterpillar fungus economy, this means questioning whether it is accurate to build research and management agendas on the assumption – as most conservation scientists do -- that harvesting is negatively influencing caterpillar fungus populations. As Forsyth (2003) has discussed, and as I do in this dissertation, challenging 'received wisdom' in this way works to ensure that inaccurate understandings of human-environmental interactions do not perpetuate inadequate scientific understandings and give rise to contextually insensitive resource management guidelines that exacerbate the marginalization of the thousands of Tibetan harvesters who are currently reliant on this source of income. Relatedly, I suggest that this 'received wisdom' is emerging because human interactions with their environments are fundamentally characterized as 'impacts' and drivers of 'environmental degradation' in 'normal' conservation science, illustrated by the persistent emphasis on "maximum sustainable yields" as the means to ameliorate the trade-induced declines in caterpillar fungus populations.

Within these overarching ideas, this dissertation employs a mixed science studies/political ecology approach (Goldman et al. 2009) to analyze how the ecological, social, cultural, and political-economic contexts of caterpillar fungus production and governance coproduce one another. After a brief overview of the fields of political ecology and science studies, I clarify how the research approach used in this dissertation can be characterized as 'ecologically-grounded political ecology,' which as I show, is particularly well suited for productively engaging with the emergent conservation social science research approach and potential paradigm shift. By exploring the intersections of ecologically-grounded political ecology and conservation social science, I illustrate how the two approaches can meaningfully examine social and ecological transformations as they coproduce natural resource use patterns and governance decisions.

Following on these discussions, I position this work among other human geographic engagements with 'the material' or the 'matter of nature' in production. Engaging with these literatures is important because they provide a theoretical way of replacing *biologizing* (Turner 1993) framings of human-resource interactions with attention to how political-economic forces and social relations influence how and why resource use patterns and decisions take form. Geographic approaches to commodity chain studies are particularly useful in examining how and why certain resources become entangled into harvesting-trade relationships, and importantly how the stabilization and flow of resources from harvesters to markets are contingent upon a host of factors that can weaken or disrupt the flow. These insights expand ideas of caterpillar fungus sustainability – where sustainability is the ability for current and future harvesters to continue to collect caterpillar fungus – beyond a focus on the proximate relationships between harvesters and resources, towards attention to how resource flows are mediated and produced through cultural politics, resource tenure arrangements, and continued consumer demand for the commodity. Within commodity chain studies, this dissertation focuses on the production side of commodity chain relations, with attention to how the nonhuman dimensions of production influence who and what places are involved in the flow of commodity exchanges.

Lastly, this dissertation engages with literatures on 'the commons,' or common pool resources. Building on broader commons scholarship that has examined how local communities produce rules that limit access to their shared resources, this dissertation discusses how harvesting communities in Yunnan have developed diverse local governance arrangements across their harvesting areas to limit access to them. While much of the commons literature has focused on the conditions under which communities will self-organize to produce local governance arrangements, the governance arrangements in Yunnan build on Chinese pastoral reforms of the 1980s that apportioned summer and winter pastures – some of which are now caterpillar fungus harvesting areas -- to natural and administrative villages throughout the pastoral regions of western China. These village-based legacies of control over their shared grasslands continue to evolve differently across harvesting areas in relationship to their political economic contexts, including the extent to which the Chinese state has devolved governance power to local villages and ongoing relations with international conservation organization interventions in the region. In considering the pervasive presence of the Chinese state in the social and ecological dimensions of Tibetan harvesting, this dissertation both builds on and seeks to retheorize the commons scholarship. The dissolution of the once strong local governance arrangements in Shusong's caterpillar fungus harvesting area calls into question whether metrics of "success" in institutional approaches to the commons – where "success" refers to enduring local governance arrangements that foster positive ecological outcomes and social equality -- are relevant in the Chinese context, where there is always a strong state presence in the social and ecological lives of caterpillar fungus collectors. Instead, the design of local governance arrangements can certainly originate through local-level communication and collaboration, but they will only persist if they are enabled to by the Chinese state. In the case of Shusong, local caterpillar fungus governance arrangements dissolved as statist development took over village collecting areas and local claims to land and resources.

Challenging the 'received wisdom' of trade-induced overharvesting

As also observed by other scholars researching dimensions of caterpillar fungus in different locations (Weckerle et al., 2010; Shrestha and Bawa 2013), Yunnan caterpillar fungus harvesters claim that there has been a *per capita* decline in the fungus in recent decades. Shrestha and Bawa recently interpreted their data showing a *per capita* decline in Nepal as an indication of a 'rapid decline' in caterpillar fungus populations due to trade-induced overharvesting (Shrestha and Bawa 2013). Soon after they published their study, reports of the trade-induced overharvesting of caterpillar fungus and its 'rapid decline' proliferated throughout popular media in Nepal and internationally (Snouffer 2013; Shahi 2013). Scientific 'truths' or scientific interpretations of environmental change in a particular resource economy can and often are used to inform conservation policies, and if it is believed that harvesters are the primary cause of a rapid decline in caterpillar fungus populations, conservation-minded policies will likely try to limit human-impacts on the resources in various ways.

While there might certainly be a decrease in the overall amount of caterpillar fungus in some collecting areas, Shrestha and Bawa's (2013) data do not, contrary to their interpretation, unequivocally indicate that there is an *overall* decline in caterpillar fungus. Their data show a *per capita* decline in the amount of caterpillar fungus collected per harvester across years, but since the number of harvesters has increased across harvesting areas in recent years it remains unclear whether there is an overall decline (Stewart et al. 2013). Neither do their data, again contrary to their interpretation, indicate that harvesting is causing the decline: upon examining 1257 freshly collected caterpillar fungus, Shrestha and Bawa (2013) found that 94.4% of them were sexually immature, which they interpret to mean that, "current harvesting practice almost certainly impedes the timely release of spores into the soil, inhibiting reproduction" (Shrestha and Bawa 2013, 518). While harvesting pressure is greatest prior to *sexual* reproduction (Stewart 2009), it does not inhibit reproduction writ large because as a fungus, caterpillar fungus is able to reproduce both sexually and *asexually*. It is not uncommon for some fungi to reproduce primarily asexually (Stewart et al. 2013), and to date it remains uncertain how caterpillar fungus' asexual reproductive pathways contribute to future populations. What is certain, however, is that these and other conservation science accounts of harvester-caterpillar fungus interactions have failed to look beyond caterpillar fungus' sexual reproductive pathways in their analyses of 'sustainability' (Winkler 2009; Weckerle et al. 2009; Cannon et al. 2010; Shrestha and Bawa 2013), which means that they are accepting and stabilizing potentially inadequate scientific explanations of harvester-fungus interactions and environmental change as 'truth.' I suggest that this acceptance and stabilization is due to the fact that the idea of 'overharvesting' – which shapes the kinds of research questions that are asked and how data are interpreted -- is a readily accepted environmental narrative of harvester-fungus interactions, but one that may not accurately reflect the biological and biophysical complexity of what is going on.

Chapter 2 discusses the biological and biophysical dimensions of caterpillar fungus production in detail, and particularly how and why asexual and sexual reproduction differ, but here I highlight that there are very different policy implications depending on how caterpillar fungus reproduces and how harvester-fungal interactions influence reproduction. This means that there are divisive policy effects depending on which environmental explanation of caterpillar fungus reproduction becomes legitimated in the scientific community. If caterpillar fungus primarily reproduces sexually, each year's spores are crucial for the ongoing availability of spores, and harvesting pressures are greatest prior to sexual reproduction, then there is a high likelihood that over time (if not already), harvesting will negatively impact caterpillar fungus populations. If, however, caterpillar fungus primarily reproduces asexually – a process that likely takes place in the soil away from direct harvester interactions -- then harvesting likely has no direct effect on caterpillar fungus populations. The policy implications of these explanations is where the politics of environmental science become clear: if there is an overall decline of caterpillar fungus and it reproduces sexually, then an appropriate conservation strategy would likely require -- and validate -- the removal of human 'impacts' on the fungal resources in the form of harvesting bans or seasonal rotations. Conversely, if there is an overall decline of caterpillar fungus and it primarily reproduces asexually, then excluding harvesters from collecting areas should not be the sole focus of sustainable management and more analysis would need to be devoted to understanding how and why broader biological and biophysical conditions – such as climate change or host moth populations -- are potentially influencing its decline. When harvesting caterpillar fungus constitutes 40-80% of Tibetan harvesters' annual cash income, these kinds of science-policy linkages need to be carefully and reflexively examined by conservation scientists to fully grasp the political uses to which science can be put.[13] This reflexivity also, by default, helps, "avoid the replication of inadequate science, and…enable[s] the production of more biophysically accurate…science" (Forsyth 2003, 2), as illustrated by the case of caterpillar fungus.

As discussed in Chapter 2, recent mycological research -- a different scientific community and "social world" (Clarke and Star 2008) than conservation science[14] -- suggests that caterpillar fungus asexual reproduction and infection in subterranean habitat associations

[13] I mention the importance of reflexivity here, as opposed to just being careful, because conducting conservation science in a reflexive manner means partly looking back at oneself and one's positionality as the researcher. Reflexive scientific conduct thus means paying attention to how one's training, background, *a priori* assumptions, accepted truths/theories, hypotheses and ultimately ways of seeing influence the kinds of knowledge that are produced.

[14] See work by Lisa Campbell (2002) and Rebecca Lave (2011) for discussions of how different scientific disciplinary training influences how individuals approach sea turtle and elephant research and conservation goals, respectively.

may play more significant roles in caterpillar fungus propagation than is currently understood (also discussed in Stewart et al. 2013). For example, Hu et al. (2013) have recently shown that caterpillar fungus can be successfully propagated with haploid mating cells, which are produced through caterpillar fungus' *asexual* reproductive pathways. Lei et al. (2011) concluded that ghost moth larval consumption of *Hirsutella sinensis* (the anamorph, or asexual strain of caterpillar fungus) can lead to its colonization by *Ophiocordyceps sinensis* and a fruiting body. Peng et al.'s (2013) recent soil analysis of *O. sinensis* DNA distribution further suggests that infection likely occurs in ghost moth larva tunnels. These studies indicate that the scientific understandings that underpin the narrative of trade-induced overharvesting of caterpillar fungus (Shrestha and Bawa 2013) are in need of serious reconsideration.

Whether or not the social worlds of conservation science and mycological science merge and come together as an arena to produce new insights about caterpillar fungus in the years to come will be revealing: will neo-Malthusian and Hardin-inspired theories of human-resource interactions continue to characterize conservation science in the years to come? Specifically, will assumptions of trade-induced caterpillar fungus overharvesting persist even when contradictory evidence -- from other scientific disciplines or sources of data -- presents itself? As next discussed, assumptions about Third World 'environmental degradation' have been persistent in the international development and conservation industry since the mid-20th century. While a new brand of conservation, known as "conservation social science," is emerging that stands a chance of distinguishing its approach to human-resource ecologies from the legacy of past conservation failures, the extent to which the conservation science can uproot itself from its sedimented ideas of human 'impacts' on the environment remains to be seen. What follows is a review of some of the seminal political ecology engagements with environmental narratives, which sets the stage for the kinds of shifts conservation social science must actualize in practice if it is to truly "move beyond its ecological moorings towards the social sciences" (Mascia 2010).

Critical political ecologists have long challenged the ways international development interventions during the 1960s and 1970s operated based on neo-Malthusian theories that 'environmental degradation' in the Third World was caused by overpopulation and local mismanagement of resources (Hecht 1985; Blaikie 1985; Blaikie and Brookfield 1987; Watts 1987). These scholars variously employed political economy frameworks to offer alternative interpretations of the cause of 'degradation,' including wealth distribution, social patterns of accumulation, the role of the state, land-ownership and control over access to natural resources. In Neumann's (2005, 28) words, these works were "based on the premise that ecological problems are at their core social and political problems, not technical or managerial, and that what was required was a theoretical foundation to address the complex social, economic, and political relations in which environmental degradation is embedded."

In his analysis of why so many international conservation policies failed in many developing countries, Blaikie (1985) critiqued the colonial or 'classic' model of soil conservation that identified soil erosion specifically as an environmental problem as opposed to a socio-environmental problem. Identifying soil erosion as a strictly environmental problem validated coercive and forceful policies as remedies, which ignored the social problems that led to soil erosion in the first place. Further, the 'classic' soil conservation approaches categorized land-users "as lazy, ignorant, backward or irrational" (Blaikie 1985, 4) and fundamentally linked neo-Malthuisan ideas with soil erosion, without looking at how political economic factors – including pricing policies, allocation of resources, national legal structures, etc. – were in fact producing resource use practices and patterns. In general, Blaikie's analysis drew attention to the pervasive influences of class power or "where power lies and how it is used" in relation to the 'problem' of soil erosion (Blaikie 1985, 4). With persistent attention to how soil erosion mattered and to whom, Blaikie documented the many cases where soil erosion was occurring at alarming rates, but how lower classes were significantly more affected by soil erosion than higher classes, which ironically cast them as the culprits of degradation.

Watts (1987) similarly employed a political economic analysis of class structure and the social relations of production to challenge the broad generalizations that were being produced by development organizations about "African pastoralists" that were inaccurately and unjustly criminalizing "irrational" land users and overpopulation. According to Watts, many of the Sudano-Sahel environmental claims of 'degradation' rested on problematic assumptions about the 'irrational' herders, the uniform environmental impacts of large herds, or poor farming practices on Sahelian land. While processes like desertification and other kinds of 'environmental degradation' might in fact be occurring in different ways across the highly heterogeneous Sahelian agro-pastoral geographies, he argued that these processes are ultimately local, place-specific processes and must be understood as such, which requires attention to the ecological and political-economic forces. This place-based approach rejects the broad application of generalized 'overstocking' and 'resource misuse' explanations of change and instead examines how and why structural processes, surplus extraction and commoditization fundamentally differentiate who is at risk of and blamed for 'environmental degradation.' In his words, "the social relations of production and exchange are central to understanding not only the complexities of land-use decisions but also in broaching the paradox of why – and for whom – the problem of environmental change arises at all" (Watts 1987, p. 189). Like Blaikie (1985), Watts underlines the unjust pairing of lower-class status and blame for environmental degradation.

Using an ethnographic approach, Watts (1987) also rebuked major development-focused narratives about African herder and pastoralist rationality that characterized them as ignorant, backwards, and fundamentally embracing a form of individualistic *laissez-faire* utility with a built-in logic of accumulation. Rather than being "backwards" farmers and pastoralists who lacked concern for ecological management, Sahelian agro-pastoralists had developed a variety of practices and knowledges – or 'peasant science' (Watts 1987, 178) -- that specifically addressed soil properties, complex land-use combinations, intercropping and adaptive capability, using experimentation and analytical problem-solving solving skills. The kinds of 'problems' agro-pastoralists were analyzing and responding to, however, were not simply biological and insulated from their socio-political contexts and land-use practices: there was not, for example, a single term for 'drought' in Nigerian agriculturalists' vernacular, but rather "they have a vast array of terms for the milieu of responses to varied climate and other factors" (Watts 1987, 180) and flexibility is key. Their experiences with drought, and their adaptive capacity to respond to change, were fundamentally tied to their position in the broader structural forces that either enabled or constrained their ability to employ the flexibility in their farming practices that they so long had valued. Conflict, for example, was not simply a result of Hardin-like logics of open access and individual use, but rather related to a complex "upheaval associated with the development and deepening of capitalism" (Watts 1987, 187). These insights collectively point to the ways that the reductionist lenses through which development and conservation industries 'misread' human-environmental interactions and environmental change belie their actually variegated, interwoven and power-laden, rather than simply biological, nature.

Hecht (1985) also argued that 'environmental degradation' in much of Amazonia was not adequately explained by many of the major environmental explanations that were being employed by international development agencies and banks during the 1960s and 1970s, namely neo-Malthusian and Hardin-inspired models, which conceptualized ecological problems as strictly endogenous due to population increases or inappropriate technologies. Through her political economic and ecological analyses, she revealed how 'degradation' in Brazil was produced through the Brazilian state's development policies (which were supported by bilateral and multilateral aid agencies and banks) that sought to pursue national development and settlement of the Amazon through the establishment of a cattle ranching industry. The state's prioritization of cattle ranching sidelined other forms of land-use practices which might have been better suited to the tropical forest ecologies, but at the time cattle production fostered international investment in land – and thus capital accumulation through land rents among very few, powerful elites – in measures far beyond the profits that could be returned through the commoditization of goods, etc. The state's choice of cattle production, however, produced soil productivity declines and expanded deforestation.

In addition to her rich analysis of the political economic foundations of Amazonian degradation, Hecht conducted rigorous soil science research that overturned the scientific 'truths' mobilized by the state to legitimize the transition to cattle production as a means of development. In short, a particular soil study conducted by the research arm of the Brazilian Ministry of Agriculture demonstrated that the conversion of forest to pasture improved soil properties (Ca, Mg and pH). This study was widely cited and used by the Brazilian state to legitimize its policies, and specifically to undermine small-scale agricultural credits that would otherwise be issued to peasant agriculturalists: peasant agriculturalists were cast as "ecologically damaging" while large ranchers were portrayed as "environmentally rational" (Hecht 1985, 673). Scientific explanations were thus used to legitimate state development policies.

Rather than unquestioningly accepting this particular scientific study, however, Hecht conducted her own soil analyses – with a larger sample size and across a larger spatial extent – and found that that the widely cited "dramatic increases" in soil nutrients after conversion were moderated when larger sample sizes were used and that the absolute levels of Ca and Mg were low-to-marginal for pasture production, and not sufficient for long term animal use (Hecht 1985, 677). Hecht's study thus called into question the facts that degradation was caused by local, ignorant small-scale farmers' misuse of their resources – or neo-Malthusian and Hardin-inspired theories of human-environmental interactions and effects -- and showed instead how soil degradation was produced through state-supported development policies. She also exposed the deliberate ways scientific 'facts' were mobilized to support and legitimate Brazilian state political maneuvers.

In their seminal challenge to "received wisdoms" in Africa, Mearns and Leach (1996) also drew attention to how the widely perceived understandings of environmental change -- overgrazing, desertification of drylands, rapid deforestation of 'pristine' landscapes, soil erosion, and overpopulation-induced resource mining -- had acquired the status of "conventional wisdom" in the major development agencies and banks at the time. To them, understandings of environmental change achieved the status of "conventional wisdoms" when "the reasoning behind them [became] taken for granted and rarely questioned," and when they thus became "signposts to the lie of the land" (Mearns and Leach 1996, 2). In the African context, such conventional wisdoms "assign[ed] to Africa's farmers, hunters and herders a particular role as agents, as well as victims, of environmental change," despite the fact that most times these narratives did not align with local realities in myriad ways. The danger of stabilizing "conventional wisdoms" is that such trends and explanations of degradation imply that local land-use practices have to be "transformed and made less destructive" (Mearns and Leach 1996, 2), where rendering local land uses "less destructive" often means eliminating them (e.g. fire bans, forest-felling bans, or removal of local control over resources in favor of the state, etc.).

Fairhead and Leach (1995; 1996) similarly examined the relationships between the production of environmental explanations and their policy responses, and particularly how social science analyses tended to operate within a certain spectrum of assumptions when explaining environmental degradation in Africa. These predominate assumptions, they argued, gained strength and credibility because they were linked together and stabilized within "narratives," or "stories of apparently incontrovertible logic which provides scripts and justifications for development action" (Fairhead and Leach 1995, 1023). Such assumptions, as they show, do not accurately convey the realities they seek to construct, which reveals "how the applied social sciences can be used to lend weight to popular Western perceptions about African society and environment – a mythical reality which development interventions are acting to recreate in vain" (ibid.) Fairhead and Leach exposed how contrary to the development narratives that attributed deforestation in Guinea's forest margin zone to "institutional breakdown," population growth and general misuse of resources, local communities had in fact produced the very forest "islands," or patches, that were being valued as 'pristine' landscapes by development agencies. Rather than progressively converting forests into savanna through shifting agriculture and fire-setting practices, and preserving only the stretch of forests around their villages, the "remnant forests" that surrounded villages had historically been planted around settlements in what was previously a predominantly savanna region.

When analyzing the policy implications that flowed from the deforestation narratives, Fairhead and Leach found that they had changed very little since similar polices that were employed during the colonial period in Guinea when the environmental degradation narrative justified removing villagers' "dysfunctional [and] incapable" control over resources in favor of the state (Fairhead and Leach 1995, 1023). The technology "packages" of the 1970s similarly wrested control over resources from local communities in the form of reducing upland farming practices, fire-bans, and timber-felling restrictions, which perpetuated the colonial-era perceptions of local land users as ignorant and backwards. It was only through conversations with village elders and aerial photograph analyses that Fairhead and Leach were able to put together 'counternarratives' that accurately explained human-environmental relationships, histories and transformations.

Not only does Fairhead and Leach's (1996) discussion illustrate the profound ways in which *a priori* assumptions about human-resource interactions can be wrong, misleading, and informed by colonial assumptions about local resource users, but it also illuminates how and why inaccurate readings of a landscape can persist for over a century. One would think that environmental narratives and "received wisdoms" would be overturned by "better science" or encounters with contradictory evidence, but this is not always the case: when Fairhead and Leach shared their findings with local resource conservation and development officers in Guinea, their data were either ignored, interpreted with distrust or explained as exceptional. Rather than being changed and made more accurate when confronted with better understandings of environmental and social change, degradation visions are stabilized through the continual production of supportive knowledge, where "observers repeatedly 'rediscover' readings for themselves, within common sets of intellectual structures and social relations" (Fairhead and Leach 1996, 261). In short, "those who are convinced of deforestation and savannisation do not lack 'evidence' to draw on in support of their convictions" (ibid.). The production of knowledge goes beyond a particular community of 'complicit' scientists and 'science' itself: social, political and financial conditions and institutions mutually support one another in maintaining reversed readings in profound ways. As Michael Goldman (2006) has also discussed in his ethnographic analysis of the World Bank, major capital and human resource investments are channeled into the production and stabilization of environmental narratives that render landscapes and people in need of intervention. These insights remind us that environmental narratives or *a priori* understandings of human-resource interactions are influenced by a host of factors, including what counts as 'normal' scientific narratives, funding cycles and cultures of practice that coalesce around certain themes.

Maintaining narratives and supporting them with scientific evidence is much easier than reversing them, and it is this ease that I wish to draw attention to through the case of caterpillar fungus. Mearns and Leach (1996) observed that a common thread running through much of the received wisdom of environmental change in Africa were neo-Malthusian assumptions about society and environmental change. These same neo-Malthusian and Hardin-inspired assumptions about the caterpillar fungus economy are pervasive in conservation science engagements with the fungal economy thus far (Shrestha and Bawa 2013; Weckerle et al. 2010; Cannon et al. 2009; Winkler 2009), illustrated by their emphases on how the recent increase in the number of harvesters, their economic 'rationality' and their wanton (ignorant) collection of the fungus are driving its "rapid decline" (Shrestha and Bawa 2013). As I discuss in this dissertation, much scientific research remains to be done in order to causally link caterpillar fungus population trends with harvesting, and I contend that the ease with which harvesters are incriminated in the presumed "rapid decline" of caterpillar fungus indicates that the narrative of trade-induced overharvesting is a received-wisdom in the making.

As Fairhead and Leach show, there is no lack of 'evidence' for those who believe harvesters are degrading caterpillar fungus resources: observations of processes in the short term can be taken to indicate long-term trends and extensions of historically worsening problems; vegetation transects and surveys can document degradation of landscapes as compared to equilibrial, 'pristine' baselines; and any environmental change can be interpreted through a lens that incriminates human interaction as the primary drivers of change. Challenging the stabilization of "received wisdom" means denying the "value neutrality both of the methods employed in the study of environmental change, and of the conclusions derived from them" (Mearns and Leach 1996, 6), which motivates the work in this dissertation. I contend that more substantive understanding of harvester-fungus relationships is needed to assess whether current "readings" of the social and environmental changes in caterpillar fungus geographies are accurate. The pursuit of challenging "received wisdoms" is driven by the threat of the 'logical' policy implications that might flow from such narratives and validate the wresting of control over caterpillar fungus resources from the hands of the collectors.

I thus share with these political ecology approaches to environmental narratives a critical view on the ways environmental explanations of 'degradation' are based on *a priori* assumptions about who is responsible for 'degradation,' for what reasons, and what the logical policy implications of mitigating degradation might be. Drawing from the early political economic critiques of 'ecological problems' in this dissertation, I examine the complex ways caterpillar fungus collecting and harvester-fungus relationships are produced through a complex and uneven set of political economic structures and processes. I do not take for granted the fact that rural

Tibetans are engaged in the fungal economy as producers: my analysis of harvesting-related degradation seeks to examine the ways fungal degradation – if it is in fact happening – is not just a result of overpopulation or 'ignorant' resource misuse, but rather is constituted by a complex set of histories and policies that have positioned Tibetan harvesters as they are today. As Watts (1983) so eloquently summarized from Marx: "men make their own history, but they do not make it just as they please…but under circumstances directly encountered, given and transmitted from the past" (Watts 1983, 244). With this in mind, I examine how caterpillar fungus harvesting is currently positioned in the broader political economic context of developing and neoliberalizing China. China's middle to upper-class citizens are certainly not vying for access to collect caterpillar fungus themselves, which draws attention to the ways class – and socio-political positioning – influences who is considered to be responsible for 'environmental degradation' in fungal collecting areas, and who will fundamentally be most at risk from "rapid declines."

This dissertation thus also builds on political ecology approaches to 'environmental problems' that seriously examine how scientific understandings of environmental issues are produced and how their science-policy interfaces operate in the world (Hecht 1985; Fairhead and Leach 1996; Forsyth 2003). This approach avoids the "presentation of "ecology" into predefined notions of fact, accuracy and political response," in recognition of the fact that the adoption of ecological facts that do not accurately engage with the biological and biophysical complexities of human-environmental relationships can "lead to the production of environmental policies that don't address the underlying biophysical causes of environmental problems, and can impose unnecessary and unfair restrictions on livelihoods of marginalized people" (Forsyth 2003, 11).

Sustainability and maximum sustainable yield as biological reductionism

In an effort to reverse human impacts on resource geographies, conservation scientists often emphasize the need for sustainable management guidelines or institutions, as illustrated by the many cases where sustainable management guidelines are mentioned as critical foci for caterpillar fungus conservation efforts (Cannon et al. 2009; Cannon 2011; Winkler 2004; 2005; Weckerle et al. 2009; Shrestha and Bawa 2013). These guidelines and institutions are anchored on the idea that they will produce and maintain harvesting rates that are equivalent to the biological replenishment of the resource, which are in turn based on the assumption that such formulaic balancing is possible in the first place. Such formulaic approaches to sustainability *biologize* (Turner 1993) harvester-fungus interactions and make it seem as though sustainability is a technical problem between a stable 'nature' and a uniform human 'impact.' My field research in Yunnan illustrates how neither of these assumptions match up to the realities of caterpillar fungus geographies of production. First, the non-human dimensions of caterpillar fungus are contingent upon an array of ecological and biophysical relationships that are dynamic across years and places. Second, the skill of harvesting – or the ability of harvesters to be able to find caterpillar fungus – is not uniform across individuals or places. Together these uneven and dynamic factors disrupt the tidy partitioning of complex human-environmental relationships and histories into the categories of "biological replenishment" and "human impact." Further, the formulaic focus on solely proximate human-resource interactions fails to account for the ways that broader political economic contexts and conditions influence social relationships with caterpillar fungus in diverse ways. As I discuss in Chapters 3 and 4, harvesters' capacity to collect caterpillar fungus is influenced by their social relationships with one another, the multiple ways in which they value the fungus and their collection of it, their situatedness in households, and their capacity to claim caterpillar fungus collecting areas in common with their villages, among other factors. In sum, "harvesters" are much more than just an impact on caterpillar fungus, they are individuals who are situated in fields of meaning-making practices and relationships. This dissertation seeks to show how conservation science understandings of the "human dimensions" of resource geographies require significantly more engagement with how and why harvesters engage in the harvesting economy in the way they do.

The sustainability of caterpillar fungus – or the ability of harvesters to collect caterpillar fungus now and in the future – thus hinges on economic, political, cultural and ecological factors. Reducing all of these broader and complex political economic and socio-cultural factors to a formulaic measure of 'impact', assigns both a burden of blame and conservation to the collectors in potentially contextually insensitive and meaningless ways. This is what Fairhead and Leach (1996) referred to when they argued that environmental narratives and received wisdoms assign roles to certain populations: only those individuals who interact with the resources of conservation interest are seen to be the culprits of 'impact' or decline, and are thus rendered conservation subjects who must change their interactions and relationships with the resources in order to conserve them. At the same time, this reductionism also obfuscates the fact that even if caterpillar fungus numbers are declining due to harvesting, analyses of caterpillar fungus sustainability should also be looking at demand by rich Chinese consumers for an explanation rather than just assigning blame to 'backwards, ignorant' harvesters' impacts on their local resources.

The reduction of complex human-environmental relationships to calculations of rates of human impact and rates of biological replenishment in resource geographies is rooted in 20th Century resource management. At that time, efforts to regulate use of renewable resources evolved into calculations for maintaining the maximum sustainable yield (MSY) of resources like timber and fish, which was achieved through the balancing of rates of resource use and rates of biological replenishment (Larkin 1977). According to fisheries biologist Larkin (1977, 1), who critiqued the ubiquitous application of the concept during his later professional years, the MSY "dogma" of the 1940s -- when the concept was gaining momentum -- was the following:

> Any species each year produces a harvestable surplus, and if you take that much, and no more, you can go on getting it forever and ever (Amen). You only need to have as much effort as is necessary to catch this magic amount, so to use more is wasteful of effort; to use less is wasteful of food.

Larkin intentionally alludes to religiosity in his recollection of the foundations of MSY because it was, according to him, operationalized as a "puritanical philosophy in which the supreme powers were pretty harsh on people who enjoyed themselves rather than doing precisely the Right Thing" (ibid.). The 'supreme powers' were resource managers and biologists who were charged with determining MSY, which were employed in the form of regulations that controlled fishermen's actions. Accordingly, he noted, "Armed with scientific knowledge about the number of fisherman and technological advances, the manager could use regulations to prevent the catch from exceeding the maximum, even if it meant telling fisherman they could only use bare hooks from sailboats on alternate Tuesdays between 6 and 7 p.m." (ibid.). Managerial decisions hinged primarily on natural science methods and understandings of resource use patterns, without explicit concern for how such numbers might match up to reality or political landscapes: "various laws of supply and demand, marginal revenue, alternative options, and psychological dissatisfaction, were mostly mumblings of the social sciences" (Larkin 1977, 2).[15]

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[15] Now, three decades later, scholars continue to find that the social issues of conservation and resource management are still pushed aside. For example, in her examination of sea turtle sustainable management, Campbell (2002)

As a 'standardized package' (Fujimura 1988; 1992), MSY proliferated in national and international fisheries biology and policy circles throughout the 1950s and 1960s because biologists and statisticians developed "a healthy bag of theoretical and statistical tools" with which to "get out there and get the harvest of the sustained maximum yield" (Larkin 1977, 2). As theorized by Fujimura (1988, 278), a standardized package, or package of theory and technology, is "a clearly defined set of conventions for action that helps reduce reliance on discretion and trial-and-error procedures." The set of conventions for action could be a theory or a technological approach. Fujimura developed the concept as a way to describe how as 'standardized packages,' the theoretical understandings and technological approaches to examining cancer during the 1980s honed in on oncogene theory and recombinant DNA technologies, which together proliferated in labs throughout the U.S. The analytical purchase of the concept is the fact that the uptake of a standardized package – whether a theory, technology or approach – streamlines the scientific process and privileges some variables more than others in order to engage with other applications in diverse contexts, and in so doing, obfuscates or omits other ways of knowing or addressing a 'problem.' As a standardized package, MSY was adopted across both natural resource fields of study and practice, and was equated to sound science in natural resource management pursuits throughout the 1970s (Larkin 1977).

The import of MSY to diverse resource management arenas has been critiqued from many angles. Larkin's internal critique of fisheries biology uptake of the concept during the late 1970s drew attention to the ways MSY oversimplified biological and social dimensions of resource use practices. In particular, he argued that the roles of age class, genetic variability, species associations and gear choice influenced fisheries 'catch' numbers in important yet under-

found that biological science 'remains the privileged language" of the conservation scientists she interviewed (see Mansfield 2009, 41, for a discussion).

examined ways, and drew attention to the ways fisheries statistics were “incomplete and riddled with guesses, inadvertent errors, omissions, and even, perhaps, some perjuries” (Larkin 1977, 5). Larkin’s critique of fisheries is important for thinking about the ecological knowledge claims about caterpillar fungus populations, because the same guesswork that constitutes fisheries abundance calculations is invariably part of caterpillar fungus sampling efforts. While ecological and biological sampling techniques and statistical understandings of abundance are always partial and at most based on 95% certainty, the inconspicuousness of the species being sampled fundamentally challenges these scientific methods. Just as fish are inconspicuous to fisheries biologists from the surface of the water, caterpillar fungus as a species and its broader ecological relationships are arguably just as inconspicuous to an untrained eye in the grasslands.

What this means is that creating “do-able” science in complex and “elusive” ecologies -- like those of fish and caterpillar fungus -- is a process of quantifying and rendering “visible” certain phenomena (Ramisch 2010, 26). As Ramisch (2010, 26) has shown through his analysis of soil fertility science in agroecologies in southern Mali, “making certain phenomena “visible”, through new techniques or research energy, implies that other components within the complex systems…are excluded or simplified by design, dismissed as irrelevant, or overlooked completely.” Ramisch showed how the scientific approaches to soil fertility – which focused on producing highly detailed and quantified budgets of soil nutrient “inputs” and “outputs” for various agroecological plots --- were fundamentally ‘partial’ (Haraway 1988) because they lacked engagement with all of the other “invisible” factors that influenced farming systems – and their linkages to food insecurity -- in substantive ways. These other “invisible” factors included market access, tenure arrangements, labor availability, harvest obligations, inter-seasonal and residual effects of farming practices (including manuring, fertilizer use, burning, and land clearance). Agroecological complexity and variation between plots was thus readily examined and interpreted through "soil mining" frameworks, which causally and unquestioningly linked broader questions about soil sustainability and food insecurity with nutrient budgets and scientific efforts to measure, quantify, and count "visible" biophysical parameters. Ramisch's study calls attention to the ways in which quantification and scientific efforts to measure environmental phenomena are situated in political economic contexts that render such approaches 'normal' (Kuhn 1968), and the ways 'counting' certain phenomena renders others "invisible." His work and my own thus builds on broader literatures that examine the politics of counting, standardization and numerification (Eden 2012; Goldman 2007; Demeritt 2001; Scott 1998; Power 1997; Porter 1995; Skocpol 1995; Desrosières 1991).

For fish and caterpillar fungus, complex biological and biophysical interactions take place beneath the water and the soil,[16] which means that count data and MSY recommendations for diverse areas – e.g. across different marine areas or grasslands -- are presumed to be commensurable and representative of the same sets of ecological relationships, when in fact this might not be the case at all. Standardizing MSY across diverse geographies can be problematic if other population-level factors are at work. According to Larkin, "there is precious little prospect of achieving MSY either for one species or for any number of [fish] species in aggregate" (Larkin 1977, 5). Because of unknown interspecies interactions among fish, count data for one area could be significantly lower in one region than another, and if these data are channeled through an interpretive framework that categorizes count data as reflections of human impact, the count data could translate into strong exclusionary fisheries regulations when perhaps other biological factors are influencing the count data. Here the environmental narrative of

[16] The life cycle of caterpillar fungus is discussed in Chapter 2, which shows how the entirety of the ghost moth larva's life is spent in the soil.

overfishing factors into the assigning of blame for all discrepancies in count data to fisherman, which might not be accurate.

Count data and MSY are equally problematic for caterpillar fungus because – as discussed in Chapter 2 -- the fungal fruiting body is the manifestation of a host of climatic, environmental, and ecological relationships between the parasitic fungus and the ghost moth larva. Producing count data for caterpillar fungus in different geographic areas means capturing whether a particularized set of biophysical and ecological interactions have given rise to a caterpillar fungus, and interpreting such count data as solely reflective of human impact (harvesting) is a potentially faulty reductionism. In Larkin's (ibid.) words, "a wide variety of unexpected consequences can flow from what seem to be simple management species," meaning that all species are subject to a host of complex interactions. These biological and ecological complexities highlight the need to carefully scrutinize how scientific knowledge claims about abundance are produced and whether they accurately reflect invisible and difficult-to-measure biological and environmental relationships. This is particularly important when MSY determinations are used by "supreme powers" to control human interactions with resources.

Larkin's challenges to fisheries science have import for current conservation science approaches to all species, and caterpillar fungus specifically. Putting Larkin's critique into practice means asking: Do current ecological methods that measure abundance and distribution adequately examine and account for invisible and complex biological and biophysical relationships? Or are these methods trying to produce a "simple management species" in order to measure and manage it? What kinds of reductionisms occur when counts are used to both examine and represent the relationships between harvesting and caterpillar fungus populations?

These questions about count-based ecological assessments of caterpillar fungus are germane for rethinking caterpillar fungus sustainability studies because all conservation-minded scholarship on caterpillar fungus has thus far pointed out that the current gaps in scientific understanding of the ecological baselines of caterpillar fungus populations preclude the development of sustainable management guidelines (Weckerle et al. 2010; Winkler 2008; Stewart 2009; Cannon et al. 2009; Cannon 2011; Shrestha and Bawa 2013). This emphasis on the need to establish ecological baselines suggests that the MSY framework prevails in efforts to examine and produce sustainable caterpillar fungus management guidelines, and thus it is critical to reflect on how critiques of the approach can give rise to more meaningful understandings of complex caterpillar fungus geographies.

Efforts to establish ecological baselines of caterpillar fungus populations have been made in Bhutan and by me in Yunnan, as discussed in this dissertation. In Bhutan, several mycologists established exclosures or areas where harvesters would not collect caterpillar fungus, in order to generate multi-year scientific insights into caterpillar fungus population densities and distributions (Cannon et al. 2010). As summarized by Aerts et al. (2009), experimental exclosures are widely used as treatments in ecology to exclude (or statistically control for) the effects of predators or grazers on the species richness and recruitment in plant communities and on processes such as sediment deposition, litter production, soil carbon sequestration and woody plant invasions. Since Cannon et al. were trying to isolate and understand the effects of harvesting on caterpillar fungus growth, their methodological decision to establish exclosures was a sound scientific approach. At the same time, because the exclosures were created in order to keep harvesters out of a particular area, it is important to critically reflect on how this method potentially produces – both ideologically and materially -- ‘pristine’ and non-human spaces in the high-alpine grasslands as ecological baselines. As Leach and Mearns (1995; 1996) and Tsing and Satsuka (2008) – discussed below -- have shown, long standing human interactions with landscapes are often important producers of landscapes that accrue conservation value. As part of the MSY 'standardized package,' exclosures are intended to produce an unbiased and replicable control, however the production of this control is a reductionism of complex biophysical and ecological relationships, and an erasure of 'the social,' which complicates the assumption that it is replicable in the first place. If the goal is to ascertain how the recent rise in the number of harvesters in the past decade is potentially influencing caterpillar fungus populations, it is important to reflect on how the "invisible" conditions and linkages of caterpillar fungus are obfuscated in the decisions about how to quantify, measure and compare 'human impact.' This is not to say that exclosures are not useful tools for understanding environmental change, but rather highlights the need to carefully evaluate what is lost in the decision to render particular factors and variable "visible" in the scientific process.

The production of 'pristine' ecological baselines is something that other critical social scientists have challenged, particularly for its social implications. Through their comparative analysis of matsutake mushroom (*Tricholoma matsutake)* conservation science and resource management in the U.S. Pacific Northwest and Japan, Tsing and Satsuka (2008) reveal how matsutake science in the U.S. is fundamentally anchored on the U.S. Forest Service's legal mandate to maintain the sustainability of commercially harvested products. Like the role of MSY in fisheries, the U.S. Forest Service's approach to sustainability hinges on the idea and management goal of sustainable yields, where "with proper management, forests could be everlasting sources of profitable natural resources (Steen 1976, as cited in Tsing and Satsuka 2008, 248). As Tsing and Satsuka show, matsutake researchers who were working to produce management guidelines during the 1980s and 1990s followed the U.S. Forest Service mission to assess sustainable yields and ecosystem health. Both the focus on yields and ecosystem health caused researchers, "at least implicitly, to compare the ecosystem effects of foraging and forest use with a hypothetical situation in which humans had not disturbed the forest at all," which Tsing and Satsuka argue is problematic given the longstanding social history of use in the U.S. Pacific Northwest forests (Tsing and Satsuka 2008, 248). While these matsutake science approaches did not produce non-human spaces, or exclosures, as controls for their analysis,[17] the intellectual framework they used to assess health and yields "pressed researchers to segregate points of human impact, such as harvesting, which might be assessed in relation to ideal-type non-anthropogenic forest ecologies" (ibid.).

Tsing and Satsuka illustrate the peculiarity of the U.S. Forest Service-based approach to matsutake, which drives a wedge between the social and ecological dimensions of anthropogenic forest ecologies like matsutake, by describing the contrasting Japanese scientific approach to matsutake conservation. Japan has a long history of collecting wild edible plants and fungi because of the cultural values that are placed on them as culinary delicacies.[18] Japanese matsutake science began in the early 20th Century and Japan continues to be a major center of matsutake research and forest management (Tsing and Satsuka 2008). Unlike the U.S., where matsutake management spun out of timber-focused management and science, Japanese matsutake research began with the understanding that mycorrhizae – the small filamentous structures that make up most fungi and which grow in mats and webs on various substrates –

[17] At least as described in Tsing and Satsuka; enclosures might have been created to scientifically examine fungal reproduction rates or human impacts.

[18] Japanese market demand for matsutake drives global harvesting practices, and in Yunnan, a vast network of matsutake collection and trade has emerged that is able to transport freshly-harvested matsutake from the woodlands in northwestern Yunnan to the markets in Japan within 48-hours (Yeh 2000; Yang et al. 2008; 2009). Also see Michael Hathaway's chapter in Yeh and Coggins (2014)

were critical dimensions of forest ecology. Also in contrast to the U.S., matsutake science in Japan began with the belief that intensive silviculture has maintained Japanese forests in unique and important ways. Contrary to characterizing humans as 'disturbances' to forest ecologies from the outset, Japanese scientists have historically integrated folk terminology and harvesters' knowledge into formal scientific inquiries, and have defined "village forests" (*satoyama*), or village-maintained and harvested forests, as "models of the harmonious interaction of people and nature," where "intensive human management is valued not only as their constitutive legacy but also as key to their conservation of biodiversity" (Tsing and Satsuka 2008, 247).

According to Tsing and Satsuka, the distinction between U.S. and Japanese matsutake science centers on fundamentally different conceptualizations of the role of humans in forest ecologies: in the U.S., forest management characterizes humans as environmentally degrading and thus seeks to redress and balance human impacts on forest ecologies through regulations and monitoring. According to these logics, forest ecologies are perceived to be stable, and thus harvesting is the key variable of concern for maintaining sustainable yields, or indefinite harvesting capacities. In Japan, research and management take anthropogenic forests and historically variable yields as a starting point. Rather than the U.S. managerial focus on regulation, monitoring and limiting human impacts in order to avoid overharvesting, Japanese scientists are said to "worry more about whether harvesting can sustain positive understandings of nature and practices of human communality" (Tsing and Satsuka 2008, 249).

The distinction between characterizing humans as external agents that impact forest ecologies or as constitutive elements of them is a major one in terms of how conservation science questions are asked and methods devised to answer them. Most simply, conservation science can either operate as a way to measure human impacts with the normative goal to abate (exclude) them, or understand human-environmental relationships with the hope to foster 'positive' forms of 'communality.' How nature-society boundaries are drawn also influences the extent to which conservation science can shift towards inclusionary and democratizing modes of operating that integrate harvesters, pastoralists, loggers, etc., into efforts to understand (and govern) environmental change. Drawing from the literatures of political ecology and science studies, described above, this dissertation considers the relationships between conservation science approaches to caterpillar fungus and their political implications in practice. This is most explicitly discussed in Chapter 4 through an analysis of the ways matsutake management guidelines in Yunnan have influenced what counts as legitimate kinds of caterpillar fungus governance and regulations. International "sustainability" projects for matsutake employ the U.S.-based matsutake managerial frameworks, reflected by the kinds of conservation projects and resource sustainability studies that have been implemented in China for matsutake (Yang et al. 2008; 2009) and other medicinal plants (Buntaine et al. 2009). In Yunnan, matsutake collecting communities were encouraged by The Nature Conservancy-China and the World Wildlife Fund-China to establish monitors, clear governance rules, and 'rest day' regulations, or days when harvesting was not allowed, in order to foster matsutake sustainability. Dimensions of these governance protocols have moved into caterpillar fungus management guidelines in some areas, despite the fact that they do not necessarily align with the ecological and social realities of caterpillar fungus geographies.

Transforming 'normal' conservation science: Intersections between conservation social science and ecologically-grounded political ecology

Tsing and Satsuka's (2008) analysis of the distinctions between Japanese and U.S./international biodiversity conservation approaches highlights how what counts as 'normal' (Kuhn 1962) biodiversity and resource conservation science are actually situated and historically produced ways of knowing and ordering the world. Rooted as they are in early 20th century ideas, these approaches reify nature/society divisions and primarily seek to limit human impacts on 'pristine' natures by focusing on regulations, monitoring and overexploitation. In resource geographies like those of caterpillar fungus and matsutake, which have been used in diverse ways for hundreds of years, I argue that current 'normal' conservation approaches are in need of transformation. In Kuhn's (1962) terms, I argue that there is a need for a *paradigm shift* in conservation science that more meaningfully generates understandings of how ongoing social and ecological transformations – e.g. shifting market economies and climate change -- map onto ecologies and influence social-natural relations in integrated and uneven ways.[19] Kuhn has argued that science moves in gestalt leaps from one 'normal science' to a new paradigm, which then becomes normal over time if enough new scientists or members take up the new epistemological and ontological orderings. Gieryn (1995, 412) offers a useful metaphor for explaining how the transformation from normal science to new paradigms occur:

> Research in normal science is puzzle solving where the perimeter frame, the cut-out pieces, and the spaces to be filled in are specified by a paradigm. On occasion, some anomalous pieces cannot be made to fit, and when this happens at a time when another puzzle paradigm becomes available, science undergoes a temporary period of revolutionary alternation between frames of meaning.

[19] While there has recently been an increase in the number of conservation science analyses examining climate change impacts, here I advocate for climate change studies that look at how climate change maps onto existing political, social, cultural and ecological relationships and uneven geographies in ways that change and/or produce new relationships and linkages (e.g. (Adger et al. 2013; O'Brien et al. 2009)

Based on Gieryn's metaphor, it is reasonable to assume that when a number of anomalous pieces begin to accrue during 'normal' puzzle solving, then that particular form of 'normal' science is getting ripe for a transformation to a new paradigm. In the case of international conservation science and resource management endeavors, the 'community' and different facets of the social dimensions of resource geographies have consistently been anomalous pieces of the resource-focused conservation puzzle, which suggests the need to shift away from what has become 'normal' resource management and conservation science, as described above. A new conservation paradigm, known as Conservation Social Science (CSS), is emerging across major international conservation organizations (e.g. World Wildlife Fund and The Nature Conservancy), professional societies (e.g. Society for Conservation Biology) and academic institutions.[20] It remains to be seen how many practitioners and scientists will choose to join in and stabilize the shift towards more explicit engagement with the social dimensions of conservation, and how the social dimensions of conservation will be approached and engaged in practice, however this dissertation argues that this shift is needed and that critical social science approaches to conservation should centrally feature in the endeavor to build this new research and practice paradigm.

According to World Wildlife Fund's Senior Social Scientist, Michael Mascia, the emerging CSS field emphasizes a "people are the answer" approach to conservation that "expand[s] the horizons of conservation science beyond its biological traditions" (Mascia 2010). WWF's turn towards an integrated approach to conservation, which formally began in 2005, hinges on the idea that social scientists' contributions of "rigorous scientific analyses of

[20] For example, during Fall 2013, the University of Idaho-Moscow advertised for a new position in Conservation Social Science.

conservation questions that explore the relationship between people and nature" can shed light on the following foci (ibid):

- What social contexts are most suitable for conservation investments?
- What conservation policies and practices best support sustainable human stewardship of our natural environment?
- What are the impacts of conservation programs for people and nature?

These foci suggest that the kind of social science research conservation scientists are seeking to integrate *into* conservation science are those Sandbrook et al. (2013) recently described as "social science *for* conservation." They contend that social science for conservation, as opposed to "social science *of* conservation," can be thought to share with conservation biology its 'mission-driven' approach that is "dedicated to the moral and practical challenge of stopping biodiversity loss" (Sandbrook et al. 2013, 1487). Social science for conservation also seeks to "increase understanding of human society in order to understand why, how and when impacts on nature and biodiversity loss occur and what motivates people to engage in activities that harm or promote the conservation of biodiversity" (ibid.). Such social scientists engage with conservation biology because they believe that the "natural science methods of conservation biology are insufficient to find solutions to complex conservation problems that have social dimensions" (Sandbrook et al. 2013, 1488). For example, de Snoo et al. (2013, 2) argue that the integration of social science that "is combined with ecological research to elucidate the social processes underlying successful agri-environmental management…[can] increase effectiveness where the aim of conservation is to conserve nature values of agricultural landscapes and fields." Here, conserving "nature values" means facilitating the conservation of rare and vulnerable species, which are goals that align with the "mission-oriented" field of conservation biology that fundamentally seeks to conserve biodiversity. This manner of turning towards social science is thus an endeavor to reinforce conservation goals to make the "farmer" – or harvester, herder, or local land user – the "owner of the nature conservation problem" (de Snoo et al. 2013, 3).

In Mascia's (2010) words, the turn towards the social sciences in conservation programs enables them to "gain a deeper understanding of the decisions people make affecting nature, why they make them, and how that knowledge can inform conservation strategies that balance the needs of people and nature, [because] *after all, conservation interventions are the product of human decisions, and require changes in human behavior to succeed*" (emphasis added). Here it is evident that the 'turn' towards the social sciences in conservation is mostly methodological and seen as a way to account for humans and their relationships to conservation geographies, however the shift has not disrupted the deeply rooted 'impact' theory of human-environmental relationships. While the shift towards social sciences in 'normal' conservation science is promising for various reasons, the implicit assumption that human behavior is in need of change is problematic and risks perpetuating the kinds of conservation failures that have led conservation science to turn to the social sciences in the first place (Mascia et al. 2003).

Efforts to understand nature-society relationships and resource use decisions and patterns have long shaped the field of political ecology, which I suggest, is the form of social science that offers the most promise in drawing together the 'social worlds' (Gieryn 1995) of the social sciences and conservation scientists. Their shared interests in "the decisions people make affecting nature, why they make them, and how that knowledge can inform conservation strategies that balance the needs of people and nature" (Mascia 2010) can lead to boundary work between the social worlds that produces socially and ecologically meaningful approaches to and understandings of change in resource ecologies such as that of caterpillar fungus. As I discuss below, ecologically-grounded political ecology is particularly well-suited for conservation boundary work because of its attention to the ways biophysical conditions and transformations influence struggles over resource access and control, wealth distribution and power relations.

A subfield of geography, political ecology has had a longstanding concern with the study of nature-society relationships, emphasizing empirical, research-based examinations of conditions and changes in social-environmental systems, with explicit consideration of relations of power (Robbins 2004, 12). It coalesced as a field during the 1980s when a Marxian political economic critique was brought against early cultural ecology concerns with the adaptation of isolated "cultures" to their environments (Denevan 1983; Rappaport 1967; Steward 1955). The Marxian critique was based in the notion that "societies and cultures have always been formed as parts of larger systems" (Wolf 1982, x), and shifted attention towards history, social relations of productions and the embeddedness of local land-use practices in broader political economies. It situated environmental degradation into broader explanatory frameworks, such as class relations, the role of the state, land ownership and control and access to resources (Bassett 1988; Blaikie 1985; Blaikie 1987; Bryant 1992; Hecht 1985; R. P. Neumann 1992; Nietschmann 1979; Wolf 1982). During the 1990s, post-structural and feminist scholars began to challenge structural Marxian explanations of access to resources, which they argued failed to capture the ways micro-politics, symbolic practices and structural forces mutually constitute resource access and conflicting claims of ownership (Berry 1997; Carney 1993; Moore 1999; Peluso 1992; Watts 1983; 1996). The structural and poststructural foundations of political ecology have given rise to its now diverse research foci and methodological approaches.

Throughout the formation of the field, political ecologists have variously engaged with the biophysical and ecological dimensions of natural resource use and governance. Recently, there have been debates among some political ecologists about whether the *political* or the *ecological* has been relatively neglected at the expense of the other in studies of nature-society relations (Walker 2005; Vayda and Walters 1999), which has engendered reflections on how much ecology is necessary in political ecology studies to merit the name of the field, and what the place of ecology is in its future (Walker 2005). According to Walker (2005), the structuralist political ecology studies of the 1980s were most strongly tied to close examinations of biophysical ecological change and the relationships this change had with the social conditions of the 'land manager' (e.g. Blaikie 1985; Hecht 1985; Blaikie and Brookfield 1987). As previously discussed, these scholars used ecological science and methods -- or the study of interactions between humans as living organisms and their biophysical environments -- to produce data that refuted scientific 'truths' that were being used by states or organizations that marginalized particular groups of people or blamed them for environmental degradation. According to Walker, these uses of natural science methods and data made the field "clearly recognizable to most outside the subdiscipline as meriting the label political *ecology"* (Walker 2005, 75).

Poststructural political ecology of the 1990s shifted away from strictly structural accounts of 'society' and 'environment' interactions, and scholars accordingly decentralized the role of biophysical ecology in their pursuits to theorize environmental politics (Walker 2005). Scholars like Vayda and Walters (1999) thought the turn away from biophysical ecology was a major shortcoming for the field. They argued that "more attention to political influences on human/environment interactions and on environmental change is no doubt a good thing," (Vayda and Walters 1999, 168) however:

> some political ecologists do not even deal with literally the influence of politics in effecting environmental change but rather deal only with politics, albeit politics somehow related to the environment. Indeed, it may not be an exaggeration to say that overreaction

> to the ‘ecology without politics’ of three decades ago is resulting in a ‘politics without ecology.’

Despite Vayda and Walters’ charge against political ecology, some political ecologists have continued to use biophysical ecology in their research. For example, Turner (1998a) gathered data on soil properties, dung-pat deposition, lignaceous cover and plant nutrient concentrations along a five kilometer radius out from historical watering wells in rangelands in Mali to examine how long-term rangeland use patterns influenced the distribution of nutrient availability in the otherwise arid and nutrient-poor region. He conducted a related study in the same area to examine how rangeland production and species composition varies according to interannual precipitation, which he examined through analyses of rainfall, vegetation cover and above-ground biomass, and soil chemistry (Turner 1998b). Turner’s multi-year ecological analyses of the biophysical dimensions of rangeland production enabled him to support rangeland management approaches that utilized dispersion and mobility of livestock during the rainy seasons and throughout the resource-poor rangelands.

Relative to the total number of political ecologists today, these kinds of ecologically-grounded political ecology studies are in the minority. Some attribute the shift away from ecological science in political ecology to the broadening of political ecology’s research focus during the poststructural turn. As Walker (2005) explained, the central goal of structuralist political ecology was to understand and explain environmental degradation using both natural and social sciences methods, whereas the post-structural evolution of the field in many ways uprooted it from its materialist foundations to grow towards a form of liberation ecology (Peet and Watts 1996), with strong social and environmental justice objectives.

Recently there has been a re-enlivened interest in materialism in human geography (see Bakker and Bridge 2006), creating a unique opportunity for ecologically-grounded political ecologists to explore how ecological methods and engagements with ecology can expand understandings of nature-society relations in new ways. Turner (2009) has discussed how political ecology studies of environmental politics and social-ecological change would benefit from greater engagement with 'ecological relations' -- where ecological relations refer to the object of study in ecological science – by offering different insights on factors influencing the distribution of wealth and power and environmental governance. He contends that examining ecological relations with respect to the differentiation of wealth and power and environmental governance can increase understanding of how, for example, temporal dynamics and spatial heterogeneity of biological productivity -- as mediated through social relations of production -- influence the differentiation of wealth and ecological vulnerability; shed light on how the spatial distribution of biological productivity (e.g. resource enclosures, environmental changes and shifts in spatial aggregations of resources) plays a role in wealth distribution; and indicate how governance structures, the potential for competing interests, and power differentials are affected by the human valuation of nature's objects (nature as 'resource') and the magnitude of resources available for extraction. Importantly, these same potentialities of integrated social-ecological approaches are echoed in Mascia's (2010) description of what CSS can and should be in years to come, but an ecologically-grounded political ecology approach does *not* operate with the a priori assumption that humans are separate from the environment and fundamentally responsible for 'environmental degradation.' Though not currently recognized in CSS, a political ecology-inspired ideological shift away from an 'impact'-focused mode of conservation is what is needed to meaningfully examine nature, society and conservation relationships and outcomes.

Based in the recognition that CSS and ecologically-grounded political ecology seek to understand how biophysical and socio-political conditions of resource geographies coproduce uneven power relations and distributions of wealth, and resource governance relations, this dissertation engages with and builds on both fields of study and practice to examine the production and governance of caterpillar fungus in Tibetan Yunnan. To do so, I use ecological methods and understandings as a way to examine how nonhuman nature contributes to the form its commodity chain takes, looking at why particular places and people are included and disarticulated through production processes and practices. I look for the ways the broader political economy, social relations, cultural norms, and histories contribute to why and how caterpillar fungus production exists as it does today, and what the production and governance of the fungus reciprocally mean for these broader contextual dimensions of the economy. I argue that by understanding how the nonhuman dimensions of caterpillar fungus enable and constrain its production, one can more readily interpret how production and governance practice work around and through 'nature,' which builds on recent geographical scholarship examining the relationships between nature and capitalism more broadly.

Examining the 'matter of nature' in production

Recent critical interventions in human geography have called for its 'rematerialization' after the cultural turn (Bakker and Bridge 2006), which highlights how this dissertation's ecologically-grounded political ecology approach contributes to contemporary geographic scholarship on resource geographies (e.g. Bridge 2010) and broader examinations of the relationships between nature and capitalism (Goodman 1999). Just as ecology was deemphasized during political ecology's poststructural phase, 'materialism' fell out of favor among some human geographic enquiries of resource politics as they deliberately shifted their analyses away from explicitly structural and political economic foci on production, towards analyses of the cultural practices and politics of consumption (e.g. Cook and Crang, 1996; Cook et al., 1996; Jackson 1999; Jackson and Taylor 1996; May 1996; and for a review see Leslie and Reimer 1999 and Hughes and Reimer 2011, 3). These poststructural approaches to studying the cultural politics of resource flows illuminated how consumption is more than just a starting point from which to 'trace back' analyses of production, but rather a complex site of meaning-making. Peter Jackson (2004), for example, has shown how contexts of consumption have 'domesticated,' or tamed and localized, even the most global name brands, like McDonald's and L'Oreal, where the situated complexity of place influences how and why certain commodities are taken up. He has also shown the complex ways that consumption is not just about buying goods, but rather a process through which identity and nationalisms form. These poststructural engagements with the micro-political dimensions of resource flow and stabilizations in markets are crucial for understanding the linkages between material natures and social forms, however explicit analytical linkages between non-human natures and consumption are not common.

Scholars who maintained focus on the 'matter with nature' -- or the ways 'nature' is not external to social relation but rather implicitly part of and produced through capitalism (Fitzsimmons 1989) – throughout the poststructural turn felt that the sidelining of nature's materiality was fueled by a necessary anxiety about attributing too much agency to 'things' and their capacity to produce social outcomes in determinist ways, but emphasized that omitting the role of nature in resource politics was analytically crippling. In Goodman's (1999, 21) words:

> In seeking to deny causal *priority* to the organic, a worthy enterprise, it is deprived of all analytical standing and becomes simply a descriptive category…this move erases the organic analytically, whether as an autonomous agent, co-actor, constitutive presence with social labour in the historical construction of food provisioning systems, or even as a

> contingent constraint on capitalist imperatives…the organic as nature or biology is a sterile concept, analytically moribund and indeterminate.

In recognition of the ways 'nature' has been sidelined in geographic studies of resource politics, Bakker and Bridge (2006) have called for a reengagement with questions of materiality in human geographic studies that build on earlier geographic pursuits to understand how nature's productive and active capacities relate to systems of provision and production (Watts 1994; Goodman 1999). Attentive to the slippages into biological determinism, Bakker and Bridge (2006, 18) highlight that fruitful engagements with materiality in recent human geography research have theorized 'nature' by using approaches that seek to "problematize and reformulate the concept of agency," or specifically, seek to "recapture the lively capacities of biophysical systems by taking seriously the question of how the different materialities of resources may be sources of unpredictability, unruliness and, in some cases, resistance to human intentions." Recent studies that examine the active capacities of nature have included Karen Bakker's (2005) analysis of the post-1989 British water industry, which showed how the biophysical peculiarities of water made it `uncooperative' with attempts at commodification and influenced the institutions governing resource access and regulation. Becky Mansfield's research on oceanic fisheries similarly showed how the material properties of mobile shoals influenced the neoliberal policies that aimed to govern their harvesting (Mansfield 2004a; Mansfield 2004b). Prudham (2005) examined the timber industry's confrontation with and reliance on ecological production processes and showed how it 'ecoregulates' capitalism.

These studies redistribute 'agency' away from strictly human agents, which in effect transforms understandings of nature-society relations and examines how and why 'nature' matters in production-consumption linkages. Drawing from these engagements with the material, in this dissertation I emphasize the need to analyze how and why the role of nature matters in how and why caterpillar fungus is produced in the way it is, and how the non-human influences who and what places are constitutive of its production. Using an ecologically-grounded political ecology approach, I examine how and why the biophysical and ecological dimensions of caterpillar fungus production influence the form its commodity chains take, how social relations are constitutive of and engendered through its production, and how harvesters have created governance arrangements that capitalize on and accommodate climatic and ecological variability. Specifically, I show how Himalayan mountain geographies, the biological complexities of the caterpillar fungal-parasite and seasonality collectively control who and what places are involved in the economy as producers.[21]

[21] While other recent discussions of caterpillar fungus have examined the cultural and political economic dimensions of caterpillar fungus as it travels from production to consumption (Yeh and Lama 2013b), this dissertation focuses explicitly on production.

Analyzing Yunnan's political economic context as uneven neoliberalizing processes

Rather than biologizing human-fungal interactions and examining only the proximate factors influencing how and why harvesters collect caterpillar fungus, in this dissertation I employ a political ecology approach that examines how and why local caterpillar fungus harvesting practices and governance arrangements vary across locality and how these variations relate to their broader political economic contexts and situated histories. It is next to impossible to conduct research in contemporary Yunnan and the broader regions of China's 'west' without being faced with the highly uneven and ongoing transformations associated with China's major focus on economic development (Coggins and Yeh, 2014; Gaerrang 2012). Since the economic and political transformations taking place in contemporary Yunnan during the time of my research were rooted in Deng Xiaoping's economic reforms of the 1980s – a time when the economic and political project of neoliberalism took shape (Harvey 2005) – this dissertation contends that the broader scholarship on neoliberalism is relevant for understanding highly heterogeneous and contested forms of economic development in Yunnan. Though the Chinese state has never explicitly articulated itself as a neoliberal state or driven by neoliberal agendas -- in fact the Chinese authorities have clearly and firmly rejected the adoption of neoliberal thinking and strategies (Ong and Zhang 2008, 4) -- many of the policies and current institutional forms in contemporary China position it clearly within the neoliberal era.

Neoliberalism, Neoliberalisation

Neoliberalism is most commonly thought of as an economic and political project that seeks to liberalize trade, privatize state-controlled industries and services, introduce market-oriented management practices to a reduced public sector, and `roll back' state provisions of social services and any restraints on a free market (Perreault and Martin 2005). As a theory of political economic practice, neoliberalism hinges on the idea that human well-being is best advanced through the liberation of entrepreneurial freedoms and skills, which is achieved within an institutional framework characterized by strong private property rights, free markets and free trade (Harvey 2005). Contrary to the usual assumptions that neoliberalism means the rolling back of the state in all regards, Peck and Tickell (2002, 384) claim that there were two phases of neoliberalism: the "roll-back neo-liberalism" which happened in the 1980s in the UK and the US, which was characterized by deregulation and state dismantlement, and the current form of "roll-out neo-liberalism," which is characterized by active state-building and (re)regulatory reform. Peck and Tickell explain that the state re-regulation phase occurred because states variously met opposition to the rolling back of social institutions, which meant they had to find new ways to ensure the expansion of capitalism without reaching an incendiary limit.

Though the political and economic goals of 'the neoliberal project' are relatively well specified – they are often referred to as the 'Washington Consensus' – tracing the processes through which places, economies and societies become *neoliberalized* is less defined. In reality, there is no single, unitary form of neoliberalism, but rather "there are multiple, often contradictory neoliberalisms, that emerge from a diversity of political contexts and generate a range of effects" (Perreault and Martin 2005, 194). Neoliberalism is "not a coherent end product," or a final state, but rather "a complex and contested set of processes, comprised of diverse policies, practices and discourses" (ibid.). To examine neoliberalism not as a static object of study, but rather as a complex and contested set of processes, many scholars prefer to speak of and study the *process* of neoliberalization (Brenner and Theodore 2002, 353). This shift in focus towards the process by which places and people are neoliberalized allows for deeper engagements with how processes like commoditization are enabled and constrained by local contexts, and understandings of why neoliberalization is not accurately understood as a uniform and consistent outcome.

Neoliberalizing China

During the late 1970s and 1980s, China joined in the global capitalist economy in significant ways, and the host of reforms that were initiated at that time and China's economic successes since would not have been possible without the consonant rise in neoliberalism at that time (Harvey 2005). At the same time, the Chinese state has maintained its authoritarian and socialist state configuration, which makes contemporary China characterized by what Ong and Zhang have described as "the tense articulation between neoliberal logic and socialist sovereignty" (Ong and Zhang 2008, 2).

Following Mao Zedong's death in 1976, Deng Xiaoping gained political power and initiated a suite of economic reforms beginning in 1978 that created a fundamentally new political order focused on economic growth. Deng recognized that Mao Zedong's highly collectivist approach to development couldn't produce the kinds of economic growth the Chinese state needed, and believed that market economics and the integration of China into the global economy were the best ways forward. Deng's political and economic agendas thus sought to reform most of the major tenets of the earlier Maoist system of rule. The Maoist system gave national leaders great control over resource allocations; prevented the free flow of information; administered the economy almost completely (market forces and personal incentives were not a feature); and prevented international trade and foreign investment (Lieberthal 2004, 248). The reforms opened up China to foreign trade and investment (but with strict state control), increased the commodification of goods and people, facilitated market-based pricing for most goods, and devolved centralized governance to townships and localities (Harvey 2005).

Deng's economic reforms focused on 'four modernizations,' which consisted of agriculture, industry, science and technology, and defense. The tenets of his agricultural reforms continue to feature significantly in the daily lives of rural citizens throughout China's 'west,' and are said to have been spurred into motion after the findings from a government study revealed that the majority of peasants in China's rural countryside were no better off in the mid 1970s than they had been during the mid 1950s (Lieberthal 2004, 249). As a result, the central government focused on ways to increase the income of rural citizens: it raised the prices paid to farmers for their agricultural products, which gave them more money; expanded farmers' rights to sell products in rural markets; and dismantled the commune system from 1979 to 1984, and replaced it with the Household Responsibility System. The Household Responsibility System apportioned use rights to land to households based on the number of individuals living in the house at the time. Reforms during the mid-1980s also gave peasant families the right to -- within limits -- buy and sell land use contracts, which made it possible for people with larger holdings to hire others to work their land (Lieberthal 2004). These agricultural reforms were the beginning of what has become the uneven commoditization of land and people in many areas.

The major agricultural reforms and their social payoffs – more capital to the peasantry, better incentive structures, more freedom of crop selection, etc. – were most realized during the early 1980s. After the mid 1980s, the central government focused its attention on urban reforms based on the fact that it could no longer continue to subsidize grain prices (as a means of rural poverty abatement and general 'rural development') and the need to shift labor from the countryside to the cities – from agriculture to industry – to create more opportunities for wage labor.[22] As urban reforms opened up opportunities for peasants to leave their land and 'float' to urban centers for work, millions moved to towns and cities (ibid.). The decline in national attention to agriculture and the peasantry coincided with rising interests by township and county officials in expanding production of urban collective and private enterprises. The reform-era devolution of governance to the township and county meant that they were fiscally responsible for their own earnings, and for the most part private enterprises were recognized to be more financially lucrative than agricultural-based programs. In some cases, local township enterprises diverted money that was allocated by the central government for crop procurement to invest in the township enterprises, giving peasant agriculturalists "IOUs" instead of cash for their produce (Lieberthal 2004, 251). These IOUs did not emerge explicitly because of the diversion of funds to enterprises, but because central subsidies for agricultural goods could themselves not be sustained, and IOUs were a broad problem that also affected thousands of communities where no enterprises were being developed at all.[23] Authorities tried to increase peasant satisfaction by encouraging elections in the villages so they could choose their own immediate leaders. However the "township" is the lowest level of government that is officially recognized in China and thus these lower level positions were largely ineffective. Collectively these policies and practices were the beginnings of what has come to be a "deeply disgruntled countryside" with low agricultural incomes (Lieberthal 2004, 251).

On top of these tensions, tax rates in rural China during the 1990s and early 2000s were as high as 30 percent in some areas where incomes were already low to begin with, which

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[22] See Lieberthal (2004, 251) for a general discussion, and I am grateful to Tim Oakes, who clarified Liberthal's discussion to highlight how these urban reforms were pursued as part of a broader state strategy to deliberately restructure the rural economy away from agriculture precisely because the government could not afford to keep subsidizing agricultural expansion. The government thus needed ways to inject more cash into the rural economy, which it was hoping to commercialize.

[23] Here I am again grateful to Tim Oakes for his clarifications on the broader context and implications of IOUs.

elicited more intense frustration among farmers and incited more conflicts and protests against local governments (Ran and Ping 2007). As a result, rural tax reform became a major focus for the Chinese state during the early 2000s in order to quell the social instability that was expanding across many agricultural-based localities. In 2002, the Chinese state initiated a rural tax reform that phased out all formal taxes and informal fees (which were being paid by local farmers to government officials) by 2006, and by 2006, the agricultural tax was successfully eliminated altogether (Ran and Ping 2007). Since then the larger sources of disgruntlement and protest have involved land expropriation for urbanization rather than IOUs or taxes and fees, though certainly incomes are still low and 250 million people are "floating" away from home for work.

The Production of Neoliberalizing Caterpillar Fungus Harvesting Areas

In tandem with China's agricultural reforms, the pastoral reforms of the 1980s transformed how semi-pastoral and pastoral Tibetans use and control access to their pastures and rangeland environments throughout China's 'west,' and gave rise to the contemporary neoliberalization of caterpillar fungus collecting areas. When the Household Responsibility system granted greater autonomy to households' farm management during the 1980s, livestock were privatized and distributed to households, and livestock production marketing channels were liberalized, which enabled households to profit from their decreased-quota surpluses (Banks et al. 2003; Bauer 2005). Summer and winter pastures[24] – some of which are now valued as caterpillar fungus collecting areas during the fungal fruiting season -- were allocated to

[24] Summer and winter pastures refer to when they are used for grazing. Summer pastures are often higher in elevation and accessible once the snow starts to melt in the high alpine grasslands during the spring. The winter pastures are generally lower in elevation and thus accessible during the winter, but in places like Qinghai Province, the winter pastures are still quite high in elevation. Which pastures are now also significant in the caterpillar fungus economy depends on the region and where pastures have been allocated relative to elevation and caterpillar fungus' range of occurrence. For example, as noted, in Yunnan caterpillar fungus tends to only grow within the higher summer pastures, but in areas like Qinghai, where the overall elevation is quite high, caterpillar fungus seems to grow in both summer and winter pastures.

administrative or natural villages, and occasionally to small groups of kin-related households (Banks et al. 2003).

The size of pastures that were allocated to different groups and villages was determined by the number of livestock which were distributed per household, whereas the number of livestock and the size of the household farming plot were decided by the number of household members living in the home at the time (infants, children, seniors and adults counted equally as household members) (Banks et al. 2003). At reform, commune work teams and production brigades were dissolved and reorganized into smaller units that better matched the scale at which livelihood actions had been organized prior to the 1950s; the former administrative levels of the collective era – the commune, production brigade, and production team – generally became the township, administrative village and villager small group, the latter of which is often called a natural village (a term I also use throughout this dissertation) (Bauer 2005, 56; Ho 2001).

This initial partitioning of grasslands and livestock continues to evolve through legal and regulatory frameworks, but generally still features the following: all grasslands continue to be owned by the state or the collective, where the "collective" is generally interpreted as the administrative or natural village; long-term use rights (generally 50-year terms) are assigned to individual households via grassland-use certificates and contracts; and stocking rates are supposed to be assigned to household pastures based on the area and seasonal type of the pasture (Banks et al., 2003). In many parts of the Tibetan Plateau, individual household use-rights (as opposed to collective village-based use rights) to pastures have been formalized, and winter (only rarely summer) pasture is sometimes contracted out and leased to other households for livestock grazing (Yeh and Gaerrang 2011) and caterpillar fungus collecting (Yeh and Lama 2013; Sulek 2011), as discussed in Chapter 4. In Yunnan, caterpillar fungus collecting areas are on summer pastures, which are generally higher in elevation than winter pastures, and they tend to be used in common by entire administrative villages for grazing (Banks et al., 2003).

The pastoral reforms thus devolved the governance of pastures from the state to villages and in some case households, which created the current space within which individuals and village collectives have the ability to produce their own local governance arrangements for their rangelands. Situated within China's broader market-based reforms -- which have increased the commodification of goods and fostered the development of consumer markets among other things – semi-pastoral and pastoral Tibetans have an unprecedented opportunity to earn revenues from the expanding caterpillar fungus economy. As I will discuss, some semi-pastoral Tibetan communities in Yunnan have created rules of access that exclude 'outsiders' from their harvesting areas or that allow 'outsiders' to collect through a systems of graduated fees for use based on their place of origin. In other areas, like Qinghai, the individuals or villages who control access to their pastures have also developed fees-based contracts with 'outsiders' to allow them to harvest, but in some cases the fees are astronomically high, or the rules and terms of access produce highly uneven benefits for those who control access to collecting areas. Sulek (2011) describes a case from her research in Qinghai in which a family who controlled access to a harvesting area (likely a winter pasture) leased their pasture to 360 people, reaping inordinately high profits. County-level government officials heard of the contracting arrangements and ended up confiscating the pastureland, and two years later the family was still trying to get their use-rights to the land back. This story illustrates how even though China's post-reform political economic context has transferred certain powers and governance rights to villagers to act as market actors, these are still limited. The recent wave of rural reforms is anchored by the state's slogan to produce a "harmonious society" (Ran and Ping 2007), but it is ultimately the state that decides how and what kind of harmony is achieved. These kinds of tensions and frictions between local 'freedoms' to govern their shared resources and China's central state authority constitute what Ong and Zhang have described as "socialism from afar," or China's form of neoliberalism where "state controls continue to regulate from a distance the fullest expression of self-interest" (Ong and Zhang 2008, 3).

Scholars debate whether China's political and economic agendas and policies since the 1980s are accurately conceptualized as part of 'the neoliberal project.' Some scholars like Nonini (2008) have argued that claims about China's neoliberalizing conditions, ideologies, political strategies and subjectivities are misleading, based on the fact that Deng's economic reforms were not explicitly neoliberal; there is still no broad consensus on the role of the market (foreign investment is still tightly controlled); social protests indicate that neoliberal subjectivities are not readily taken up across much of the population; and *guanxi* exchanges and their function in contemporary Chinese culture blur clear divisions between state, market and everyday life.

Other scholars have suggested that the fact that China has maintained its socialist political foundations while launching various market liberalizing reforms makes it "a particular kind of market economy" that is accurately defined as neoliberalism "with distinctly Chinese characteristics" (Harvey 2005, 151). Ong and Zhang (2008, 2), while agreeing with the fact that "the tense articulation between neoliberal logic and socialist sovereignty is reconfiguring contemporary China," have pushed back on claims that China's form of neoliberalism is exceptional in the way Harvey has claimed. According to Ong and Zhang (2008, 9), Harvey's claim suggests that there is only one kind of standard "neoliberal state" – one that is characterized by individual liberty, free markets and free trade – which wrongfully marks China as "a deviant entity" that doesn't fit with the "neoliberal template." Ong and Zhang call for a shift away from a focus on the "neoliberal state" as the unit of analysis, which expands our understandings of how there is no singular form of neoliberalism (from which China deviates), but rather how neoliberalism is "a mobile set of calculative practices that articulate diverse political environments in a contingent manner" (Ong and Zhang 2008, 9).

In addition to China's privatization in the "official recognized economic forms"[25] -- such as dismantling state enterprises, the spread of private property, and the emergence of private enterprises within China (who competed with foreign investors) -- Ong and Zhang (2008, 7) examine "a range of privatizing ideas and practices that are fundamental to neoliberal governmentality." Drawing from Foucault's notion of governmentality or the "conduct of conduct," Ong and Zhang (2008, 2) describe how the kind of privatization that has emerged from Deng Xiaoping's reforms is a:

> deliberate shift in China's governing strategy to set citizens free to be entrepreneurs of the self. But these conditions of possibility came about not by dismantling the socialist apparatus,[26] but rather by *creating a space* for people to exercise a multitude of private choices, but always within the political limits set by the socialist state. In contemporary China, regimes of living are shaped by the intersection of powers of the self with socialism from afar (emphasis added).

As I discuss in this dissertation, and as illustrated by Sulek's example above, the rise of the caterpillar fungus economy and China's reforms have created a space within which Tibetans can produce and govern caterpillar fungus, but always within a political context of "socialism from afar." Building on Ong and Zhang's notion that regimes of living "are shaped by the intersections of powers of the self with socialism from afar," my dissertation draws attention to the ways that conceptions and powers of the self are contingent upon and continually coproduced through social, cultural, historical, ecological *and* political relations. In some cases, citizens'

[25] Ong and Zhang note in the late 1970s, the Communist Party was careful to define "privatization" (*siyouhua*) as "systematic reforms" (*tishi gaige*), which were limited to the market sector within the socialist political system (Ong and Zhang 2008, 6).

[26] As would be the case according to Harvey's "neoliberal template."

‘freedoms’ to produce and govern caterpillar fungus as they desire are significantly affected by socialist state interventions, and in other cases they are not. Contrary to other caterpillar fungus production areas, fungus collectors and the fungus itself remain incompletely commodified in parts of Yunnan. This dissertation thus expands understandings of how and why neoliberalizing processes are uneven and why, despite their neoliberalizing contexts, people choose not to embrace the commodification of their social relations.

The idea of ‘freedom’ is one that is often bundled with ideas of what neoliberal agendas, policies, and practices offer. According to Harvey, “the assumption that individual freedoms are guaranteed by freedom of the market and of trade is a cardinal feature of neoliberal thinking” (Harvey 2005, 7). As discussed above, China engages with these fundamental ideas of market liberalization, without the attendant decentering of socialist state authority which means that ‘individual freedoms’ and ‘self-interest’ are really only authorized in relation to the “commodifiable and the marketable” (Ong and Zhang 2008, 12). Within this authorized zone of the commodifiable and the marketable, there are, however, multiple kinds of ‘freedoms’ that influence the formation of what Ong and Zhang call the “new social,” or the mix of ‘self-governing entrepreneurs’ who embrace ‘freedom’ and socialist governing from afar. For example, there is the ‘freedom’ to engage in the market economy as a wage-earning laborer. There is the ‘freedom’ of capitalism, where one is able to purchase a red car or a green car, and as discussed in this dissertation, there is another kind of ‘freedom’ that relates to how individuals perceive and culturally and socially value the kinds of ‘work’ that emerge throughout neoliberalizing geographies of production. The latter kind of ‘freedom,’ which is invoked by Tibetan caterpillar fungus in Yunnan, is in many ways a kind of resistance that has emerged within the created spaces in neoliberalizing Yunnan. As I discuss in Chapter 3, caterpillar fungus harvesters describe the practice of collecting as a ‘freedom,’ when they compare it to the road or building construction jobs that are their alternatives to collecting caterpillar fungus. As I describe, the “freedom” associated with collecting is based in cultural and social values for the landscapes, harvesters’ relationships with one another, and the fact that collecting caterpillar fungus is not ruled by the clock-based and calculative logics that characterize construction labor conditions.

Political ecology engagements with 'the commons'

Bearing in mind how the ecological and social relations of production influence caterpillar fungus production, this dissertation examines how and why caterpillar fungus collectors in Yunnan have developed local governance arrangements that limit who has access to their shared resources. As previously described, the pastoral reforms throughout rural China during the late 1970s and early 1980s apportioned summer and winter pastures to natural and administrative villages, which in a sense devolved governance power from the state to local communities. Some of these pastures have since become highly valued because they have caterpillar fungus growing within them, and thus their contemporary local governance – or how harvesters determine and limit access to them – is meaningfully examined in relationship to broader literatures on 'the commons,' or common-pool resources.[27]

At the center of all scholarly engagements with 'the commons' is the shared refutation of Garrett Hardin's (1968) now classic "tragedy of the commons" model of human-resource relationships, which assumes that in the absence of state or individual ownership, common pool resources will invariably be overexploited due to the 'rational' human desire to maximize one's personal utility (which is achieved through resource overexploitation). Though Hardin is widely credited for the "tragedy of the commons" thesis, the implicit causal linkages between human 'rationality' – the individualistic, self-interested desire to maximize personal utility -- and resource overexploitation were not original to his model. Hardin attributed his idea of the model to a "little-known pamphlet" published in 1833 by the 'amateur mathematician,' William Forster Lloyd, who was writing about the political economy of the Poor Laws during the early-

[27] One of Ostrom's "design principles" is that resource managers must have a certain degree of autonomy in the management of the resources. When that autonomy disappears – because of political reasons- then so too does the ability of the management rules to persist

nineteenth century (Hardin 1968, 1244). Even before and during the time he wrote his now classic *Science* paper, other economists during the 1950s and 1960s were putting forth similar ideas in relation to various resources. In fisheries, H. Scott Gordon (1954, 135) wrote a very similar thesis in his paper "The Economic Theory of a Common-Property Resource: The Fishery," an excerpt from which illustrates the common threads:

> …everybody's property is nobody's property. Wealth that is free for all is valued by none because he who is foolhardy enough to wait for its proper time of use will only find that it has been taken by another. The blade of grass that the manorial cowherd leaves behind is valueless to him, for tomorrow it may be eaten by another's animal; the oil left under the earth is valueless to the driller, for another may legally take it; the fish in the sea are valueless to the fisherman, because there is no assurance that they will be there for him tomorrow if they are left behind today…Common-property natural resources are free goods for the individual and scarce goods for society. Under unregulated private exploitation, they can yield no rent; that can be accomplished only by methods which make them private property or public (government) property, in either case subject to a unified directing power.

Gordon's assumptions about human rationality and the most effective ways to avoid the inevitable resource overexploitation of shared resources are echoed in Hardin's model of human relationships with common pool resources. In Hardin's words (Hardin 1968, 1244):

> The tragedy of the commons develops in this way. Picture a pasture open to all…As a rational being, each herdsman seeks to maximize his gain…Adding together the component partial utilities,[28] the rational herdsman concludes that the only sensible course for him to pursue is to add another animal to his herd. And another; and another. . . . But this is the conclusion reached by each and every rational herdsman sharing a commons. Therein is the tragedy. Each man is locked into a system that compels him to increase his herd without limit—in a world that is limited. Ruin is the destination toward which all men rush, each pursuing his own best interest in a society that believes in the freedom of the commons. Freedom in a commons brings ruin to all.

[28] As theorized by Hardin, adding one animal to the pasture produces a positive utility of +1 and a negative component that is a fraction of -1 because the negative effects on the pasture of adding an additional animal is distributed across all other herdsmen. According to this "logic of the commons," the herdsman will always rational choose to add another animal.

Like Gordon, Hardin posited that the best way to prevent the 'tragedy of the commons' was to either centralize or privatize common pool resource ownership. His thesis was both readily taken up and widely refuted among his contemporaries. His binary policy solution was incidentally bipartisan, and gave traction to either state interests to devolve power and let the 'invisible hand of the market' reign (privatization) or crystallize state authority and introduce rational resource management practices (centralization), which meant it was popularly referred to by both parties (McCay and Acheson 1987). It was also readily taken up by many politically conservative conservation biologists who were active in the US environmental movement of the 1960 and 1970s, because it legitimized their desires to assign blame for the post-World War II ecosystem destruction to human selfishness. In Michael Goldman's (1998, 24) words, "their call was, and still is, for replacing communal institutions (in which footloose individuals reign) with private ownership and stronger state interventions in order to reverse the actions of the world's majority who blindly think they can have the freedom to overgraze, overconsume and overbreed." Even though some conservation-minded scholars are endeavoring to shift away from 'tragedy'-based frameworks, Hardin's thesis is still pervasive in much of conservation practice and science.

Broadly known as scholarship on "the commons," reactions to the 'tragedy of the commons' model have come from a variety of directions and disciplines. As mentioned, commons scholarship is united by a shared refutation of Hardin's major assumption that all common pool resources are invariably "open-access," or "nobody's property," in Gordon's terms. Countless case studies and reviews of case studies have shown the numerous instances and circumstances where communities and groups of users have self-organized to govern their own resources outside the purview of the "unified directing power" of individualized or centralized ownership (McCay and Acheson 1987; Ostrom 1990; Bromley 1992; Oakerson 1992; Neumann 1992; Fortmann 1995; Berry 1997). From this shared foundation, commons scholarship ranges from examinations of why and how local groups of resource users self-organize and what kinds of institutional arrangements produce net positive social and ecological outcomes (Ostrom 1990; 2005), to analyses of how and why history, political economic context, social relations, cultural norms and systems of meaning influence resource governance in "the commons" (McCay and Acheson, 1987).

There have been recent claims by commons scholars stating that there is surprisingly little geographic engagement with scholarship on the commons (Giordano 2003; Brewer 2012; also Young 2002, as cited in Giordano 2003). This dissertation is thus an answer to this call for more geographic engagement with the commons, though I disagree with the claims that geographers have been largely silent about theorizations of the commons. For example, some geographers have recently examined aspects of the commons with respect to critical cartography methods and implications (Bauer 2009; St. Martin 2009) and species mapping in biodiversity science (Campbell and Godfrey 2010), and many political ecologists have substantively expanded understandings of the commons, which inform my own approach to examining the politics of 'the commons.'

The field-based research tradition of political ecology examines the ways property rights and governance processes are "forged in specific places in specific political-economic contexts and embedded in locally generated meanings of land and resources" (Neumann 2005, 105). Some of the earliest contributions to political ecology were in critical reaction to the implementation of Malthusian-inspired 'tragedy of the commons'-based policies and development interventions; local governance was not viewed as a harmonious and stable process of cooperation, but rather as a complex set of struggles and conflicts that related to broader political economies. In Watts' (1987, 187) words:

> Despite the intuitive appeal of a commons approach, it is far from clear whether the preconditions of self-interest through open access are actually met in pastoral systems…ethnographic research documents the numerous local, ethnic, and jural claims which herders may exercises with respect to rangeland. Such claims often bring herder and farmers into direct conflict in the southern Sahel where sedentary cultivators move into and cultivate lands 'traditionally' considered by clan, lineages or household as their legitimate use-values…

Here, Watts draws attention to the ways local access to resources often involves uneven and ever-evolving negotiations and conflicts between and within groups that invariably benefit some and not others. Fundamental to this and other political ecology approaches to resource access and control, however, is attention to how localized struggles are produced in relation to the broader political economy and processes of change within specific historical contexts (Watts 1983; Blaikie 1985; Hecht 1985; Blaikie and Brookfield 1987; Bassett 1988; Neumann 1992; Carney 1993). Rather than "regulated closed systems" (Watts 1983, 233), human resource use patterns, decisions and outcomes are fundamentally expressions of the social relations of production. These theoretical moorings mean that political ecologists examine 'the commons' not only as a type of 'good' or as a set of localized human-environmental interactions, but rather as a set of human-environmental relationships both constitutive of and embedded in a broader political economic contexts.

Emphasizing the ways the broader political economic context influences local human-environmental interactions has a great impact on efforts to understand whether local communities are degrading their local resources or environments, and what to do about it. Some scholars have shown that it is not local 'backwards' mismanagement of resources that was contributing to environmental problems, but rather that state or international development interventions were driving environmental degradation. As previously discussed, Blaikie (1985), Hecht (1985) and Watts (1987) elucidated how environmental degradation was not caused only by overpopulation or local misuse of resources, but how they were at their core social and political problems. These insights usefully expand ideas of 'the commons' beyond those that stabilize them as spatially fixed and endogenous human-resource relationships, towards attention to the ways "the commons" are fundamentally influenced and produced by local-state relationships and configurations of power.

In his book, *Political Economy of Soil Erosion in Developing Countries*, Blaikie (1985) argued that most conservation policies fail because they do not realize the social and political causes of the problem, and instead try to address problems solely with managerial or technical approaches to local management. He argued that a better approach to conservation was to look at the influences on class power and struggle, or "where power lies and how it is used" (Blaikie 1985, 5), which means analyzing "the local" in relation to their non-proximate dimensions. Hecht (1985) similarly used a Marxian political economic analysis to reveal how Brazilian state policies – as opposed to 'backwards' local land use practices of agro-pastoralists – were supporting deforestation practices (the 'problem') and contributing to the decline of land productivity over time by offering heavy subsidies and other incentives to investors who were supporting state interests to develop the Amazon through cattle ranching. Watts (1987) similarly refuted orthodox development claims that characterized Nigerian agro-pastoralists as 'backwards' abusers of pastoral regions by revealing how political conditions – as opposed to pastoralists' lack of knowledge – subjected pastoralists to conditions 'not of their own choosing.'

These early political ecology approaches to examining "the commons" influence my own approach in this dissertation, because they theorize the role of the state in the production of resource "commons." As I illustrate through the case studies analyses of caterpillar fungus harvesting areas – each of which has a unique set of local governance arrangements -- local caterpillar fungus governance arrangements in Yunnan are continuously (re)produced through complex negotiations with the Chinese state, in the form of historical state policies, practices or interventions. These insights contribute to the commons scholarship by illustrating how 'successful' local governance arrangements – which are often understood to be persistent and enduring local governance arrangements that foster social equity and ecological sustainability (Ostrom 1990; 2005) – are not only reflections of the capabilities of local communities to establish clear and contextually relevant governance arrangements through communication and cooperation, but also reflections of the extent to which the state has established and reinforced community-based control over and access to shared resources. As previously discussed, the state partially devolved governance power – in the form of use rights -- to local communities in Yunnan through pastoral reforms of the early 1980s, however local caterpillar fungus governance arrangements are continuously produced and negotiated within a political economic context of "socialism from afar" (Ong and Zhang 2008), where the pervasive Chinese state is as much a factor in local governance arrangements as are community interests. Rather than identifying complete state devolution of power to local communities as a necessary precondition for 'successful' local governance arrangement (Ostrom 1990; 2005), or determining how much or how little the state should be involved in local governance arrangements in order to produce successful co-management power-sharing arrangements (Carlsson and Berkes 2005; Andersson et al. 2006), this dissertation examines how the interplay of local and state power influences governance arrangements and outcomes in Yunnan's caterpillar fungus 'commons' in uneven and contradictory ways.

Examining how the broader political economy matters in local governance arrangements and human-environmental relationships requires attention to how multiple actors (e.g. state officials, international organizations, granting institutions, politicians, resource users), policies, desires, values, cultural norms, and systems of meaning collide in the everyday struggles over the control of nature. In some cases, local governance arrangements and claims to shared resources are enabled and legitimized by political economic contexts, and sometimes they are destroyed by them. A classic illustration of this is Nancy Peluso's (1992) comparative examination of pre-colonial and post-colonial forest tenure arrangements in Kalimantan, through which she sought to understand how the scaling up of rattan production influenced the social relations of production and tenure arrangements. To summarize briefly, the government divided Kalimantan territories up into various concessions with timber companies, plantations, and transmigration projects, as well as national parks, wildlife research and watershed protection areas – all of which denied local village management. The migrants who moved into previously traditionally managed forests to produce rattan either ignored traditional rights of access or "[failed] to recognize the less visible forms of management" (Peluso 1992, 54). The influx of migrants to traditional areas changed the previous common property arrangements -- with rules of access and sanctions for transgressors -- to an open access situation beyond "effective control" (ibid.). My dissertation engages with Peluso's central findings which illustrate how political economic context can erode local governance arrangements, and additionally how the erasure of local governance arrangements occur through the transformation of claims of ownership, values and locally generated meanings of land and resources.

Resources are imbued with meaning through their histories of use and how they factor into the social lives of those who lay claim to them. In her discussion of the political ecology of durian fruit in West Kalimantan, Peluso (1996) illustrates how certain resources have the capacity to represent or generate power, wealth, and meaning for those who control or have access to them. She also draws attention to the ways biological specificities of certain resources influence the types of rules and relations of power that can emerge around the resource, which my dissertation engages with and builds on through an examination of the governance of caterpillar fungus. Focusing on durian trees, Peluso illustrates how the longevity of the durian tree, the way it is harvested, the survival rates of seedlings, the time it take to produce fruit, its reproductive strategies and people's abilities to own or cultivate it in particular ways – all significantly shape the development of rules governing ownership and shared property rights of the trees. Like durian trees, the spatial and temporal dimensions of caterpillar fungus growth, as well as its histories of use and current social and cultural values, influence its governance arrangements in Yunnan.

Contrary to recent claims that contend geographers have been silent on theoretical engagements with the commons, here I have illustrated the many ways political ecologists have shown how access to and control over common-pool resources are determined by a broad set of factors other than property rights. Beyond those mentioned here, political ecologists have shown how historical narratives (Fortmann 1995), gender (Schroeder 1997; Carney 1993), and uneven power relations that are produced through international development and conservation interventions unknowingly privilege some groups or individuals while burdening others in the effort to govern shared resources (Nightingale 2005; Carney 1993; Schroeder 1997). Ribot and Peluso (2003) have similarly argued that property rights and property relations constitute only one set of mechanisms by which people gain, control, and maintain resource access, and develop a 'theory of access' that includes property rights within a broader set of mechanisms of access.

Rather than focusing on property as a "bundle of rights," they examine access as a "bundle of powers," where various kinds of power relations can influence rights-based mechanisms of access, including access to technology, capital, markets, labor, knowledge, authority, identity and social relations. In this dissertation I draw from their discussion on the ways access to markets influences how and why claims of access evolve for resources like caterpillar fungus, and how access to capital is important in some cases (where calculative logics reign) while not others (where social relations influence access in substantive ways).

CHAPTER 2

UNVEILING THE NON-HUMAN AND HUMAN DIMENSIONS OF CATERPILLAR FUNGUS PRODUCTION

Introduction

While Chinese scientists have been trying to cultivate and artificially produce the wild-harvest form of caterpillar fungus since the 1980s,[29] to date it remains impossible to artificially cultivate caterpillar fungus in its valued caterpillar-fungus form.[30] Researchers' efforts to artificially produce caterpillar fungus have been varied, ranging from 'fertilizing' meadows with fungus spores to placing fungal spores directly on host larvae in controlled lab settings. Scientists explain their inability to produce the caterpillar-fungus complex by the fact that some sort of 'environmental trigger' must be present in the wild that can not be reproduced in the lab settings. In other words, nature has some form of agency that can not be technologically replaced in the artificial production of caterpillar fungus. Nature's resistance to industrialization, substitution and appropriationism[31] in caterpillar fungus production means that the current supply of caterpillar fungus to the steady if not expanding market hinges on the social and ecological relations of its production. To produce caterpillar fungus, harvesters have to employ

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[29] In 2007, a Chinese scientist who was involved with the 'Cordyceps station' in Yunnan described how he and other scientists were 'fertilizing' a particular patch of grassland outside of Shangri-la with *Ophiocordyceps sinensis* spores. Shangri-la is located at approximately 11,000 feet elevation which is well below the usual growing range of caterpillar fungus, so it was not surprising that this fertilization technique didn't work.

[30] While the wild–harvested form of the fungus has not been successfully cultivated, caterpillar fungus mycelia, or hair-like structures, have been successfully cultivated and grown within controlled lab settings. These latter fungal products are what make their way onto the shelves of international medicine stores in the form of caterpillar fungus capsules.

[31] Some scholars (e.g. Goodman et al., *From Farming to Technology*) have discussed nature's increasingly socially produced character under capitalism, namely through appropriationism and substitution. Appropriationism refers to processes by which discrete aspects of farm production are carved off and become the basis of industrial production processes, e.g. chemical fertilizers. Substitution is one way that capital can work around nature, where substitution is the replacement of farm processes and products with industrial ones (Prudham 2005: 17).

particularized production practices that attend to the *in situ* character of caterpillar fungus production across its geographic range of distribution. The biological characteristics and spatial specificity of where caterpillar fungus grows – in the high Himalayan grasslands – means that certain people and places are invariably included and excluded from caterpillar fungus production. 'Nature,' however, is not the only determinant of who and where production occurs because governance arrangements and a broad suite of social and cultural factors also variegate the geographies of caterpillar fungus production.

My exploration of the nonhuman dimensions of caterpillar fungus production is based in the awareness that "a certain amount of production by definition takes place prior to human intervention or design, [and] technologies and the deployment of labor to some extent revolve around natural properties (Prudham 2005, 16). This chapter examines what kinds of biophysical and biological conditions, relationships and interactions produce caterpillar fungus as it occurs in the high alpine grasslands. I explore the ecological relations of caterpillar fungus production by describing how the spatial, morphological and temporal dimensions of caterpillar fungus – namely its endemism to Himalayan geographies, the host-parasite relationships of the fungus, and its seasonality -- constrain who and what places have the capacity to engage in the caterpillar fungus economy.

As I discuss here, the nonhuman dimensions of caterpillar fungus have a material influence on the extent to which the fungus can be produced, but the caterpillar fungus is only realized and produced through the bodily practice of harvesting. The skill or ability to find caterpillar fungus in the grasslands varies across individuals and is not just based on the technical ability of harvesters to 'see' caterpillar fungus; skill is highly influenced by social, political and economic factors that influence an individuals' willingness, ability and desires to harvest. As discussed in Chapters 3 and 4, an individual's ability to harvest is influenced by their situatedness in their household and the kinds of governance arrangements that control access to collecting areas. Thus harvesting caterpillar fungus is not just a physical act that uniformly 'impacts' the biological conditions of the resource, but is rather a complex practice influenced by social relations, cultural norms, and broader political economic contexts of economic development.

This chapter engages with scholarship examining the active properties and capacities of nature, or how nature resists commodification (Bakker 2003; Bakker and Bridge 2006), 'ecoregulates' capitalism (Prudham 2005) or is 'uncooperative' with attempts at commodification (Bakker 2005). With attention to nature's materiality,' I describe the complex set of ecological and biological relations that go into the production of wild-harvested resources like caterpillar fungus, that fundamentally *constrain and enable* who and what places can participate in its production, and draws attention to the fact that producing nature is a social, cultural and political process. What follows is a discussion on how the biological and biophysical dimensions of the Himalayan landscapes, the contingencies of its parasite-host relationships, and the seasonality of its growth limit the extent to which the fungus can be produced and commodified in contemporary China.

Himalayan landscapes and variable ecologies

The current inability to artificially produce the wild-form of caterpillar fungus means that it is both enabled and constrained in the physical space of the high alpine grasslands of the Tibetan Plateau. Unlike industrialized production processes, which can scale up production through economies of scale, harvesters can only scale up production by expanding to different harvesting areas where possible[32] or by more intensively harvesting in already utilized harvesting areas. By and large, the sparse distribution and inelasticity of where and how caterpillar fungus grows includes and 'disarticulates' certain people and places through its production.

Himalayan mountain geographies are highly heterogeneous and characterized by high climatic variability. Aspect, slope, elevation, soil type, vegetation composition, climate, and weather events influence caterpillar fungus production in synergistic ways, which makes the biophysical growing conditions for caterpillar fungus highly uneven, heterogeneous and dynamic. These characteristics mean than growing conditions in one particular spatial area are likely significantly different than another, which reminds us of the various ways biophysical and biological complexities of resource geographies complicate efforts to generalize ecological measurements as representative of large spatial areas, or most importantly, as reflections of different ecological effects of human 'impact' in resource geographies like caterpillar fungus. The highly variable climate conditions of Himalayan mountain geographies create growth boundaries that fluctuate across years. For example, late spring snow events or slides can reduce growth patterns and rates in some years while receding permanent snow fields might open up new harvesting areas in others. Caterpillar fungus harvesters in Yunnan often discussed the seasonal variability across years, and how often times they might send an individual up to the collecting areas in the later spring to see how deep and extensive the snow cover was in order to determine when they would be able to access collecting areas. 'Access' in this case refers to

[32] In his master's thesis, Kunga Lama (2007) described how some harvesters in Qinghai had expanded their caterpillar fungus searching into sacred areas in order to increase their earnings from collecting caterpillar fungus. Sacred areas were not supposed to be used for collecting, which meant that harvesters were faced with moral dilemmas about whether to harvest in potentially more abundant places or avoid them based on their values of these places. Also, as Chinese market demand for caterpillar fungus grows, more and more geographies of caterpillar fungus production are emerging throughout the Eastern Himalayas. Harvesting caterpillar fungus is becoming a more prevalent practice in northeastern India, Bhutan, and Nepal, each of which are characterized by unique historical, political, social and cultural relations of production and governance.

snow melt, which is requisite for harvesters to see the aboveground fruiting body of caterpillar fungus.

Being endemic to an environment like the Tibetan Plateau means that caterpillar fungus has evolved particular biological characteristics and reproductive strategies that enable it to persist in the harsh, arid, and variable biophysical conditions that characterize the region. The Tibetan Plateau is the highest raised landmass in the world. Eighty five percent of its total 2.5 million square kilometer area – approximately four times the size of Texas -- rises above 3000 meters elevation and 50 percent of its landmass lies above 4500 meters elevation (Schaller 1998). The plateau has highly variable precipitation and temperature gradients across its landmass from east to west and south to north: the northern and western reaches of the plateau are characterized by frigid and dry conditions, and the southeastern portion of the plateau is warmer and has more precipitation. The combination of elevation and limited precipitation makes most of the plateau characteristically arid and frigid (Schaller 1998). The freezing winter months on the plateau generally range from September to April, and spring and summer months are May to August, which means that species endemic to the region have evolved to capitalize on a short growing season that is constrained by the spring snow melt and the onset of summer monsoon rains.

As scientific monitoring and understanding of climate change advances, it is increasingly realized how extensively the high alpine regions of the Himalayas – or the ‘Third Pole’ -- are undergoing rapid changes due to global climate change. In their recent analysis of temperature, rainfall date and Normalized Difference Vegetation Index (NDVI) values from remotely sensed imagery of the Eastern Himalayas, Shrestha et al. (2012) found that there were significant changes in temperature, rainfall and vegetation phenology across the Himalayas from 1982 to

2006. The average annual mean temperature increased by 1.5 degrees Celsius with an average increase in 0.06 degrees Celsius per year, and the annual precipitation increased by 163 millimeters or 6.52 millimeters per year (Shrestha et al. 2012). Importantly, they found that the amount of precipitation during the Himalayan spring – which is important for snow loading – decreased slightly, while the summer monsoon precipitation levels increased. Many caterpillar fungus harvesters relate annual fluctuations in the amount of caterpillar fungus to the levels of spring precipitation, which makes these climate change-related fluctuations an important focus for analyses examining climate change effects on livelihoods. For example, many harvesters in Yunnan would commonly say "no rain, so no *chong cao* [caterpillar fungus]," meaning that they attributed lower caterpillar fungus abundances to drier spring conditions.

Caterpillar fungus is generally found between 3500-5000 meters elevation in the alpine grasslands and grassland-rhododendron woodland habitats. Alpine grasslands are dominated by *Kobresia* sedges (*K. schoenoides, K. pygmea* (C.B. Clarke), and *K. humilis* (C.A. Meyer)) and dwarf *Rhododendron* (*R. nivale, R. setosum*)) (Maczey et al. 2010), and are characterized by patchy distributions of rocky outcrops, scree, and semi-permanent snowfields. Contrary to the claim that caterpillar fungus grows better on north-facing slopes (Boesi and Cardi 2009), caterpillar fungus grows on all mountain faces in its geographic range of production, but its timing, growth rate and distribution are contingent upon suitable temperature and precipitation conditions -- which vary by aspect, slope and elevation -- and not aspect alone. Based on temperature and moisture conditions, caterpillar fungus generally fruits earlier in lower elevations and south-facing slopes (because they are warmer and likely have favorable moisture conditions after the snowmelt) and later on north-facing and higher elevation slopes. The difference in elevation is likely the major explanation for varied fruiting time across different harvesting areas, for example in Bhutan, collecting seasons generally start later than in Nepal (Maczey et al. 2010: 118). Likewise, Yin et al. (1992, as cited in Maczey et al. 2010: 118) observed almost a month-long delay in the emergence of the fruiting bodies across sites that differed by 1100 meters in elevation.

With the rise of the caterpillar fungus economy, production has expanded beyond the Tibetan Plateau and is now a significant dimension of the social lives and economies in northeastern India, Bhutan, and Nepal. Bounded as it is by elevation and likely vegetation assemblages, the spatial specificity of caterpillar fungus means that particular people and places participate in the economy while others do not. For example, there are natural villages in Yunnan whose summer and winter grazing pastures do not have caterpillar fungus growing in them, while other village's pastures do, which means that the nonhuman dimensions of caterpillar fungus production constrain the participation of some villages in the fungal market.[33] Important here, however, is the fact that governance arrangements and rules of access to caterpillar fungus are also major influences on who and what places can access caterpillar fungus, which points to the ways spatial specificity is not the only determinant for participation in the fungal market, which I discuss in Chapter 4.

To date, there have not been any ecological studies that have established baseline caterpillar fungus population understandings, where 'baseline' refers to the traditional ecological definition for the idea of how many organisms would exist without any anthropological influence. Baseline abundance figures are often used to produce maximum sustainable yield (MSY)-inspired resource management guidelines that seek to 'balance' harvesting rates or 'impacts' with a resource's rate of biological replacement (see Introduction for a full discussion

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[33] I did not explicitly examine why some pastures have caterpillar fungus while others do not, but presume it is because they are too low in elevation and do not have the right assemblage of complex biological and biophysical dimensions of caterpillar fungus growth.

of MSY). An often under examined dimension of these resource management instruments, however, is that they are based on early equilibrium-based models of succession theory that hinge on the assumptions that climatic conditions are stable and that there is a linear rate of biological replenishment. In reality, these assumptions don't hold in places like Himalayan rangelands, which are characterized by high levels of climatic variability (Ho 2001; Behnke and Scoones 1993).

Since caterpillar fungus has been harvested for hundreds of years, producing 'pristine' ecologies in order to understand human 'impacts' obfuscates the fact that Tibetan uses of these high alpine landscapes – including herding and harvesting caterpillar fungus -- have produced the landscapes that exist today. I contend that it is neither socially just nor scientifically meaningful to deliberately erase human relationships with their high alpine grasslands in order to study human 'impacts' on caterpillar fungus. It is more meaningful to base scientific efforts to understand how environmental and social transformations are potentially influencing caterpillar fungus growth on ecological baselines where human interactions with resource ecologies are maintained and methodologically acknowledged. As discussed below, this is a shift in ecological method and ideology that I explore in this dissertation.

Another way to understand the abundance of caterpillar fungus is to try to capture a snapshot of how much caterpillar fungus exists in what harvesters identify as an ideal harvesting location or patch at a particular time during the harvesting season. This approach builds on the idea that people have harvested in a particular area for a long time, and likely during that same season, because it has caterpillar fungus in it and because they identify it to be a good representative of where caterpillar fungus should be. This approach contrasts one that seeks to produce 'pristine' baselines because it recognizes that harvesters' interactions with their environments, and their knowledge about these environments and resources, should be part of the production of ecological understandings of environmental change. Using ecological banded transects, I sought to establish a 'baseline' that is a contextually relevant representation of how much caterpillar fungus there is in the grasslands in relation to caterpillar fungus production as a social process.

I was hesitant to use ecological transects as a method to quantify caterpillar fungus abundances. My central concern was that since caterpillar fungus is so sparsely distributed, it is questionable whether transects can produce a meaningful measure of abundance. Harvesters are of course finding caterpillar fungus in the grasslands, so what good was a measurement of abundance that would invariably produce inordinately low values, or even suggest that there are no caterpillar fungus individuals in an area at all? Furthermore, what difference would it make ecologically or socially if transects revealed that there were 0.4 caterpillar fungus individuals per square meter in one area and 2 individuals per square meter in another? And given the vast heterogeneity of the grasslands, how could such quantified representations of abundance be trusted, or considered comparable across sites, let alone across regions? Finally, given the difficulty in actually spotting the fungal fruiting bodies – described more in the next section – how could the number be trusted as having counted everything that was there? With these reservations in mind, I decided to employ transects anyways, recognizing that fundamentally all ecological methods are efforts to gather understandings about the environment but that they are always positioned, partial representations of reality and never 'truths' (Haraway 1988).

Spatiality of caterpillar fungus: Banded/strip transects

As discussed in the Introduction, to quantitatively assess the abundance of caterpillar fungus in a 'good' harvesting area, I conducted banded or strip transects across Yangla, Dongwa and Adong in 2009. The results from the transects are shown in Table 1. Collectively these data indicate how sparsely distributed caterpillar fungus individuals are across the high alpine grasslands. Based on the average number of individuals found per square meter for Dongwa (0.002 individuals/sq m), a harvester would have to search 500 sq meters (0.12 acres) to find one individual, or 200 sq meters to find one in Adong. Notice that transects in Yangla failed to capture even one individual caterpillar fungus within their spatial sampling area, which again reflects the limitations of this method for producing meaningful measures of abundance.

Transect data

Yangla May 5-6, 2009

Transect	# bands	Elev Range (m)	Aspect (Dir)	# indiv.	Transect area (sq m)	Ind/area (sq m)
YLS09T1	12	4520-4548	150 (SSE)	0	480	0
YLS09T2	16	4636-4704	200 (SSW)	0	640	0
YLS09T3	5	4646-4665	200 (SSW)	0	200	0
					Avg ind/total area	**0**
Dongwa May 20-21, 2009						
DWS09T1	7	4623-4635	100 (E)	2	280	0.0071
DWS09T2	10	4625-4652	60 (ENE)	0	400	0
DWS09T3	10	4680-4700	50 (NE)	1	400	0.0025
					Avg ind/total area	**0.002**
Adong June 5-6, 2009						
ADS09T1	10	4358-4378	0 (N)	3	400	0.0075
ADS09T2	10	4400-4417	350 (N)	1	400	0.0022
					Avg ind/total area	**0.005**

Table 1: Transect data from banded transects conducted in Yangla, Dongwa and Adong during 2009 harvesting seasons.

Despite the fact that I methodologically sought to produce 'baselines' that recognized human-environmental interactions and use practices, that employed harvesters' knowledge of the resource to identify both a 'good' collecting area, and that employed harvesters' skills to 'count' caterpillar fungus individuals in the transects, these data illustrate the fundamental reductionisms and erasures that quantification produces. Using these data as universal 'truth statements' about the abundances in Yunnan alone would imply that Yangla caterpillar fungus distributions are extinct, and would thus likely signal the need for serious resource management regime shifts. In reality, harvesters in Yangla were finding the same amount of caterpillar fungus per individual per day (0-8 individuals) as in the other areas in Yunnan, which illustrates not only that these samples are not accurate representations of reality, but also hints at the political and social implications of doing *apolitical* ecology – or producing numbers and truth claims that fail to account for and interpret their contextual specificities. While ecological methods can be important ways to generate general understandings about the nonhuman dimensions of caterpillar fungus production, quantified data are fundamentally partial truths and must be interpreted as such. This is particularly the case when the quantification of nature stands chance of being used as an instrument of power to produce particular social and ecological orders, whether by the state (Scott 1998) or conservation scientists who characterize human-environmental relationships as fundamentally degrading.

These transect data are useful in illustrating just how sparsely distributed caterpillar fungus is in the high alpine grasslands, which in turn influences how it is harvested. Harvesters crawl on their hands and knees, close to the ground so that they can spot the small fruiting body of the fungus if they intersect it, and they often search for hours at a time before finding one. To relay a sense of what the bodily practice of harvesting entails and how irregularly harvesters find caterpillar fungus, below is a time/space log of a harvester's collecting 'path' during a usual harvesting day. This time/space log was recorded in Adong in 2008,[34] and documents the time spent, elevation changes and number of caterpillar fungus found by the father of the family I stayed with during the 2008 harvesting season. Lobsang was in his late 40s and was known to be a skilled collector by other harvesters from the village. During the time I spent with Lobsang and his family, he consistently found six to eight caterpillar fungus each day and he was a focused, methodical collector.

> May 26, 2008
>
> *8:30 am*
> We went harvesting this morning. We woke at 7am and were harvesting by 8:30am. A group of 17 collectors met at the top of the hill next to what appears to be an old shepherd's hut that has fallen into disrepair. After sitting on the grass and visiting for a while, everyone dispersed into smaller groups and started moving upslope to collect. There is always the sound of bells in the distance: mostly the lower tones from the yaks/*dzo* and occasionally the higher tones from the donkeys.
>
> JieJie [my field assistant] and I began following two male harvesters, one of whom was Lobsang, the father of the family we were staying with, and the other an older man who is also known to be a skilled collector.
>
> We begin following the harvesters up a south-facing slope. They start searching at 14,132 feet elevation in grasslands that have a mixture of low-lying shrubs, stones and low grasses/tundra. There are alternating mosaics of differing proportions of grass, stones, and shrubs.
>
> I follow Lobsang from the shepherd's hut. He collects through a combined set of movements involving walking, hunching, sitting, and crawling up the mixed grasslands. He crawls, looking right below him, one arm's length spotting distance below. I can see other harvesters doing the same movements as they move off, dispersing into smaller groups of four to seven.

[34] I was using the time/space logs to explore the potential applicability of the "catch-per-unit-effort" (CPUE) method, which is used in fisheries to determine abundances when overall abundances are unknown, to caterpillar fungus collecting. The notes here were written to record time, elevation and 'catch,' and are thus rather limited in their ethnographic details.

8:56 am
Lobsang finds the first piece of caterpillar fungus after 26 minutes of harvesting, at 14,145 feet elevation, in a mixed shrub/grass mosaic.

We are with a group of four men now, all searching within about 30 feet of one another, now 10, 20 feet apart, working upslope. Crawling, walking, sitting.

JieJie just followed the older harvester towards his bathroom break, everyone laughed.

Elevation 14,281 feet: shrub, rock, grass mix.

Elevation 14, 342 feet: fewer shrubs, more low tundra and rock.

Elevation 14,500 feet: we are moving to a steeper slope, moist ground, rocks and tussock.

9:50 am
Lobsang finds his second piece, one hour and 20 minutes after we started searching, 14,515 feet elevation.

9:52 am
Lobsang finds a third just two minutes later, elevation 14, 517 feet, one hour 22 minutes after we started searching. Mostly turf/rock and moist. When these two were found, the other three harvesters came and crowded around, very excited.

At various points, we are joined by a couple or three harvesters who come with us for a bit and then move on.

10:04 am
We were climbing higher, and then we came lower, sat down and the father found one immediately – his fourth – after we sat, at elevation 14,521 – one hour 34 minutes, the fourth one of the day in a group of four male harvesters. He spotted the fruiting body from about 3 meters away and leapt over another harvester to harvest it. They laughed about the event. All while we sat, harvesters scanned the ground for caterpillar fungus.

When a person finds one, there is a tradition where everyone runs over to look nearby the place it was found because there is a belief that when you find one, another one is nearby. Some say the pair is the male and female caterpillar fungus. If there is only one, someone has already collected the other one. It is common that harvesters collect in groups, individuals crossing over one another's paths as they search.

11:17 am
A man from our group of four finds one, 14, 730 feet elevation and two hours 47 minutes since we started collecting together.

11:30 am
At three hours, Lobsang finds one – his fifth – elevation 14, 748 feet, and within six feet in either direction, two more were found by other harvesters. The sporacia [bumpy surface on the fruiting body] are not visible on any of these pieces collected.

11:37 am
Three hours and 7 minutes after we started, Lobsang finds another one, 14, 782 feet elevation, his sixth of the day. The ground is moist, tussocky, and there are small yellow flowers covering the ground.

11:47 am
A different harvester from our group found one, three hours and 17 minutes after we started harvesting, elevation 14, 806 feet.

12:17 pm
14,786 feet elevation, another one found, three hours and 47 minutes after we started, it's 1pm and time to hike back to camp for lunch.

During the morning described above, we harvested for four hours. By the time we returned to the camp we had been out collecting for five hours total.[35] Lobsang found six pieces while we were together: at 50 *yuan* each, he earned 300 *yuan* in four hours, or the equivalent income of working six eight to ten hour days of road or building construction. The harvester JieJie was following, an older male, found four individuals total in the same amount of elapsed time and distance. One harvester who was not collecting with our group said she found one in the four hours we were out.

This time/space log reveals several things. First, it illustrates how the sparse distribution of caterpillar fungus influences how harvesters necessarily produce it: they devote hours of labor

[35] When harvesters are traveling to and from different harvesting areas, their eyes are always scanning the ground for caterpillar fungus. Every now and then they stop and crouch down low and search more closely in places that seem like promising areas, and otherwise their eyes are always searching. On the return to our camp in Dongwa in 2011, one male harvester in a large group spotted a piece of caterpillar fungus in the middle of the trail and yelped. I was hiking down a ways behind him and the others he was with, and by the time I reached the spot where he had found it a group of harvesters were gathered around, sitting and crouching. They had been waiting for me and my field assistant to see if we could also find the caterpillar fungus, which was a game harvesters often liked to play with me knowing that they were invariably much better at spotting it than I was.

and time to crawling, crouching, walking and stooping, searching the grasslands carefully for the small fruiting body in a sea of similar looking vegetation. Harvesting is thus physically demanding and not necessarily and bodily labor that everyone can engage in. According to a 65-year woman from Adong village, who does not harvest herself, “whoever is strong in the household will go up to harvest.” The ‘work’ of harvesting is not physiologically benign. Many harvesters develop respiratory illnesses in the high camps; sore joints, knees and elbows from crawling; sun and windburns from exposure; and headaches from dehydration.[36] In addition to physical strength and endurance, harvesting also requires knowledge about how to safely navigate and live in high alpine environments. In Nepal in 2011, several young harvesters died from exposure and avalanches because they were not familiar with or prepared for the high alpine environments. Thus the physical demands and challenges associated with where caterpillar fungus grows means that not everyone is willing or able to collect.

Second, the time/space logs illustrate that harvesters find caterpillar fungus with varying degrees of success even if they invest the same about of time and effort searching. The different amounts of caterpillar fungus harvesters collect in a day can in a sense be random, depending on how many fungi a harvester happens to encounter in her harvesting ‘path.’ Even if caterpillar fungus is in one’s path, however, it is not guaranteed that someone will find it because it is so small and difficult to see. Like many skills, the ability to spot and harvest caterpillar fungus without damaging tends to increase over time. During a conversation in Dongwa in 2011 with two younger female harvesters, who were 16 and 19 years old, they explained that when they

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[36] In Adong’s camp one evening in 2009, Lobsang’s daughter returned to the hut with a headache and asked him for some pain medicine. He had recently bought pain medicine while he was in Deqin, the major town near their village, and had brought up large quantities of it so that other harvesters could buy it from him if needed. He gave her a small white envelope that contained powdered pain medicine, which she opened and poured into her mouth and swallowed with a small amount of hot water. That particular day, she had gone with several of her friends to a harvesting area that was much higher and farther away than where we had gone that day, and was likely dehydrated after the long day of travel, exposure and limited water. In general, harvesters do not carry water with them when they collect, meaning dehydration is probably quite usual for most harvesters.

first started harvesting they couldn't find anything and they looked everywhere for caterpillar fungus. Over time, however, they started to find more because they began to take their time and look more slowly. Their explanation of how their skills increased over time suggest that the skill of harvesting is not just about training one's eyes, but is also related to increasing one's patience and a methodical attention to the focused practice of searching.

Skill – the ability to locate caterpillar fungus successfully -- is also related to the personal willingness and desire to search for caterpillar fungus, both of which are influenced by a harvester's social and political contexts. In Dongwa, there was an older collector who was known to be a skilled caterpillar fungus harvester. During the time I was in the camps in 2009 he consistently found more caterpillar fungus individuals than other harvesters -- generally four to six pairs in a day as opposed to others' two to four. Unlike most harvesters who usually collected with other harvesters as a group during the day – generally friends and family from the village -- he collected by himself and in areas that were not part of the usual harvesting routes that the group of collectors generally followed.[37] His relatives, with whom I was staying at the time, boasted to me that he walked much farther and higher than most harvesters, which contributed to his success. One afternoon after we returned to the hut after harvesting, I asked him why he chose to harvest alone. He explained that it was because he was getting older, and if he found one caterpillar fungus, he couldn't afford to have others find the 'mate.'[38] Though he didn't say so explicitly, I interpreted his appeal to age to indicate that his vision and general pace were perhaps decreasing with age. When harvesters collect in groups, when a harvester finds a

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[37] Across the four areas, harvesters generally harvested in groups and would travel from their camps to various familiar harvesting areas to collect. Though they didn't exactly follow harvesting routes, they had general patterns they would follow to get to different areas, e.g. up a particular watershed, across a particular face, etc. Harvesters also tend to collect in groups and visit with one another during the day, share lunch, etc.

[38] As mentioned in the time/space logs, there is a common narrative among harvesters that when you find one caterpillar fungus, you usually find a 'mate' nearby. Some harvesters explained this as the male and female caterpillar fungus.

caterpillar fungus, it is usual for several people to look around the area in the immediate vicinity to where one was found to search for its 'mate.' By harvesting alone, this could take his time and search the vicinity himself as quickly or slowly as he needed to.

When there are few to no economic alternatives to generating the kind of cash income collecting caterpillar fungus offers in contemporary Tibet, the sparse distribution of caterpillar fungus – and thus the highly uneven rewards of harvesting -- is something harvesters are acutely aware of. The same harvester discussed above also explained that he preferred to harvest alone because he was the only harvester in his family and that his wife remained in the village during the harvesting season. In his house, it was only him, his wife and their two kids, and the money he earned by collecting caterpillar fungus was necessary for him to pay for his children's school fees and related expenses: if he didn't find caterpillar fungus, his family income decreased significantly. Here, his 'skill' and ability to find several caterpillar fungus individuals each day are inextricably bound to his personal sense of obligations to his household to collect. This is not to say that only those who really need income or want to find caterpillar fungus will find it, or that those who are financially aware of their limited alternatives will collect alone (which is not common), but rather illustrates that 'skill' is not just technical and the amount of caterpillar fungus people find is not linearly related to the hours people harvest. People harvest with different sets of motivations and intensities, and differing levels of experience and abilities to spot caterpillar fungus in the grasslands.

Though harvesting is not entirely technical, some of the basic harvesting techniques – how to harvest the fungus out of the ground, training one's eyes to identify the fungus, etc. – are sometimes taught to younger harvesters by more experienced ones or family members, but many harvesters also say that they learn how to collect just by doing it. During a focus group in Yangla in May 2009, a harvester shared a story about a case when a harvester didn't have the technical knowledge of how to harvest, which indicates how it is a learned practice:

> A long time ago, during the collective period when village leaders decided what activities different work units and individuals did (e.g. who farmed, who collected caterpillar fungus, etc.), the village leader sent one person up to the high mountains to collect caterpillar fungus. When the harvester returned to the village with his collections, the village leader and others saw that he had hundreds and hundreds of pieces of "the grass" only, and not the joined caterpillar-fungus complex. He had simply broken off the fruiting body when he found it, as opposed to digging it out of the ground. The village leader cried.

A 53-year old Dongwa male collector said that to teach younger people to find caterpillar fungus, he has them look in the area where he has just found one. This practice helps train younger harvesters' eyes to see it. Incidentally, several harvesters used this same pedagogical approach to train my eyes while I was out in the grasslands with them while they collected. When a harvester found a caterpillar fungus individual in the grassland, he[39] would call me over and gesture towards a one to three square meter area in front of him with a wide swooping circle of his arms, and then have me search for the tiny brown stalk. At first, I couldn't see the tiny stalk until it was pointed out to me, and then gradually I began to spot it more quickly.

Influences of historical narratives on perceptions of scarcity

Realizing that the sparse distribution of caterpillar fungus requires significant amounts of time and energy in order to find it, the current perceptions of caterpillar fungus scarcity among harvesters are influenced by the limited economic alternatives to this form of cash income and

[39] I say "he" here because in my experience, only males used this method of teaching me to collect. Though I didn't explicitly examine whether there was a gendered dimension to who teaches harvesting practices, I would assume that gender does not significantly play a role in teaching because males and females harvest in relatively similar numbers.

historical narratives from harvesters that convey a history of caterpillar fungus abundance. Many elders in their 50s and 60s collected caterpillar fungus during the collective era in China when work groups were sent up to collect caterpillar fungus in groups of five or six individuals. When these elders shared stories about harvesting when they were younger, they consistently referred to the historical abundance of caterpillar fungus, as opposed to its scarcity. For example, during a focus group in 2009, an elder male reflected on what caterpillar fungus collecting was like for him when he was a boy, and he recalled being sent up to the same harvesting area we were in as a member of a small group during the collective era. When he and the other were sent up to collecting areas to harvest caterpillar fungus, they carried large grain baskets on their backs. When they reached the high alpine grasslands, they flipped the baskets over and placed them rim-side down on the grasslands, and within the space of the basket's rim they found many pieces of caterpillar fungus. He recalled that there was so much caterpillar fungus at that time that he and the others could fill five-kilogram rice bags by the end of the morning, and after lunch they would not even look for caterpillar fungus, but would instead go hunt the wild chickens that were found in the forests flanking the grasslands.[40] Other elders similarly recalled finding hundreds of caterpillar fungus in a day. These kinds of stories about the historical abundances of caterpillar fungus – which were often elicited through group conversations and focus groups -- generated great reactions from younger harvesters who could hardly imagine such mythical abundances. When asked why they thought the amount of caterpillar fungus people were finding in recent years had declined, the elders attributed it to the fact that the number of harvesters had increased significantly since that time. The work teams who were sent up to collect caterpillar fungus during the collective era generally consisted of five to six people,

[40] As I discuss in Chapter 3, during the collective era work teams were sent up to gather caterpillar fungus which was sold in the village at the state-run medicine shop.

and they usually only went up for a week at a time. Now, in the these same harvesting areas, 60 to 400 people might collect for the duration of the season (45-60 days). Compared to the historical narratives of caterpillar fungus abundance where collectors could find hundreds in a day, or many within the rim of a basket, contemporary collectors find but a fraction of these amounts in a day. Since the collective era, no technological improvements have been made that make harvesting easier or more efficient, so the time and energy currently required to collect caterpillar fungus contrasts starkly with the relative ease with which past harvesters could find so much of it.

Throughout Yunnan, most harvesters claim that there has been a *per capita* decrease in the number of caterpillar fungus they find each season, which they attribute to the increase in the number of harvesters and drier spring conditions. While these per capita declines might indeed reflect and correlate with an *overall* decline in caterpillar fungus, contrary to Shrestha and Bawa's (2013) interpretation, it remains unclear whether there is an overall trade-induced decline of caterpillar fungus at this time (Stewart et al. 2013). What is important to examine, however, is how harvesters' perceptions of scarcity are produced and reinforced through their social, historical, and political economic contexts, and not just their biological conditions. Harvesters commonly explain that their concern about the *per capita* decline in caterpillar fungus is based in the fact that, "for farmers, caterpillar fungus is the most important source of income." Perceptions of caterpillar fungus scarcity are thus inseparable from the fact that the income is crucial to their household economies, as discussed in Chapter 3, and there are few alternatives to earning this kind of cash income. What alternatives do exist, such as road or building construction, are not necessarily desirable forms of work, as discussed more in Chapter 3. As mentioned in the Introduction, these broader contextual dimensions of how and why caterpillar fungus harvesters perceive and talk about caterpillar fungus abundance changes over years are critical to integrate into scientific understandings of harvester-fungus relationships.

Distribution as dynamic

Caterpillar fungus is sparsely and unevenly distributed relative to the complex assemblages of shrubs, grasses, rocky scree slopes, slopes and aspect. Mapping onto these complex relationships and patchy realities is the characteristic climatic variability of the Himalayas. Several harvesters in Dongwa said in separate accounts that caterpillar fungus distribution varies according to weather and climatic trends (as discussed more in the next section) reflecting that distribution is not a stable state. One harvester explained in 2009 that the year before, he could find caterpillar fungus everywhere in the area we were talking in, but in 2009, he could only find it in the lower or wet places. Many harvesters described how in rainy years, caterpillar fungus is more often found on steeper slopes and higher areas, and in drier years, it is more prevalent in lower, flat areas.

Harvesters' knowledge of caterpillar fungus centers on an understanding that it is both diffuse and dynamic. While there are particular harvesting areas or 'physical spaces' that constrain who and what places are involved in caterpillar fungus production, harvesters' practices and knowledges have honed their ability to capitalize on this variability in contextually significant ways.

Temporality: The beginning, end and contingencies of the harvesting season

As Prudham (2005) has described, the seasonal rhythms of animals and crop growth have confronted industrial capital with a challenge to the continuous deployment of capital and labor.

Some resources cannot be produced year round despite any amount of social or technological investment in production, and thus production is contingent on ecological processes and their related rhythms and contingencies.

The production of caterpillar fungus is contingent on seasonal rhythms because it only grows in visible ways during May and June each year. Prior to the beginning of the season, the fruiting body of the fungus – its visual cue to harvesters -- is not developed and thus the fungus remains covered in a blanket of snow. After the season, any remaining caterpillar fungus individuals are in a state of decomposition and can fetch only a fraction of their market value. But with these temporal constraints, there are also opportunities: harvesters use the late season caterpillar fungus for household consumption.

The Tibetan term for caterpillar fungus (*dbyar rtswa dgun 'bu*) "summer-grass, winter-worm," reflects both the indigenous understandings and temporal dimensions of caterpillar fungus production. 'Summer grass' refers to the brown, stalk-like caterpillar fungus fruiting body, or *stroma*, that is visible to collectors in the high alpine grasslands during May and June each year. 'Winter-worm' refers to the host larva, which generally burrows deep beneath the surface of the soil during the winter months to avoid soil frost zones.

As discussed above, fungal growth requires particular moisture and temperature conditions, and in Himalayan geographies climate variability makes these growth conditions vary across years. In the Himalayan alpine grasslands, spring and summer are important and intense growing periods for most flora, fauna and fungi because the solar gains melt the winter snowpack, recharge soil water content and expose the moisture-laden grasslands. Once the grasslands are snow-free, the caterpillar fungus fruiting body can successfully emerge from the soil and grow above the grasslands. In some years, the snow cover remains until late spring and in others there is hardly any snow. Since the timing of the harvesting season is contingent in some ways on when the fruiting body is visible, villages sometimes send individuals up to the grasslands during the early spring to see if the snowpack has receded and if caterpillar fungus has begun fruiting. Heavy spring snow events can push back the start of the harvesting season, just as drier years can advance it. In general harvesters travel to their harvesting camps during the end of April and early May.

2009 was notably a drier spring than the years prior, and the last big winter snow event that year was in February when usually the precipitation continues into late March. The lack of precipitation was in the forefront of many people's minds that year across all harvesting areas because they recognized that it was influencing the amount of caterpillar fungus they were finding. While collecting many people kept explaining their difficulties in finding it with the phrase, "no rain, so no caterpillar fungus." One harvester in Dongwa pointed to the cracking tundra and said, "see, no caterpillar fungus can grow, it's too dry." Another Dongwa harvester pointed to an area that normally had residual snow patches during the harvesting season that was completely bare in 2009. One harvester said that in drier years like in 2009, north-facing slopes were better for collecting, though harvesters still searched all aspects and sides of the mountains during the season with the understanding that there would still be caterpillar fungus on the south-facing sides of slopes as well. The amount of caterpillar fungus was so much lower in 2009, several harvesters across all sites returned home to their villages during May because they were not finding any caterpillar fungus.

Climate variability thus influences when and whether people harvest, but the timing of the caterpillar fungus harvesting season is also highly contingent on other social and cultural factors, including governance (as discussed in Chapter 4) and harvesters' household labor needs.

As one female harvester explained, generally people start harvesting around April 23 and 24 each spring because that is when the caterpillar fungus starts to emerge in the grasslands, but that her and other families' start date depends on the family: if there are not as many people at home, they have to stay back home in the village to finish their house work before they can travel up to the high camps. At the end of April and early May, the recently planted barley – a major staple grain for Tibetans -- begins to break ground and thus requires watering and weeding. If there are capable elders living in the home, younger generations of the household can leave the village and live in the high camps during the caterpillar fungus season, but if not, either one person remains in the village to tend to the barley during the caterpillar fungus season or the family works out arrangements that enable one or more people to travel to and from the village and the camp to collect but also care for their household production.

The length of the caterpillar fungus harvesting season is constrained by both ecological and social factors, the latter of which has not been emphasized enough in most caterpillar fungus studies (C.f. Weckerle et al. 2010; Winkler 2008). In agricultural systems, the end of a production season is indicated by either exhaustive collection (there are no remaining resources to collect) or the passing of an economically valuable state of the resource (e.g. rotting, bolting, going to seed, etc.). Agricultural metaphors and frameworks are often used to think about the management dimensions of wild-harvested resources, but these are often misaligned with the human-environmental realities and relationships (Nadasdy 2011). Interpreting caterpillar fungus production through an agricultural metaphor, the harvesting season could either end when harvesters have exhausted the resource and harvested every individual during the fruiting season or when the economically viable form of caterpillar fungus has passed. From a management perspective, whether the collecting season stops due to resource exhaustion or a decline in market value has implications for caterpillar fungus sustainability, *but only if sexual (not asexual) reproduction is the major reproductive channel for future populations.*[41] If harvesters stop collecting caterpillar fungus because they can no longer find it, there is a high likelihood that harvesting is negatively influencing caterpillar fungus reproduction, whereas if harvesters stop collecting because the fungal bodies are soft, it is likely that after the harvesting season there are enough remaining caterpillar fungus individuals in the grasslands to propagate future fungi.

The desired economic state of caterpillar fungus relates to its sexual reproductive cycle, which I explain more in the next section. Collected caterpillar fungus individuals are most economically valuable prior to sexual reproduction (up to 100 *yuan* for highest quality individuals in 2009), and after sexual reproduction, market value of the fungus drops off exponentially (1-2 *yuan* each during 2009). The market value of pre- and post-reproductive individuals is signaled by 'softness' in the larval body: if the larval body is still firm, it is considered a higher grade and more valuable, and if it's 'soft,' it is marginal. The physical transformation of the fungal body from firm to soft correlates with stages in sexual reproduction because the living fungus releases secondary metabolites that mummify the body of its host larva and keep it firm and free of decay in its subterranean environment. After sexual reproduction, the fungus stops producing secondary metabolites that are created during parasitism and the larval body begins to decompose in the soil. To check for quality, harvesters pinch the body of the larva to check for firmness after they collect it out of the ground, and traders also pinch the body of the larva to determine price when they're buying it. The length and texture of the fruiting body generally correlates with the larval body firmness: as the fungus matures, the

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[41] This is a crucially important caveat that is usually not conceptualized in most ideas of caterpillar fungus sustainability, as discussed in the next section.

fruiting body lengthens, and as it nears sexual reproduction (the release of sexual spores), the top of the fruiting body develops a bumpy texture that indicates the spore-containing structures are developing.

There are, however, other factors besides resource exhaustion and market value that prove to be the most important influence on when people stop collecting: their household production needs. As shown in Table 2, when asked if they stop collecting caterpillar fungus because it was too difficult to find (resource exhaustion), because the body was 'soft' (market value) *or because of household needs*, 68% of harvesters (44 of 65 individuals) in Yunnan said they stop collecting in mid June because they have to return to their villages in order to harvest wheat and barley. One person explained that if they didn't have to return home to take care of the wheat and barley, "we wouldn't want to come back [to the village] because the weather and environment is so nice in the high mountains." In the lower valley villages, summer temperatures are extremely hot, whereas the high alpine grasslands stay cool. An elderly couple in Adong (he was 64 and she was 60), who had remained in the village during the 2011 harvesting season to take care of the family livestock and meadows, said that their family always came back around June 15 because they have to harvest the barley. During the collecting season, the older couple was able to take care of the household labor needs, but the labor of the younger working generation is needed for the physically demanding task of harvesting.

Site	*Total number of interviewees (who were harvesters) (n)	Start date	Stop date	Stop because "soft"	Stop because too hard to find	Stop due to household needs
Adong	12	Apr 20-May 1	June 10-15	0	0	12
Shusong	9	Apr 28-May 1	June 3-July	6	2	1
Dongwa	20	May 8-May 20	June 17-20	1	0	19
Yangla	24	Apr 15-May1	mid-June	7	5	12

Table 2: Harvesting season timing across four villages. *Of 94 household interviews, harvesting-specific questions were only asked if interviewees were actually harvesters. This table shows the average start and stop dates to the harvesting seasons in Adong, Shusong, Dongwa and Yangla, and interviewee rankings on what was the most important reason why they stopped collecting. They were asked a closed-ended question, "what is the most important reason why you stop collecting: (1) caterpillar fungus is "soft," (2) it is too hard to find, (3) household needs, (4) other.

The fact that the duration of the caterpillar fungus collecting season is constrained by both ecological and social factors pushes back on the *biologizing* of resource studies (Turner 1993), that make *a priori* assumptions about resource users' decision-making processes and assume that they are based solely on biological factors. In their Yunnan-based study examining caterpillar fungus harvesting in nature reserves, Weckerle et al. (2009) also examined why harvesters stop collecting, but presented interviewees with response options of "difficult to find," "softness," or a combination of both. They did not examine how household labor affects decision-making, and found that 52.1% of their 102 interviewees stopped collecting when it was soft, 33.3% say they stop when they can't find an individual for several days, and 12.5% said that it is a combination of both. One of my study villages in Shusong overlapped with one of their study sites, which indicates that had they also examined whether people stop collecting due to household labor needs, their findings might have been different.

Beyond the majority of respondents that said household needs was the primary reason the harvesting season ends, 22% (14 individuals) of respondents said they stop collecting when the fungus is "soft," and 10% (7 individuals) said they stop collecting when it is too hard to find. These findings corroborate Weckerle et al.'s findings that declining market value of caterpillar fungus is an important reason why people stop harvesting. It is worth noting here that while harvesters' responses that they stop harvesting because it is "too difficult to find" can indicate that harvesting has exhausted the resource, the perception of whether caterpillar fungus is difficult or not difficult to find is influenced by many other factors than just the supply of the fungus. Harvesters' perspectives on what constitutes productive and worthy investments of time and labor also influence their perceptions of whether or not it is difficult to find. Caterpillar fungus is always difficult to find, and if for example, harvesters have household labor needs and/or they know the market value of caterpillar fungus is declining and their collecting efforts no longer reap the same benefits, these factors will be bundled into their perceptions of whether or not it is "too difficult to find."

These bundled meanings and perceptions were evident throughout the interview process. Though I asked harvesters what they found to be the most important reason for the end of the harvesting season, many harvesters had integrated reasons for stopping. For example, a Dongwa harvester said that he usually returned to the village around June 20 to collect barley and because the caterpillar bodies are empty. He added that some harvesters stay until July, but most find that the bodies are "empty" [soft] at that point. I asked him if, in general, people find less when the bodies are empty, and he said, some of them are empty and some are full, reflecting the fact that 'softness' is contingent upon elevation and aspect. Similarly, another male Dongwa harvester explained:

> I stopped harvesting on June 20 in 2008 because I couldn't find so much, but I could still find some. In my village, I'm the only one that has a field for one person,[42] so I don't

[42] The Households Responsibility System implemented at decollectivization, apportioned land use rights to households according to the number of household members.

> have to work at home much. I have a wife and two children, so they can take care of the field and I don't have to return home during the collecting season. Last year, I found 15,000 *yuan* worth of caterpillar fungus, and 8,000 *yuan* the year before [2007]. At the end of the season last year, when I went home, I could still find 30 individuals per day at least.

These integrated explanations of why the harvesting season ends reflects the ways harvesting, home, weather variability and the condition of the fungal body are not compartmentalized in the lives of harvesters, but rather collectively and variously influence why and when people choose to harvest caterpillar fungus, and why these decisions vary across years. While nature as time influences the beginning and end of the harvesting season in significant ways, harvesters work within and 'around' the active and variable properties of nature by choosing to harvest in particular places, at particular times or sometimes returning home to engage in other activities. Important here is the fact that while the nonhuman dimensions of caterpillar fungus "make a difference" in the way it's socially produced, the harvesters' decisions and practices are not only influenced by nature's materiality.

A morphology of contingencies: Fungus-host-grassland-harvester interactions

Himalayan physical geographies influence when and how caterpillar fungus grows because they influence moisture and temperature conditions, but caterpillar fungus production is also contingent on a complex set of interactions between the *O. sinensis* fungus and its host: just because the physical habitat conditions are opportune does not mean that caterpillar fungus populations will exist. A recent study by Peng et al. (2013) provided evidence for the intuitive fact that soils without caterpillar fungus spores and mycelium do not give rise to caterpillar fungus populations. Further, as discussed, just because caterpillar fungus exists in a range of areas doesn't mean that it is automatically enrolled in the fungal economy: each piece is located and harvested by hand, enabled through practice-based skill and the willingness and desire to harvest.

The specific form of caterpillar fungus, produced through the relationships between the fungus, a host ghost moth larva, and grassland geographies, fundamentally constrains the extent to which caterpillar fungus production can be scaled up. The small size of the resource and its dispersed distribution preclude mechanized production, and its contingency on environmental 'triggers' precludes its artificial lab-based cultivation. These biological and ecological particularities have simultaneously enabled and constrained the kinds of social arrangements and practices involved in caterpillar fungus production today. This section describes the unique relationships between the *Ophiocordyceps sinensis* fungus, the *Thitarodes* ghost moth larvae, and the grassland ecologies that together give rise to the unique form of caterpillar fungus, and how this form both enables and constrains human harvesting ecologies that reciprocally interact with caterpillar fungus populations in unknown ways.

Unlike other fungi that form in symbiosis with plants or trees, caterpillar fungus parasitizes the larval stage of ghost moths of the genus *Thitarodes* to produce the unique caterpillar-fungus complex, which to date, cannot be artificially produced in a lab. This makes caterpillar fungal production subject to its host ghost moth population dynamics and distribution, as well as its own capacity to successfully colonize its host larvae and reproduce. Caterpillar fungus host *Thitarodes* ghost moths are of the family Hepialidae (Lepidoptera: Exoporia: Hepioloidea). Hepialidae is one of the earliest evolutionary lineages of lepidopterans (moths and butterflies) (Cao et al. 2012), and comprises 56 genera and 537 species which are found on the continents of Asia, North and South America, Africa and Australia and on the continental crust fragments of New Zealand, New Guinea and Taiwan, as well as a few islands, including Japan

(Nielsen et al., 2000). The geographic range of *Thitarodes* ghost moths has a northern limit about 50 degrees north in central Asia and a westernmost limit about 85 degrees west in Nepal and Southern China (Grehan 2011). The moths are found in most vegetation types, including forest, shrub land, grassland, tundra, swamps and bogs (Grehan 1989). There is a considerable concentration of species in southeast China and the Himalayas with 16 species being recorded from Yunnan province, though many of the Yunnan identifications are considered superficial and this diversity may decrease in the future with more comparative phylogenetic research (Grehan 2011).

To understand how fungal production is contingent on ghost moth larvae, it is useful to review the basic biological phases of moth life cycles and reproduction: once an adult female moth has mated, she lays her fertilized eggs. After their development within the eggs is complete, larvae hatch from their eggs and begin feeding.[43] A newly hatched larva is said to be in its first *instar*, an age-classification term that describes the stage between *molts*, or shedding of their *cuticle* (exoskeleton). Once a larva grows too big for its cuticle, it molts, and once it does, it has reached its second instar. Larvae go through several instars before they *pupate*, or create a cocoon, and metamorphose into a moth. Some moths go through all of these phases in the course of months, and for *Thitarodes* ghost moths, years. A recent lab-based life history analysis of *T. pui* -- a ghost moth species from the alpine meadows and alpine shrub meadows of Mt. Segyi La in Tibet -- suggests that larval development lasts three to four years (about 1095-1460 days) and involves seven to nine instars (Zou et al., 2012). The 7th instar pupates into male adults, the 9th instar into female adults, and the 8th instar larvae into both males and females. Pupation for lab

[43] It remains uncertain where first instar larvae live while feeding. They might immediately burrow into the soil to begin feeding on roots, or they might reside on the surface for some time to feed on leave litter (and fungi).

specimens was observed to last 35-41 days and began at the end of April to early May and ended during late June to mid-July, when adult moths emerged to live for 3-8 days.

In general, Hepialidae are some of the most fecund lepidopterans and lay high numbers of eggs to facilitate greater reproductive success because paternally they don't invest time or care in their offspring development. Some Hepialidae species have been observed to lay 29,000 eggs in captivity, and it is common for female ghost moths to lay thousands of eggs during their reproductive period, which can last from two days to a week (Grehan 1989). Adult Hepialidae have reduced mouthparts and are non-feeding, which means that their adult morph is entirely focused on mating and laying eggs. While it remains relatively unclear how and where *Thitarodes* ghost moths reproduce, ghost moth flight times generally take place during short flight periods at dusk during July and August, and it's likely that they engage in crepuscular 'lekking' displays, where males hover in 'leks,' or groups, and flutter their wings in particular locations during twilight hours to attract females for mating. This lekking behavior earned the 'ghost moth' its common name because groups of fluttering light-winged moths in front of trees at dusk resemble ghosts. When lekking, males start and stop their flight periods together, and hover in groups for varied lengths of time to attract females into their groups. Females generally fly into the lek and approach a male who then follows her to a settling position for mating. Based on his observations of *Hepialus humuli* lekking behaviors in England, Mallet (1984) suggests that females are attracted to the groups of white fluttering males by visual stimuli, as well as olfactory substances that are produced by the males' hind tibial brushes (hair-like structures). In Bhutan, Maczey et al. (2010) similarly described and explained that the hind tibial brushes on their two observed *Thitarodes* species likely emit a musky pheromone and facilitate lekking behaviors (Maczey et al., 2010).

After mating, female *Thitarodes* moths distribute their fertilized eggs somewhere on the grasslands. Two *Thitarodes* species in Bhutan were observed to start laying eggs by sitting at the bases of plants and laying eggs on the ground (Maczey et al., 2010: 117), though it is generally believed that female ghost moths disperse their eggs while flying (Grehan 1989). After the larvae develop enough inside their eggs, *Thitarodes* larvae hatch and remain in their larval form from two to five years, depending on the species (Grehan 1989).

In contrast to their adult form, Hepialidae larvae have generalized, biting mouthparts with well-developed mandibles that enable them to consume a range of foods, including leaf litter, humus, plant leaves and stems, roots, moss, ferns and fungi (Grehan 1989; Nielsen et al., 2000). A number of them are even purported to be cannibalistic (Nielson et a., 2000). Caterpillar fungus host *Thitarodes* larvae are claimed to be specifically root-feeders (Grehan 1989; Wang and Yao 2011), though leaf and stem-eating Hepialidea species have been documented throughout China (Wang and Yao, 2011). Both root and stem/leaf-boring Hepialids live underground in tunnels that are partly or completely lined with silk (Grehan 1989: 809). Tunneling and foraging are closely related activities for hepialids, and tunnels are located into and around roots and plants that are associated with foraging (see Grehan 1989 for diagrams of tunnels). *Thitarodes armoricanus,* a caterpillar fungus host-species found in the Tibetan Plateau, has been observed to construct vertical tunnels -- which may include lateral connecting burrows and chambers -- in the soil around the alpine flower Alpine Bistort (*Polygonum viviparum* (Polyconaceae) while feeding on it (J.R. Grehan 1989). The tunnels are 5-20 cm below ground in the summer, and generally 10-20 cm below a 3-8 cm upper layer of frozen soil in the winter (Chen et al., 1973, as cited in Grehan 1989: 810).

Combined with the limited *Thitarodes* field-based behavioral observations, the generalist foraging characteristics of Hepialidae larvae make it possible that *Thitarodes* larvae feed on other substances in addition to roots throughout their larval stages. Since leaf and stem eating larvae mainly forage at night, and return to their concealed tunnels during the day (Grehan 1989), there is a chance that some *Thitarodes* larvae species feed on stems, leaves and humus during the night and return to their tunnels during the day, which would fit with theories that *Thitarodes* are root foragers because day-time foraging behaviors wouldn't be observed. On several occasions, harvesters have mentioned that they occasionally see living larvae on the surface of the soil, which suggests larvae may in fact feed on more than just roots. For example, a female harvester in Dongwa, who had been collecting for 17-18 years, responded that she occasionally sees live caterpillar crawling on the surface of the grassland – "maybe one every ten days or so" -- and that she generally sees more at the beginning of the season.[44] Harvesters have also shown me several larval molts on the surface of the soil, which similarly suggests that larvae spend more time on the surface of the soil than is currently understood, but it remains unclear whether they are foraging or not.[45]

Mycophagy (eating of fungi) has been recorded in the early instars of a wide range of leaf and root eating Hepialidae species, and mycophagy is said to be "particularly possible in pasture and grassland ecosystems where live and dead plant tissues are in close physical proximity to one another" (Grehan 1989: 815). There have been several cases where Hepialidae species were seen eating leaf litter and detritus in their early instars, but not in their later instars, which

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[44] According to Zou et al.'s (2012) life cycle study, if larvae are traveling to the surface at the beginning of the season, or early May, this could be the time just before they enter into pupation.

[45] The entrances to leaf and stem foraging larvae's tunnels are generally concealed on the surface of the grasslands by a web of silk and debris (Grehan 1989), thus it would be useful to purposively examine whether these webs exist to further delineate *Thitarodes* foraging behaviors.

suggests that there are potentially shifts between mycophagy and phytophagy during different stages or instars of Hepialids. If *Thitarodes* larvae are dedicated root-feeders throughout the entirety of their larval stages, there is still a high possibility that they passively (or purposively) consume fungi while consuming plant roots and/or soil while burrowing because many fungal spores and mycelia are likely present in the soils and/or are associated with plant roots as mycorrhizae.

Mycophagy and the time larvae spend on the surface has important implications for understanding the biophysical contingencies of caterpillar fungus reproduction, because it currently remains uncertain how and when the *Ophiocordyceps sinensis* fungus colonizes and kills its host species in order to produce caterpillar fungus. To understand the kinds of contingencies underlying caterpillar fungus reproduction, it is useful to review some of the basic biological dimensions of fungal reproduction.

Spores are one of the key signatures of fungal biology and fungi are often able to succeed in systems of patchy resource availability because they release many small spores instead of few large propogules. Spores can be asexual or sexual and their dispersal varies: most spores are passively dispersed, meaning they rely on an external medium to transport them, including gravity, air or water currents, rain splash, or animals, especially insects. Fungal spores may remain dormant for many years, especially under dry and cold conditions. Fungi can reproduce, or propagate, both sexually and asexually, and each reproductive pathway is independent of the other. Many fungi are known to reproduce primarily asexually with infrequent sexual reproduction.

Caterpillar fungus' sexual reproductive strategy and pathway is the most visible aspect of the fungal-host parasitism, and is what appears to harvesters as a 'blade of grass' when they are collecting. It is thus most readily perceived to be the major biophysical constraint on caterpillar fungus production, though in actuality, this might not be the case. Caterpillar fungus sexual reproduction hinges on the development of a stroma, or fruiting body, which grows out of the head of its parasitized host larva. Parasitized larvae are located and vertically anchored in the upper 5-8 cm of the soil, which enables the stroma to grow from the head and break out above the soil surface to eventually release sexual spores across the grasslands. As the fungus sexually matures, the stroma elongates and grows vertically -- which enables the fungus to disperse its sexual spores further across the grasslands – and the texture of the stroma grows more bumpy due to the development of perithecia, or spore-containing structures. Once the fungus has reached sexual maturity, it releases its spores across the grasslands.

Since the fungus parasitizes subterranean larvae, it is biologically curious why the larvae don't decompose or break down in the soil since they have been killed through the parasitism. This decaying process is actually actively combated by the fungus, which releases secondary metabolites during its parasitic phase which essentially mummifies the larval body to preserve its own nutrient source until it sexually reproduces, which is common in parasitic fungi (Roy et al. 2006). As previously mentioned, after sexual reproduction, the fungus stops producing the secondary metabolites, and the larval body begins to decay or grow 'soft.'

In addition to sexual reproduction, fungi reproduce asexually. Little is known about the ecology of the caterpillar fungus' asexual stage (anamorph) *Hirsutella sinensis*, though it likely grows in the soil and/or around plant roots (Bushley, person. Comm.). It has been suggested that *H. sinensis* asexual spores (conidia) play a major role in caterpillar fungus reproduction since it has been difficult to produce caterpillar-fungus infections in the laboratory by inoculating host larvae with *O. sinensis* sexual spores (ascospores) or mycelium alone (Li et al., 1998, as cited in

Zhong et al. 2010). Using gut content analysis, Lei et al. (2011) more frequently detected *H. sinensis* in larvae that were preferentially foraging on certain high alpine plant roots, and the authors conclude that it is possible that larval consumption of *H. sinensis* can lead to infection with *O. sinensis* and development of the caterpillar fungus fruiting body. Peng et al.'s (2013) recent soil analysis of *O. sinensis* DNA distribution further suggests that infection likely occurs in *Thitarodes* tunnels. Bushley et al. (2013) recently found through genetic analyses that there is a high likelihood that caterpillar fungus reproduces asexually. These studies collectively suggest that asexual reproduction and infection in subterranean habitat associations play a much more significant roles in caterpillar fungus propagation than is currently understood.

While it remains uncertain in the scientific literature how and when caterpillar fungus spores colonize host larvae, here I contend that the caterpillar fungus parasitism advances and takes over *Thitarodes* larvae during their pupation phase. This conjecture is supported by the fact that parasitism takes place during the last instar phase of larvae, which would be the phase at which larvae pupate and metamorphose. Maczey et al. (2011: 42) recently claimed that "larvae are infected by fungal spores during their early life stages and killed by fungus parasitism in the final larval instar prior to pupation." Since this has not been documented to date, I asked Maczey to clarify his rationale by email, to which he responded:

> We have indeed no certain scientific proof that only the last instar is taken over and killed by the fungus. However, there are strong indications to assume this. We have unearthed numerous caterpillars at *Ophiocordyceps* sites and none of the younger instars showed any obvious signs of infection. And then, basically all harvested fruiting bodies are developed on last instar caterpillars (simply recognized by their size). I believe that younger stages lack the biomass to support the development of a fruiting body large enough to push through the surface of the soil. This doesn't mean that a takeover of younger instars does not happen (possibly even on a regular basis) but we did not find any evidence to support this in the field.

Maczey's explanation suggests that the biological size of the larvae (and thus nutrient availability) is the limiting factor for parasitism, where a larger larval size is the 'trigger' for parasitism, but admits that there might be exceptions in this theory that haven't been documented to date. I suggest that the final instar and the *pupation stage* itself is the environmental trigger for parasitism, supported by the fact that when moths pupate, they create a cocoon out of silk, within which the larval body undergoes major chemical and physical transformations associated with metamorphosis. This silk layer is visible on caterpillar fungus individuals when they are first harvested, and is usually combined with or covered by a soil layer. Before caterpillar fungus is bought, traded or sold as a commodity, at some point along the commodity chain someone cleans this soil/silk layer from the larval bodies to expose the golden color of the larval bodies. In Yunnan, either harvesters themselves or traders clean this layer off by using a toothbrush (See Figure 2).

There are several potential evolutionary reasons why parasitism likely advances during pupation. First, several studies have shown that during metamorphosis, larva metabolic rates decrease in a U-shaped curve in order to allocate energy towards the energy-intensive process of metamorphosis (Merkey et al. 2011). It is possible that as larvae metabolic rates drop, fungal parasitism advances. During metamorphosis, major chemical and biological transformations take place within the pupal case: the cells of virtually all of the differentiated larval structures –

Figure 2: Three collected caterpillar fungus individuals that are being bought by a Dongwa trader (his ledger and briefcase are visible). The fungal individual in his hand, farthest from view, shows the whitish layer of silk still coating the un-cleaned larval body. The central individual, which appears yellowish, reveals the golden color that is usually associated with caterpillar fungus. The fungal individual closest to the viewer shows the layer of soil that is most often visible when caterpillar fungus is harvested.

muscles, salivary glands, gut, etc., -- die by apoptosis (a type of self-induced cell death). The nutrients they release are then made available for the development of other nests of cells that grow into other structures such as legs, wings, compound eyes, etc. Revealingly, insect molting and metamorphosis in insects are under the endocrine control of secretory organs such as the brain, the prothroacic glands, and the corpora allata (Nagata, et al., 2005) - all of which are located in the head of insects, which is also the location from which the fungus emerges from in larvae. The hormones that are released by the corpus allatum, known as juvenile hormones, play a significant role in metamorphosis: it has been shown that surgically removing the corpora allata from larvae can make them pupate at the next molt and that transplanting corpora allata from a young larva to a fully mature larva can extend the larval stage. These hormones have been well studied in silk worm moths (*Bombyx mori*) for their influences on silk production. Collectively, these suppositions and Maczey et al's (2011: 42) claim that larvae are "infected by spores of the *Ophiocordyceps* fungal spores during early life stages when they stay dormant for a considerable time," highlight future potential research areas for understanding caterpillar fungus parasitism processes. For example, if caterpillar fungus production is contingent upon pupation, which takes place after three to five years of larval development, the current scientific foci on trying to place spores on young larvae will never successfully trigger parasitism because they are missing the ecological and environmental 'triggers.'

Conclusion

This chapter has discussed how the spatial, temporal and morphological properties of caterpillar fungus enable and constrain its production. Collectively these nonhuman dimensions of production influence whom and how people engage in the economy as producers, and what places are sites of production. Through this discussion of who and what places are incorporated and linked through the production of caterpillar fungus, we can also understand who and what places are 'disarticulated' through these same processes, which has recently been suggested as a gap in the commodity chain studies literature (Bair and Werner 2011). 'Disarticulations' here occur through ecological, social, and cultural dimensions of production that collectively influence not only whether people are able to engage in the production of caterpillar fungus, but also whether they choose to.

From a political ecology standpoint, engaging with the ecological dimensions of production as I have in this chapter illustrates how doing so expands our understandings of how harvesting as a social practice relates to a broader set of ecological and social relations, how and why social relations of production operate in the ways they do, how systems of meaning and practices are influenced by material relationships with the environment, and the relationships between different ways of framing, examining and thus knowing about the environment. Here I have shown the many ways the production of 'numbers' about caterpillar fungus abundance can be a problematic abstraction, but also how ecological methods can be a useful tool for expanding understanding about the nonhuman dimensions of production if they are designed, conducted, and interpreted in contextually relevant ways. By engaging with ecological science and literature as I have in this chapter, I join with other "critical" or ecologically-grounded political ecology approaches that seek to "avoid the presentation of 'ecology' into predefined notions of fact, accuracy and political purpose" (Forsyth 2003, 11). Recognizing the various ways scientific understandings of environmental change and phenomena are fundamentally partial opens ways to identifying what other kinds of scientific questions must be examined in order to produce potentially more accurate biophysical understandings and move towards a more "politically aware understanding of the context within which environmental explanations emerge and are seen to be relevant" (Forsyth 2003, 21). For example, this chapter has underlined the need for more scientific research examining caterpillar fungus' asexual reproductive pathways, which as I have shown, are currently poorly understood and vastly underemphasized in conservation approaches to caterpillar fungus. Building on this chapter's focus on how the non-human dimensions of caterpillar fungus growth influence its production, the following chapters examine how Tibetan social relationships with one another, their environments, and their political economic contexts, enable and constrain how and why caterpillar fungus is produced and governed as it is in Yunnan today.

CHAPTER 3

SITUATING CATERPILLAR FUNGUS PRODUCTION IN NEOLIBERALIZING YUNNAN

Introduction

In Chapter 2, I discussed how the non-human and biophysical dimensions of caterpillar fungus influence its production and governance. In this chapter I discuss how the social dimensions of caterpillar fungus production relate to these ecologies and the broader political economic context of neoliberalizing China to examine how and why the caterpillar fungus economy has taken shape in the lives of producers as it has today. Specifically I examine how the practice of harvesting and sets of meanings associated with collecting caterpillar fungus have and continue to evolve in relation to the rising market for the fungus.

While it is disputed whether China is (Ong and Zhang 2008; Harvey 2005; Rofel 2007) or is not (Nonini 2008) accurately conceptualized as neoliberal, I agree with Yeh and Gaerrang's (2011) turn to neoliberalization as a way to meaningfully interpret the political, economic, cultural and social transformations of China's 'west' that stem from Deng Xiaoping's economic reforms of the 1980s. Deng's reforms increased the commodification of goods, opened China up to foreign investment and trade (within limits), fostered the development of market-based pricing of goods, devolved governance to townships and villages and distributed communal lands and pastures to households and villages. Collectively these policies and the ongoing development agendas for 'the west' have given rise to the space within which Tibetan caterpillar fungus harvesters engage in the fungal economy as 'self-regulated entrepreneurs,' to use Ong and Zhang's (2008) phrase.

This chapter thus expands understandings of neoliberalizing China as constituted by "situated constellations of social rule, neoliberal logic and self-governing practices that shape…situated variations emerging across the nation" (Ong and Zhang 2008, 3). I do this by examining the everyday practices of caterpillar fungus harvesters to shed light on how "socialism from afar" has engendered the rise of self-enterprising subjects who embrace the "freedom" of the economic opportunities associated with the commodification of caterpillar fungus. While China's political and economic reforms of the 1980s significantly transformed caterpillar fungus to a commodity "through pricing mechanisms that open them up to free-market profiteering" (Heynen et al. 2007, 15), the "expanded and highly contested opportunities for capitalist profit-making in the production of life" (Heynen et al. 2007, 10) are enabled and constrained by caterpillar fungus' social and ecological relations of production.

Contrary to the fallacy of neoliberal capitalism that believes "free markets" can successfully disembed from their social and ecological relations and self-regulate, this chapter examines how the price of caterpillar fungus is influenced by political and social factors, and how its production is enabled and constrained by harvesters' positionality in their households and their values of harvesting. This chapter builds on the idea that -- as discussed in Chapter 2 – the commodification of caterpillar fungus must be negotiated in relation to biophysical processes, which together illustrate how "neoliberalizations of resource and environmental management must be negotiated and concretized in relation to biophysical processes, as well as human uses and understandings of these processes, [which] make for complex outcomes" (Heynen 2007, 13). This chapter thus engages with recent literature that examines the relationships between nature and neoliberalism (Heynen et al. 2007), which calls attention to the ways the social and biophysical dimensions of neoliberalization processes give rise to their uneven and diverse realities.

The emergence of "socialism from afar"

The extent to which Tibetan harvesters are currently engaged in the political economic processes through which caterpillar fungus is commodified is unique in the longstanding history Tibetans have had with the fungus. While Tibetans have used caterpillar fungus as medicine and valued it as a trade good for hundreds of years,[46] their current value of it as the "most important income for farmers" illustrates the extent to which producing caterpillar fungus has now become a central feature of how Tibetans throughout the Tibetan Plateau are finding an economic place in the neoliberalizing geographies of the 'west.'

The earliest known documentation of caterpillar fungus' Tibetan medicinal properties is said to have been written by Nyamnyi Dorje, a Tibetan physician and lama who lived from 1439 to 1475, in a text titled, "An Ocean of Aphrodisiacal Qualities" (Winkler 2008). It is likely, however, that Tibetans probably consumed and used it well before this time. As a valued medicinal product, caterpillar fungus has long been an important trade good and was used to barter and trade for other items. An elderly couple from Adong recounted in 2011 how their parents used to bring rice bags full of caterpillar fungus down from the high grasslands via donkeys, which they traded for rice, barley, or whatever other food they needed from Deqin (the nearby trade town). Historically, caterpillar fungus was likely circulated within and out of Yunnan (and other production areas) along the major trade routes heading eastward or westward, bundled with the other kinds of medicinal plants that were harvested from the alpine and

[46] I refer to caterpillar fungus here as a "trade good" instead of a commodity based on the understanding that the production of something for sale on the market is what makes things commodities. As described here, caterpillar fungus was traded for goods and not money for a long time.

subalpine landscapes, including snow lotus, *beimu*, snow tea (a form of lichen), and others. The Hengduan mountain region, where this research has been based, is known as *Menri*, or "medicine mountains" in Tibetan, which suggests how important the trade of medicinal products like caterpillar fungus has been to the region for a long time (Byg et al. 2010).

The historical medicinal and trade-based values of caterpillar fungus were significantly transformed during the Maoist collective era. One woman's narrative of her three experiences harvesting caterpillar fungus – two of which were during the collective era and one after -- is a useful entrée for understanding how extensively Tibetans caterpillar fungus harvesters' relationships with caterpillar fungus changed during the collective era, which sheds light on the significant ways they were again transformed during the reforms. Drolma, a 66 years old harvester from Adong, explained that she had harvested at the three following times:

> When I was 11 [1956 – the collective era], there was a lot of caterpillar fungus in the mountains, but not many harvesters. The price was very low and I didn't sell it, I only ate it. We [the work group] didn't go up to the camp every day, just once a week and often only the kids went. At that time, there were no rules for the mountains, villages didn't own the mountains or their own fields.
>
> When people started selling caterpillar fungus, when I was 25 years old [1970 – the collective era], we could earn 1 *yuan* for 30 pairs. We took our collected caterpillar fungus to Deqin [the township] where the medicine company bought it. At that time, only four to six people went up to the mountains to collect caterpillar fungus at a time, they sold it to the medicine company and then the money went to the village. Some groups harvested caterpillar fungus, some cut wood, some collected *beimu* [a medicinal plant]…they sold all of the items and collected the money together for the village. Mostly men were sent up to collect caterpillar fungus at that time.
>
> When I was 43 [1988 – reforms underway], one pair of caterpillar fungus was 1.3 *yuan*, and at that time lots of women started going to collect. Families would leave one member at home and all other household members would go up to harvest. The year I went, my husband stayed home and I went up to harvest.

Drolma's first experience collecting caterpillar fungus was as a member of a work group during the collective era. From the late 1950s to the late 1970s, the countryside and all economic activities were controlled by the state and all social and ecological arrangements were ordered to produce surplus, whether agricultural, livestock or other resources. Social organizational units were hierarchically organized around labor: several households were organized into work groups, work groups into teams, teams into brigades, and brigades into communes. As Drolma describes, work group activities were decided by the team leader and were assigned to different activities based on which activity the team leader thought would be most productive at that time. In Yunnan, some work groups were sent out to collect local medicinal products like caterpillar fungus because they were desired by the state-run pharmacies. The team leader's goal in organizing and directing work group activities was to generate revenue for the team (now referred to as natural villages), which was used to support social services in the villages such as schools and health care facilities. Team leaders had the authority to allocate funds at their discretion, which apparently sometimes did individualize caterpillar fungus harvesting profits.

A 53-year old male harvester from Adong recalled that when he was 11 years old (~1970), he was one of 50 or so individuals who had experience harvesting caterpillar fungus, and the team leader sent groups of about eight people up to the higher mountains to collect caterpillar fungus. He recalled being sent up to harvest for about 15 days, and then being sent back to the village to harvest barley. After he finished collecting caterpillar fungus, he sold it to the medicine store and gave all of the revenue to the village leader, who kept half of it for the village and then gave half back to him. For example, he explained, if he found 500 caterpillar fungus individuals, he earned 5 *yuan* (because at that time 100 individuals was worth 1 *yuan*), the village kept 2.5 *yuan* and about 1.7 *yuan* went back to him.[47] One year he earned 80 *yuan* for himself. "I was so happy to get that money," he said with a big smile, because it was very difficult to make money during the collective era.

[47] I did not follow up with questions about why this income did not add up to the full 5 *yuan*, but presumably the team leader kept a portion of the profits for himself.

As a form of labor during the collective era, harvesting caterpillar fungus was a relatively enjoyable activity for those harvesters who were sent up to collect caterpillar fungus. One 57-year old male harvester, who started harvesting when he was 15-16 (late 1960s), explained that during that time all of the groups were working very hard, and there was very little food then. For him, harvesting caterpillar fungus and caring for the cows in the mountains were preferable forms of work compared to the other labor options. These same affinities for the grassland environments and the practice of collecting caterpillar fungus persist for harvesters today, as discussed below.

Reforms and the rise of the caterpillar fungus market

Like the Maoist collective era, Deng's reforms transformed caterpillar fungus harvesters' relationships with one another and their grassland environments in significant ways, and for the first time situated the practice of harvesting in a market economy that attached the personal capacity to find caterpillar fungus with individuated economic gains. This was achieved by what Ong and Zhang (2008, 2) have identified as the "rubric of privatization" that emerged from Deng Xiaoping's reforms during the late 1970s and 1980s, characterized by the "deliberate shift in China's governing strategy to set citizens free to be entrepreneurs of the self…conditions of possibility [that] came about not by dismantling the socialist apparatus but rather by creating a space for people to exercise a multitude of private choices, but always within the political limits set by the socialist state." Most caterpillar fungus harvesters who were either collecting caterpillar fungus prior to the reforms or started because of them recall that they started earning cash income by collecting caterpillar fungus during the late 1970s and 1980s.

Drolma's recollections of the key difference between the time she harvested in 1970 and then again in 1988 signal the ways the central government created the effects it sought with the reforms: the successful commodification of resources like caterpillar fungus, market-based price increases (as opposed to state regulated), and the rise of self-enterprising subjects who had developed the basic "individual capacities to make autonomous decisions, to take initiative and risk, and otherwise to act on his or her own behalf to achieve optimal outcomes" (Ong and Zhang 2008, 3). Collectively these features mark the successful expansion of neoliberalizing policies and processes that sprang from Deng's market-focused reforms. Compared to the price Drolma earned when she collected caterpillar fungus in 1970 (1 *yuan* for 30 pairs), by 1988 she and other harvesters earned more than 1 *yuan per pair*, or *30 times* the value they earned less than 20 years before.

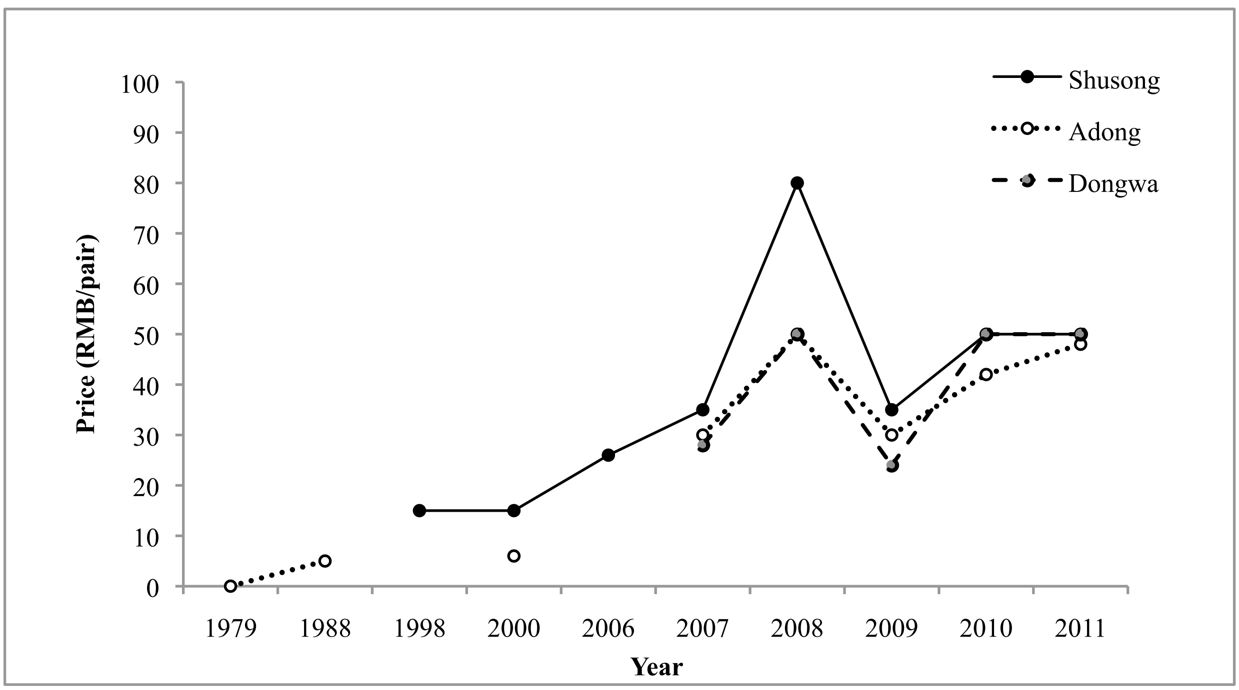

Figure 1: Average price paid to harvesters for each pair of caterpillar fungus

As shown in Figure 1, the price paid to collectors for caterpillar fungus has risen steadily since the 1980s across Adong, Shusong and Dongwa, and increased most markedly from 2000 to

2008.[48] These price increases suggest that the broader opening up of the Chinese economy as a result of the reforms and the commodification of caterpillar fungus have had measurable successes. At first glance and relative to other commodification stories, it might seem that such price increases are likely achieved through the disembedding of the "free market" from social relations, where the market and all social relations to produce, buy, trade, and sell the fungus gain radical importance over the social lives and bonds between producers, traders, buyers and consumers. This process of disembedding is believed by neoclassical economists to mark the successes of a self-regulating "free market." But as Polanyi (1944) observed about the impossibility of a truly "free market," the caterpillar fungus market is in fact deeply embedded in social relations that make its price and exchange a much more complex matter.

The 'great fallacy' of price neutrality

Though the increasing price of caterpillar fungus since the 1980s reflects the successful creation of market-based prices versus the previous state-determined price structures of the collective era, the pricing of caterpillar fungus has not been guided by an 'invisible hand,' but has rather been politically influenced. As shown in Figure 1, the price paid to harvesters for

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[48] In Shusong, collectors claimed that the price for caterpillar fungus began increasing during 1998, when it sold for 15 *yuan*/pair. In 2000, it still sold for 10-15 *yuan*/pair, but by 2006, the price had doubled to 25-28 *yuan*/pair, and trebled in 2007 when was 30-35 *yuan*/pair (best quality were 60-70 *yuan*/pair). 2008 was the peak year, when usual was 70-80 *yuan*/pair and 150-200 *yuan* per pair for the best quality. In 2009, the prices had dropped back down to 30-35 *yuan*/pair for the usual quality, while best was 60 *yuan*/pair. In Adong, one harvester remembered that in 1979, they sold it to the medicine store in Deqin for 40 pairs for 1 *yuan.* In 1988, harvesters were selling it to the medicine store for 4-5 *yuan*/pair, which was a very high price at that time. By 2000, the price had risen slightly to 6-7 yuan/pair. By 2007, the price was changing, 22-23 *yuan*/pair, then 30 *yuan*/pair, then 50 *yuan*/pair during that year; in 2008, price ranged from 30-50 *yuan*/pair. In 2009, it was 28-30 yuan/pair for usual, and 50 yuan/pair for the best quality. In 2010, prices were 42 yuan/pair, and in 2011, 42-48 yuan/pair. In Dongwa in 2007, the price averaged 25-28 *yuan*/pair. In 2008, it was 50 *yuan*/pair and the highest quality was 70-80 *yuan*/pair. In 2009, the price dropped to 20-24 *yuan*/pair. In 2010, the price went back up to 50-56 *yuan*/pair, and up to 120 *yuan* per pair for the best quality. In 2011, it was 50 *yuan*/pair, and occasionally 70-80, and 120-140 *yuan* for the best.

caterpillar fungus increased across Adong, Shusong and Dongwa from 1979 to 2008, and then after 2008 the price dropped back to the 2007 levels.

As shown in Figure 2, these fluctuations of market price paid to collectors were reflected in household incomes, where a similar spike in caterpillar fungus income in the household increased in 2008. In 2009, a buyer in Dongwa explained that the rapid spike in the price paid to harvesters in 2008 related to the Beijing Olympics. Prior to the 2008 caterpillar fungus harvesting season, several medicine stores told caterpillar fungus buyers that they wanted to buy large volumes of caterpillar fungus that year because of the Olympics. Medicine stores were likely basing their purchasing decisions on their knowledge of the Olympic torch tour, which was planned to travel through Yunnan during the month of June, pass through Kunming during the second week of June and make its way to Lhasa, before continuing north on June 21, 2008. With the torch in the region, tourism was expected to rise significantly, which meant that Yunnan-collected resources like caterpillar fungus stood a strong chance at being key commodities for tourists who wanted to buy memorabilia or authentic regional gifts for others. Under other political circumstances, these prospective buying choices would likely have resulted in a spike of tourism-related sales of regional commodities like caterpillar fungus, however due to the tense Tibet-China relations and protests during that time, the influx of tourists never arrived and was in fact prevented by a travel ban for all group and individual travel to the region while the torch was passing through.

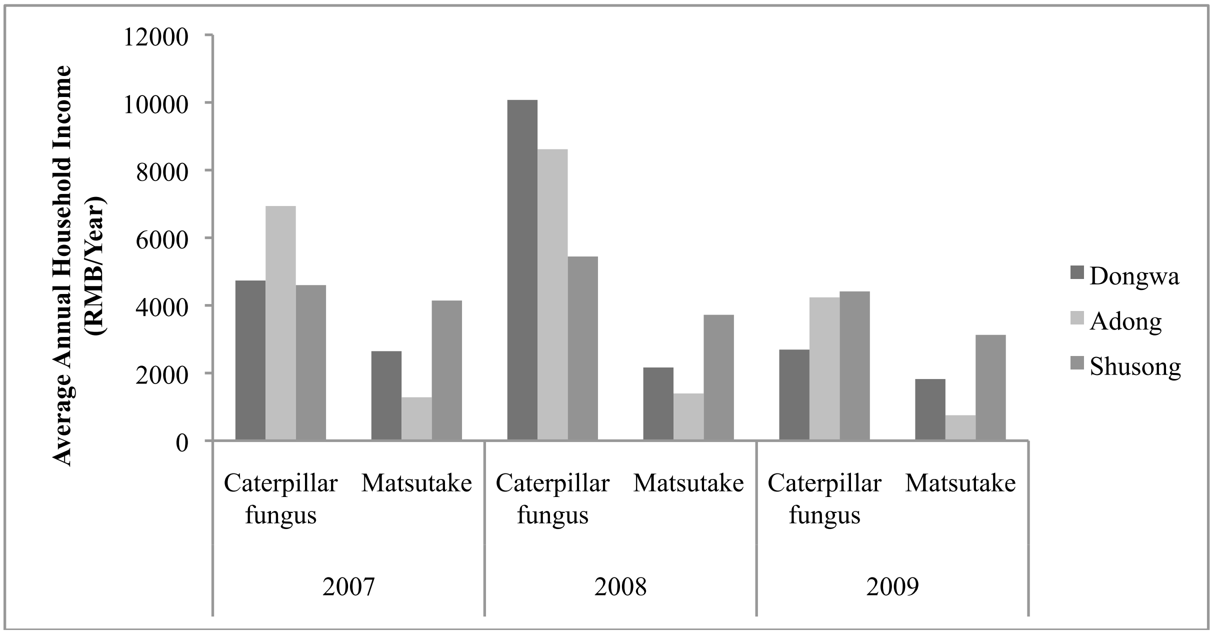

Figure 2: Total annual household cash income for caterpillar fungus and matsutake collections from 2007-2009 interview responses. The 2008 peak in price paid to harvesters for caterpillar fungus is reflected across all harvesting villages.

Not only were international groups banned from entering the region, but so too were Chinese nationals. All formal academic projects, groups, and conferences were canceled that summer, including the International Union of Anthropological and Ethnological Sciences meeting that gathers every five years, which was scheduled to take place in mid-July at Yunnan University. The organizers of the conference said they received notice to postpone the event from their Chinese affiliates, who said they had: "encountered complex difficulties hard to resolve in its preparation work recently, which makes it impossible for us to hold the congress at the time originally planned." Some 6000 participants were expected to attend the conference. The 2008 NSF Integrated Graduate Education Research Training (IGERT) training trip was similarly cancelled, and Dr. Yang Yongping, my research-host from the Kunming Institute of Botany and the formal host of the University of Wisconsin's NSF IGERT informally explained that, "Chinese officials did not want people (groups or individuals) in Yunnan while the Olympic torch was in the area because they were afraid of a repeat of what happened in France."[49] In France, the passing of the torch through the region elicited strong pro-Tibet and human rights demonstrations, which were reacting to the Chinese state lock down after the March 14, 2008 Tibetan uprisings and longstanding Tibetan social justice issues. China's plans to take the torch into the TAR and over Mount Everest exacerbated already tense relations, and international protests continued to occur as China's global Olympic torch toured through major international cities such as Paris and London.

Within these broader price fluctuation trends in Yunnan during 2007-2009, prices paid to caterpillar fungus collectors vary across different areas in Yunnan. For example, Figure 1 shows that Shusong's prices have been consistently higher than Adong and Dongwa's since the rise of the market, which indicates that prices are geographically situated. Shusong village and its harvesting area are located next to a major national highway that connects Shangri-la and Deqin, both of which are major stops on the regional tour of "China's Tibet." Both Chinese national and international tourists frequently travel between the two cities on buses or by car -- particularly during the spring and summer months when the harvesting season is underway – and Shusong's harvesting area is bisected by the highway. The proximity of the harvesting area, and their camps, as explained in the next chapter, mean that harvesters can sell their collected fungi to traders each day who can drive to the collecting area, and to tourists when and if they happen to stop on the road to buy out of curiosity or with intention. If tourists know what caterpillar fungus is, or if they have significant amounts of disposable income and are interested in buying or consuming caterpillar fungus as part of their unique experience in the region, harvesters can earn significantly more by selling their collected fungi directly to tourists. A female harvester

[49] From email communication with Teri Allendorf, the NSF IGERT program manager, who was quoting Dr. Yang's comment on the reason for the cancelation.

explained that in 2010, she was able to get 220-240 *yuan* per pair from tourists, when the usual price being paid by buyers that year was 100 *yuan* per pair. Not all tourists know what they are looking at or want to buy caterpillar fungus, however, which makes them an inconsistent source of income for caterpillar fungus harvesters. In general, harvesters tend to sell to buyers, who use the road and access to travel to the camps in the afternoons to buy and return to their village or cities that same evening.

Contrary to Shusong, Adong and Dongwa's harvesting areas are remote to major roads. The buyers in these areas either hike to harvesting camps – which can be a day's hike from villages in some cases – or if possible ride motorbikes to the camps, and hike further up into the harvesting areas to buy individually from harvesters. Many of the buyers in Adong and Dongwa are *xiao laoban* ("little bosses" in Chinese), or individuals from the same township or natural village who become buyers -- some of whom are both buyers and harvesters -- during the harvesting season and then return to their other village-based activities during the rest of the year. Like harvesters, *xiao laoban* hike up to and around the collecting areas during the day to buy directly from harvesters as they collect, stay for a few days to a week, or until their money is gone, and then they travel to the nearest township or city to sell to other buyers (*da laoban,* or "big bosses" in Chinese), medicine stores, or individual consumers. These sales usually occur in informal streetside markets that crop up during the collecting season in different larger towns, such as Deqin or Shangri-la, where buyers aggregated together to sell fungus from large bags or boxes. The *xiao laoban* and *da laoban* illustrate the diverse kinds of "self-enterprising subjects" that both constitute and are a product of the rise of the caterpillar fungus economy in Yunnan.

Harvesters and household reproduction in the caterpillar fungus economy

Drolma recalled that in 1988, more and more individuals – particularly more women – *chose* to go collect during the harvesting season, leaving as few people as possible in the home to maintain household reproduction. This trend persists today, and here I discuss how harvesters' capacity and willingness to engage in the caterpillar fungus economy Yunnan is controlled by their need to maintain their household production practices. Importantly, the fact that harvesters can maintain their household production practices and engage in the harvesting economy has contributed to the successful commodification of caterpillar fungus.

The scale of the harvesting economy in Yunnan is small relative to harvesting areas in other provinces. In Shusong's harvesting area, the number of harvesters averages 400 individuals; in Adong, less than 100 harvesters in some areas; and in Dongwa, approximately 400-500 in one of the three major collecting areas.[50] By comparison, Qinghai's Dhomkok Township is said to have 10,000 harvesters visiting the area during the collecting season, many of whom are non-local harvesters traveling from other parts of Qinghai, Gansu and Sichuan (Sulek 2011). The number of harvesters in Yunnan has increased in recent decades, but only to the extent that most households are sending as many people up to collect during the harvesting season as possible. As discussed in Chapter 4, villages have developed governance arrangements that constrain 'outsiders' access to their caterpillar fungus collecting areas. The number of harvesters in Yunnan collecting areas fluctuates across years, as is likely the case elsewhere, influenced by such things as alternative labor opportunities or health. In Shusong, for example, many harvesters said that the number of harvesters had dropped by half from 2010 to

[50] I did not calculate or measure the spatial extent of the harvesting "areas" I describe here, but for scale, the different area boundaries often aligned with visual cues from within a particular harvesting areas, for instance ridgelines, which indicates they were not extremely large.

2011 because many harvesters had decided to join construction crews that year on the major road expansion project for National Highway 214, as discussed in Chapter 4.

As Drolma's narrative indicates, the increased price of caterpillar fungus brought about through the reforms incentivized more people to travel up to the harvesting areas to collect caterpillar fungus for income. In some commodification stories, the rapid increase in price for a particular good can cause households to abandon other activities that are important for their household and/or subsistence. For instance, Sulek's (2011) research in Qinghai's Golog Prefecture has shown how the commodification of caterpillar fungus has engendered situations of 'disappearing sheep,' or shifts away from "traditional" sheep rearing, in Golog and other Tibetan pastoral areas since 2000 because caterpillar fungus-derived income has become such a major part of their local economies. Here I explain how the individual capacity and willingness of individuals to become 'self enterprising' caterpillar fungus collectors and thus market-oriented actors is contingent upon their relationship to their household. For Tibetans in Yunnan, their agricultural production practices are central to their subsistence and people do not choose to abandon their household production practices in order to collect caterapillar fungus for cash income. However, the limited and seasonal timing of the caterpillar fungus harvesting season does not interfere with household production practices if households have elders living in the home who can take care of particular tasks while harvesters are away from the village and up in the harvesting camps during the season.

Traditional Tibetan households generally have three and sometimes four generations living within them, ranging from newborns to individuals in their 80s. In general, household members who are in their late teens to late 40s and early 50s are primarily responsible for the majority of activities that are required to maintain household reproduction, e.g. planting and harvesting crops, collecting caterpillar fungus, cutting timber, and going out for wage labor. I use the term ‘elders’ to refer to the group of individuals who are no longer engaged in these major labor-based household activities. Depending on how many people are in a household and what is required for labor, ‘elders’ can be in their 50s or their 80s. The individual profits household members earn through various activities like collecting caterpillar fungus are aggregated in the household and go into a pool of funds that are used to provide for everyone. Household expenses generally include: children’s school fees and materials, clothing, rice and other foods, livestock, household items (rice cookers, *baba* presses, blenders for making yak butter tea, televisions, DVD players), motorcycles, tractors, and healthcare.

As shown in Figure 2, Tibetans in northwest Yunnan are engaged in a range of activities throughout the year that collectively support and maintain household production. Some activities generate income while others reproduce their household subsistence. Here I provide a brief overview of the annual calendar of household activities to illustrate how the timing of the caterpillar fungus harvesting season relates to other activities, and how Tibetan decisions to maintain these other activities constrain their ability to become explicitly market-oriented actors or ‘self-regulating entrepreneurs’ in the caterpillar fungus economy.

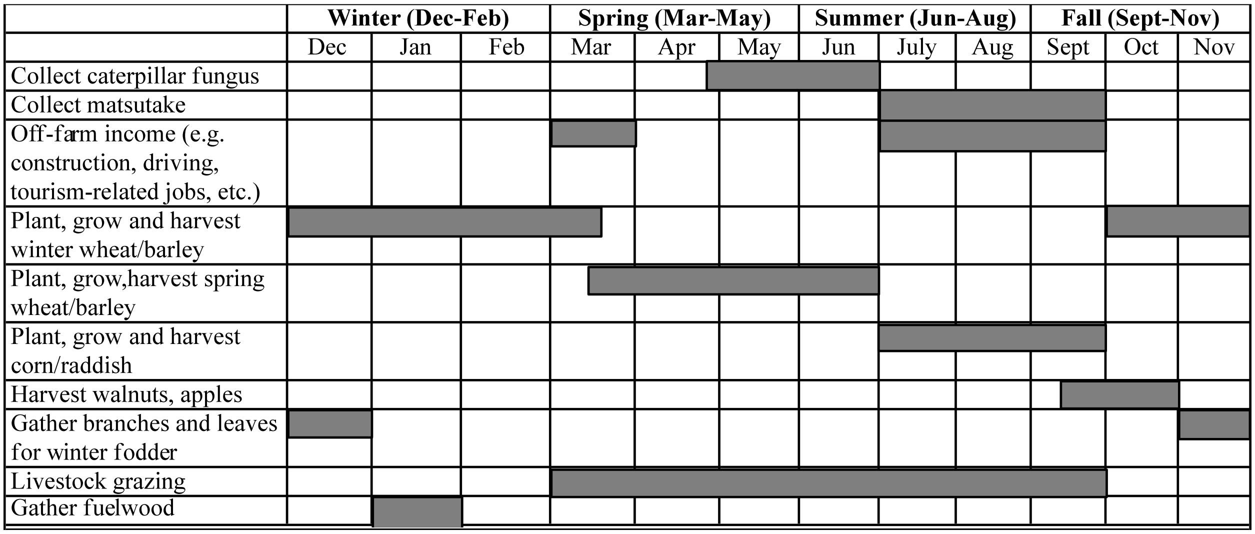

Figure 2: Table showing calendar of average Tibetan household livelihood activities. Notice that the beginning of the caterpillar fungus collecting season overlaps the summer wheat/barley growth period and its end aligns with the end of the growing season for wheat and barley, and thus their harvesting time.

In Yunnan, agriculture is a major anchoring point for Tibetan subsistence and a focal point for household production practices. During the reforms and when the Household Responsibility System was put in place, communal lands were apportioned to the household based on the number of individuals in a household at the time. In Shusong, household plots average 3.5 *mu* (ranging from 1-8.5, n=22), where 1 *mu* is approximately equal to 1/6 of an acre. In Adong, household plots average 3.4 *mu* (ranging from 1.8-5.2 *mu,* n=25), and Dongwa plots average 5.1 *mu* (ranges from 1-10, n=20).[51] Throughout the year, these household farming plots are alternately used to grow barley, wheat, corn or radishes. As in all Tibetan areas, barley is a culturally valued staple grain in northern Yunnan, and most families grow barley in order to produce their own *tsampa* (dry-roasted and ground barley). Some families also grow wheat,

[51] In Dongwa, many interviewees said that they had land in higher pastures in addition to their village plots, which likely explains this higher plot area average. For example, one person said that their family has 4 *mu*, but 9 *mu* including their higher pastures. I interpret these higher pastures to be winter pastures, which were potentially allocated to the household for pastoral purposes during the pastoral reforms of the 1980s (see Chapter 4), which have been transformed into additional farming areas. The Dongwa family I stayed with in 2009 and 2011 lived in a home adjoining their higher pastures in 2011, and both harvested and tended to their potato fields during the 2011 caterpillar fungus harvesting season.

which they mill into flour in order to make *baba* (a flat, round bread). Tibetans plant their winter barley during October, which takes root during the winter, and plant wheat in March or April. At the end of April, families put fertilizer[52] and water on the established barley and wheat seedlings.[53] In some areas, March and April are windows when some members of the family (often males) go out for work to earn more income, often road or building construction, while others take care of the farming. February through April is also an important time for repairing homes or building new ones. In cases where families have higher-elevation fields, as in Dongwa, April and May – the start of the caterpillar fungus season -- is when they go to their higher winter pastures and plant potatoes.

The caterpillar fungus season starts at the end of April and beginning of May and continues until mid to late-June. From a household production viewpoint, the harvesting season takes place at a time when the barley and wheat are maturing and growing, which requires routine watering and weeding. By the end of the caterpillar fungus season, most of the barley has matured and is ready to harvest, which is a major reason why harvesters return to their villages

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52 For fertilizer, families in Yunnan use a mixture of broken down and trampled branches, leaves and manure that are produced during the winter by their household livestock. Families generally collect the branches and leaves from the forests nearby the village, carry them down to the households in bundles, and chop them into pieces with a hand machete. They fill the livestock area with the cut pieces, which are then trampled and defecated on by the animals during the winter, which produces a black, nutrient-rich fertilizer for their fields

53 In Dongwa, two of the villages had created a zip line traveling from their mountains forests to a road that was across the valley from the collecting area. Generally one or two people from the household would get up in the early morning, around 5 am, and hike up to the collecting area, gather branches and tie them into bundles, and mark them with a particular flag or scrap of fabric that was a known identifier among the other villagers as signifying that the bundle belonged to that particular family. With an ingenious design, the branch collectors would tie the large bundles to carved wooden hooks, which they would hook over the zip line and send down across the valley towards the collection area that was well over a mile away. I happened to join the villagers as they were catching these large bundles, soaring down across the valley towards the road. When they landed on our side of the valley, the bundles would crash in with amazing speeds, sending dust clouds up. There was a line of receivers, and the villagers would take turns leaning their back across the bundle, while another couple of villagers looped a stretch of carrying strap underneath the bundle and the group would "chig, ni, sum…" heave the bundle up onto the carriers back and send him/her on her way to deliver the bundle to the proper pile. Each of the families had a pile of branches that were later transported via truck or *tuolaji* (a open-belt tractor) to everyone's respective houses. This activity would persist for several weeks, and elder family members could be in the receiving line and the younger (caterpillar fungus harvesting) household members hiked up to the mountains to cut and bundle the sticks.

(as discussed in Chapter 2). Importantly, the caterpillar fungus fruiting season also ends around the end of June, which means that harvesters' need and desires to harvest their barley and wheat do not seriously conflict with or decrease their caterpillar fungus earnings.

In July, after the caterpillar fungus collecting season and after the wheat and barley have been collected, families plant corn. July is the start of the monsoon season and the heavy rains trigger matstutake growth, and thus its harvesting season, which extends through September. Beginning in the 1980s and particularly during the 1990s, matsutake was one of the most important sources of incomes for Tibetan Yunnan residents (Yeh 2000; Yang et al. 2008; Yang et al. 2009). In recent years, however, matsutake profits have been eclipsed by caterpillar fungus and many harvesters explain that the amount individuals earn by selling matsutake doesn't last the season. In other words the small amounts of cash they earn by selling it each day to buyers is quickly used to buy snacks or other items. During 2007, 2008 and 2009, households in Shusong earned approximately 4143 *yuan,* 3722 *yuan* and 3128 *yuan* per year, respectively, from matsutake collecting; in Adong 1284 *yuan,* 1397 yuan, 752 *yuan* and, respectively; and in Dongwa, 2647 *yuan,* 2165 *yuan* and 1823 *yuan*, respectively. One woman in Shusong explained that because of the declining matsutake price in recent years, many people are starting to deliberate more and more on whether harvesting matsutake is worth their time and effort compared to the potential wages they could earn during the same July to September window. Many families do send people out to do construction during this time. By comparison, from 2007 to 2009, individuals generally earned 50 *yuan* per day working building or road construction.

During September and October, households harvest corn, and if they have them, apples and walnuts. Walnuts, which are collected from household plots and sold to traders for walnut oil, can be a significant source of income for households if they have them. For example, households in Shusong earned 2084 *yuan* and 1654 *yuan* per year in 2008 and 2009, respectively; in Adong they earned 1124 *yuan* and 1716 *yuan*, respectively; and in Dongwa 1161 *yuan* and 1125 *yuan*, respectively. In general, the amount of walnuts families have depends on whether or not they had walnut trees in their apportioned household plots during the reforms.[54] After they harvest the corn, households prepare the fields and plant winter barley. In November, families collect branches and leaves from the mountains, which they chop up and put in their household livestock pens during the winter to be trampled and nitrified during the winter. During December, families gather fuelwood and stack it for the next year's use.

Most Tibetan households in Yunnan own livestock, as shown in Figure 3, but very few own yaks, which have been maintained and culturally valued by pastoral Tibetans throughout the Tibetan Plateau. Rather than yak, households in Yunnan keep small numbers of cattle and/or *dzo* (a cow/yak hybrid), and rarely more than 10 animals at a time. By comparison, Sulek (2011) noted that it is usual for pastoral Tibetan families in Qinghai to maintain yak herds of about 100 individuals at a time, and historically sheep as well. Though families keep cow and *dzo* as livestock, they are kept and maintained for household reproduction as opposed to resources to

[54] Similar to Peluso's (1996) finding that the inheritance of durian fruit trees in Kalimantan was an important source of income as access to market increased, the inheritance of walnut trees in some parts of Yunnan has proven to be a major source of income as their markets (and access) have increase. In a village in Yangla township, walnuts proved to be a major source of income for families who had many trees on their household plots, which related to how land was apportioned to households during the 1980s. When the land was decollectivized and apportioned to homes for household reproduction, some of the apportioned household plots had walnut trees in them and some did not. One woman had several large walnut trees in her plot, which provided her with 10,000 *yuan* in 2008, three times what her family made collecting caterpillar fungus. In Yangla, households had developed unique tenure rules for the walnut trees that made them a common resource to the village in certain ways: those households that had walnut trees within their plots harvested the walnuts when they were ripe by using long sticks or poles to shake the branches and knock the ripe walnuts to the ground where the family can collect them. After the family finishes collecting the walnuts like this and have collected the ones they knocked to the ground, any remaining walnuts that are either left on the ground or continue to fall to the ground are then available to other villagers to collect. A family I stayed with in Yangla during October 2009 sent their young children out to collect fallen walnuts from the village trees – not their own -- after they returned home from school. Children and elders can engage in this relatively low-labor practice and income generating activity, which significantly supplements household income for many of the villagers.

produce and sell. During fall 2009 I asked individuals if they or anyone in their households had sold any livestock during 2008,[55] and the majority revealed that their households did not sell livestock for income. For those that did sell, they sold only one to three cows or *dzo,* and occasionally horses. In Yangla in 2009, approximately 28% of household (7 of the 25 households) said they had sold between one to three cows or *dzo,* where selling a cow or *dzo* can usually earn a family 2000 *yuan*; 20% of households in Dongwa (4 of 20 households) sold one to three cows; in Adong only 16% (4 of 25 housholds) sold either one or two *dzo*; and no households in Shusong sold livestock at all. Three interviewees responded with an emphatic, "*kaka!"* to my question about whether or not they sell livestock, which I interpreted as a vernacular explicative conveying disbelief or shock because they followed it with explanations that they never sell livestock.

A livestock herder in Yangla explained to me that some families pay a herding fee to him or other herders to herd their animals during the summer grazing season, which was similarly observed by Buntaine et al. (2007) in their study on livelihood practices throughout Yunnan. The herder was 56 years old, and was not participating in the caterpillar fungus economy as a collector because he was responsible for watching the animals during that time and was paid to do so. During the 2009 summer grazing season, he took care of 12 milk cows and 12 regular cows, and was paid 200 *yuan* per milk cow and 50 *yuan* for the regular cows, earning him a total of 3000 *yuan* for the summer. After the summer grazing season, which generally lasts from March to November (the duration of which varies by elevation and seasonality), households presumably put their animals on their winter grazing pastures from November to March, if they have them, or stall feed them during the winter, though I did not examine this specifically in my interviews.

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[55] At the time of the interview the annual household activities for 2009 were still ongoing.

	Total #/household	Adong (n=25)	Shusong (n=22)	Dongwa (n=20)	Yangla (n=25)
# *mu/household*		3.4	3.5	5.1	6.5
Cow	0	2	2	0	2
	1 to 5	23	19	4	7
	6 to 10	0	1	13	15
	>10	0	0	3	1
Yak	0	22	20	17	25
	1 to 5	3	1	1	0
	6 to 10	0	1	0	0
	>10	0	0	2	0
Dzo	0	2	2	14	24
	1 to 5	18	16	3	0
	6 to 10	2	4	1	1
	>10	3	0	2	0
Pigs	0	0	0	0	0
	1 to 5	17	11	3	6
	6 to 10	8	11	12	16
	>10	0	0	5	3
Horse	0	3	22	9	1
	1 to 5	22	0	11	24
	6 to 10	0	0	0	0
	>10	0	0	0	0
Donkey	0	12	22	20	23
	1 to 5	13	0	0	2
	6 to 10	0	0	0	0
	>10	0	0	0	0
Mule (*Dri*)	0	7	22	19	25
	1 to 5	18	0	1	0
	6 to 10	0	0	0	0
	>10	0	0	0	0
Sheep	0	25	19	15	8
	1 to 5	0	3	5	8
	6 to 10	0	0	0	8
	>10	0	0	0	1

Figure 3: Total number of livestock per household according to 2009 household interviews.

Harvesting as enabled by elders

With this understanding of how the caterpillar fungus harvesting season fits in the broader scheme of annual household activities and incomes, I now turn to a discussion on how the ability of individuals to engage in the caterpillar fungus economy is enabled and constrained by the demography of the household. The amount of income a household earns collecting caterpillar fungus depends in part on how many people within the household are collecting, and the more individuals a household has harvesting the more earning-potential they have in the caterpillar fungus economy.[56] In 2007, 2008, and 2009, households in Shusong earned 4600 *yuan*, 5446 *yuan*, and 4414 *yuan*, respectively, collecting caterpillar fungus; in Adong, they earned 6938 *yuan,* 8618 *yuan,* and 4238 *yuan*, respectively; and in Dongwa, they earned 4735 *yuan*, 8050 *yuan*, and 2692 *yuan*, respectively. To maximize their profit potential, households send all able-bodied harvesters up to collect during the harvesting season. This leaves only the very young and the very old behind in the villages, creating "empty towns, crowded mountains" as Lama (2007) has described, and a significant reverse-migration from urban to rural spaces (Yeh and Lama 2013). What has not often been emphasized in these accounts of 'empty villages,' however, is the important role elders play in enabling the harvesting economy and harvesters' ability to collect.

In 2011, I asked a couple in their late 60s in Adong about their activities during the caterpillar fungus harvesting season and how they manage them. At the time, they were taking care of the fields and the household livestock, had been doing so for weeks and were expecting the other members of their family to return in the next few days. They explained that yes, it is hard work to take care of the household while the other family members are collecting caterpillar fungus, and that they get tired during the day, but that they are happy to be able to help. While we were visiting, we were seated in the central courtyard of the family home and the couple was drinking cold beer. The woman laughed during our conversation and said how much she enjoys cold beer after working in the hot sun all day. That day, she and her husband had gone together to the household's wheat field to pull weeds. That afternoon, she took care of the planted

[56] As discussed in Chapter 2, many things influence how much an individual collects, so there is not a linear relationship between the number of people collecting and the total amount found in a household.

vegetables they had in another small plot closer to the house, which we saw when we passed by her on our return to the house and we collected mustard greens with her for dinner that night. Each morning and evening, the woman also cared for the family's large pig and her six small suckling piglets, which requires carrying buckets of water and food scraps to the pen. "The work is hard during the caterpillar fungus season," the woman said, "but not even the township government officials rest like us [old people] after the caterpillar fungus season! After the season we don't work at all!" Once the family members return from the harvesting camps, she explained, she and other elders often go to Deqin to walk around and have fun.

In a later conversation with a 68-year old woman in Adong, who was cutting grass in front of her house for fodder when we met her, she explained that yes, it is hard work for her when the family is up harvesting and she herself has to take care of the household. While we talked she took a break from cutting and sat next to us. When asked how she felt about the work during the caterpillar fungus season, she smiled, and said, "people need money." "It is very tiring to take care of the livestock and the fields," she said, "but we have no other choice. Sometimes I get sick and have to take injections, so we need money…so I have to water, take care of the livestock and watch the children."[57]

If families don't have elders in the home, either one individual remains behind in the village to take care of things or the family finds a way to travel to and from the village nightly or every few days from the camps. Sometimes even if there are elders in the home, families still send someone back to the village every five or six days to take care of things. One family I stayed with in Dongwa invested in a motorcycle in order to get around the fact that they didn't have any elders in their home. By motorcycle, and by way of a new road that was built to the

[57] Most antibiotics are administered by IV-injections, so her need of the injections could have been for a range of bacterial illnesses.

base of the winter pastures he and others used during the collecting season,[58] the father of the family could reach the high mountain camp in about 30 minutes, as opposed to the usual two or three hour hike up the mountain.[59] The motorcycle enabled him to commute to and from the harvesting area each morning and night, and take care of his family's animals and fields during the evenings.

This discussion illustrates how an individual's capacity and choice to engage in the caterpillar fungus economy is not just contingent upon 'rational' desires to earn income. It is anchored and constrained by their positionality in the household and the need to maintain household reproduction. In many ways this discussion builds on Chayanov's (1986) classic work on the "peasant mode of production," which emphasizes the important role household demographics have in the successes of their reproductive strategies. Importantly, elders in the home – which are usually not considered part of the caterpillar fungus economy – are a crucial enabling force in the production of caterpillar fungus because they enable household reproduction during the season.

'Freedom' in the grasslands

Thus far I've described how the broader neoliberalizing reforms, household production systems and harvesters' household relations influence the extent to which harvesters participate in the growing caterpillar fungus economy as market actors. But as scholars have variously showed, engaging in a resource economy as a producer or a market actor is not just an economic behavior and rational decision, it is a practice that relates to and is constituted by a web of social

[58] See Chapter 4 for the discussion on winter and summer pastures for Dongwa.

[59] The road was put in to help the natural village access their winter pasture, which they grew potatoes in during the summer, and also helped reach the caterpillar fungus collecting area. It was put in by a township government official who was from the village and in a government post at the time, and he had used many opportunities to improve various aspects of the village's broader infrastructure, e.g. bridges and roads.

relations, cultural norms, and systems of meaning (Yeh and Gaerrang 2011; Ong and Zhang 2008; West 2012). Here I examine what participating in the caterpillar fungus economy as 'entrepreneurs' means in the daily lives of collectors by exploring how harvesting resonates with collectors' affinities for the grasslands, how it enables them to continue using it as medicine if they desire and how it is perceived as a form of 'freedom' relative to other kinds of labor.

Tibetans have had a longstanding relationship with caterpillar fungus as a culturally valued medicine. Since it only grows in the high alpine pastures of the Tibetan Plateau and Himalayas, its history of use signifies that Tibetans have been traveling up to the high alpine grasslands during May and June to collect it for a very long time. Historically and still, the high alpine grasslands are an important grazing area for yak herds in the early summer months, and it is likely through Tibetan herding that caterpillar fungus was discovered and brought into the canon of Tibetan medicine. This means that when Tibetans are harvesting caterpillar fungus, they are engaging in a long-standing practice with cultural and historical significance. This contrasts, for example, with a practice like assembling technological machinery in a factory.

When asked whether or not they enjoy collecting caterpillar fungus, most harvesters say they do. Many of them say they like it because of the money – caterpillar fungus is their most important income source. Several harvesters explained that they like harvesting caterpillar fungus because of their affinity for the grasslands. Some say they enjoy the alpine environments, which are generally much cooler than their villages because they are located at 14,000 feet elevation and have alpine weather and winds. Their villages, located in lower river valleys at approximately 5000-6000 feet elevation, get extremely warm during the summer months. Illustrating his appreciation of the alpine environments, one harvester said, "yes (smiles), I like harvesting caterpillar fungus because the weather is nice and not so hot…even if we have something to do in the village, we don't really want to stay in the village because it is so hot." Another harvester said, "yes, I like to collect caterpillar fungus (smiling) because the weather is nice in the harvesting area, also it's very easy to make money, and soon the area will be filled of flowers."

These affinities for the grassland environments parallel Yeh and Gaerrang's (2011) findings in their recent examination of the social and cultural dimensions of pasture contracting and privatization (of use rights) in Gouli. Contracting in Gouli refers to herders' leasing of use rights of land and livestock to other households, where herders variously pay others to take their livestock onto their land or lease their own land to other herders for grazing needs. This deepening of economic logics among herders could be interpreted as the "successful fulfillment of state aims of turning pastoralists into market actors" and their desires to abandon their lives and identities as herders. But as Yeh and Gaerrang discuss, they embrace contracting[60] not because they want to abandon their lives and identities, but precisely because they want to maintain them (Yeh and Gaerrang 2011, 170). For Gouli herders, the black yak-hair tents and their affinities for the grasslands featured significantly in their identities as Tibetan herders. Similarly, the ways caterpillar fungus collectors express their affinity for the high alpine grasslands suggests that their participation in the fungal economy is about much more than the successful fulfillment of state aims to enroll Tibetans in the commodification of caterpillar fungus, but rather how their participation in the economy produces and maintains their identities as Tibetans who intimately relate to their surrounding mountain geographies. Tibetan sacred relationships to the mountains are manifest in various forms – prayer flags hung on passes,

[60] For clarity, contracting was not a result of state policies, they were created and implemented by the herders themselves.

stacked *mani* stones, and chortons -- and are practiced in their daily lives in the mountains, whether through morning offerings of incense or circumambulations of sacred lakes.

While some harvesters' affinities for the mountains ascribe meaning to the practice of collecting, other harvesters ascribe value to the practice of collecting because it is a kind of 'freedom,' and a preferred and valued way of earning income relative to the alternatives. In Adong, one harvester explained:

> Yes! [I like harvesting caterpillar fungus.] But the problem is I can't find it! (laughter) Harvesting is much easier work, it's not physical labor – we could work with the Chinese on road construction, but then we must start at 8am and time is controlled. But when we harvest caterpillar fungus, we can do whatever we want.

It is impossible to travel through northwestern Yunnan and not be faced with the major development projects that are underway in various dimensions of the social lives of residents in the region. In cities like Shangri-la and Deqin, new hotels, buildings and tourism attractions are continuously being built as the region is refashioned as "China's Tibet." Roads are being widened and paved, and in places like Shusong, road construction has become a major feature in their daily lives in conflicting ways (as described in Chapter 4). The road and building construction jobs are physically demanding because much of the construction is minimally mechanized: it is not uncommon when traveling between villages in Yunnan to pass by several road construction teams who are transporting huge reinforcement boulders via wheelbarrow, or using rubber and wood scoops to move piles of debris and stones to different areas to use as bedrock for road surfacing, and hand-drawn pavers are common. In 2011, major machinery was being used for the expansion of the national highway between Shangri-la and Deqin, though unskilled and strenuous manual labor was still a fundamental component of the project.

Another individual explained that he liked harvesting caterpillar fungus because, "harvesting [caterpillar fungus] is easier work, you don't need to sweat like you do when you're working hard and doing physical labor." Though harvesters are hiking from 14,000 to nearly 17,000 feet elevation each day they harvest, which is considered a major hardship for most people in general, it is not considered "work." Other harvesters similarly explained that harvesting caterpillar fungus is "not much effort," and that "you can sit and look for it" or "you can lie down and look for it."

Other individuals conceptualize collecting caterpillar fungus as "freedom." In one harvester's words: "there are so many people enjoying time together when they are collecting caterpillar fungus, and joking together – if we go to Shangri-la to do construction, it's not free, caterpillar fungus is free." Another harvester explained that when collecting caterpillar fungus, there is "lots of free time to rest, if there is snow, we can rest in the tent," and others similarly explained that when they want to rest, they can rest, when they want to eat, they can eat – harvesting caterpillar fungus is very 'free.'

These cultural conceptualizations of caterpillar fungus collecting as "easier work," "not much effort," and "free" are aligned with what Yeh (2007) observed and analyzed in her examination of the cultural politics of development in Lhasa. In her ethnographic examination of how development is experienced in Lhasa, Yeh noticed the peculiar frequency with which Tibetans in Lhasa were invoking tropes of indolence to describe their work behaviors, stating in various ways how Tibetans were lazy. She recognized however, that the statements about laziness were made in comparison to Han or Han-dominated kinds of work, like vegetable gardening in Lhasa. She contended that Tibetans were not invoking self-criticism in their statements, but rather using them to demarcate ethnic and cultural difference between Tibetans and Hans under the assimilatory forces in Lhasa that remain prevalent throughout the region today. She also illustrated how Tibetan explanations of their present lives as restful and having time to relax marked a valued difference between their contemporary lives and their experiences and lasting memories of the collective era. During the collective era, Tibetans' days were characterized by endless toil, which made the ability to rest when someone wanted to rest a meaningful transformation in their lived existence.

Drawing from Yeh's analysis here, I suggest that these descriptions of caterpillar fungus collecting as "free," "not much work," and "easy work," are bundled into a combined value for what harvesting caterpillar fungus means in the lives of collectors today. One harvester's statement summarizes the dimensions of "freedom" clearly: "if you have to work for other people, there is less freedom." Contrary to the arduous, road and building construction work of China's development interventions in the region in which wages are calculated based on daily labor, and contrary to their memories of labor during the collective era, harvesting caterpillar fungus is a kind of work and a "freedom" they culturally and socially value. In addition to the ways they can rest when they want and harvest when they want, the "freedom" to harvest is also influenced by the deep cultural resonances Tibetans have for the mountains themselves, and the fact that producing caterpillar fungus enables them to be in the high alpine environments. Mountains for most Tibetans are not forms of nature that are "out there," but rather are integrated into their social and cultural lives. Travelling to caterpillar fungus harvesting areas from villages involves passage along trails that have been used by local villagers for hundreds of years, which flow clockwise around stupas (chortens) marking the routes, that people place stones on top of as they pass. In the mornings in the camps, families light incense and pine boughs as offerings, and also alongside sacred lakes throughout the harvesting day. These kind of "freedoms" and ritualized relationships with the mountains and one another are starkly contrasted by the disciplining dimensions of labor under the surveillance of Chinese bosses, where clocks and construction dust constitute a day's work.

Harvesting as 'Freedom' with uneven benefits

The extent to which harvesting caterpillar fungus is "freedom" and a meaningful practice for contemporary Tibetans is fundamentally contingent on their ability to find caterpillar fungus to an extent that makes it financially viable. For example, one harvester explained that he enjoys harvesting caterpillar fungus, and that he can find much more than others usually can -- which makes him feel good – but explains that maybe for people who can't find as much caterpillar fungus it might be more difficult.

As discussed in Chapter 2, collecting caterpillar fungus is a practice and time investment that invariably has inconsistent rewards. Some people find more, some people find less, and the act of harvesting is difficult because the fungus is sparsely distributed and the fruiting body is so small and difficult to see. Thus engaging in the caterpillar fungus as 'self-regulating entrepreneurs' is fundamentally risky, particularly for those harvesters who have to pay a fee to collect in a caterpillar fungus harvesting area. One woman shared a story with me about her cousin who was living and working in Shangri-la. He went to Dongwa to collect caterpillar fungus and because he was not from the township, he had to pay 1000 *yuan* to harvest in the area (see Chapter 4 for details of the governance arrangements). He went to the harvesting area and was not prepared for the cold temperatures during the night, didn't take a lot of the necessary heavy clothing needed for the variable weather, and after three days of collecting had only found a few pieces of caterpillar fungus. He decided to return to Shangri-la and didn't recover all of his financial investments.

For some individuals in Yunnan, the uneven benefits of collecting relative to their time investments are less preferable to wage-labor positions like construction. An older male Shusong harvester explained, "sometimes you can find caterpillar fungus and sometimes you can't, for some it's better to work in construction because you have income all year, it's consistent income." However, when asked if he would harvest or do construction the following year, he said that he would harvest the following year as he had been collecting for 20 years. "People have different ideas," he said, "some like to harvest and some like construction…many people prefer caterpillar fungus collecting to construction because you make money in such a short time, whereas you keep going with construction." His and other explanations illustrate that fundamentally the 'freedom' of collecting caterpillar fungus is contingent upon the ability to find it.

As discussed above, the fallout of the 2008 price decline in caterpillar fungus fell mainly on the shoulders of buyers who decided to take risks and buy based on the prospective market of the Olympic games. Basing their buying decisions on the medicine stores' anticipated sales, buyers offered record high prices to harvesters and bought high quantities during the season. One Adong buyer explained that he didn't check back with the medicine stores during the season after hearing that they wanted high volumes of caterpillar fungus. He kept buying and buying -- paying anywhere from 30-40 *yuan* for one piece of caterpillar fungus – but in the end found that the stores and bigger buyers didn't buy as anticipated. Another buyer said he bought 100,000 *yuan* worth of caterpillar fungus in 2008, and he wasn't able to sell any of it because he would have had to sell at a net loss. In 2009, he was still in possession of his 2008 purchases. He had traveled to the provincial capital, Kunming, in 2009 to see if he could sell at a profit, but couldn't reach 30,000 *yuan* for the preceding summer's stock and decided not to sell. Not all buyers suffered a loss, however: another buyer said that he didn't buy too much caterpillar fungus in 2008, so he didn't have any left over at the time of our conversation in 2009. Some harvesters in Dongwa were aware of the dire straits some of the buyers were in from 2008. When I asked a group of harvesters why the price of caterpillar fungus declined in 2009, several of them explained that the buyers had bought too much in 2008, so they were paying less the next year.

Maintaining use-value through harvesting: Broken caterpillar fungus

The practice of collecting caterpillar fungus as market actors is valued by harvesters in many ways. Usually the commodification of resources like caterpillar fungus precludes the ability of harvesters or longstanding users of the resource to continue consuming or using it because the market value for it becomes too high. Here I describe how as caterpillar fungus collectors are able to keep consuming it as medicine due to the production of 'broken' caterpillar fungus during the collecting process. This means that the practice of collecting caterpillar fungus is imbued with meanings and use values that further illustrate how the market has not become disembedded from social relations.

Many Yunnan Tibetan elders recall their parents consuming caterpillar fungus as medicine and continue to use it themselves today, which suggests that the cultural value of consuming caterpillar fungus as a medicine is at least in part passed along through the family. Of 64 households interviewed in Yunnan in 2009, 31 said one or more persons in their house consume caterpillar fungus throughout the year. Most caterpillar fungus users were elders who used it one to two times each year for general wellness, and both elders and non-elders use it to treat stomach, leg, knee, joint and eye maladies. One man in his 40's said that he once had a serious stomach illness, and he tried taking pharmacy drugs but they didn't work, so he decided to take caterpillar fungus and he improved. A 66-year old woman from Adong similarly described a case in which her daughter became ill and her stomach grew very big, and after eating caterpillar fungus her stomach grew smaller again and she convalesced; the woman vouched that it was a "very good medicine." Blindness and visual impairment are significant public health problems in rural Tibetan areas, and cataracts are the major cause of blindness among elder populations (Dunzhu et al. 2003). Many harvesters – both elders and non-elders – claim to take caterpillar fungus to help with eye problems, which likely includes cataracts and other acute eye problems. The most common way Tibetans (usually elders) consume caterpillar fungus is by putting one to four individuals in a small jar of *arak* (barley alcohol), which they drink each evening for a few days to weeks. Some Tibetans said that they fry it with butter, or grind it into a powder and eat it like *tsampa* and drink it with their tea.

These contemporary narratives and its medicinal history suggest that even though the caterpillar fungus economy has burgeoned in recent decades, and harvesters are producing caterpillar fungus to sell it for income based on the exchange value determined by the market, it maintains use-value among many harvesters because it is still consumed by them or members of their families and households. According to Marx (1906, 42), "the utility of a thing makes it a use-value…this property of a commodity is independent of the amount of labor required to appropriate its useful qualities…use-values become a reality only by use or consumption." For Tibetan harvesters, caterpillar fungus is an important medicine, thus it gains its use value through consumption. However, Marx also notes that the use-value of a commodity makes it "the material [depository] of exchange value" (ibid.), meaning that while caterpillar fungus can have use-value, it simultaneously has exchange value because they can sell it for income – an income that is highly important to their household economies. Keeping harvested caterpillar fungus for use is simultaneously denying an opportunity to earn income, which is a difficult trade-off. In most cases, harvesters would likely rather exchange and sell their collected caterpillar fungus individuals for income, which would likely over time erode their use of it as medicine. Based on interviews, however, households continue to use caterpillar fungus because they have started to consume and use 'broken' and 'soft' caterpillar fungus, which are economically sidelined in the caterpillar fungus market.

Late-season or 'soft' caterpillar fungus individuals were explained in Chapter 2. 'Broken' pieces are produced during the practice of harvesting when a harvester accidentally breaks off the fruiting body of the caterpillar from the larval body. Generally, when people are collecting caterpillar fungus, they use a hoe-like tool or a stick to pry up the earth around the fruiting body to enable them to gently remove the subterranean larval body from the soil without breaking it away from its above-ground fruiting body. Often harvesters perforate the ground surrounding the fruiting body – perhaps 6 inches away from the 'grass' blade – so when they bury the stick or hoe in the ground, the earth pops up as a wedge of sod and soil. After the wedge is freed, they carefully sort through the soil and roots to locate the larval body and carefully remove the joined caterpillar-fungus complex from the soil. In some unfortunate cases, harvesters break or separate the joined complex while digging or pulling it out of the soil if they haven't made the soil wedge large enough around the larva or if they hurriedly pulled the fruiting body out of the soil without properly freeing it.

Economically, once the fruiting body is broken from the larval body, its value diminishes exponentially and the price drops from 50-100 *yuan* to a fraction of 1 *yuan.* Knowing this, harvesters sometimes try to bind 'broken' pieces back together with a small stick or other material so it passes a buyer's inspection when they're selling it.[61] In other cases, harvesters choose to keep the broken pieces, which is now the major way Tibetans are able to continue to consume caterpillar fungus in the currently fungal economy. Biochemically, broken caterpillar fungus pieces are no different than intact pieces, and the decline in market value likely stems entirely from the fact that caterpillar fungus quality is visually graded in its joined form.

Important here is the fact that contrary to many cases where the commoditization of resources precludes the ability for producers to consume the commodity, caterpillar fungus collectors are uniquely able to continue to consume it because they have access to 'broken' caterpillar fungus individuals. The use value of caterpillar fungus is thus maintained through the collection of the fungus, indicating that the caterpillar fungus is only partially marketized in the contemporary Yunnan production economy.

Camps and Harvesting: The ongoing production of social relations

Thus far I've discussed how the market is embedded in social relations, cultural values and systems of meaning about what harvesting is as well as what the fungus is. People continue to produce caterpillar fungus both for its use value and as a major source of income. Here I discuss how through the production of caterpillar fungus, new social relations continue to be created and that the multiple forms of entrepreneurialism have emerged in the caterpillar fungus economy.

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61 There have been many rumors that harvesters insert lead into the caterpillar fungus to make it heavier and thus more profitable. In Yunnan, harvesters never sell their harvest by weight – only by the pair (*dui*) or individually. If lead is indeed being found in the caterpillar fungus individuals, it is likely happening at some point further down the commodity chain, between buyers, when weight matters. Harvesters will sometimes bind broken collections back together with sticks – if they have metal wire that could also be used, but it would not be deliberately to make them heavier – only to pass the buyer's eye.

Caterpillar fungus harvesting camps are not just places where people sleep and eat, but rather they are significant sites for the production of social relations. They are constellations of huts and tents that families and groups of families stay in during the harvesting season. Since harvesters are at the camps and living in the huts for six to eight weeks at a time, they are outfitted with a central woodburning stove, blankets and bedding, and various things to cook and eat with such as large tin bowls for kneading dough, large soup stock pots, bowls, chopsticks, tea bowls, salt, chilies, tsampa, a tea kettle, a yak butter tea urn, and various spices. In general there are two different kinds housing structures people live in while collecting: the permanent herding huts, which are usually constructed of stone and wood and wood shingled roof, and tents, which are constructed from blue tarps or plastic sheets and wood poles. Sometimes the huts have stones stacked up around the foundation, but sometimes people use branches and boughs to secure the edges of the A-frame tent to the ground. Like the more permanent huts, the plastic tents also have central wood stoves, which makes the plastic roof around the central stove pipe leading out the tent yellow and blacken over time and over the course of the collecting season.

Families live in the huts or the tents depending on whether they are from the village that governs the particular harvesting area. In Dongwa, harvesters who are not from the village stay in tents lower down in the valley and farther away from the major trail leading up to the collecting areas. Beyond the family tents, Dongwa has a series of other larger blue-tarp tents that are centrally located in the camp which variously house three pool halls, a teahouse, a barbeque shack, and a movie theater with a snack shack. It is as if the village center is transplanted to the high alpine meadows for the duration of the harvesting season. The pool halls housed full-size tables that were not disassembled when they were carried up, but were instead carried up intact by four men. The movie theater consists of a mid-sized box television connected to a generator, which is centrally positioned at the front the tent in front of 15 low, wooden split-log benches. The snack shack is located next to the television, and artfully displays the various offerings, including sodas, milk, peppered and pickled tofu strips, chicken feet, eggs, sausages, and candies.

I went to the movies one night with my field assistant and the two teenagers of the family I was staying with at the time. The benches were filled with people and several people had brought blankets with them. A Taiwanese soap opera was being shown that night which was apparently a very popular show because my field assistant had been following it in Shangri-la. All eyes of all ages were glued to the television. Some people loitered in the entry way of the tarp, watching as if they were drawn in on their way somewhere, and several people visited. At one point, the daughter of the family, Tsomo, hopped up from beside me and went and bought a bag of sunflower seeds. When she came back, a friend of hers stretched her blanket over all of our four laps and Tsomo opened the bag of sunflower seeds, poured some into all neighboring hands. After the movie ended at about 11pm, we walked back up towards our hut via flashlight.

In addition to the secondary businesses that are in Dongwa's main camp, some have also emerged in the harvesting areas. On a mountain pass at the juncture of the three different harvesting areas used by Dongwa township, a restaurant sits perched at 16,000 feet elevation. The restaurant consists of a main pole across the center of a dug pit, with poles running perpendicular to the main center beam and resting on the ground. While they were once likely attached, reams of clear plastic were wrapped and tucked around the base of various poles, flapping in the persistent and cold wind. The roof was open to the sky. Inside the restaurant, two were seated in the front of the pit preparing various things for the six harvesters visiting at the time. We joined the group and each had hot instant noodle bowls. Other offerings generally include *mantou* (steamed wheat flour buns) that the two men prepare on the fire. Piles of empty noodle bowls were piled along the sidewalls of the restaurant.

The day after our first visit to the restaurant, while crossing over the ridge next to the restaurant, a young man came walking towards us on the faint dirt trail that ran along the rims of the ridges. He was wearing a maroon long sleeved polo shirt with black stripes and khakis, and his head was closely shaved. He had a sense of ease and leisure in his stride, as if he were walking across a park instead of ridges. He was walking casually behind a donkey that was heavily laden with several rice bags that were distorted into various boxed and angular shapes. He had just come up from the township, he said, and was resupplying the ridge top restaurant. After he walked along, Loshi told me that he had once been a monk but wasn't one any longer.

The next day, while we were collecting caterpillar fungus, a man hiked down to us from the ridge above. He was carrying a large bag on his back, which he swung off and laid down on the ground next to him as he reached us. He opened the bag to show us its contents: Cokes, pickled eggs, peppered jerky, wrapped century eggs, peppered tofu strips, and various candies. The uncle of the family I was staying with bought three sodas, a couple of packets of peppered jerky and several packs of peppered tofu from him. It was nearing lunchtime, so we all took a break and the uncle asked the man if wanted to join us. He sat for a while, and then repositioned his bag as he stood and then moved on to the next cluster of harvesters. We pulled out the *mantou* we had carried with us from the camp and combined them with the peppered items for lunch.

The existence of pool halls, movie theaters, teahouses, ridgetop restaurants, and traveling vendors illustrate how the caterpillar fungus economy and life in the camps is not just anchored on human-fungus interactions, economic desires to maximize personal utility, and sites of competition, but rather they are dynamic sites for the production of social relations. Market actors in the caterpillar fungus economy extend beyond the harvesters themselves, and encompass a broad suite of people and activities that contribute to how and why collecting caterpillar fungus aligns with social and cultural values, which contributes to the expansion of the market itself.

Conclusion

This chapter has examined dimensions of neoliberalising China by focusing on how "socialism from afar" has created a space within which Tibetans engage in the caterpillar fungus economy as market actors. I have shown how the commodification of caterpillar fungus is enabled and constrained by Tibetan social relations and systems of meaning for the fungus and the practice of collecting, which points to the ways the caterpillar fungus market is deeply embedded in social relations within the household and with other harvesters, I have also examined how Tibetans' longstanding relationship with the fungus and their cultural and social values influence how and why they choose the "freedoms" of harvesting over other kinds of labor options that are available to them..

Important to this discussion and expanded on more in the next chapter, is the recognition that the 'freedom' to collect caterpillar fungus is coproduced by social, cultural, political, and historical factors. The 'freedoms' associated with caterpillar fungus production are, as Ong and Zhang (2008, 12) highlight, ever only an "individual freedom of expression…authorized only in relation to the commodifiable and the marketable" in contemporary China. The 'freedom' of harvesting is thus only available to those who have access to caterpillar fungus, but it is a kind of freedom that has dual and contradictory meanings. Harvesting caterpillar fungus is both an entrepreneurial subjectivity, and at the same time, is situated in dimensions of cultural identity and is fundamentally a rejection of the capitalist forms of labor constituting the neoliberalization project throughout the region. These simultaneous meanings of 'freedom' are important for our broader understandings of neoliberalism, and neoliberalizing China, specifically, because they concretely illustrate how and why neoliberalizing processes are heterogeneous and uneven. At the same time, they illustrate how identities are brought into being and enacted in time and place through the processes of neoliberalization. These latter insights engage with feminist and poststructural scholars who examine identity and subjectivities as, "constituted through…disciplining institutional practices that are dynamic, constantly changing, yet time and place specific" (Sundberg 2004, 46), and who have, for example, analyzed how conservation-in-the-making is constitutive of identities-in-the-making (Sundberg 2004). In the case of caterpillar fungus production in neoliberalizing Yunnan, neoliberalization-in-the-making and identities-in-the-making are mutually constitutive.

CHAPTER 4

CONSTRUCTING AND DECONSTRUCTING THE COMMONS: CATERPILLAR FUNGUS GOVERNANCE IN DEVELOPING YUNNAN

Introduction

Building on the preceding discussions of how the social and ecological relations of production influence who and what places are included and 'disarticulated' in the caterpillar fungus market as producers, this chapter draws attention to the fundamental ways access to and control over caterpillar fungus collecting areas matters significantly in how and why it is produced in the ways it is. I examine access in a way that aligns with Ribot and Peluso's (2008) recent articulation of it, where property rights are part of access and the "bundles of power" – as opposed to "bundles of rights" – that influence who gets to benefit from caterpillar fungus, how and when. Here I explain how access to caterpillar fungus is influenced by a "range of powers…embodied in and exercised through various mechanisms, processes and social relations that affect people's ability to benefit from resources" (Ribot and Peluso 2003, 154).

The following discussion of the governance arrangements in Dongwa, Adong and Shusong,[62] point to ways social relations, multi-scalar interactions between villages and conservation organizations, the formation of boundary objects like 'rest days' and multi-level governance collectively and variously enable and constrain control over caterpillar fungus. As discussed in the Introduction, the current tenure arrangements for caterpillar fungus collecting areas in Yunnan took root in China's pastoral reforms of the 1980s. Contrary to assumptions that caterpillar fungus collecting areas are "open access," in reality they are collectively-owned

[62] Portions of this dissertation chapter appear in Stewart (2014).

and collectively governed. By illustrating how local communities govern their shared caterpillar fungus commons, this chapter contributes to the growing scholarship on the commons and common property.

Dongwa: "Villagers own the mountains"

> Villagers own the mountains, they decide how much they will benefit from them and they come up with their own rules.
>
> *Dongwa Township government official, June 2011*

> The rules were created [by the administrative village] to show people that the mountains belong to them, and all resources on the mountains are theirs. And if others are going to use their resources, they need to benefit from them. The villages made the rules, not the township government. The mountains are village owned, so village managed.
>
> *Elderly male caterpillar fungus harvester from Dongwa, June 2011*

Dongwa Township consists of five administrative villages, each of which has approximately 12 natural villages within its administrative village territory. Based on the current distribution of caterpillar fungus collecting areas in Dongwa, it seems that when summer and winter pastures were distributed in Dongwa Township during the reforms, summer pastures were apportioned to the five administrative villages to be used for grazing. After the caterpillar fungus economy began to rapidly grow during the later 1990s, an intervillage meeting was requested by the natural villages to create rules of equal access to the township's caterpillar fungus collecting areas. In particular, only three of the five administrative villages were productive caterpillar fungus collecting areas, which points to the ways 'nature's agency' and the nonhuman variegate the production of caterpillar fungus in significant ways, as discussed in Chapter 2. However, governance arrangements and the rules people produce can be an important way people 'work around' the disarticulations of the nonhuman to facilitate social equity – where the nonhuman doesn't determine *who* is disarticulated, only *where.* Recognizing the uneven distribution of caterpillar fungus, the villagers in Dongwa township wanted to create governance arrangements that enabled all of them to have an equal opportunity to participate in the emergent and increasingly lucrative fungal economy. Over time, a system was created to enable all Dongwa harvesters the opportunity to collect caterpillar fungus, but through fees that varied according to harvesters' village-of-origin, depending on whether someone was from the administrative village that owned the harvesting area, outside of the administrative village but from Dongwa township, or outside the township. In 2009, residents from the administrative village that owned the harvesting area did not pay a fee to collect caterpillar fungus, and fees ranged from ¥100-300 for Dongwa township residents and ¥700-1000 for non-Dongwa township residents. People who marry out of their village could return to their home-village collecting areas to harvest (without a fee, for example, if they are from the village that owns a given harvesting area) but their spouses and children had to pay the fee associated with their own village-of-origin.

The amount of the fee is continuously negotiated and is determined by the village that controls access to a particular harvesting area. One natural village leader said in 2009 that there were discussions to have the Dongwa resident fee be ¥400, but that they decided on ¥300 because they didn't want the fee to be too high – and thus difficult to pay -- for township residents. In 2011, the Dongwa resident fee had been raised to ¥400-500 and was ¥1000 for non-Dongwa residents. The fees are generally decided at meetings usually held in the harvesting camps at the onset of the season. One female harvester said the 2011 meeting for her village was quite lively when they were determining fees for non-Dongwa residents; some argued that the price should be higher while others thought it should be lower.

Some of the contention around the non-Dongwa fee is attributed to the perspective that non-Dongwa harvesters don't have the same sense of respect and care for their shared resources. During a group interview in one of Dongwa's harvesting areas in 2011, one harvester said that when the non-Dongwa harvesters (*waidiren*) collect caterpillar fungus, they destroy the land and discard garbage, so it is fitting that they have to pay a high fee. His explanation illustrates not only the fact that Dongwa village-ownership claims of their caterpillar fungus harvesting areas are strong because they can exclude or include other users based on their own terms, but also how access to resources -- the *who* does (and who does not) get to use *what*, in *what ways*, and *when* – are influenced by a "range of powers…embodied in and exercised through various mechanisms, processes and social relations that affect people's ability to benefit from resources" (Ribot and Peluso 2003, 154).

According to a village leader in 2009, the collected harvesting fees are distributed across the households of the village that owns a given harvesting areas. The harvesting fee was generally collected one-third of the way through the caterpillar fungus season to give harvesters the opportunity to earn income by collecting so they could pay the fee without financial strain. As in other areas, harvesters generally sell their collected caterpillar fungus individuals to buyers throughout the day or sometimes at the end of the day at a particular location. In Dongwa, buyers usually travelled to harvesting camps by foot or by motorcycle, and from the camp they hike up to the collecting areas to buy from harvesters individually, and often there is a group of buyers who wait for harvesters near to the confluence of several trails leading out of the camp and up to different harvesting areas. If harvesters hadn't already sold to buyers up in the harvesting areas, they can sell to the buyers on their way back to the camp in the evenings.

As discussed in Chapter 3, the fees system creates a certain degree of risk for harvesters, because even if they aren't able to successfully find caterpillar fungus, they still have to pay the harvesting fee. According to the administrative village leader in 2009, when fees are due, he and other village leaders gather at the location used by buyers, at the confluence of trails, and collect payments as people head up to the harvesting areas, and record harvesters' names in a ledger. Harvesters and the village leaders monitor and enforce payments collectively (as similarly observed for livestock resources in Banks et al. 2003), however there are not rigid sanctions and methods for punishing those who do not pay. The village leader explained in 2009 that some people occasionally run away on the designated payday, but that it is very hard to run away without consequences because it is "hard to come back the next year." When asked how he knew who ran and who didn't, he explained that they know each other, that the rule is not so strict, and that they don't follow or pursue those who don't pay in order to obtain their fees.

Here we see the significant ways the caterpillar fungus market is deeply embedded in social relations (Polanyi 1944), and further, how social relations continue to be produced through the governance and production of caterpillar fungus. Not only do harvesters in Dongwa "know each other," but their actions relative to governance arrangements influence how their social relationships to one another continue to evolve. For instance, if a couple decided to leave the harvesting area on the payment day, their action would go against the grain of the social norms that are continually being produced through governance practices, which would sever some social relations while producing others. Reciprocally, those who are involved in setting the harvesting fees for collectors are equally enmeshed in social relations that influence their decisions and actions, based on the understanding that they contribute to the ongoing formation of new social relations through the formation of the caterpillar fungus economy. Though villages "own" their harvesting areas and want to lay claim to their lucrative caterpillar fungus populations, their relationships to other villagers and desires to minimize economic burdens likely factor into their "lively" discussions, as mentioned above. These deliberations about the burdens of prices differ from situations reported in Tibetan communities elsewhere, such as in Gouli, Qinghai, as previously mentioned, and also other caterpillar fungus collecting areas in Qinghai.

As Sulek (2011) has described, in some caterpillar fungus collecting areas in Qinghai, pastoralists who have use-rights to caterpillar fungus collecting areas also collect fees from non-local harvesters that want to collect in them. Contrary to Yunnan, the contracts and fees are determined by groups or individuals (whoever has use-rights of the land) as opposed to just villages,[63] and in some cases the fees have become astronomical. One harvesting area, Wirkung, which is known to have excellent quality and high abundances of caterpillar fungus, is controlled by four households that have capped the number of harvesters they allow in their areas at 80, charging 10,000 *yuan* per individual. This amounts to 800,000 *yuan* to share between four households. In another valley, which allowed up to 300 harvesters, the fee was 5,000-6,000 *yuan.* The highest fee was in an area called Gangri, which had at one point gone up to 20,000 *yuan* per person. According to legal regulations, harvesters traveling to these collecting areas are supposed to only be from Golok Prefecture, and various roadside checkpoints have been put in place to capture 'illegal' harvesters, but harvesters continue to come in to the area from other placed in Qinghai, as well as from Gansu and Sichuan. Like Yeh and Gaerrang (2011) observed in relation to the land and livestock contracting in Gouli, Qinghai, the high price transactions and

[63] In Qinghai individuals and small-groups have use-rights to pastures because they are probably winter pastures, which were variously apportioned to households, small groups and villages during the reforms. Because the winter pastures in Qinghai are higher than in Yunnan, they are also caterpillar fungus collecting areas in addition to the summer pastures.

exploitation of price differences suggest a deepening of calculative logics among caterpillar fungus harvesters and land contractors in Golok, and overall a disembedding of the market from social relations (Yeh and Gaerrang 2011, 169).

The fact that fees are emerging in Dongwa as governance strategies and ways to demarcate membership – and thus access – to caterpillar fungus commons suggests that calculative logics are beginning to permeate some dimensions of how harvesters relate to one another and their grassland landscapes. This is illustrated by the fact that villagers are now assessing resources and lands monetarily that previously had no price. In some ways the fees system suggests that access to capital – as discussed by Ribot and Peluso (2003) -- is a potentially important factor of who can access the benefits of the caterpillar commons, but in other ways, it doesn't matter at all, as illustrated by the ways "exceptions" to fees-based rules are socially constructed.

After a conversation with Dongwa's administrative village leader in 2009, which took place in his family's harvesting hut one early morning in camp, I was walking around the lower part of the harvesting camp with my field assistant and the uncle of the family I was staying with, Aka. We were walking around the secondary businesses in the camp, nearby one of the pool halls and the movie theater (as described in Chapter 3), and we passed by a young couple who were walking towards the lower part of the camp towards the group of temporary, plastic-topped tents. Aka smiled at them as if he knew them when they passed. I asked him if he knew them from his village, and he replied, no, they were from a different administrative village, but one that was within Dongwa township. Having just learned about the various permitting fees from the administrative village leader, I asked him if they had paid 300 *yuan* that season to harvest there. "No, they don't pay," he said. Thinking I had perhaps misunderstood the rules before, I asked why. "We know they can't pay so they don't," he explained quietly.

This kind of flexibility in the fees-based system of governing caterpillar fungus are contrasted by the inflexibilities found elsewhere, where social relations have become relatively subordinated to the economy. To draw from Sulek's (2011, n.p.) observations in Qinghai again, she found that many pastoralists who had set the fees for harvesters to collect in their pastures were unwilling to compromise their fees, and some said: "If they can't pay, they can't dig. If they have no cash, there is no way." These kinds of statements were accompanied by others that explained how sought after the digging "positions" were and how many other people are in line to pay the fees in the place of those who can't afford them. Here, access to capital is a major mechanism by which people gain access to resource benefits (Ribot and Peluso 2003), which contrasts the ways caterpillar fungus access in Dongwa is negotiated. Aka's explanation of the young couple as an exception to the fees system suggests that governance arrangements are produced and practiced in Dongwa with attention to the ways the commodification produces uneven material effects.

Resource governance arrangements for caterpillar fungus – as well as many other commoditized resources -- are fundamentally about controlling access to production, or an individual's capacity to make a living through production. This discussion has shown how governance arrangements in Dongwa have worked around the uneven distribution of caterpillar fungus to facilitate more access and more equal benefits across particular groups of people. Governance arrangements can also exclude people based on their membership to different places and ideas of how 'outsiders' fail to value a lucrative resource that is owned by the village. In Dongwa we see that the social processes by which people produce governance arrangements take into account the ways the broader contexts of neoliberalizing Yunnan are producing uneven benefits.

Adong: 'Rest days' as multiscalar boundary objects

Adong is an administrative village in Shenpin Township in Deqin County, with 16 natural villages total. Like Dongwa, Adong's caterpillar fungus collecting areas are village-owned and village-managed, but here each natural village that harvests caterpillar fungus has its own caterpillar fungus harvesting area.

When the caterpillar fungus economy began growing during the late 1980s, while villagers were still selling caterpillar fungus to the (likely state-owned) Deqin-based medicine company at very low prices, villages didn't have any formalized caterpillar fungus harvesting rules for their collecting areas other than the pasture allocations from the reforms. During the later 1990s, when the price started to increase significantly, according to the village leader and several villagers, the village created rules of exclusion that only allowed Adong harvesters in their harvesting areas. When asked, harvesters explained that these rules were not formed because there was a major influx of 'outsiders,' or non-Adong harvesters (*waidiren*), to their collecting areas. Even at the time of this research their harvesting areas were still evidently only used by very small numbers of people (50-60), and only by harvesters from their village.

This suggests that the emergent commodification of caterpillar fungus at the time and harvesters' increased ability to commercially benefit from it instigated the creation of their rules governing access, which is something Peluso and Ribot (2003) discuss (also see Yeh 2000). Peluso and Ribot called attention to how the rise in resource values – whether through commodification or when national or international merchants or state agents begin extracting resources – affects property rights and can engender local claims to resources when before there were none.   They illustrate a similar case in West Kalimantan where candlenut trees were rarely claimed and used by local villagers, but when Javanese and Madurese migrant laborers --who valued candlenut as an ingredient in their cuisine -- came into the area, villagers began to restrict access to their candlenut trees in their swidden fallows, suggesting that "they created property rights in a new resource because of their emergent commodity status" (Peluso and Ribot 2003, 166). Unlike the case of candlenut, there were not significant influxes of 'outsiders' and harvesters had use value and more minimal exchange value of caterpillar fungus at the time, but the expanding market made them able to benefit more from it, and thus valued it more as a resource to claim.

Though natural villages in Adong each have their own harvesting areas that they use, which were apportioned to them during the reforms, villagers from any of the natural villages within Adong can collect in other natural village areas without paying a fee. In general, however, villagers tend to harvest in their own collecting areas and base their harvesting out of the same camp each year because families continue to maintain their huts each year. In Adong, all of the huts were made of stacked stones and wood, and families continue to repair and build new ones if needed. This contrasts the case in Dongwa, where some of the huts were permanent and made from wood/stone, which were also maintained each year, as well as some that were plastic-topped tents and thus more temporary (these were used by harvesters who were not from the same natural village that owned the collecting area). If villagers choose to collect in other harvesting areas or stay in another village's camps, they are able to but they are not supposed to bring their horses or cattle with them to graze while they stay and/or collect. If they bring horses with them to help transport items to the camp, for example, the horses can only remain in the area for one evening and then they have to take them back to their village the next day. Similar to

Dongwa, Adong's rules of access were formed around harvesters' village-of-origin, and if villagers marry outside of the village (for example to someone from Shangri-la) they themselves can return to harvest each season, but their spouses and children can not come back to harvest with them.

In 2011, one of the village leaders said that there were discussions among the village leaders earlier in the spring to initiate weekend 'rest days' for caterpillar fungus harvesters that year, that is, a system through which people would collect for five days and then take two days of 'rest' when no one would go out to collect. When asked about why the 'rest days' were being discussed as a new governance rule, he explained that it was because it was beneficial for both the harvesters and for the fungus, based on the fact that people could use the 'rest days' to take care of their houses while the fungus grew.

To see if 'rest days' were an emergent governance strategy in Adong in 2011, I asked several harvesters about whether they had taken any rest days that year. Collectively their responses illustrated that villagers had a different conceptualization of 'rest days' that did not align with how the village leaders were discussing and articulating them. According to one female harvester, 'rest days' had started in Adong five or six years before, which indicates that they were not a new rule for 2011. When asked why people take 'rest days,' she explained: "when people find the amount is getting low, they take a rest day and they think [caterpillar fungus] will get better…if the weather is good, they will only take one rest day, and if it is rainy, they will take several rest days." The first part of her response suggests that the 'rest days' are practiced because they are resource-focused, and that they are determined when people find that the amount is *getting low.* Here the logic doesn't fit with caterpillar fungus, per se, because the fungus matures and grows over the course of weeks, and a single rest day wouldn't have immediate effects on the amount harvesters find. Moreover, as discussed in Chapter 2, the sparse and uneven distribution of caterpillar fungus mean that its amount is always low. The second part of her explanation suggests that their decision to take ‘rest days’ is influenced by weather, where inclement weather prevents them from collecting. It is true that people will often return to their camps if it starts to rain heavily, sleet or if there’s snow. Another woman’s explanation suggested that weather was not a determinant of ‘rest days,’ and she explained, “people think if we take a rest day, we will find more [caterpillar fungus] after the rest day…[we] take rest days if it’s rainy, or when it’s very cold in the camp, and also when it’s sunny.” In other words, they take rest days in all weather conditions, suggesting that their rest days are not just weather-dependent.

When asked how she knows when to take a ‘rest day,’ one woman explained that villagers just discuss amongst themselves and decide when to take a rest day. At the time of the interview, June 13, she had just returned to her house in the village because the wheat was ready to harvest. Her mother was still living in the home and took care of the livestock while she and other family members harvested, though she had come back to the village several times during the collecting season to take care of things. I asked her about the village leader’s comment about the new 2011 caterpillar fungus “weekend rest days,” and whether harvesters were using them that year. She became flustered by my question about the weekend ‘rest days,’ as if I had offended her personally. “Caterpillar fungus harvesters don’t always talk and listen to the village leader about rest days,” she said, “if you want to go [collect], you go, if you find [caterpillar fungus], you find it. If villagers decide to rest, they rest, and the [caterpillar fungus] gets bigger.”

In as few words, she had shown how the standardized and formulaic notion of a weekend rest day was reductionist relative to the complex decision-making processes that factor into how, when and why people engage in the economy as they do. In her case, and as discussed in Chapter 3, her responsibility to take care of various household needs and her mother influenced her decisions to leave the camps, which by the village leader's definition, are 'rest days' from harvesting. These kinds of 'rest days' aren't actually work-free, however, just different kinds of 'work' that are a signficant part of Tibetan's lives in the current economy, but not ones that are formally recognized according to economic logics. Important here is that for caterpillar fungus harvesters, these 'rest days' are not determined by calendar days and 'weekends'; they are negotiated and determined by harvesters based on their own assessments of what needs to happen when. The standardized and calendar/clock-based mode of governance and the related ideas of 'rest days' do not align with harvesters' relationships to their homes, one another and to the fungus.

What is important here is the fact that in *function*, the village leaders' and villagers' perceptions of the effects of 'rest days' do not contradict one another. Both village leaders and villagers recognize that rest days have a positive effect on fungal growth,[64] and the 'rest days' do enable harvesters to attend to different household activities. What does differ considerably between the two ideas of 'rest days' is how they are *operationalized*: according to the village leader, 'rest days' are standardized and align with weekday working hours, whereas for harvesters, 'rest days' are negotiated and unpredictably placed in framework of calendar time. A question here is why these different actors were both talking about 'rest days' as 'things,' but with different definitions of what they were and when they were taken. Where did the idea of

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[64] To clarify, rest days would enable the caterpillar fungus to grow and would thus have a 'positive effect,' but the effect is largely negligible for reasons explained earlier.

‘rest days’ emerge from? Interestingly, the idea of ‘rest days’ in Yunnan is not unique to caterpillar fungus, but rather was a concept that was produced in relation to conservation efforts to create sustainable management guidelines for matsutake (*Tricholoma matsutake)* mushrooms, which is another highly commodified fungus from the region.

As briefly described in Chapter 3, matsutake mushrooms are produced in northwest Yunnan from July to September each year. During the 1990s, matsutake was the major source of cash income for villagers throughout northwest Yunnan due to its value as a fresh mushroom in Japanese cuisine (Yeh 2000; Yang et al. 2008; Arora 2008; Faier 2011). The matsutake commodity chain is characterized by an intense time/space compression, where the time from when a mushroom is dug in northwestern Yunnan to the time it arrives in Japanese markets for consumers is only 48-hours. As the Japanese market expanded and its value grew, its governance became a major focus for nongovernmental conservation organizations like The Nature Conservancy and the World Wildlife Fund who recognized it as a promising sustainable resource management project in the broader arena of conservation in the region.

In their study of matsutake governance in Yunnan, Yang et al. (2009) describe how ‘rest days’ were produced as conservation interventions in the area, which was based in a broader agenda to foster better livelihoods through sustainable resource use. Yang et al.’s (2009) description follows:

> With help from The Nature Conservancy (TNC), A’dong set up a rest-day system in which the village was not allowed to harvest on 1 d each week, with inspectors checking households for mushrooms harvested on the rest day. In the beginning, this regulation was welcomed by villagers because it gave them a chance to do farming and look after their livestock. It was not continued, however, because villagers found that neighboring communities were illegally harvesting on the rest day, and this was difficult to monitor and control. In addition, in order to prohibit the harvesting of baby mushrooms, inspectors also monitored sales at the local market. When the rule was violated, a fine was levied.

Here we see that through the 'help' of TNC, a rest day system was attempted to be put in place according to a standardized set of practices. They were regularly scheduled to make it easier to remember and monitor. In practice, everyone takes a break from harvesting on the predefined rest day. If someone collects while others are 'resting,' it means that one person benefits unevenly by capitalizing on and 'free riding' on other people's investments in governance, which is not desirable, so they have developed a system of monitoring and sanctions to control against free riders. 'Free riders' are a fundamental weakness for collective governance and are thus a major focus in efforts to theorize ways to avoid 'tragic' outcomes.

In practice, the tidy concept of rest days didn't work for a variety of reasons. Harvesters found that "neighboring communities" were free riding on the rest days, which means that the standardized rules were not uniformly accepted and valued by all collectors. As described above for caterpillar fungus, and as seen above, 'rest days' or decisions to invest time and effort in other activities than harvesting fungi are something that are negotiated based on an array of things, which would invariably make them bump up against the imposition of a standardized framework. For instance, after a rainy period, matsutake's rapid growth would be a major factor in people's decision-making to harvest. I suggest that the lack of abidance by the rigid programmatic design of the rest days was a larger reason why the governance strategy was discontinued.

As in Dongwa, people in Adong know each other. According to an assistant village leader of Adong in 2011, Adong began implementing 'rest day' governance arrangements for matsutake in 2006, where each week, villagers harvested for five days and then took two days of rest "to protect the mountains and matsutake." These 'rest days' originated, he said, when the village leaders discussed the idea, then they discussed it with the villagers, and then it became a rule. His explanation reveals the similar designs of 'rest days' for matsutake and caterpillar fungus, but also the fact that the idea came from village leaders, who then discussed the idea with villagers. Though the village leader didn't ascribe the origins of 'rest days' to the village's relationship with TNC, Yang et al.'s (2009) description suggests that TNC was instrumental in the development of the 'rest day' governance strategy for Adong.

The involvement of conservation organizations like TNC in village level governance arrangements, it turns out, are not unique to Adong village, but are rather part of the broader turn to community-based resource management in the conservation community during the 1990s. According to a World Wildlife Fund (WWF)-China activities summary (Montanye 2005), WWF China began working with the *Baimaxueshan* Nature Reserve, in which Adong and Shusong's caterpillar fungus collecting areas are located – in 1996 to initiate field research and an awareness campaign to save the highly endangered Yunnan Snub-nosed Monkey, and simultaneously established efforts to "improve living standards among targeted poor households in Deqin County…reduce degradation of forest and wildlife habitats in Baimaxueshan reserve and promote sustainable co-management of forest resources at local, county, provincial and national levels…and reduce social tension and promote cooperation between reserve authorities and the local population." As part of its focus on co-management and livelihoods, and following the logging ban of 1998, WWF initiated an Integrated Conservation and Development Project (ICDP) with villagers "to discuss ways to sustainably manage Matsutake and to teach villagers effective management methods for the sustainable use of Matsutake."

In a description of its "achievements to date" in China, WWF notes that the ICDP project in Baimaxueshan helped "local communities develop and improve local regulations," where five villages were reportedly conducting forest monitoring patrols, and that other villages were learning from the ICDP project and "improving their local regulations on resource management." As of 2005, when the summary was written, there were said to be thirty villages in "the movement for the sustainable management of Matsutake," which suggests that there was a network of conservation interventions throughout the area, which includes Adong. Drawing together the various ideas of sustainable matsutake management as articulated by the WWF summary, Yang et al. (2009) and the village leader's articulation of governance, we begin to see how the standardizing dimensions of monitors and 'rest days' can gain traction not only as tidy concepts but also tidy governance metrics to list as achievements for intervention reports, something Michael Goldman has discussed as a feature of many World Bank intervention reports (Goldman 2006).

Looking at the regional construction and implementation of 'rest days' begins to illustrate how the politics of multi-scalar governance take root, where ideas and concepts are produced elsewhere and then transported "in" to various localities as forms of sustainable governance. But here I have also suggested that the idea and practice of 'rest days' isn't alien to the ways people engage with caterpillar fungus and matsutake markets as individuals who have a broad set of responsibilities and needs.[65] What this means is that the concept and idea of 'rest days' is fluid enough to move across boundaries and bring together multiple actors –conservation practitioners, village leaders and caterpillar fungus/matsutake harvesters – to arrive at a place of agreement that the concept matters, even though different actors imbue the concept with different meanings because they define it within different frameworks of what makes it relevant. As Goldman (2009) has shown with corridors, here I suggest that 'rest days' are functional 'boundary objects'

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[65] According to Arora (2008), two villages were known to have begun implementing matsutake 'rest days' in 1994, which was before TNC and WWF became more actively involved in livelihood and resource governance interventions in the area, during the later 1990s (Montanye 2005).

in governance negotiations (Star and Griesemer 1989). As Star and Griesemer (1989, 393) articulated the concept:

> Boundary objects are objects which are both plastic enough to adapt to local needs and constraints of the several parties employing them, yet robust enough to maintain a common identity across sites. They have different meanings in different social worlds but their structure is common enough to more than one world to make them recognizable, a means of translation.

What counts as a 'rest day,' what its function is, is "plastic" enough *in meaning* to bring villagers, village leaders and conservation organizations to the table and recognize that it is a valuable governance tactic both ecologically and socially. From a resource-focused perspective, 'rest days' are beneficial for matsutake growth because they enable the mushroom to grow larger before the cap opens (more valuable), allow it to grow vertically and through the duff layer (making it easier for harvesters to find and minimizes digging down in the duff layer) and facilitate spore dispersal on already productive areas if the mushrooms have already begun to open. Socially, if everyone in a village takes a 'rest day' together, no one's decision to invest their time and effort in other activities – which is something that has to be done by harvesters anyways – is a personal burden because the fungus would not be collected by other during that time.

This discussion shows how in practice, the idea of 'rest days' for caterpillar fungus as they are conceptualized 'from above' will invariably bump up against the ways 'rest days' can and can't be incorporated into the daily lives of harvesters. Contrary to the ways the village leader articulated 'rest days' 'from above' -- as giving harvesters a chance to take care of their households – villagers themselves viewed 'rest days' as something they take when needed, with an awareness that taking 'rest days' from harvesting comes with certain tradeoffs and benefits.

As indicated by the discontinued use of 'rest days' in matsutake governance arrangements, I anticipate a similar dissolving of the rules will occur in caterpillar fungus governance if 'rest days' are imposed in standardized, formulaic ways. Without examining why and how villagers reject 'rest days,' it is easy to define villagers as 'irrational' or 'backwards.' On closer examination of how the practice of harvesting matters in the social lives of harvesters, however, it becomes evident that 'rest days' from harvesting are part and parcel of the way they engage in the economy, but based within different rationales and put into practice in flexible, opportunistic ways.

Shusong: Transitions in home, land and caterpillar fungus governance

Contrary to Dongwa and Adong and their strong village control over caterpillar fungus resources, Shusong currently exhibits weakened control over its collecting areas. Shusong is an administrative village within Benzilan Township, which includes within its administrative territory 13 natural villages, referred to here collectively as Shusong. When I first visited Shusong in 2007 and 2009, its caterpillar fungus governance arrangements were some of the clearest and most detailed of my case study locations. When I returned in 2011, however, most of the earlier rules of membership and exclusion had eroded. While governance arrangements and rules are not rigid and fixed (Peluso 1992; Fortmann 1995), the political economic context, histories and multi-scalar interactions -- between Shusong villagers, *Baimaxueshan* Nature Reserve and the Chinese state -- coproduce local claims of authority to place and their shared resources. Shusong harvesters must not only negotiate intervillage interests through their governance arrangements, as is the case as well in Dongwa, but also the interests and highly uneven power structures associated with *Baimaxueshan* Nature Reserve and Chinese development infrastructure.

Shusong's caterpillar fungus harvesting areas lie entirely within *Baimaxueshan* Nature Reserve, which co-manages all resources within the reserve boundaries according to different zones of use (Weckerle et al. 2010). The reserve was established in 1983 to protect the Yunnan snub-nosed monkey and it has had conflicted relationships with local residents since its formation because of its authority to regulate social activities within reserve boundaries. As mentioned above, major conservation organizations like the World Wildlife Fund (WWF)-China and The Nature Conservancy (TNC)-China and conservation scientists have had longstanding relationships with the reserve, which has introduced an additional set of power relations and control over the resources in the reserve. In 2009, reserve managers granted research permission to conservation scientists to collect caterpillar fungus samples from an area that was within Shusong village's harvesting areas, but rather than negotiating access to caterpillar fungus with Shusong village, the scientists hired a non-Shusong harvester to collect the samples and did not offer any compensation. This encounter not only excluded Shusong residents from caterpillar fungus conservation negotiations and decisions, but placed the burden of conservation science on the village by drawing from their shared fungal resources without compensation.

Like Adong, Shusong administrative village had developed clear rules of exclusion for all non-Shusong harvesters, where Shusong villagers from any of the natural villages had equal access to their collecting areas but no one from the township outside of Shusong had access. Also like Adong, Shusong's matstutake governance arrangements significantly influenced its caterpillar fungus governance arrangements, illustrated by Shusong's unique use of a formalized system of monitors, who were paid to prevent outsiders from coming in to their harvesting areas.

According to the village leader, the monitoring system for caterpillar fungus began in 2006, which was a year when 50-60 non-Shusong harvesters came to the area to collect. In 2007, there were 24 monitors in place, and the village leader said that a few harvesters from the township had come to Shusong's collecting area that year, but that the monitors had greatly limited the number of outsiders. The monitors were not allowed to collect caterpillar fungus while they watched for outsiders, and Shusong villagers paid approximately ¥20 each to pay for their services (also noted in Weckerle et al. 2010). According to Shusong's assistant village leader, Shusong villagers initiated the rules of exclusion for outsiders because they thought that outsiders didn't care for the environment in the way locals did. Non-Shusong harvesters were claimed to dig big holes when they were collecting caterpillar fungus, whereas Shusong harvesters always covered the holes over.

Shusong's harvesting areas are located within Baimaxueshan Nature Reserve and are bisected by G214, the major national highway connecting Shangri-la and Deqin. Co-managed by the reserve, Shusong harvesting camps had a unique set of formalized rules, which included: harvesters' tents had to be alongside the road, or G214; harvesters were not allowed to cut down trees around their camps for either constructing their tents or for fuel wood; garbage was not to be left lying around the camps; and there were not to be any fires in the forests. According to Baimaxueshan staff in Deqin, the harvesting camp rules were created to make sure harvesters are not harming the environment around their camps and reserve staff travel to the harvesting camps several times each year to monitor whether or not they are abiding by them.

The rules governing access to caterpillar fungus and Shusong's harvesting camps had persisted from their implementation prior to 2007 through 2009, but by 2011, the rules of exclusion for non-Shusong harvesters and the use of monitors had dissolved. Making sense of these erasures requires a fuller explanation of the environmental and social transitions that were taking root in the daily lives of harvesters during that time as a result of tourism-based state development interventions in the area. In 2010, the expansion project for G214 was set in motion, and by 2011 when I returned to Shusong, its material effects in Shusong village and its harvesting areas were indisputable. There were piles of construction rubble and debris along and on the road stretching from Shangrila to Deqin; dirt slides of up to 3000 feet running downslope from the freshly scored mountains; and dust and noise filling the air as excavators, levelers and grinders worked around the clock. Dynamite explosions could often be heard in the background during most of my 2011 interviews in the harvesting camps.

The material transformations associated with G214 were immediately evident in Shusong, but the effects of its construction on the social lives of villagers and harvesters were gradually unveiled through conversations. For example, in previous years, Dongwa and Shusong harvesters generally described a slight increase over time in the number of harvesters as more households sent more household members up to harvest when possible. I asked a female harvester in the camp about her perspectives on the number of harvesters in 2011, expecting her to reply that there were about 300-400 people harvesting that year, given the figures I had for 2007 and 2009. To my surprise, her response was quite different.

> Last year there were 400 people in this area, but this year there are 100-150 people. This is because the road is being built and affects the houses and fields it has to pass through. If the road passes through a particular family's house or farming plot, the government compensates the family so they can rebuild. Those families whose houses were along the road are busy rebuilding this year so they didn't come up to harvest.

She then launched into an unprompted narrative about G214 that explained some of the many ways the expansion project and state development visions for the area have significantly transformed Shusong villagers' relationships and senses of ownership of their lands and resources.

> When the road started being built in Shusong there were many arguments. The government did not pay Shusong villagers for the trees and saplings that the road was cutting through. Saplings are important for villagers because they can give good wood, they can sell it or make furniture. They are very good resources, but the government does not care about them or compensate villagers for them. We are much smaller than them [the state (*guojia)*] and can't do anything to them. They are just destroying the trees and rocks, but not doing anything for the villagers. Take for instance, the big trees on Shusong villagers' land – the government compensates villagers with ¥2000-3000 if the road passes through them, but this compensation is only given once, when in fact these trees are good money over time.[66]

Her narrative illustrates a politics of scale at work in these landscapes, where the state's vision and imaginary for the region conflicts with local claims and meanings of a landscape. In this case, different values for the land and resources collide and Shusong villagers are forced to settle the incongruities on monetary terms, which begs the question whether both parties agree to their commensurability as 'goods.' In general, villagers are compensated ¥100,000 if the road passes through their house and ¥30,000 per *mu* if the road passes through their land. While the compensation for houses is supposed to enable villagers to rebuild their houses, the land compensation is not intended to allow villagers to clear forests and rebuild their fields again; instead, villagers are given ¥600 per year to buy vegetables and grain. According to one villager, these stipends are problematic because if they are given to household elders who later pass away,[67] the stipends do not transfer to the household or new members therein, but rather disappear. This compensation arrangement thus removes not only villagers' land and capacity to

[66] A handful of individuals from some of these households said in 2009 and 2011 that their households did in fact receive a sum of money related to these fees. They did not, however, have an explicit memory of the total amount, curious given the proclaimed contestation over the actual fee amounts.
[67] In my own research I did not ascertain whether these stipends are given in perpetuity (for the lifetime of the person being given the money) or just for a certain number of years, as is more the norm in state compensation packages.

produce vegetables and grains for subsistence needs, but also the option to securely procure these grains and vegetables monetarily. Losing the capacity to either produce or procure subsistence subjects these displaced villagers to further social and economic marginalization in the rapidly expanding cash-based economy of the region. Paradoxically, socio-economic marginalization is most pronounced among those whose losses enable development in the region to take form.

Villagers have not in the past practiced the act of assessing the value of their homes and land in order to agree to a settled amount of exchange. An older woman from Shusong village claimed that there are two different kinds of people in relation to the road compensation fees: those who have the road cross their home and say "why me? I have money, I would rather be working in the field", and those who say "why not me - why don't I get the money from the road crossing?" Whether Shusong villagers are compensated or not - and whether the road passes through their houses and land or not -- no one that is affected is really satisfied with the development compensation settlements because the transactions have been unsolicited by residents and in most cases result in a permanent transition in the life they have known. In some cases, the compensation is simply inadequate: one Shusong villager who had an injured leg was compensated ¥100,000 for the road's passage through his traditional three-story home. For him, the money was not adequate to rebuild a new house because he would have to hire help with the construction.[68] The man is vocal about his situation, saying that he is homeless, and has nowhere to go.

Further complicating the local frictions resulting from the compensation process is the fact that the fees and negotiation processes are not uniform. Some families have been able to

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[68] It remains unclear to me how the process of rebuilding homes works in these compensation plans. Recipients would have to secure use rights to another plot of land in order to rebuild a home, which is made difficult by the fact that the state is presumably not allowing resettled villagers to clear any forests for new land.

successfully negotiate higher payments, whereas others have not. According to one Shusong resident:

> Other families were getting lots of money from the government through compensation because they know how to bargain. Some had received almost ¥1,000,000 for their house, while others don't know how to bargain and didn't get enough. When the government developers were taking notes and bargaining with villagers for their houses, they would say to some, 'your house is worth ¥100,000' and the villagers would trust the government officials and accept this amount. Later, however, these people would ask their neighbors about their compensations and learn that they had earned ¥900,000.

Whether or not villagers know how to bargain is not the sticking point in these transactions - bargaining for goods and services is a common social practice in this region and settling on accepted exchange values between bargaining parties is a deeply socialized process. The difference in bargaining for compensation fees for one's home or land between villagers and a state official is whether the terms of engagement are well defined and whether local villagers have the power to bargain with the state at all. For some, state interests and power preclude local negotiations in the first place: some villagers reportedly tried to refuse letting the road go through their house, and were told that they could either take the money or refuse it but that the road would still go through their house. Reflecting on this, one woman explained that if the road belonged to the village, villagers could reject the road's expansion if its effects or costs weren't agreeable, but there is nothing the villagers can do about G214 because it is for the state. In other words, local and state bargaining power is hardly symmetrical given the power differential. These kinds of asymmetries illustrate the use of power in the relationships between local political struggles and state initiatives on development in determining control over resources (Agrawal 1999).

Just as G214 has transformed Shusong villagers' valuation and ownership claims of their homes and land in the villages, the development of the road has reconfigured their caterpillar fungus governance arrangements in diverse ways. Prior rules of exclusion have been disbanded for several overlapping reasons. For one, the ‘outsiders’ Shusong villagers were governing have changed in both composition and number. One elder Shusong villager, whose children were collecting caterpillar fungus for the household, said that harvesters could not chase the outsiders out anymore, and that in 2010, the village had a meeting about stopping the outsiders, but in 2011, outsiders were no longer banned. Other harvesters mentioned that the village leaders didn’t meet with Shusong villagers at all in 2011 to talk about caterpillar fungus rules, which suggests a shift in Shusong village attentions towards other matters. When asked who the outsiders were, the elder woman explained that they were the people who were building the road -- they worked on the road during the day and collected caterpillar fungus at night. While harvesting caterpillar fungus at night would be nearly impossible given the difficulties in finding it during the day, her narrative illustrated the ways expansion of G214 invaded the social lives of Shusong resident in multiple ways.

As previously described, most state-led development projects across Tibetan regions benefit migrant laborers who are brought in to various localities to perform services that require certain skills (Yeh 2013; Hillman 2008; Fischer 2005). While some Shusong villagers have joined construction teams as unskilled laborers (earning ¥50 to ¥120 per day), migrant laborers have been brought in to work on the road in contracted sections and currently perform the majority of G214 construction labor. When migrant laborers travel to different localities for work, they strain local systems of customary rights because they utilize local resources (e.g. water and fuelwood) for basic needs without necessarily knowing or abiding by the rules of use for these resources. Resource use for basic needs is perhaps locally acceptable if there is a general shared idea of equal access to subsistence needs, but collecting caterpillar fungus – a highly valued local resource – draws attention to the ways asymmetrical power relations likely factor into the current acceptance of migrant laborers' fungus collecting.

According to Shusong's previous definition of 'outsider,' migrant laborers of G214 should be characterized and excluded like all other 'outsiders,' such as villagers from neighboring Benzilan township. However, in practice, this is not the case and road laborers are not excluded because they have very different sets of social relations with Shusong harvesters. As laborers for G214, road workers are perceived as by local residents as appendages of the state, where the same uneven power relations that characterize G214 resource and land negotiations with Shusong villagers also characterize access and control over caterpillar fungus resources. Local contestations with road workers over access to caterpillar fungus go beyond interpersonal and intervillage politics and become contestations with the state because road workers' claims to the area are legitimized through their connection to the state interventions taking form in these landscapes. While all non-Shusong villagers might be regarded as interlopers in Shusong's harvesting areas, some 'outsiders' are more legitimized and less excludable than others. This observation expands our thinking on environmental governance by illustrating one of several ways local control over resources is not solely determined by the design or implementation of governance institutions themselves, but rather is enabled and constrained through social relations and political economic context.

In addition to the ways power asymmetries contribute to the loosening of rules of exclusion, the rapid influx of migrant laborers to the area overwhelms Shusong's earlier governance arrangements in practical ways. Previously monitors patrolled the area for unamiliar faces, which might have uncovered a handful of caterpillar fungus collectors that would then be asked to leave. The same monitoring system would now locate hundreds and thousands of unfamiliar faces, and collecting caterpillar fungus is no longer the only shared pursuit bringing these masses to the region.

The disbanding of exclusion rules is also likely attributable to a less definable and multifaceted transformation in the ways Shusong residents value caterpillar fungus and the labors of its collection. Though not all villagers participate in the construction of G214, the unskilled labor opportunities are desirable to some, because it increases their income earning potential beyond harvesting caterpillar fungus for eight to ten hours per day. One male harvester explained that some villagers who were not finding as much caterpillar fungus had decided to leave the camp early to go back for construction labor. The more stable income of construction, in comparison to caterpillar fungus collecting, is appealing for some.

Though Shusong villagers' reception of compensation fees is uneven and conflicting, the injection of state funds and compensation into the region recalibrates ideas of value in palpable ways. In one harvester's words:

> People are saying that if the road crosses your house, you get good money: ¥100,000. In your whole life, you will never find ¥100,000 in one day, so it is very good money.

While caterpillar fungus collecting has to date provided households with relatively high sums of money, the profits and the labor associated with collecting are now compared to exorbitant one-time state compensations, which as suggested above, reconstitutes ideas of labor value and personal assessments of what one's labor, time and effort should be worth. Most harvesters today claim to find less caterpillar fungus than they did in prior years. Combined with the overall amount of the fungus available, the ability of a harvester to find caterpillar fungus is contingent upon practice, patience, focus, and a personal sense that the trade-off of the time and effort spent searching is worth it. Narratives of decline can be interpreted in a number of ways:

the sense that people are finding less caterpillar fungus can indicate a decline of the overall amount of the fungus (whether due to harvesting, climatic factors, or broader ecological factors like moth population declines); a decline in *per capita* collection since the number of harvesters is increasing each year; a decline in or a decline in the personal value harvesters assign to collecting as a practice. Here in Shusong, I think it is a combination of the decline in the personal value harvesters assign to caterpillar fungus collecting as a way to earn money given the broader economic transformations of the region and the injections of unprecedented sums of cash into the lives of various villagers. The extent to which harvesters think that their time and effort investments in collecting caterpillar fungus is worthwhile is intimately related to the market price and the financial gains associated with collecting it. Harvesting caterpillar fungus requires hours if not days of searching, and if harvesters feel that these hours could otherwise be spent in more meaningful (or profitable) ways, they are more likely to perceive caterpillar fungus abundances as acutely limited.

For example, during a conversation I had with a group of harvesters in Shusong's camp in 2011, the most vocal of the harvesters, drinking from a bottle of hard alcohol that was being passed around, had been digging caterpillar fungus for 20 years and commented that quantities are decreasing each year. Before, he said, he could find 200 pairs[69] of caterpillar fungus per day because there were not many harvesters, but now he can only find one pair per day. "In the past, you could earn lots of *yuan* in one day collecting caterpillar fungus -- in 2008, you could earn ¥1000 per day and only ¥300-400 per day this year." In 2008, collecting caterpillar fungus was the major source of income for Shusong households, and 2009 household interviews revealed

[69] When harvesters sell caterpillar fungus individuals to buyers, they sell them in pairs, e.g. ¥50 per pair (*dui*). This perhaps relates to the common idea among harvesters that there is a male and a female caterpillar fungus, and when a harvester finds one, the "mate" is generally nearby. When caterpillar fungus is bought and sold between buyers and later to consumers, it is valued by its gram weight value and the 'pair' metric is no longer used.

that 50-80% of their annual cash income was derived from collecting. These incomes are now assessed in relation to the lump-sum state compensations and other labor opportunities.

Paradoxically, the sense and experience of finding fewer caterpillar fungus -- where the sense of "more" is relational to both historical narratives and the overall sense that one's energy and time investment in searching is met with sufficient rewards -- can diminish desires to invest in governance arrangements. In the same group interview, several harvesters mentioned that two to three years before (2008-2009), they had a village meeting about stopping the outsiders, but that they don't really care about the outsiders now. When asked why, they explained that it was because the amount of caterpillar fungus was decreasing: "there's so little caterpillar fungus, and the outsiders can't find much because they are from Deqin." In a separate interview, a harvester similarly explained that in 2008-2009, they had stopped outsiders but weren't doing so in 2011. When they used to stop people, they were finding a lot more, but in 2011, harvesters find so little in a collecting day that it is a 'little strange' to stop the outsiders. According to economic logics of value, where laws of demand and supply suggest that a decrease in supply causes an increase in value (price) when demand is assumed to be constant, it would make sense that Shusong harvesters would want to tighten control over their resources if the supply is noticeably declining. Here, harvesters are paradoxically loosening control over their resources while perceiving a decline in supply and now claim that it is a 'little strange' to stop outsiders when two years before this was a goal of governance. Not only is the value of caterpillar fungus contextually defined and continuously shifting in relation to political economic transitions in the area, but caterpillar fungus governance is an intimate function of its social value.

The transformations in Shusong's caterpillar fungus governance arrangements from 2007 to 2011 reflect the complex ways in which local claims of ownership and access to resources are coproduced by their histories, broader political economic contexts and geographies. While Shusong residents once exercised strong village-level ownership of their caterpillar fungus resources, these claims have recently been weakened and rearranged as new sets of interests, values, and power relations have mapped onto the region. These transitions influence and rework the daily lives of residents and landscapes in uneven and materially important ways.

Conclusion

> When the government came in, when they first starting building the road, there was only a meeting with the very high leaders and they did not ask the locals if they wanted it. If they destroy the mountain, they say, "You will get a good life in the future." If they wanted them to really get a good life in the future, they would pay them every year. They say, "If the country develops, you can also develop, it's good for you – in the future you can get a good life."
>
> - Shusong caterpillar fungus harvester, June 2011

Despite the intense flows of state capital to developing Yunnan, caterpillar fungus harvesting continues to be the most important source of income for the majority of rural, pastoral Tibetans. The critical role of caterpillar fungus in contemporary Tibetan economies and lives makes the rules of access to and exclusion from fungal resources important matters for social relations, where the governance of resources is intimately about the governance of people.

This chapter has drawn attention to the ways in which local governance realities are produced and negotiated through relationships with broader political economic contexts and actors. In Dongwa, Adong and Shusong, all villages have developed governance arrangements to control access to their shared fungal resources. Dongwa has created a fee-based permitting system for its harvesting areas, which suggests some of the ways economic logics and neoliberalizing processes are permeating caterpillar fungus governance arrangements. However, the fact that Dongwa governance arrangements are not produced solely through economic logics illustrates that the basic features of governance – which determine how and why particular people have access to their collecting areas -- continue to be intimately negotiated and reproduced through complex social relations.

Adong has developed exclusive access rights to its caterpillar fungus collecting areas, where anyone in the village could harvest. But here we saw how historical relationships with conservation organizations had influenced what is conceptualized as resource governance among village leaders – 'rest days' – which were both practiced and interpreted quite differently by the harvesters themselves. This discussion draws attention to the ways 'local' governance arrangements are situated in a unique set of histories and multi-scalar relationships, which can give rise to particular forms of governance that may or may not fit when they are fluidly transported across resource boundaries – e.g. from matsutake to caterpillar fungus – or geographic areas. Importantly, this discussion highlights the need for conservation science to deeply examine the social lives of harvesters to understand the implications and trade off of particular governance practices.

The loosening of Shusong's control over their caterpillar fungus resources illustrates the significant ways political economic context conditions the formation and persistence of environmental governance arrangements. While Shusong villagers, like those in Dongwa, previously had strong control over their shared fungal resources, local control has significantly weakened as the G214 expansion project, which enables and represents the imagined future of the region as Yunnan's version of "China's Tibet," has run through Shusong village and its collection areas. G214 has materially reconstructed the landscapes and destroyed the mountains, as noted above, and also reconfigured local claims to villagers' homes and land, perceptions of value of work and caterpillar fungus income, and the collective benefits from previous investments in governance arrangements like monitors. These transformations in Shusong's governance arrangements illustrate how access and control over resources are not fixed and static, but rather are continuously produced and negotiated through multi-scalar and highly uneven relations of power -- they are political processes.

In all of the villages discussed in this chapter, historical Chinese pastoral reforms laid important groundwork for the production of the caterpillar fungus commons. In both Adong and Dongwa, village-level governance and the capacity to govern has enabled villages to lay claim to their resources in flexible and continuously adapting practices that articulate with social norms and political economic context. In Shusong, however, statist development interventions materially influenced villager's claims to their land and resources, but also reworked their sets of meaning for what their claims meant and why they mattered. This chapter has shown how environmental governance is inherently about "*both* the social organization of decision making with respect to the environment, *and* the production of social order via the administration of nature" (Bridge and Perreault 2009, 477, emphasis in original). For caterpillar fungus, which has a range of actors and interests at stake in its governance, who makes decisions about the resource – and how and why -- bears significant consequence for the thousands of harvesters currently relying on the resource for income.

Chapter 5: Conclusion

Examining the politics of "conserving" caterpillar fungus

Introduction

At the "Winter Worm, Summer Grass: Interdisciplinary Workshop on Caterpillar Fungus" event that was held at Yale University on February 2014,[70] a female Bhutanese master's student from the Yale School of Forestry raised a provocative question during the open discussion: "why does caterpillar fungus matter now?" Having grown up in Bhutan, she remembered her grandparents talking about caterpillar fungus and the various ways it was a valued medicine and trade item for them and many other families in her area. Though the formal collection of caterpillar fungus has only been opened up to Bhutanese collectors in the past decade, the informal caterpillar fungus economy – namely the trade networks that passed overland to Tibet – has a long history in Bhutan as elsewhere in the Eastern Himalayas. If caterpillar fungus has been collected and valued as a medicine for hundreds of years throughout Tibetan regions, what makes it so notable right now? Why has it suddenly become such a newsworthy, science-worthy, and even workshop-worthy phenomenon?

As this dissertation has shown, caterpillar fungus matters significantly in the contemporary social and ecological lives of its Tibetan producers in Yunnan – and increasingly throughout the Eastern Himalayas -- because it is both a source and site of struggle for power in the uneven and rapidly transforming political economy of neoliberalizing western China. During

[70] The workshop was hosted by the Yale Himalaya Initiative, and featured three other panelists in addition to myself: Craig Jeffreys, Uttam Babu Shrestha and Ken Bauer. The workshop was designed to foster regional comparison and discussion about the social, political, cultural and ecological dimensions of the caterpillar fungus economy in India, Nepal and China.

the harvesting season each year, villages are empty of all but the young and old, and mountains are crowded with harvesters who search the high alpine grasslands for the valued fungus. They search with the hopes that they will secure enough cash income to pay for household necessities (school-related fees and costs, household food provisions, health care, etc.) and any luxury material items they might desire (name-brand clothes, motorcycles, electronics, etc.).[71] In many caterpillar fungus production areas, schools are canceled during the collecting season so that children can join in the harvesting practice to contribute to their household's income. If villagers do not have immediate access to harvesting areas through preexisting village governance arrangements, some Tibetans travel great distances and pay exorbitant fees for the opportunity to collect the fungus (Sulek 2011). For most rural Tibetans today, collecting caterpillar fungus is the single most important source of cash income, which means caterpillar fungus matters a great deal to thousands of individuals and households.

As a major source of income, concerns over access to and control over caterpillar fungus has risen to an unprecedented place in the social, political, cultural and ecological lives of rural Tibetans. As discussed in Chapter Four, Tibetan relationships with one another and their high alpine grasslands are continually transformed and reproduced through the process of – and the meanings associated with -- collecting caterpillar fungus for income. The caterpillar fungus harvesting season has become a central feature of Tibetan's social lives and their annual calendar of household reproduction activities. Prior to the past decade (and post-Deng reforms), households might have sent one or two individuals up to the high pastures to collect caterpillar fungus, whereas now households send every able-bodied individual up to collect. The social

[71] For a discussion of how caterpillar fungus income relates to the some of the contemporary desires of Tibetan teenagers and young adults, who wish to purchase name-brand clothes and other goods to "fit in," see the recent short documentary film (2014), "Golden Worm," by Tsering Dorje (Cairang Duojie). Tsering is an undergraduate student majoring in Visual and Media Studies at Duke University, and a native of Jianzha County in Qinghai Province, China.

relations that emerge and are reproduced within the harvesting camps and areas build on the social fabrics that are produced in harvesters' villages, with acute attention to caterpillar fungus access, collecting and income. As discussed in Chapter Four, Dongwa caterpillar fungus collectors have created an array of secondary businesses in their harvesting areas, demonstrating not only how significantly the caterpillar fungus economy is in the lives of collectors, but also the novel ways harvesters and villagers make use of and capitalize on the time they spend in the high alpine pastures. Replete with pool halls, a movie theater, snack shack, barbeque house and teahouse, Dongwa village is trans-located to the high alpine pastures during the collecting season, and the camps become significant places within which Tibetan identity and relations are produced. Likewise, in recent years in Shusong -- where harvesting areas are located alongside the major National Highway 214 between Shangri-la and Deqin -- harvesters have increasingly developed vending relationships with tourists traveling along the road because tourists are often willing to pay more for caterpillar fungus than buyers. Though I did not explicitly examine how these encounters transform harvesters' perceptions of themselves or their perceptions of tourists, such harvester-tourist social encounters – which are predominantly Tibetan-Han encounters -- likely (re)produce Tibetan collectors' senses of identity through their encounters with Han tourists and the politics of difference such encounters entail (Gladney 2004).

While Yunnan caterpillar fungus harvesters do not characterize their collecting areas as competitive and filled with tense social relationships, struggles over access to and control over collecting areas have erupted in other areas. A feud occurred in China's Sichuan Province in July 2007 due to conflicts over access to fuel and caterpillar fungus, resulting in eight fatalities. A similar conflict occurred in Qinghai Province in 2006 and Nepal's Manang district in 2009. Beyond these formally reported conflicts, it is likely that tensions and struggles over caterpillar fungus access are pervasive throughout the Eastern Himalayas as rules of access and claims of control are staked and stabilized (c.f. Sulek 2011).

In addition to the struggles over access that occur between harvesters, new configurations of power between the state and rural Tibetans continue to take form throughout caterpillar fungus collecting areas. China's pastoral reforms of the 1980s and ongoing neoliberalizing processes have continued to create and constrain the caterpillar fungus commons in myriad ways. While the pastoral reforms apportioned use rights of summer and winter pastures to natural and administrative villages, the ways in which villages continue to lay claim to their pastures are constantly negotiated through local-state relationships and desires. As the changes in Shusong's caterpillar fungus governance arrangements from 2007 to 2011 illustrate, once-strong village-based use rights for caterpillar fungus collecting areas can be dissolved in various ways if and when the state chooses to reclaim or transform its territory. While Adong and Dongwa continue to maintain relatively strong village-based governance within their collecting areas, these harvesting areas, too, are subject to the same state seizures of their lands and resources. The caterpillar fungus commons of China are thus as equally controlled "from afar" as they are by their local villages, meaning that in cases where local governance arrangements persist over time – and are thus 'successful' according to many commons theorists (e.g. Ostrom 1990; 2005) – they are as equally reflective of local-state power arrangements as they are endogenous 'community' characteristics and governance capacities.

State formation: The 'flagship fungus of China'

Mapping on to the existing local and local-state power arrangements for caterpillar fungus control and access that have been described in this dissertation, new forms of state control seem imminently poised to take form through the interfaces of science-policy definitions of what caterpillar fungus is, what it represents and ultimately who should control it. Recently, a group of Chinese mycologists nominated caterpillar fungus as "the flagship fungus of China," based on the logic that many countries in the world have selected national flowers, birds or trees, "with which they have close cultural associations, as a pictorial or cultural icon or symbol" (Zhang et al. 2012, 2). These mycologists nominated caterpillar fungus based on five characteristics, which include (Zhang et al. 2012, 3):

> (1) *O. sinensis* [caterpillar fungus] is distributed mainly in China and is even referred to as the "Chinese caterpillar fungus." According to recent estimates, China accounts for more than 90% of its known production areas (Winkler 2008) and more than 95% of its annual yield (Winkler 2010).
>
> (2) *O. sinensis* has close cultural connections to China, and natural *O. sinensis* specimens have been used as a TCM [traditional Chinese medicine] or an important dietary supplement since ancient times. Its pharmacological properties were discovered 1,500 years ago by herdsmen who observed that their yaks became energized after consuming it (Hollobaugh 1993). For a long time, however, the fungus was so difficult to obtain, and expensive, that only nobles and Chinese emperors were able to use it…
>
> (3) Sales of natural *O. sinensis* specimens represent an important portion of the gross domestic product of local governments and represent most, if not all, of the cash income of many rural families. About 80% of families in the major production areas are involved in collection of natural *O. sinensis* specimens, and cash income from sales of this resource accounts for 50–80% of their total income. Currently, more than 300,000 Chinese citizens in local regions rely on the collection and sale of this resource. No other fungus in China, or in any other country, plays such an important role in the local economy. The price of natural *O. sinensis* specimens has been rising in recent years and is currently higher than that of gold owing to its limited distribution and yield.
>
> (4) *O. sinensis* is considered a flagship species of the Tibetan Plateau (Cannon 2010), and over-harvesting of the fungus poses a threat to this fragile ecosystem. The Tibetan Plateau is an especially important ecosystem as it is the source of many important rivers in Asia. It is estimated that in the Nyingchi district of Tibet alone, about 100,000 square meters of grasslands are damaged each year by human activities such as digging natural *O. sinensis* specimens out of soil, soil compaction by people and vehicles, and destruction from shrub cuttings to establish camps or to use as fuel for campfires. These destroyed grasslands are difficult to recover and can even lead to desertification.

> (5) *O. sinensis* is a fascinating organism, and there are still many unanswered questions concerning its biology. These include "Why is its distribution so limited?", "How has the fungus coevolved with its insect hosts and with the plant hosts of the insects?", and "Does parasitism of ghost moths by *O. sinensis* reduce herbivory and thereby alter the plant community?" Recognizing *O. sinensis* as the national fungus of China will promote research on its biology, ecology, and conservation.

Here as a 'flagship species' of China, caterpillar fungus is being mobilized as an instrument of stabilization and state-building through the course of its "five characteristics," where it can hardly be ignored that nearly everything Tibetan about the fungus is being reformulated as distinctly Chinese. As Zhang et al. (2012) specify, caterpillar fungus' range of production is within China, its colloquial name (among Chinese consumers!) is Chinese, its producers are Chinese, and its production is an important Chinese livelihood and contribution to the national GDP. Contrary to these Chinese inscriptions on to caterpillar fungus, as discussed in this dissertation, it has been and continues to be a characteristically Tibetan resource and source of income.

At the same time, when Zhang et al. (2012) describe the environmental impacts or degradation of caterpillar fungus harvesting, it is once again rendered distinctly Tibetan: "in the Nyingchi district of Tibet alone, about 100,000 square meters of grasslands are damaged each year by human activities such as digging natural *O. sinensis* specimens out of soil, soil compaction by people and vehicles, and destruction from shrub cuttings to establish camps or to use as fuel for campfires…these destroyed grasslands are difficult to recover and can even lead to desertification" (Zhang et al. 2012, 3). Characterizing Tibetan harvesters as "destroyers" of the grassland and contributors to desertification in this way harkens to the many cases in international development and conservation interventions where "resource users" are inculpated for 'resource degradation.' As discussed in Chapters One and Two, much political ecology scholarship has shown how these *a priori* assumptions about the causal linkages between 'resource users' and environmental degradation are in some cases false or inaccurate, and the linkages between harvesters and caterpillar fungus resources remain to be substantiated. Formalizing caterpillar fungus as a national symbol, as Zhang et al. (2012) promote, will likely elicit more research on caterpillar fungus – as they hope -- and thus create greater scientific opportunity to understand the relationships between harvesting and caterpillar fungus resource abundance. However, as I argued in Chapter One, the production of hypotheses, methods, findings and ultimately outcomes of science operate within social worlds and sets of understandings about what is going on. Science that is promoted through the discourse of caterpillar fungus as the "national fungus of China," and founded on the premise of Tibetan 'destroyers' of caterpillar fungus, is in need of careful consideration of the political uses to which science can be put (Forsyth 2003). In cases where the practice of collecting caterpillar fungus is considered to degrade or negatively impact caterpillar fungus, "socialism from afar" – legitimated by scientific claims -- will presumably impose governance regulations that limit or remove 'human impacts' on caterpillar fungus. With 40-80% of their annual cash income derived from collecting caterpillar fungus, such governance maneuvers threaten to cripple the social, economic and political lives of most pastoral Tibetans.

International conservation: The 'flagship species of fungal conservation'

As Chinese national science-policy attention is turning towards caterpillar fungus, caterpillar fungus is also gaining the attention of the international conservation science and practice community. Cannon (2011) recently nominated caterpillar fungus as a "flagship species of fungal conservation," justifying the nomination via the *Fauna and Flora International* definition of the concept, which describes: "high profile and charismatic species that may play a significant ecological role…often have important cultural associations…[and] act as symbols for the threats to the broader ecosystems in which they occur, and thus provide a catalyst for wide-ranging conservation activities" (Cannon 2011, 35). Important here to the *Fauna and Flora International* definition of 'threats' is that they are generally conceptualized as proximate human-impacts in the form of resource over-exploitation or land misuse. Applying this "flagship" analytic to caterpillar fungus similarly implicates harvesters as 'threats,' when in fact such causal linkages remain to be substantiated. Importantly, as illustrated in Shusong, the "threats to broader ecosystems" in caterpillar fungus geographies are those driven by statist development interventions.

Optimistically, caterpillar fungus becoming marked as a "flagship species of fungal conservation," may present a unique opportunity for conservation science to go beyond the usual considerations of proximate human-driven impacts on caterpillar fungus towards more explicit engagement with the state. Statist development interventions that demolish caterpillar fungus hillsides have a significantly greater impact on sensitive caterpillar fungus ecologies, and the international definitions of 'threats' – in the broader frameworks and global networks of conservation – can have material consequences in the determination of control over resources like caterpillar fungus. For example, if development-related land-use changes in high alpine pastures are characterized as having major impacts on the 'flagship species of fungal conservation,' then conservation policies could garner international backing for conservation efforts to dampen China's statist development impacts on global biodiversity. If successful, international conservation interventions into caterpillar fungus production areas could have the potential to stave off statist development transformations of regions like Shusong, and serve to maintain local governance arrangements. The important point here is that these kinds of conservation frameworks look beyond the local 'human impacts' on resources, to understand the how both state practices and political economic contexts give rise to and influence resource geographies. The globalizing discourses and practices of conservation continue to produce multi-scalar politics, which both complicates and makes productive wedges in local-state negotiations of resource governance.

With attention to the ways the stakes of science-policy interfaces for caterpillar fungus continue to rise for the vast majority of rural Tibetans, this dissertation has built on political ecology approaches to 'environmental problems' that examine how scientific understandings of environmental issues are produced and how their science-policy interfaces operate in the world (Hecht 1985; Fairhead and Leach 1996; Forsyth 2003). In recognition of how important access to caterpillar fungus is in the lives of contemporary Tibetans, my political ecology approach has entailed critical attention to the political uses to which scientific understandings of caterpillar fungus can be put. This dissertation has not taken for granted the fact that emergent scientific assessments of caterpillar fungus are accurate accounts of what is going on, but has rather engaged with the science to understand how attention to the social-natural and politics-science interfaces can engender scientific understandings of caterpillar fungus that are potentially more biophysically accurate and conducive to policy outcomes that do not inaccurately assign blame of resource declines to harvesters (Forsyth 2003). To clarify, my engagement with the scientific understandings of caterpillar fungus is not blind to the potential that harvesting might be negatively impacting caterpillar fungus populations. I am, rather, adamant about the idea that the causal linkages between harvesters and caterpillar fungus resource impacts need to be substantiated -- and not accepted as 'receieved wisdom' -- before conservation science-policy prescriptions addressing Tibetan 'destroyers' of the grasslands are stabilized.

In sum, caterpillar fungus matters so much right now because it has risen to an unprecedented place in the economic lives of rural Tibetans, and control over and access to this crucial resource is continuously being negotiated through social relationships, local-state power relationships, and science-policy accounts of what is going on. While rural Tibetans have to date been marginal to the economic 'benefits' of the state investments in the 'west' (Goodman 2004), the cash income Tibetan collectors earn is crucial for their finding of a place in the neoliberalizing processes that are transforming the social and ecological lives of Tibetans, where economic standing and calculative logics are increasingly part and parcel of daily life in Chain's 'west.' Importantly, the rising caterpillar fungus economy presents – in some cases -- an unprecedented rural strategy for generating income that aligns with harvesters' affinities for their mountain landscapes and the kind of 'freedom' they value. Collecting caterpillar fungus, which has a historical and cultural value among Tibetans, is an entirely different practice and way to earn money than working along a dusty, noisy road, under the surveillance of a foreman. While it is important not to romanticize the practice of harvesting caterpillar fungus, or strip it of its economic utility, it is equally important to consider the social and cultural dimensions of the practice that are absent in road and building construction conditions. Access to and control over caterpillar fungus collecting areas is thus a major leverage point for Tibetan caterpillar fungus producers, meaning it is both a point of stability and instability in their contemporary place in neoliberalizing China.

Reflections on caterpillar fungus 'sustainability'

With its economic importance in mind, the 'sustainability' of caterpillar fungus has become a central question and concern for an array of actors, including harvesters, traders, resource conservation-minded scholars and practitioners, development practitioners, broader publics, and various scientists. While the idea of caterpillar fungus is often enframed by the formulaic balancing of harvesting 'impacts' and the rate of fungal replenishment, in reality, the 'sustainability' is contingent upon a host of factors. Sustainability is in part biological, but just because the fungus is biologically available does not mean that everyone has *access* to it. Likewise, the sustainability of caterpillar fungus is contingent upon its continued production, or the stabilization of contemporary 'producers' as the subjects of conservation and development in the first place: Tibetan caterpillar fungus collectors are by and large economically and politically marginalized in the broader landscapes of developing China. The "freedom" collectors find in the mountains by collecting are defined in opposition to the other kinds of 'work' that are available to them at this time: unskilled building and road construction. Here, the 'sustainability' of the caterpillar fungus economy rests on the continued economic and social marginalization of Tibetans. Further, its sustainability is contingent upon a stable demand for it among Chinese consumers. If, for instance, the cultural demand for "Himalayan gold" declines significantly, it can be artificially produced in its wild harvested form, or a cultural preference for the lab-produced form develops, the caterpillar fungus economy will not be sustained. These beyond-proximate, beyond-biological, and beyond-harvester conceptualizations of caterpillar fungus sustainability are rarely considered in the pursuit to address caterpillar fungus sustainability, and are arguably more immediate in their impacts.

At this time when caterpillar fungus is gaining traction among Chinese national and international conservation communities, and in the social and economic lives if its producers, it is critical to be aware of how and why access to caterpillar fungus is enabled and constrained now and in the coming years. Though I did not explicitly examine the role of climate change on Tibetan livelihoods and the caterpillar fungus economy in this dissertation, there is increasing evidence that suggests that shifting climatic conditions in the high alpine regions of the Himalayas are affecting residents in diverse ways. In future research, I plan to examine how climatic shifts and weather trends influence harvester-fungus relationships, bearing in mind the fact that shifting biophysical conditions -- and ‘hazards’ more generally (Watts 1983) – are ever mediated by their political economic and socio-cultural contexts.

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