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GENERAL ARTICLE

Caterpillar Fungus Gold Rush: Growing Dependence on a Lucrative Trade with Disputes among Communities in the Himalaya

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Abstract Caterpillar fungus (*Ophiocordyceps sinensis*) is a flagship species of the Himalaya and is one of the world's most expensive natural medicinal resources. In the Nanda Devi Biosphere Reserve and Dharchula–Munsiyari landscape of the western Himalaya, it inhabits ioslated patches of alpine grasslands (elevation from 3,000 to 4,500 masl) of Mana, Niti, Rishi, Pindar, Gori, Dhramganga and Kali Valleys. Although there was a steady increase both in price and demand of the resource, overall harvest at the local level was decreasing and the number of harvesters were increasing every year. With the gradual increases in the market value of *O. sinensis*, the dependency of local communities was becoming more prominent on the income generated through its collection, whose livelihoods were earlier based on pastoral and agricultural activities. Caterpillar fungus played a significant role in the economy of communities who were living in the region. Thus, the caterpillar fungus harvest-boom was facilitating the integration of rural upper Himalayan households into regional, national and international economic cycles by providing the necessary product and cash in exchange for sharing in this commodity trade. There was a drastic growth in the economy empowerment of villagers and in contrast the growing dependence of the local community on this remarkable gold rush had promoted violent confrontation among harvesters.

Key words NTFPs, Caterpillar fungus, Biosphere reserve, Alpine meadows, Himalaya

1. Introduction

In India, natural resources and people are inextricably linked since millions of people live adjacent to or within protected areas and harvest forest products (Davidar *et al.*, 2010). However, often the human pressure on natural resources is not sustainable and can result in habitat loss and degradation (Sagar and Singh, 2004; Arjunan *et al.*, 2005), and together with intensive livestock grazing can reduce carrying capacity, that is the net primary productivity available for herbivores in a year (Madhusudan, 2005). Improving the sustainability of relationship of humans with the natural resource is firmly established as a societal goal for the twenty-first century. Over the last two decades, devolution of resource management and access rights from the state to local communities and user groups has become an important policy tool in developing countries (Shackleton and Pandey, 2014). The sustainability of non-timber forest products (NTFPs) extraction for the long-term ecological integrity of forests depends on a variety of considerations, including its importance to the local economy, possibility of alternative sources of income to the people, ecological impacts of NTFP extractions and legal status of the forests (Mutenje *et al.*, 2011).

During the last two decades significant progress has been made in understanding the role of biological resources in the lives of poor people, particularly their contribution to the household economy and their role in alleviating poverty (Vira and Kontoleon, 2013). Trade and collection of NTFPs including medicinal plants have a long history in the

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Himalayas (Olsen, 2005), but harvesting of Caterpillar fungus has become extremely popular in recent years, surpassing all other species in terms of revenue. The caterpillar fungus (*Ophiocordyceps sinensis*), locally known as Kira Jari (in India), Yartsa Gunbu (in Tibet) and Yarsa gumba (in Nepal), is among the most valuable NTFP products in the world almost like gold and plays a major role for the local economies in its distribution area on the Tibetan Plateau and adjacent regions. Large proportion of its habitat in the Indian Himalaya has been designated under the protected area network.

2. Caterpillar Fungus (*Ophiocordyceps Sinensis*)

The caterpillar fungus is a parasitic species of fungus and is endemic to the Himalaya and the Tibetan Plateau including the adjoining high altitude areas (between 3,000 and 4,500 msl). In the western Himalaya, it has been documented in alpine meadows of protected area like Nanda Devi Biosphere Reserve and Askot Wildlife Sanctuary (Figure 1). *O. sinensis*, belonging to the family Ophiocordycipitaceae, is a parasitic fungus on Lepidopteran larvae. It infects the caterpillars of ghost moths (family Hepialidae) and produces a fruiting body (stroma) which emerges from the head of the larvae and eventually kills it by paralysis and mummification. As the insect is the sole source of food for the fungus, the size of its stroma is dependent on the size of host caterpillar (Negi *et al.,* 2014). Caterpillars prone to infection by *O. sinensis* generally live 5–7 in underground and thrive in subalpine and alpine grasslands or meadows as well as open dwarf scrublands around the potential timberline.

For centuries, caterpillar fungus has presumably been used in traditional Tibetan and Chinese medicine as a tonic, aphrodisiac and as relief medicine for lung, liver and kidney problems (Holliday and Cleaver, 2008; Zhou *et al*., 2009). Nevertheless, it is widely traded as an aphrodisiac and a powerful tonic in the name of 'Himalayan Viagra' (Winkler, 2009; Shrestha and Bawa, 2013). Global trade of caterpillar fungus rapidly expanded after the 1993 World Athletic Championships in Stuttgart, Germany, when Chinese athletes reportedly training on dietary supplements of *O. sinensis* and turtle blood set multiple records in distance running (Winkler, 2010). Now-a-days, it is the world's highest-priced biological lucrative trade, more expensive by weight than gold (The Economist, 2015). Best quality fungus in China fetched up to US$100,000 kg^{-1} in March 2012, and in Singapore it reached US$ 130,000 kg^{-1} at a time when the price of gold was about US$68,000 kg^{-1} (Shrestha and Bawa, 2013).

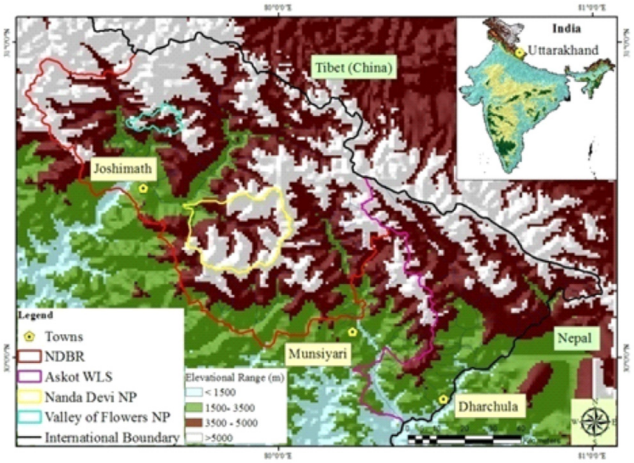

Figure 1. Location of caterpillar fungus' inhabited protected areas in Uttarakhand

3. Harvesting Techniques and Collection Period

The collection season starts in the beginning of May and lasts till the end of June. The collection period depends on many factors like the local weather, condition of snow in the pasture and elevation of the collection site. The harvesters recline on the ground over the high-altitude expanses, attentively scanning the terrain. It is a difficult task requiring attention and tolerance for harvesting. Indeed, the height and thickness of caterpillar fungus are so small almost like stalk of the apple that it cannot be easily seen. During spring the ground is covered with short vegetation stumps as brownish as the small caterpillar fungus. But mountain people work hard since it is considered particularly strenuous, the enterprise is highly profitable. Caterpillar is first dug out of the ground it is covered in dirt (Figure 2A) and the best way to remove this layer is with a toothbrush. During cleaning process careful consideration must be taken not to damage or break the caterpillar fungus. After drying in shade, species is ready to trade (Figure 2B) and people store it on dray place to save from moisture.

Figure 2. Caterpillar fungus: uprooted from the ground (A) and cleaned and dried which is ready to sell (B)

4. Medicinal Value of Caterpillar Fungus

The caterpillar fungus is one of the most highly priced natural resource used in traditional oriental medicine. It was discovered about 1,500 years ago by Tibetan herdsmen who observed their livestock become energetic after eating certain mushroom. Consequently, the King's physicians in Ming Empire explored to develop powerful and potent medicines.

It is usually consumed by cooking with aged duck to treat patients suffering from cancer and asthenia, or cooked with hen's meat to treat hypo-sexuality and male impotence, especially emission (Jiang, 1994). Moreover, it is also cooked with pork, sparrow and turtle to treat fatigue (Miller, 2009). In some parts of Nepal, *O. sinensis* is powdered and combined with the rhizome of *Dactylorhiza hatagirea* for consumption (Devkota, 2006). A combination is made with *D. hatagirea,* honey and cow's milk for tonic and aphrodisiac (Lama *et al*., 2001). It has also been reported to possess a range of more specific therapeutic properties, including action against asthma and bronchial inflammation (Kuo *et al*., 2001), cure of renal complaints (Guo and Yang, 1999), stimulation of the immune system (Kuo *et al*., 2005), potent cytotoxic effect on various human cancer cells, including human lung carcinoma cells (Park *et al*., 2009) irregular menstruation (Zhu *et al*., 1998; Francia *et al*., 1999) and anti-inflammatory (Qian *et al*., 2015).

5. Harvesting and Trade of the Caterpillar Fungus

The collection session starts at the beginning of May till the end of June. Although, collection period depends on many factors like local weather, condition of snow in the pasture and elevation of the collection site. Most of the harvesting areas are located on the north-facing slopes of the mountains. The gatherers recline on the ground over the high-altitude expanses, attentively scanning the terrain. It has been observed that when the caterpillar is first dug out of the ground it is covered in dirt and the best way to remove this layer is with a toothbrush. Careful consideration must be taken in order to avoid damage to the caterpillar during the harvesting and cleaning process. It is a challenging task, requiring careful attention and patience for harvesting. Indeed, the height and thickness of the fungus is so small that it cannot be easily seen. During spring, the ground is covered with short vegetation stumps, which appear as brown as the small caterpillar fungus. Despite being a strenuous process the collectors put in immense efforts as the enterprise is highly profitable.

Due to resource scarcity and high publicity, both demand and price of caterpillar fungus have very high causing high competition among harvesters and traders. Over the last decade Himalayan villagers have become astute to the commercial potential of caterpillar fungus. After harvesting it, the produce is sold to the traders. These traders feed the growing demands in Asia's fast growing urban centres, as well as that of the western countries. In India, a single fungus sells for about US$4.00 to US$7.00, depending on the health and size of the fungus while traders sell the product to wholesalers or exporters for US$12,365 to US $18,307 kg^{-1} (Yadav, 2016). About 5–6 years ago, people could collect around 55 to 60 individuals, but due to engagements of more people in the harvesting, now villagers can scavenge as many as 15 to 20 of these per day, making it a new gold rush for the Himalaya. Owing to the upsurge in consumer demand for this ingredient in the last decade, local people have been gathering more quantity of caterpillar fungus over the high-altitude expanses in upper Himalayan regions and this activity has become one of their most prosperous sources of income in the landscape.

6. Opportunity and Challenges for the Community

The villagers who harvest caterpillar fungus in the Nanda Devi Biosphere Reserve and Dharchula–Munsiyari landscape belong to the marginal community, historically shepherds, porters and traders. Woolen handlooms and beverage production are the traditional cottage industries. Investigation for socio-economic contribution of caterpillar fungus among mountain dwellers illustrates that stream of cash income to harvester from this gold rush has caused a far-reaching revolution in social and economic conditions in the last 12–15 years. During our filed visits in the study area harvesters informed us that as early as 2 years, after initiating harvesting of caterpillar fungus, the households' income from its trading during the month of June, July and August had increased tremendously. Harvesters spend this income on child education, family healthcare and subsistence needs for whole year. Furthermore, they do not have to rely completely on agriculture which again is subjected to rainfall and wildlife depredation. Thus, the income derived through the collection and trade of this precious fungus has led to an enhanced empowerment of marginal communities, often living in extremely remote locations, who used to secure their survival only through pastoral and agricultural activities. Furthermore, the cash influx has led to a commoditization of local production and services. Thus, the caterpillar fungus boom is facilitating the integration of rural upper Himalayan households into regional, national and international economic cycles by providing the necessary product and cash in exchange. Although a proper scientific investigation is required to establish these assumptions.

But there is dark side also to the harvesting of caterpillar fungus. In addition to having to brave harsh climates to find caterpillar fungus, its rarity means that there are no guarantees that a collector will find anything at all. Some villagers return with nothing to show, for their weeks of hardship in high altitude snow fields and many falls ill. People often return to the village with snow-blindness, painful joints and problems of breathing. In the past, community disputes mostly occurred over grazing rights, now they are mostly fought over access to caterpillar fungus resources, and some of these turn violent. Thousands of villagers go for mass-collection of the species each year, along with their tents, food, other consumables and domestic

Figure 3. Poor logistics is representing challenges for the harvesters in the alpine meadows

Figure 4. Harvesters' camps and cattle in alpine pasture during harvesting season

animals. These huge aggregations in the remote pastures are bound to destroy the pristine nature of the ecosystems and the threatened species that inhabit them (Figures 3 and 4). Local people and ecologists alike have been complaining about the sharp decline in the abundance of the caterpillar fungus as well as the destruction of the habitats in the concerned areas within a span of a few years. Ultimately, increasing trade-induced over-harvesting seems almost certainly responsible for declining populations of the caterpillar fungus, which needs to be assessed more scientifically.

7. Discussion and Conclusion

Hundreds of villagers go for the mass-collection of the species each year, carrying with them tents, food, other consumables and domestic animals. These huge aggregations in the remote pastures are bound to destroy the pristine nature of the ecosystems and the threatened species that inhabit them. Despite increase in price and demand of caterpillar fungus, results show that the harvest at local level is decreasing and on other hand number of harvesters has increased. Ultimately, increasing trade induced over-harvesting seems almost certainly responsible for declining populations. Over harvesting and decreasing population of the caterpillar fungus is leading the species towards extinction from natural habitat of its occurrences. Other studies Shrestha and Bawa (2013, 2014), Winkler (2009) and Stone (2008) also show that over-harvesting is one of the primary causes of population decline of the species. Studies conducted by Negi *et al*. (2014) and Sharma (2004) in the Dharchula–Munsiyari region conclude that since it was discovered in those areas by the villagers, massive exploitation has occurred, leading to a drastic decrease in populations. The regulation of rampant exploitation and implementation of scientific sustainable harvesting is thus the need of the hour for the sustainability of the species.

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