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Ethnomycological Use of Medicinal Chinese Caterpillar Fungus, *Ophiocordyceps sinensis* (Berk.) G. H. Sung et al. (Ascomycetes) in Northern Yunnan Province, SW China

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ABSTRACT: *Ophiocordyceps sinensis* is a well-known medicinal mushroom in traditional oriental medicine such as traditional Chinese medicine (TCM) and traditional Tibetan medicine (TTM). It is endemic to alpine habitats on the Tibetan Plateau, located predominantly in Tibet and Tibetan autonomous prefectures of neighboring Provinces and the high Himalayas. This area includes parts of Northern Yunnan, but is inhabited by other ethnic groups. Although ethnopharmacological use among Tibetan people has been researched, such studies among other ethnic peoples are limited. This study aims to review the traditional uses of caterpillar fungus among Bai, Naxi, Lisu and Tibetan people living in the mountainous Northern Yunnan Province. Ethnomycological survey methods, interviews, participatory action research and field visits were conducted to elicit information on the uses of caterpillar fungus. In this paper, we have presented this traditional knowledge about collection, discovery, protection, and nutritional value, learned from these indigenous peoples. Of special interest is the range of diseases treated with *O. sinensis* and the corresponding methods of application. Furthermore, the diverse ethnic groups examined each have their own unique legends regarding *O. sinensis*.

KEY WORDS: medicinal mushrooms and fungi, *Ophiocordyceps sinensis*, *Cordyceps sinensis*, ethnomycological survey, traditional uses of mushrooms, China, Yunnan

ABBREVIATIONS: AR: Autonomous Region; **TCM**: traditional Chinese medicine; **TTM**: traditional Tibetan medicine

I. INTRODUCTION

Chinese Caterpillar fungus, *Ophiocordyceps sinensis* (Berk.) G.H. Sung, J.M. Song, Hywel-Jones et Spatafora (≡ *Cordyceps sinensis* (Berk.) Sacc.), Ophiocordycepitaceae, Ascomycetes,[1] is the rarest medicinal fungus of traditional Chinese medicine (TCM). In China, it is well-known as "Dong Chong Xia Cao" ("summer-grass, winter-worm"), and abbreviated as "chongcao" ("grass-worm"). Its first documented record dates back to the 15th Century in Tibet under the name "yartsa gunbu" [winter grass (yar tsa) and summer worm (gun bu)][2]. In Nepal, Bhutan, and India it is popularly known as "Yarsagumba,"[3] "Yartsa Goenbub,"[4] and "Keera Jhar,"[5] respectively. Its name describes the main life stages of *Ophiocordyceps sinensis*: the infected host [usually a species of *Thitarodes* (formerly classified as *Hepialus*) the larva of a ghost moth].[6,7] The organism inhabits the soil as a "worm" during winter; and in early summer, a stroma or "grass" emerges above ground. *Ophiocordyceps sinensis* has been considered a complex of a *Hepialidae* caterpil-

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lar and *Hirsutella sinensis* (the name for the anamorph or asexual stage of *O. sinensis*).[8-10]

Ophiocordyceps sinensis is endemic to alpine grassland ecosystems (3000-5000 m in elevation) on the Tibetan Plateau and the Central and Eastern Himalayas in Nepal, Bhutan, and India (Fig. 1). In China, the known range of *O. sinensis* includes the Tibetan Plateau, including areas within Tibet and the Tibetan autonomous prefectures of Sichuan, Yunnan, Qinghai, and Gansu Province. Some mountainous areas of Southwestern Sichuan and Northern Yunnan are inhabited by non-Tibetans.

In TCM, the caterpillar fungus is most typically used as a tonic to strengthen and revitalize the kidney and the lungs and stimulate the immune system; it is used in the treatment of fatigue, night sweating, hyperglycemia, hyperlipidemia, asthenia (after severe illness), respiratory disease, renal dysfunction and failure, arrhythmias, and other heart diseases and liver disease.[11] An overview of modern research on *O. sinensis* includes possible antitumor, anticancer and antiviral activity, immunomodulating, cholesterol reducing and antioxidant effects, and the potential to increase stamina and libido.[11-14] In a recent treatise on Tibetan medicine,[15] *O. sinensis* is included with several other tonics. It is recommended as a general tonic for boosting the virility and the immune system and is prescribed, usually in conjunction with other medicines, for kidney, lung and heart problems, as well as for Hepatitis B, and is also thought to improve eyesight. Among its uses in traditional Tibetan medicine, *O. sinensis* is used for the treatment of sexual dysfunction (eg, lack of sex drive, premature ejaculation).[2] The people of Dolpa in Nepal use *O. sinensis* as a tonic and sexual stimulant.[3] Overall, for its use as an aphrodisiac in TCM, TTM and in Nepal's folk medicines, it has been deemed by some journalists to be the "Himalayan Viagra."[3-5]

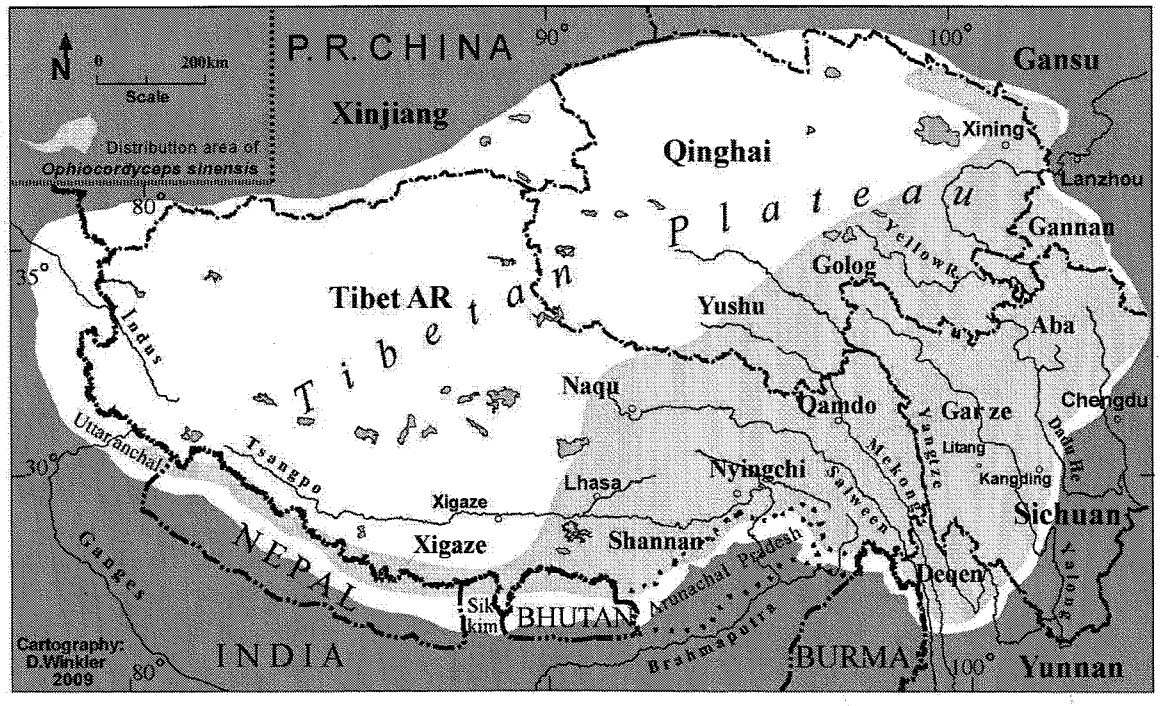

FIGURE 1. The range of distribution of *Ophiocordyceps sinensis.*

Current ethnomedical reports on the uses of *O. sinensis* are limited to its application as a general tonic in China and as an aphrodisiac in Nepal.[16] In contrast to other origins of the caterpillar fungus (outside the Tibetan Autonomous Region (AR)), the range of ethnomedical uses in Tibetan culture is diverse.[2,6,17,18] Data regarding the ethnomedical use of *O. sinensis* among Tibetan people in the Tibetan areas outside of Tibet AR and among other ethnicities of the Tibetan Plateau is scarce. In this study, we have chosen the Northern Yunnan Province as our geographical area of research. The Yunnan Province, like Tibet AR, is well known for its richness and diversity of medicines and is important to the supply of crude drugs for TCM.[19] The diversity of ethnic medicines, such as those of the Dai, Hani, Lahu, Miao, Naxi, Tibetan, Yao, Yi and Zhuang nationalities, plays an important role in the treatment of human diseases and in healthcare in Yunnan.[20]

This study aims to investigate how indigenous people use *O. sinensis* for curing various ailments. Ethnomycological survey methods, interviews, participatory action research and field visits were conducted. The objective of the study was to record traditional knowledge of the use of *O. sinensis* in ethnic groups, such as Bai, Lisu, Naxi and Tibetans in Northern Yunnan Province of Southwestern China.

II. MATERIALS AND METHODS

A. Study Area

We have chosen the distribution area of *O. sinensis* in Yunnan Province of Southwestern China as our study area. This includes two counties (Deqin and Shangri-La County) and one Autonomous County, Weixi Lisu AC of the Diqing Tibetan Autonomous Prefecture. Furthermore, Mt. Laojunshan is included in a mountainous area to the South of Diqing Prefecture located between Dali Bai Autonomous Prefecture, Lijiang Naxi Autonomous Prefecture and Nujiang Lisu Autonomous Prefecture (Fig. 2).

B. Ethnomycological Survey

Ten interviews were carried out during caterpillar fungus season, over a period of four years, in four districts of Northern Yunnan province: Mt. Laojunshan, Weixi Lisu AC, Deqin and Shangri-La County. Methods of anthropology, ethnomycology and participatory rural appraisal were adopted for the field survey.

During each visit, detailed field records were collected from different regions, following the methodology outlined by Croom.[21] Information was obtained through conversations with elderly villagers, local healers, and herbalists. Voucher specimens of *O. sinensis* were collected in the field and were deposited in the HKAS (Cryptogamic Herbarium, Kunming Institute of Botany, Chinese Academy of Sciences). Local names of *O. sinensis*, the types of diseases to be cured and method of application were carefully recorded in the field.

III. RESULTS AND DISCUSSION

A. Traditional Knowledge about Collection, Discovery, Protection and Nutrition among Indigenous Bai, Lisu, and Tibetan Peoples

Tibetan people in Shangri-La County refer to a legend of how the medicinal value of *O. sinensis* was originally discovered. One day, herders realized that after grazing, one yak's mouth turned red, while other yaks' mouths did not. They could not explain this phenomenon, so they carefully examined the grass that the yaks had eaten. Many days later, a few of the inquisitive herders solved the mystery. They realized that one "grass" would, within a short period after ingestion, turn the yak's

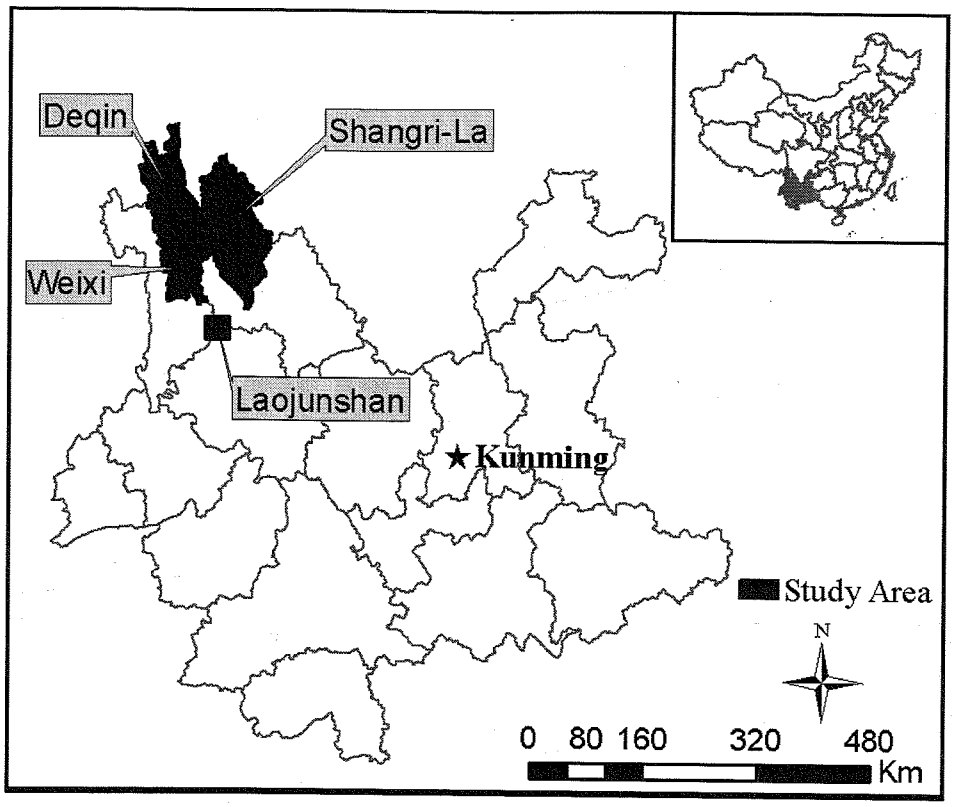

FIGURE 2. Study area in Diqing Tibetan Autonomous Prefecture and Mt. Laojunshan, northern Yunnan, SW China.

mouth red and as a result the yak would become vigorous. This magic "grass" was yartsa gunbu, "summer grass winter worm," or *O. sinensis*. Another interesting story reported by locals of Shangri-La County is that the top of the fungus "moves" when it is thundering. The movement was explained by the fast growth of the fungus during a thunderstorm.

The Lisu people living in Weixi Lisu AC have their own story concerning the collection of *O. sinensis*. In order to collect *O. sinensis*, one must get out very early in the day because the dew covers the top of the fungus. The Lisu stated that the dew drops would dazzle in the light of the rising sun and help them to find the fungus much more quickly. At this point, they mark each fungus with a bamboo skewer until all the dew has evaporated and they can't use this technique anymore. Then they begin to dig out all the marked caterpillar fungi. This approach enables them to collect more *O. sinensis* in the early morning than during any other time of the day.

At Mt. Laojunshan, indigenous Bai and Naxi people think that the larva of the ghost moth feeds on litter, especially on rotten wood. In fact, the host larva feeds on the roots of many plants. Through long-term observation, the Lisu and Bai people found that spore production of the caterpillar fungus coincides with flight and mating of the adult ghost moth in early June. They speculate that the adult ghost moths might help to spread the spores of the fungus. They observed that a certain bird feeds on adult ghost moths. These birds are described as having a red neck, a green back, and a short and pointed beak. This description fits a rose finch or a tit (*Parus monticolus*). The au-

thors speculate that this bird might assist in the spread of the fungal spores over long distances. Indigenous Bai and Naxi people have their own unique idea regarding the infection of the host larva by the fungus. They observed that there are always a few other larvae in the soil under the fruiting body of *O. sinensis*; also many sclerotia (larval part of *O. sinensis* in the soil) exhibit bite marks by other larvae. Thus, there is a hypothesis that the ghost moth larva becomes infected with the fungus by feeding on the sclerotium of infected larvae. What we know of the life cycle of this fungus is limited to the sexual and asexual generations; *Hirsutella sinensis* is the confirmed anamorph of this species,[8,9] but little is known about the process of caterpillar-fungus interactions.[10] Generally, it is thought that after ejection from mature ascus, one ascospore fractures into many secondary propagules, which the rain washes into the soil. After attaching to an appropriately aged host, the propagule would expand in shape and germinate a germ tube,[22] which penetrates through the exoskeleton of its host larva. In the larva, the fungus grows rapidly, first feeding on non-essential tissue but eventually killing it.[10,16]

Regarding the protection and conservation of caterpillar fungus, there is a consensus among all the ethnic groups in the study area that the quality of the habitat of *O. sinensis* is very important and that it must be protected. This clearly reflects that all the collectors are aware of the importance of a pristine environment for the successful collection of the caterpillar fungus. Furthermore, it attests to the importance of the resource. For Tibet AR, Winkler has calculated that the caterpillar fungus contributes 40% of the overall rural cash income and even up to 80% in some prime production areas.[2] Collectors agree that one very important method of habitat protection is to reclose the holes after digging up the fungus; a technique already applied by many of their ancestors.

To conserve the quality of caterpillar fungus after collection, the interviewers state, "we must dry caterpillar fungus in the shade," since drying in the sun lowers its quality and potency. After it has been completely dried, it should be stored in sealed plastic bags. This method has been used often and has shown that the caterpillar fungus can be kept easily for two- to three-years, possibly even as long as 10 years. However, if the fungus is not dried completely, larvae of other insects or molds might develop, completely destroying the product.

B. Types of Diseases to Be Treated and Methods of Application

In our study area, the different ethnic groups use caterpillar fungus to treat different types of diseases and have several methods of application. We summarized the indigenous Bai, Naxi, Lisu, and Tibetan people's traditional ethnopharmacological use of *O. sinensis* separately (Table 1). The Bai and Naxi people in Mt. Laojunshan use *O. sinensis* for improving eyesight, treating calcium deficiency, indigestion, diabetes, nephropathy, and strengthening the immune system to prevent disease. The Lisu of Weixi Lisu AC and Tibetan people in Deqin County use *O. sinensis* as a general tonic or for improving eyesight. The Tibetans in Shangri-La County use *O. sinensis* for treating hypertension and rheumatism, blindness caused by rheumatism, and for speeding up labor parturition. Different diseases are treated with different methods. For example, for improving eyesight, different peoples have different applicative methods. The Bai and Naxi peoples living on Mt. Laojunshan often first grind *O. sinensis*, mix the powder with raw eggs, and then steam the mixture to take it orally; sometimes they also stew it with chicken. The Lisu people always first dry it over the fire and then chew it with water or grain alcohol. Tibetan people may grind it and mix it

TABLE 1. Ethnopharmacological Use of *O. sinensis* by Bai, Naxi, Lisu, and Tibetan People in Northern Yunnan Province, SW China

People	Types of diseases to be cured	Methods of application
Bai and Naxi people in Mt. Laojunshan	Improving eyesight (specific to the aged)	Dried *O. sinensis* is ground and the powder mixed with raw eggs. The mixture is steamed and taken orally; sometimes it is stewed with chicken.
	Treating calcium deficiency (specific to children)	*O. sinensis* is dried over the fire and taken with boiling water.
	Indigestion (specific to children)	Dried *O. sinensis* is ground and the powder mixed with pork. The mixture is steamed and taken orally.
	Diabetes and nephropathy	Dried *O. sinensis* is eaten raw.
	Strengthening the immune system for disease prevention	*O. sinensis* is steeped in grain alcohol for one day before drinking the tea and eating the caterpillar fungus.
Tibetan people in Shangri-La County	Treating hypertension and rheumatism, and blindness caused by rheumatism	*O. sinensis* is steeped in grain alcohol or is ground and taken with hot water.
	Speeding up labor parturition	*O. sinensis* is stewed with pork. Women need to eat this stew while in labor.
Lisu people in Weixi Lisu Autonomous County	Improving eyesight	*O. sinensis* is dried over the fire and chewed with hot water or grain alcohol.
	Use as a tonic	Dried *O. sinensis* is ground and the powder mixed with chicken soup.
Tibetan people in Deqin County	Improving eyesight	Dried *O. sinensis* is ground and mixed with butter, then used in the typical butter tea; sometimes *O. sinensis* is boiled in water and steeped for one day before drinking the tea and eating the caterpillar fungus; sometimes *O. sinensis* is just eaten raw.
	Use as a tonic	*O. sinensis* is stewed with chicken and taken with chicken soup; sometimes *O. sinensis* is stuffed in a chicken and steamed; sometimes *O. sinensis* is steeped in grain alcohol.

with butter, then drink it just like their typical butter tea; sometimes they boil it in water and let it steep for one day before drinking the tea and eating the caterpillar fungus; some Tibetans just eat it raw.

IV. CONCLUSIONS

Ophiocordyceps sinensis is considered a medicinal mushroom in oriental medicines, such as TCM[23] and TTM.[2,6] Caterpillar fungus is endemic to alpine habitats on the Tibetan Plateau including Northwest Yunnan, as well as the Central and Eastern Himalayas (Nepal, Bhutan, and India). In China, the known range of *O. sinensis* includes Tibet AR, Sichuan, Qinghai, Gansu, and Yunnan Provinces; the latter inhabited by Tibetan, Bai, Lisu, Naxi, Yi, Hui, and, of course, Han people. The ethnopharmacological use of the caterpillar fungus among Tibetan and Han people is wildly known, but use of it by other ethnic groups has not been significantly documented.

In this study, we focused emphatically on the ethnomedicinal use of *O. sinensis* among Bai, Naxi, Lisu, and Tibetan people, who all live in the distribution area of *O. sinensis* in the Northern Yunnan Province. We reviewed the traditional knowledge about collection, discovery, protection, and nutrition among indigenous people and the types of diseases treated and various methods of application, which differ, as do the legends about *O. sinensis*, depending on the ethnic group in question.

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