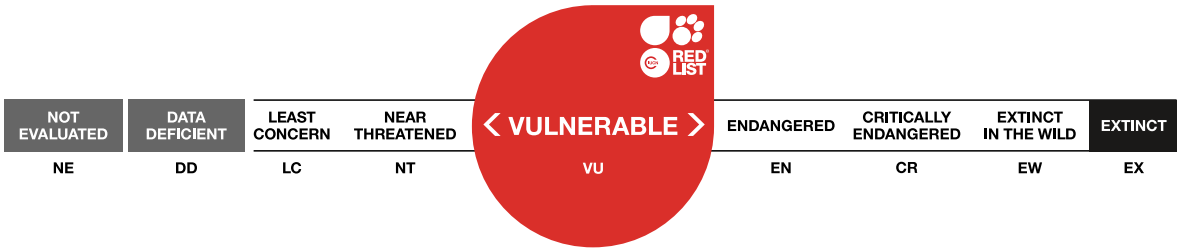
The IUCN Red List of Threatened Species™
ISSN 2307-8235 (online)
IUCN 2020: T58514773A179197748
Scope(s): Global
Language: English

Ophiocordyceps sinensis, Chinese Caterpillar Fungus

Amendment version

Assessment by: Yang, Z.-L.



View on www.iucnredlist.org

Citation: Yang, Z.-L. 2020. *Ophiocordyceps sinensis* (amended version of 2020 assessment). *The IUCN Red List of Threatened Species* 2020: e.T58514773A179197748.
https://dx.doi.org/10.2305/IUCN.UK.2020-3.RLTS.T58514773A179197748.en

Taxonomy

Kingdom	Phylum	Class	Order	Family
Fungi	Ascomycota	Sordariomycetes	Hypocreales	Ophiocordycipitaceae

Scientific Name: *Ophiocordyceps sinensis* (Berk.) G.H.Sung, J.M.Sung, Hywel-Jones & Spatafora

Synonym(s):

- *Cordyceps sinensis* (Berk.) Sacc.
- *Sphaeria sinensis* Berk.

Common Name(s):

- English: Chinese Caterpillar Fungus, Caterpillar Fungus
- Chinese: Dōng chóng xià cǎo
- Tibetan: Yartsa Gunbu, Yatsa Gunbu

Taxonomic Notes:

The species is known to exhibit substantial genetic diversity (Stensrud *et al*. 2007, Zhang *et al*. 2009), especially in the southern part of its range. Here, populations are likely to be more isolated due to the terrain and it is possible that speciation has occurred.

Assessment Information

Red List Category & Criteria: Vulnerable A2bcd+3bcd+4bcd ver 3.1

Year Published: 2020

Date Assessed: October 31, 2019

Justification:

The Chinese Caterpillar Fungus (*Ophiocordyceps sinensis*) is a terrestrial fungus parasitizing larvae of ghost moths and produces a fruiting body that since long has been used as one of the most valued Traditional Chinese Medicines. Recent studies have also demonstrated that the fungus can be used to treat a wide range of conditions. It has been officially classified as a drug in the Chinese Pharmacopoeia since 1964, and listed as an endangered species under the second class of state protection since 1999. The conservation status of the species is deteriorating due to its strict host-specificity on moth insects, and confined geographical distribution, and over exploitation by humans in recent decades. The price of natural products of *O. sinensis* has increased sharply in recent years and is now sold at the price of gold or higher.

The mean annual harvest of this species has declined in many if not all areas across its range, e.g. in the Gurjakhani area of Barse block of Myagdi district, Nepal, the collection of *O. sinensis* declined by 37% (based on collected weight) between 2008 and 2010. An analysis of harvesters' perceptions of resource abundance and sustainability in Nepal shows that virtually all harvesters (95.1%) believe the availability of this fungus to be declining in pastures, and 67% consider current harvesting practices to be unsustainable. The evidence from interviews of harvesters and traders in Bhutan and China largely mirrors that found in Nepal. Although information on the extent of the declines is not available across

https://dx.doi.org/10.2305/IUCN.UK.2020-3.RLTS.T58514773A179197748.en

the whole range of the species, it appears to be reasonable to suspect that the population reduction in the past 15 years (three generations) has been greater than 30%, that the future reduction in the next 15 years may be even larger approaching 50% and that the ongoing reduction using mostly the time period in the past 12 years is also >30%. As a result the species is here assessed as Vulnerable under criteria A2bcd+3bcd+4bcd.

Surveys across the whole range of the species are required as the declines may well be larger than suspected here and the species could well qualify for a more threatened listing.

Previously Published Red List Assessments

2020 – Vulnerable (VU)
https://dx.doi.org/10.2305/IUCN.UK.2020-2.RLTS.T58514773A58514845.en

Geographic Range

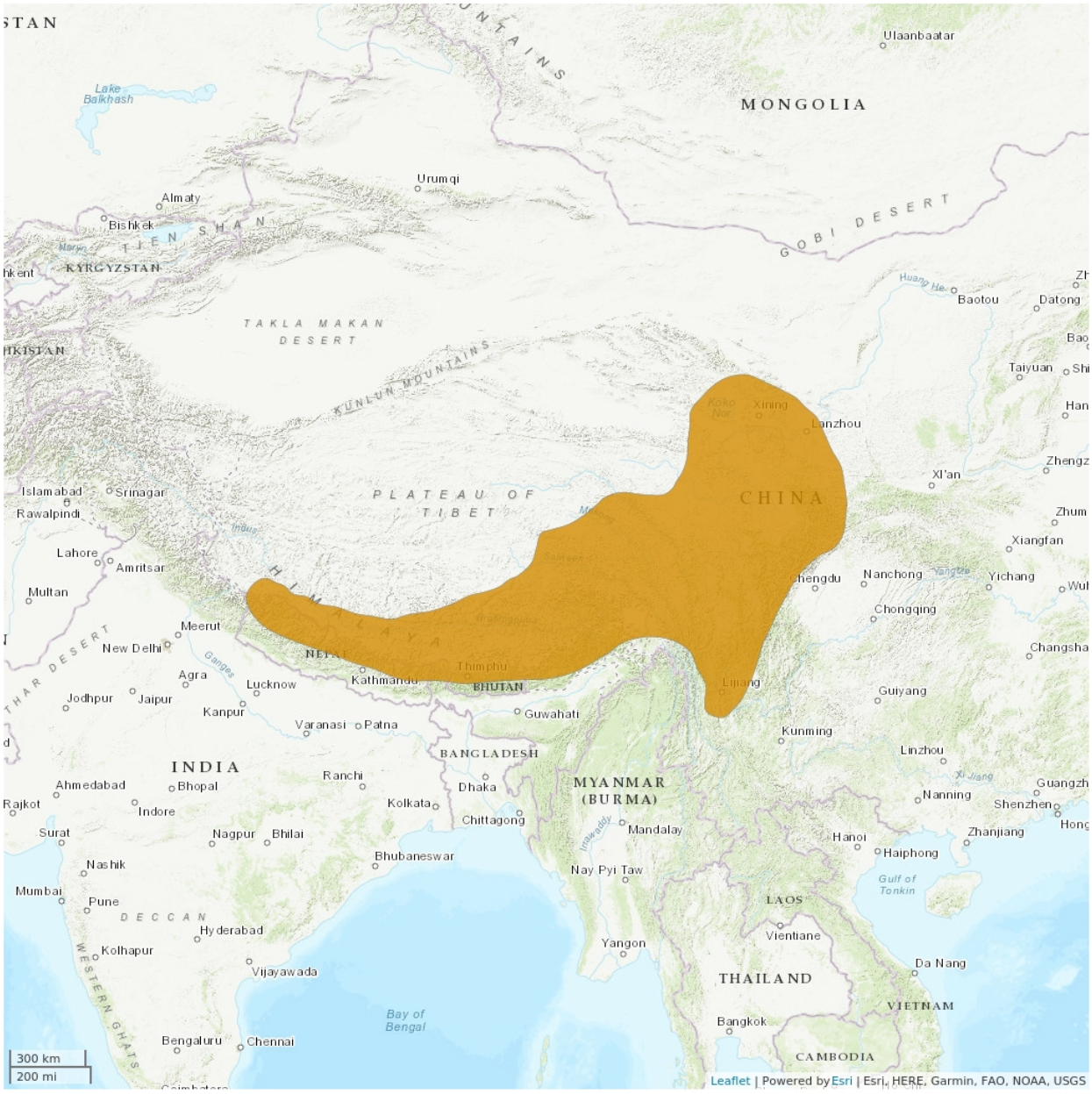
Range Description:

Ophiocordyceps sinensis is confined to Bhutan, southwestern China, northern India (mostly Himachal Pradesh, Sikkim and Uttarakhand), and Nepal, at altitudes between 3,000-5,000 m. In China, it is distributed in Tibet, Gansu, Qinghai, Sichuan, and Yunnan provinces.

Country Occurrence:

Native, Extant (resident): Bhutan; China (Gansu, Qinghai, Sichuan, Tibet [or Xizang], Yunnan); India (Himachal Pradesh, Sikkim, Uttaranchal); Nepal

Distribution Map



Legend

EXTANT (RESIDENT)

Compiled by:
IUCN 2020

The boundaries and names shown and the designations used on this map do not imply any official endorsement, acceptance or opinion by IUCN.

https://dx.doi.org/10.2305/IUCN.UK.2020-3.RLTS.T58514773A179197748.en

Population

It is a challenge to estimate the population size and trends of *Ophiocordyceps sinensis* due to natural fluctuations of the hosts, increasing commercial activities and few monitoring initiatives. A small-scale study in Bhutan indicated a 60% variation in numbers of individuals in a research plot over a three-year period, probably due to natural fluctuations in population size of the host caterpillars (Paul Cannon pers. comm.). However, the harvest size and market price of the fungus may serve as a gross population estimate. The local market price has increased by up to 2,300% over the last 10 years in Dolpa, Nepal. This has encouraged local harvesters to collect more intensively and to focus more carefully on suitable locations. Based on interviews with 203 harvesters and 28 traders, and focus group discussions in Dolpa, Nepal, Shrestha and Bawa (2013a) quantified the amount of harvest and trade. Since legalization of trade in Nepal in 2001, trade volume has increased consistently, reaching a peak of 2,442.4 kg in 2009 and subsequently declining to 1,170.8 kg in 2011. The mean annual harvest declined from 260.66 ± 212.21 pieces per person in 2006 to 125.82 ± 96.84 pieces per person in 2010. Their analysis of harvesters' perceptions of resource abundance and sustainability shows that virtually all harvesters (95.1%) believe the availability of this fungus to be declining in pastures, and 67% consider current harvesting practices to be unsustainable. The evidence from interviews of harvesters and traders in Bhutan and China largely mirrors that found in Nepal. In Gurjakhani area of Barse block of Myagdi district, Nepal, the collection of *O. sinensis* has declined by 37% — based on collected weight (kg) — between 2008 and 2010 (Thapa *et al*. 2014). The opinion of harvesters throughout the range of this species is that populations are in decline (see also Shrestha *et al.* 2019, Yadav *et al.* 2019).

In the mountains of northern India, in March–April, as soon as the snow starts melting, whole villages, except the elderly and small children, go and stay in the alpine meadows for nearly three months to collect the fungus (Negi *et al*. 2006). Family members working elsewhere come back on leave to help in collecting because the economic return is higher. Before 1995 prices were not good and there were few collectors. The number of collectors and the harvest then increased steadily until 2007. The size of harvest subsequently gradually declined, probably because of disturbance of the fragile ecology and habitat of this fungus by the increased numbers of collectors. In a single season, a primary collector may collect 45 to 55 mummified larvae with the fungus. In Munsyari market in Pithoragarh district (Uttarakhand, north India) alone nearly 90 kg of these were sold in 2009. The state government has put in place regulations for collection of this fungus policed through local village cooperative bodies with the aim of legalizing the trade. This has not been universally successful. About 3–5 quintals (i.e. 300–500 kg) of *O. sinensis* per annum is estimated to be traded illegally from Dharchula (India) to Nepal and finally to the international market. During the collecting season local tea shops and restaurants arrange transportation of food to the collection areas, generating about 48,000 employment days per year for the local economy (G.C. Pant pers. comm.).

Given its high altitude habitat there is also some evidence that there could be complimentary declines as a result of climate change (Yan *et al.* 2017), but this does contrast with work by Shrestha and Bawa (2014) who did not find strong evidence for such an impact.

Current Population Trend: Decreasing

Habitat and Ecology **(see Appendix for additional information)**

Ophiocordyceps sinensis, a fungus endemic to the Himalaya and Tibetan Plateau, is found largely in isolated patches of alpine grasslands at 3,000-5,000 m elevation. It parasitizes underground dwelling larvae of moths (Lepidoptera), especially species of *Thitarodes* (Ghost Moths). The larvae of the host insects live underground for their entire larval stage of three to four years or longer, feeding on roots and caudexes of alpine plants. If infected by the fungus, they usually die in the winter. The body of the insect host is used by the fungus as substratum to form the mycelium, and is finally converted into a sclerotium, leaving the exoskeleton intact. The fungal stroma comes out in spring or early summer of the following year.

There are probably many species of *Thitarodes* associated with *O. sinensis*, few of which are well-known (*T. armoricanus* and *T. jianchuanensis*). Some at least will face the same threats as *O. sinensis*. There is some evidence that *O. sinensis* co-evolved with its hosts (Quan *et al*. 2014a,b), but little information as yet to show that particular populations or other subgroups are specific to particular *Thitarodes* taxa.

Thitarodes caterpillars seem to be generalist feeders and recent information suggests that they prefer roots of grasses and other herbaceous plants over those of *Rhododendron* species that are frequently present in the same habitats. Spread of Rhododendron may therefore threaten *O. sinensis* populations.

The infection process and life cycle of the fungus and its host need more research. There are indications in some areas that the caterpillar is infected soon after hatching and the fungus may stay dormant within its body for several years until the caterpillar is ready to pupate. Physiological changes caused by pupation may stimulate active growth of the fungus and death of the caterpillar.

Systems: Terrestrial

Use and Trade

Ophiocordyceps sinensis has been used for at least 2000 years to treat many diseases related to lungs, kidney, and it is also used as an aphrodisiac. This fungus is not yet cultivated commercially, despite the fact that several fermentable strains of the species have been isolated by Chinese scientists.

The species is known in the West as a medicinal mushroom, and its use has a long history in traditional Chinese medicine as well as traditional Tibetan medicine. The hand-collected fungus-caterpillar combination is valued by herbalists and as a status symbol; it is used as an aphrodisiac and treatment for ailments such as fatigue and cancer, although such use is mainly based on traditional Chinese medicine and anecdote. Recent research indicates that the species has a variety of beneficial effects in animal testing, including increased physical endurance through heightened ATP production in rats.

In rural Tibet, trade in this species has become the most important source of cash income. The fungus contributes more than 40% of the annual cash income to local households and almost 10% of the GDP (Winkler 2009).

Threats **(see Appendix for additional information)**

The major threat is the largely unregulated large scale and increasing harvest of the fungus throughout its range fueled by high demand and increasingly high prices. Besides over-collection by humans, there are numerous other minor threats. Over-grazing leading to desertification has been observed;

https://dx.doi.org/10.2305/IUCN.UK.2020-3.RLTS.T58514773A179197748.en

paradoxically there are concerns also that under-grazing is deleterious to the species as the increased vegetation height reduces the effectiveness of spore dispersal. Ecosystem-level threats caused by harvesters chopping down trees for firewood are important in some parts of the fungus's range, and nitrogen pollution from the growing human population probably has a negative effect on the habitat of the species. Changes in vegetation cover are reported; especially increase in growth of dwarf rhododendron which probably does not benefit the species. Ground-dwelling birds and charismatic megafauna are also deterred by the harvesters, reducing the value of the collection sites for ecotourism. Climate change may also cause further desertification of the Tibetan plateau and reduce the altitudinal islands in the Himalayas that are suitable for *Ophiodordyceps sinensis*.

Conservation Actions **(see Appendix for additional information)**

To-date, various actions have taken place. In Bhutan and in some areas of China, collection is restricted to the local indigenous human population. Restrictions have also been placed on the number of family members allowed to collect, and on the period in which harvest is allowed. In Bhutan, collection at the end of the season was/is restricted, to allow the remaining stromata to sporulate. Immature specimens have a higher economic value so this rule minimized the financial impact on the harvesters. In Bhutan, support for the harvesters by regulating the market and preventing exploitation in the economic chain, and through education in post-harvest processing, has improved incomes and hopefully also trust between harvesters and conservation officials. Despite all of these measures, there is some pessimism that they have actually achieved even a degree of sustainability, due to the sheer value of the product stimulating a short-term approach. In Bhutan and other parts of the fungus's range, much of the land is already protected through designation as national parks or nature reserves. However, under-resourced regulatory organizations mean that their protection is limited and is particularly weak in border areas. A participatory approach which gives some decision-making power to the indigenous people is more likely to succeed, unless the protected areas are sufficiently remote.

The species occurs in a number of protected areas across its range e.g. Baima Xueshan Nature Reserve in China. However, more protected areas should be established, e.g. in the mountainous areas of southwestern China and the Qinghai-Tibetan Plateau.

There is currently a substantial amount of research into cultivation of the species, which could reduce the impact on natural populations. While numerous claims have been made, it appears that there has been very limited success in rearing the caterpillar hosts and infecting them with *Ophiocordyceps sinensis* to produce farmed stromata; although there does appear to have been some recent progress on this front (Li *et al.* 2019, Liu *et al.* 2019). Successful artificial rearing of host insect species for *O. sinensis* under low temperature conditions will allow the cultivation of this important fungus-insect complex to ensure its protection as a bio-resource and for commercial supply (Tao *et al*. 2016).

Credits

Assessor(s): Yang, Z.-L.

Reviewer(s): Dahlberg, A.

Contributor(s): Cannon, P., Devkota, S. & Yao, Y.-J.

Bibliography

Baral, B., Shrestha, B. and da Silva, J. A. T. 2015. A review of Chinese *Cordyceps* with special reference to Nepal, focusing on conservation. *Environmental and Experimental Biology* 13: 61-73.

Buenz, E.J., Baue, B.A., Osmundson, T.W. and Motley, T.J. 2005. The traditional Chinese medicine *Cordyceps sinensis* and its effects on apoptotic homeostasis. *Journal of Ethnopharmacology* 96: 19-29.

Cannon PF. 2011. The caterpillar fungus, a flagship species for conservation of fungi. . *Fungal Conservation* 1: 35-39.

Cannon PF, Hywel-Jones NL, Maczey N, Norbu L, Tshitila, Samdup, T. & Lhendup, P. 2009. Steps towards sustainable harvest of Ophiocordyceps sinensis in Bhutan. *Biodiversity & Conservation* 18: 2263-2281.

IUCN. 2020. The IUCN Red List of Threatened Species. Version 2020-2. Available at: www.iucnredlist.org. (Accessed: 13 June 2020).

IUCN. 2020. The IUCN Red List of Threatened Species. Version 2020-3. Available at: www.iucnredlist.org. (Accessed: 10 December 2020).

Liu, F., Wu, X.L., Yin, D.H., Chen, S.J. and Zeng, W. 2005. Overview in biological studies of host insects of *Cordyceps sinensis*. *Chongqing Journal Research on Chinese Drugs and Herbs* 51: 45-52.

Liu, G., Han, R. and Cao, L. 2019. Artificial cultivation of the Chinese *Cordyceps* from injected ghost moth larvae. *Environmental Entomology* 48(5): 1088-1094.

Li, X., Liu, Q., Li, W., Li, Q., Qian, Z., Liu, X. and Dong, C. 2019. A breakthrough in the artificial cultivation of Chinese *Cordyceps* on a large-scale and its impact on science, the economy, and industry. *Critical Reviews in Biotechnology* 39(2): 181-191.

Negi, C.S., Koranga, P.PR and Ghinga, H.S. 2006. Yar tsa Gumba (*Cordyceps sinensis*): A call for its sustainable exploitation. *International Journal of Sustainable Development & World Ecology* 13: 165-172.

Quan QM, Chen LL, Wang X, Li S, Yang XL, et al. 2014. Genetic diversity and distribution patterns of host insects of caterpillar fungus Ophiocordyceps sinensis in the Qinghai-Tibet Plateau. *PLoS ONE* 9(3): e92293.

Quan, Q.M., Wang, Q.X., Zhou, X.L., Li, S., Yang, X.L., Zhu, Y.G. and Cheng, Z. 2014. Comparative phylogenetic relationships and genetic structure of the caterpillar fungus *Ophiocordyceps sinensis* and its host insects inferred from multiple gene sequences. *Journal of Microbiology (Seoul, Korea)* 52(2): 99-105.

Shrestha, U.B. and Bawa, K.S. 2013a. Trade, harvest, and conservation of caterpillar fungus (*Ophiocordyceps sinensis*) in the Himalayas. *Biological Conservation* 159: 514-520.

Shrestha, U.B. and Bawa, K.S. 2013b. Dimensions of caterpillar fungus (*Ophiocordyceps sinensis*) decline—A response to Stewart *et al.*. *Biological Conservation* 167: 448-449.

Shrestha, U. B. and Bawa, K. S. 2014. Impact of Climate Change on Potential Distribution of Chinese Caterpillar Fungus (*Ophiocordyceps sinensis*) in Nepal Himalaya. *PLoS ONE*: https://doi.org/10.1371/journal.pone.0106405.

Shrestha, U. B., Dhital, K. R. and Gautam, A.P. 2019. Economic dependence of mountain communities on Chinese caterpillar fungus *Ophiocordyceps sinensis* (yarsagumba): a case from western Nepal. *Oryx* 53(2): 256-264.

Stensrud, O., Schumacher, T., Shalchian-Tabrizi, K., Svegården, I.B. and Kauserud, H. 2007. Accelerated nrDNA evolution and profound AT bias in the medicinal fungus *Cordyceps sinensis*. *Mycological Research* 111: 409-415.

Stewart, M.O., Bushley, K.E. and Yang, Y.P. 2013. Regarding the social–ecological dimensions of caterpillar fungus (*Ophiocordyceps sinensis*) in the Himalayas – Reply to Shrestha and Bawa. *Biological Conservation* 167: 446-447.

Tao, Z., Cao, L., Zhang, Y., Ye, Y. and Han, R. 2016. Laboratory rearing of *Thitarodes armoricanus* and *Thitarodes jianchuanensis* (Lepidoptera: Hepialidae), hosts of the Chinese medicinal fungus *Ophiocordyceps sinensis* (Hypocreales: Ophiocordycipitaceae). *Journal of Economic Entomology* 109(1): 176-81.

Thapa, B.B., Panthi, S., Rai, R.K., Shrestha, U.B., Aryal, A., Shrestha, S. and Shrestha, B. 2014. An assessment of Yarsagumba (Ophiocordyceps sinensis) collection in Dhorpatan hunting reserve, Nepal. *Journal of Mountain Science* 11(2): 555-562.

The State Pharmacopoeia Commission of PR China. 2010. *Pharmacopoeia of the People's Republic of China. Volume 1*. China Medical Science Press, Beijing.

Wang, X.H. 2010. How to collect fungal specimens: Key needs for identification and the importance of good taxonomy. In: A.B. Cunningham and X.F. Yang (eds), *Mushrooms in Forests and Woodlands: Resource Management, Values, and Livelihoods*, pp. 21-38. Earthscan Ltd, London.

Wang, X.L. and Yao, Y.J. 2011. Host insect species of *Ophiocordyceps sinensis*: a review. *ZooKeys* 127: 43-59.

Weckerle, C.S., Yang, Y.P., Huber, F.K. and Li, Q.H. 2010. People, money, and protected areas: the collection of the caterpillar mushroom *Ophiocordyceps sinensis* in the Baima Xueshan Nature Reserve, Southwest China. *Biodiversity Conservation* 19: 2685-2698.

Winkler, D. 2008. Yartsa Gunbu (*Cordyceps sinensis*) and the fungal commodification of Tibet's rural economy. *Economic Botany* 62: 291-305.

Winkler, D. 2009. Caterpillar Fungus (*Ophiocordyceps sinensis*) production and sustainability on the Tibetan Plateau and in the Himalayas. *Asian Medicine* 5(2): 291-316 (doi:10.1163/157342109X568829).

Yadav, P.K., Saha, S., Mishra, A.K., Kapoor, M., Kaneria, M., Kaneria, M., Dasgupta, S. and Shrestha, U.B. 2019. Yartsagunbu: transforming people's livelihoods in the Western Himalaya. *Oryx* 53(2): 247-255.

Yan, Y., Li, Y., Wang, W.-J., He, J.-S., Yang, R.-H., Wu, H.-J., Wang, X.-L., Jiao, L., Tang, Z. and Yao, Y.-J. 2017. Range shifts in response to climate change of *Ophiocordyceps sinensis*, a fungus endemic to the Tibetan Plateau. *Biological Conservation* 206: 143-150.

Yao, Y.J. 2004. Conservation and rational use of the natural resources of *Cordyceps sinensis*. *Scientific News* 15: 28-29.

Zang, M. and Kinjo, N. 1996. Type study on the *Cordyceps sinensis*. *Acta Botanica Yunnanica* 18: 205-208.

Zhang, Y., Li, E., Wang, C., Li, Y. and Liu, X. 2012. *Ophiocordyceps sinensis*, the flagship fungus of China: terminology, life strategy and ecology. *Mycology* 3: 2-10.

Zhang, Y., Xu, L., Zhang, S., Liu, X., An, Z., Wang, M. and Guo, Y. 2009. Genetic diversity of *Ophiocordyceps sinensis*, a medicinal fungus endemic to the Tibetan Plateau: implications for its evolution and conservation. *BMC Evolutionary Biology* 9: 920.

Citation

Yang, Z.-L. 2020. *Ophiocordyceps sinensis* (amended version of 2020 assessment). *The IUCN Red List of Threatened Species* 2020: e.T58514773A179197748. https://dx.doi.org/10.2305/IUCN.UK.2020-3.RLTS.T58514773A179197748.en

Disclaimer

To make use of this information, please check the Terms of Use.

External Resources

For Supplementary Material, and for Images and External Links to Additional Information, please see the Red List website.

Appendix

Habitats
(http://www.iucnredlist.org/technical-documents/classification-schemes)

Habitat	Season	Suitability	Major Importance?
3. Shrubland -> 3.4. Shrubland - Temperate	-	Suitable	Yes
4. Grassland -> 4.4. Grassland - Temperate	-	Suitable	Yes

Plant Growth Forms
(http://www.iucnredlist.org/technical-documents/classification-schemes)

Plant Growth Form
M. Fungus

Use and Trade
(http://www.iucnredlist.org/technical-documents/classification-schemes)

End Use	Local	National	International
Medicine - human & veterinary	Yes	Yes	Yes

Threats
(http://www.iucnredlist.org/technical-documents/classification-schemes)

Threat	Timing	Scope	Severity	Impact Score
5. Biological resource use -> 5.2. Gathering terrestrial plants -> 5.2.1. Intentional use (species is the target)	Ongoing	Whole (>90%)	Rapid declines	High impact: 8
	Stresses:	1. Ecosystem stresses -> 1.2. Ecosystem degradation 2. Species Stresses -> 2.1. Species mortality 2. Species Stresses -> 2.2. Species disturbance 2. Species Stresses -> 2.3. Indirect species effects		

Conservation Actions in Place
(http://www.iucnredlist.org/technical-documents/classification-schemes)

Conservation Action in Place
In-place land/water protection
Occurs in at least one protected area: Yes
In-place species management

Conservation Action in Place
Subject to ex-situ conservation: No
In-place education
Included in international legislation: No
Subject to any international management / trade controls: No

Conservation Actions Needed

(http://www.iucnredlist.org/technical-documents/classification-schemes)

Conservation Action Needed
1. Land/water protection -> 1.1. Site/area protection
3. Species management -> 3.1. Species management -> 3.1.1. Harvest management
3. Species management -> 3.1. Species management -> 3.1.2. Trade management
3. Species management -> 3.4. Ex-situ conservation -> 3.4.1. Captive breeding/artificial propagation

Research Needed

(http://www.iucnredlist.org/technical-documents/classification-schemes)

Research Needed
1. Research -> 1.2. Population size, distribution & trends
1. Research -> 1.3. Life history & ecology
1. Research -> 1.4. Harvest, use & livelihoods
1. Research -> 1.5. Threats

Additional Data Fields

Distribution
Estimated extent of occurrence (EOO) (km^2): 1891095
Lower elevation limit (m): 3,000
Upper elevation limit (m): 5,000
Population
Continuing decline of mature individuals: Yes
Extreme fluctuations: Yes
Population severely fragmented: No
All individuals in one subpopulation: No

Habitats and Ecology
Continuing decline in area, extent and/or quality of habitat: Yes
Generation Length (years): 3-5

Amendment

Amendment reason: Coding as 'not cultivated' in the use and trade section was removed, because it appears to be cultivated, just not commercially. Text in the conservation actions section have been updated (along with associated reference changes), to reflect this too.

https://dx.doi.org/10.2305/IUCN.UK.2020-3.RLTS.T58514773A179197748.en

The IUCN Red List Partnership

The IUCN Red List of Threatened Species™ is produced and managed by the IUCN Global Species Programme, the IUCN Species Survival Commission (SSC) and The IUCN Red List Partnership.

The IUCN Red List Partners are: Arizona State University; BirdLife International; Botanic Gardens Conservation International; Conservation International; NatureServe; Royal Botanic Gardens, Kew; Sapienza University of Rome; Texas A&M University; and Zoological Society of London.