

2011 - The Year Cordyceps Mushroomed in the Media Landscape but did not thrive in Tibet

Daniel Winkler

To collectors of *Yartsa gunbu* 2011 was a lousy year. The BBC (Jolly, 2011) broadcasted that caterpillar fungus (*Ophiocordyceps sinensis*) was the “Curse of the Himalayas,” but all in all, it was a stellar fungal year in the Western media. From NPR and *National Geographic Daily News* to *Men’s Journal* and *The New York Post* (Giove, 2011) *Cordyceps* mushroomed on the networks and in print. Furthermore, not just Tibetan caterpillar fungus thrived but Zombie Ants crawled into the limelight.

Very intriguing were the photos, which made it on *National Geographic Daily News* (2011), and especially the research results published by a team around Penn State’s David Hughes. The media, like *Discover Magazine* (Zimmer, 2011), *Huffington Post*, BBC, countless blogs and many others leapt on fascinating articles with titles referring to zombie ants, whose existence is nothing new to science, but apparently to the news people. Hughes, Andersen, Hywell-Jones et al. (2011) explain “The term zombie ants underlines that, while the manipulated individual may look like an ant, it represents a fungal genome expressing fungal behavior through the body of an ant.” The paper is entitled “Behavioral mechanisms and morphological symptoms of zombie ants dying from fungal infection.” It was “found that infected ants behave as zombies and display predictable stereotypical behaviors of random rather than directional walking [...]. Transitions from erratic wandering to death grips on a leaf vein were abrupt and synchronized around solar noon.”

Hughes’ team researched the mechanisms that make the infected *Camponotus leonardi* ants in the Thai rainforest move to the end of a low, shady branch in a more humid environment where the fungus has

the best chances to spread its spores far and wide. The usual habitat of this carpenter ant is higher up in the drier canopy. At the end of the branch the zombie ant bites into the vein below the leaf, a behavior healthy ants do not display. Interestingly, once the ant bites the leaf, its mandibles lock, a reaction known as a “death grip.” A physiological change in the mandibular muscles caused by the fungal parasite “transforms functional mandibles into death grip lock-jaws.” Already in 2010 Hughes et al. published a paper that showed this “death-grip behavior” was already in existence around 48 million years ago as evidenced in a fossil record from now Messel, Germany. Furthermore, in 2011 the gene was identified that activates “topism” in gypsy moths (*Lymantria dispar*). Topism, which was already described in 1890 as *Wipfelkrankheit* (“tree top disease”) by the German biologist Hofmann, is the phenomena that infected moths will climb to the top of a tree to die and liquefy, and by doing so, spreading far and wide the infective viral particles of the *Baculovirus* that made the caterpillar climb the tree in the first place. Kelli Hoover, a Penn State colleague of Hughes, co-authored a paper (Hoover et al., 2010) on finding the gene that triggers the behavior, a finding that went beyond the entomoparasitic community—not sure if I like to be part of that community!—since it also was the first solid genetic proof of Richard Dawkins’ 1982 theory on extended phenotype, which suggested “that the genes of an organism can be expressed beyond its immediate biological boundary, extending for example to birds’ nests, or the behavior of hosts infected by parasites” (*Science Daily*, 2009), a hot topic in evolutionary biology. Finally the article “Hidden Diversity Behind the Zombie-Ant Fungus *Ophiocordyceps unilateralis*” (Evans et al., 2011). Hughes co-

authored with Simon Elliot and Harry Evans (yes, Harry of CABI, UK and not to be confused with my Amazon MushRoaming buddy, Missoula mycologist Larry Evans) presented the split into four of aforementioned species native to the highly endangered Atlantic forest of Brazil. As it turned out each ant species had their personal poisonous parasite. This split indicates there might be a much higher diversity within the entomophagous fungi, and more of them might turn out to be so narrowly host specific.

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Most media attention, however, zoomed in on a tragic caterpillar fungus event – no, not the tragedy that happens annually to the literally billions of poor ghost moth larvae, but a tragic tale that took place when eight Nepalis were killed when stealthily collecting *Yartsa gunbu*, as Tibetans and Himalayan inhabitants know *Ophiocordyceps sinensis*. The eight poachers were busted by a local posse while intruding onto the caterpillar fungus turf above a remote village in the Annapurna region. In a nut shell, one poacher got killed in the process of “teaching” the intruders a lesson. As a result 36 villagers went along with the brilliant idea to kill the remaining seven poachers in hope that no one would ever find out what happened in the dark of the night to the



Yabu collecting above Da Nge Valley in Zadoi, Yushu, Qinghai, 4800m (15,000ft). *Yartsa gunbu* collection is her main income. She has been collecting since 25 years, since her early childhood.

one poor fellow. With eight men gone missing and 36 perpetrators—although sworn to silence—a crime so hideously committed was impossible to conceal. Soon most men of the village were arrested and finally in November 2011 six of the villagers received life sentences for their role in the killings and thirteen others received a two year prison term. Returning to their slopes for hunting *Yartsa gunbu* this spring the spirit of the collectors will surely be weighed down by the tragic and monstrous act of the past.

Although the Nepali Caterpillar fungus murders were already published by Jamie James in *Men's Journal* in June 2010, Eric Hansen's long feature entitled "The Killing Fields" in *Outside Magazine* in August 2011 triggered all kinds of secondary reports including a short, but good piece in *Huffington Post*, the BBC and several reports on NPR. And since Hansen declared me the "the world's foremost yarchagumba expert" [using the Nepali version of *Yartsa gunbu*] I was contacted by a bunch of media outlets including NPR, which really excited me, since I am a listener-supporter of many years. NPR's Lauren Silverman produced a story called "Caterpillar Fungus: The Viagra of the Himalayas" featuring



WWF's Norbu sharing the author's *Yartsa gunbu* maturity chart with Yabu. Zadoi County, Yushu Tibetan Autonomous Prefecture, Qinghai


Eric Hansen, Britt Bunyard (Editor in Chief of *FUNGI*) and myself. The gist of Silverman's story was that *Cordyceps* has no proven medical value, a statement that ignores decades of medical research, especially in East Asia. A great and critical review of *Cordyceps sinensis* medical research was published by Paterson in 2008 already showing potential uses and dire need of more rigorous Western research.

Fox News even ran a piece on the story. They contacted me for a *Yartsa gunbu* image; however, they were not willing to pay. When the Fox News representative tried harder to get my image for free, by dangling the honors of having my name on Fox News, I probably disappointed her by informing her that I did not regard it as an honor to have my name

displayed as a contributor to the Fox News misinformation service. It is not surprising that even Fox News picked up a caterpillar fungus crime story, it has all the elements of tabloid news: exotic location, mass murder and sex. To sell a mushroom story to the mainstream media is an even more uphill battle

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Tibetan collectors searching the ground for the tiny brown fruiting bodies of *Yartsa gunbu*. In the background a collectors' camp used for six weeks in Da Nge Valley 4700m (14,600ft) in Zadoi County, Yushu, Qinghai.

than climbing a steep slope at 15,000 feet while searching for a the elusive caterpillar fungus as gales, laden with icy sleet, threaten to knock you off your feet. But the media, ever subservient to their readers and their low instincts needs a powerful hook. And, crime laced with a bit of sex fills that role smugly. Where is the sex in this some might wonder? Caterpillar fungus is regarded as a powerful aphrodisiac in East Asia, and that is not just a recent fabrication. When I asked Jakob Winkler, my twin brother, to translate the oldest text on *Yartsa gunbu* (Winkler, 2008)—as the name of caterpillar fungus is properly transcribed from Tibetan—authored by the Tibetan doctor Zurkhar Nyamnyi Dorje in the second half of the fifteenth century, the heading reads “An Ocean of Excellent Aphrodisiac Qualities” and the text started with:

“In this world sexual bliss is the most marvelous of all pleasures, the essence of the enjoyment of the all senses.”

And so far no older textual sources have surfaced. Often invoked is a sixth century Tang dynasty text on caterpillar fungus that only seems to exist in a somewhat hastily compiled chapter on *Cordyceps sinensis* in *Healing Mushrooms*, by George Halpern (2007), which can also be downloaded from the internet, which was not around in

the sixth century, but I am sure at some point we will find some website that will offer evidence the internet was already up and running back then (but only known to a sworn-in circle of Templars, aliens and Kung Fu masters). Still, this mysterious Tang Dynasty text is kept alive by *Cordyceps* dealers, who care more about the bottom line than facts, and authors who have not made the effort to find at least a title or author of this too often-invoked, mysterious

source. I personally first came across this mysterious reference in the writings of George Halpern in 2004 and wrote him requesting more specifics. He kindly replied and suggested I should check with his Chinese research assistant Josh Zhu (Zhu Jia-Shi), who is now senior scientist at Nu Skin, busily working on *Cordyceps* skin products in Utah. Back then, Dr. Zhu wrote me there was no such source. And, so far, I have not managed to find it anywhere else, although I keep looking since it is not impossible that there might be an older Chinese record than the 1694 compendium of material medica *Ben Cao Bei Yao* by Wang An, now commonly quoted as the first reference in Chinese medicine.

***Cordyceps* as medicinal fungus... a challenge to the West**

Reducing caterpillar fungus to an aphrodisiac and comparing it to Tiger penis and Rhino horn, as James does in his *Men's Journal* feature, might suit the publication, but does not do justice to this medicinal fungus, but that would be a whole different story. Also, an omnipresent favorite in many reports is the term “Himalayan Viagra” coined by journalists; I suspect Indian journalists, twelve years ago or so; even NPR's Silverman was compelled to use the term. However, *Cordyceps* surely does not work like Viagra; *Cordyceps* will not erect an instant miracle to help



Two *Yartsa gunbu*/caterpillar fungi sliced open. Note how the whole inside is completely taken over by the mycelium. The darker coloration is remnants of the larval digestive system.

overcome sexual dysfunction. Like most natural medicines it needs to be taken for quite awhile to make a difference, unless blind trust will give immediate thrust, or more scientifically the libido effect—or was it the placebo effect?

Discussing the medicinal value of *Cordyceps* is a challenging topic. Although there are hundreds of published articles, most research is done in East Asia, especially China, and much of it is not up to the standards of the Western medical establishment. Especially, the lack of double blind studies [and we are not taking about studies on the aphrodisiacal powers of *Cordyceps* where both partners enter the bed blind-folded], is a contentious issue. Anyway, I am no medical practitioner and I gladly leave the job of trying to win over doubters regarding the medicinal propensities of this myco-medicinal to *Cordyceps* producers and dealers. All I can state is that I keep getting contacted by people who swear that they have tried everything and now since taking wild *Ophiocordyceps sinensis* whatever health trouble they are plagued by is gone or at least controlled.

Moving from anecdotal evidence to more objective reports, two medical news items regarding the capacity of *Cordyceps* got my attention. The first was a British publication from the University of Nottingham (Wong et al., 2010) that describes Cordycepin as having a large spectrum of biological activities, including anti-inflammatory, anti-proliferative, and pro-apoptotic effects – the latter two referring especially to treating cancer cells; anti-proliferative meaning to inhibit tumor cell growth and pro-apoptotic meaning to induce death of tumor

The idea [was] to use *Cordyceps* against multiple sclerosis, an autoimmune disease, since *Cordyceps* must outwit the immune system of the ghost moths it feeds on in the Highlands of Tibet.



A *Yartsa gunbu*/caterpillar fungus consisting of the parasitized ghost moth larva and the fruiting body of *Ophiocordyceps sinensis*. The fruiting body is mature and just started to sporulate. 4300m / 13,300 ft Dechen Tibetan Autonomous Prefecture, Yunnan Province.

cells. The paper describes the pathway of Cordycepin via mTOR signaling to inhibit cancer cell reproduction, something Cordycepin was suspected to do since the 1950's, but the mechanism was not yet understood. It seems like I am still stuck in the fifties, but I recently learned that the mTOR signaling pathway regulates key cellular processes such as translation of RNA, ribosome biogenesis, cell growth and autophagy, and is responding to growth factors, energy metabolites and/or levels of nutrients.

Fingolimod, a new *Cordyceps*-derived multiple sclerosis drug introduced in 2011 by Novartis under the name Gilenya, is the second interesting medical news item. The narrative according to Kanoko Matsuyama (2011) of Bloomberg News, Tokyo



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Office is that 25 years ago the Japanese researcher Tetsuro Fujita had the idea to use *Cordyceps* against multiple sclerosis, an autoimmune disease, since *Cordyceps* must outwit the immune system of the ghost moths it feeds on in the Highlands of Tibet. Actually, the active ingredient used in Gilenya is Myriocin originally derived from *Isaria sinclairii*, the anamorph of *Cordyceps sinclairii*, which grows on cicadas in East Asia. For drug production the Myriocin is synthesized. The pharmaceutical analysts are hearing the ring of cash registers and searching for Gilenya on the internet as first yields suggest a plethora of projected profits. In 2011 it was speculated that it will generate up to US\$5 billion a year in global annual sales and Gilenya is projected to reach the top ten drugs, no, not most efficient or most expensive, just highest grossing drugs. The cost of treatment with Gilenya at \$3000 per month surely matches the astronomical costs of real *Yartsa gunbu* - *Ophiocordyceps sinensis* [although the list of Gilenya's serious side effects including lethal ones clearly outshines *O. sinensis*]. However, I highly doubt the Novartis marketing team based their price on the current value of *Yartsa gunbu*. Novartis would probably charge the same amount if the base was *tsampa*, roasted Tibetan barley, as long as patients were in dire need with few alternatives.

An uncertain future ahead for *Yartsa gunbu*

Dreams of huge profit were also prevalent on the Tibetan plateau in early 2011. The previous year had been an excellent one for most *Yartsa gunbu* collectors. However, a great *Cordyceps* media year did not translate into a banner harvest season. Collectors over most of the caterpillar fungus distribution area on the Tibetan Plateau and the Himalayan Range were unhappy with the scant harvest. When asked about slim pickings, native Tibetan collectors in Yushu Tibetan Autonomous Prefecture, Qinghai Province, blamed the low harvest on a dry winter and lack of spring showers that usually would precede a good *Yartsa gunbu* harvest like the one in 2010. And, of course, everyone is aware of the fact that now there are so many pickers, all financially dependant on the sumptuous fungal income, that it gets harder and harder for each family to keep

finding as much as in previous years.

Furthermore, in interviews I carried out in cooperation with the Worldwide Fund for Nature, WWF, to study the sustainability of the current harvest, it was repeatedly pointed out to me by the collectors that the harvesting is getting harder and harder. Because of increased collection pressure everybody has to walk further and to look harder to find *Yartsa gunbu*. What worried me most was that seasoned collectors told me that sites, that some decades ago used to have a hundred or more caterpillar fungi growing closely together, were now devoid of *Yartsa gunbu*. These reports made me rethink my previous position that *Yartsa gunbu* is very resilient to collection, a perspective supported by several hundred years of continued collection.



A fresh *Yartsa gunbu*/caterpillar fungus consisting of the parasitized ghost moth larva and the fruiting body of *Ophiocordyceps sinensis*. The fruiting body is just emerging from the ground and darkens with exposure. It does not produce spores in this stage, but is most sought after. 4400m/13,600 ft Nagchu, Nagchu Prefecture, Tibet Autonomous Region.

However, the collection intensity has increased so much that a balance that seemed to have functioned for centuries

is now apparently at risk. One major change I observed is that in the last five to ten years, people do not stop collecting when the *Yartsa gunbu* is past prime as the larva underground becomes very soft, as most of the resources have been consumed in the sporulation process. Once dug up, such an almost emptied exoskeleton softened by chitinase will dry to just a tiny appendix protruding from the fruiting body, a feature not desired at all, it is all about the size of the worm after all. In the past, Tibetans would leave these over-mature specimens in the ground and they could continue to produce and spread their spores to make sure the fungus can infect enough ghost moth larvae (*Thitarodes* spp.) to secure next year's crop. Although it appears that it was not a conscious traditional management approach, nevertheless it seemed to have functioned well as such. Now, with the new complete dependence on *Yartsa gunbu* money these way-past-prime specimens are collected and sold mixed in with the prime *Yartsa gunbu*. The buyers do not like this practice, they are mostly interested in a well preserved complex of larva and fungus, but the Tibetan sellers offer it as an "all or nothing" deal.

Among the objectives of the WWF mission was to find out how the collectors would react to the suggestion of leaving the over-mature specimens in the ground as investment for the future. Before suggesting such a practice I had to introduce the collectors to the fact that *Yartsa gunbu* reproduces via spores and I brought images to illustrate the point. In general it is only recently that Tibetans have learned that *Yartsa gunbu* is a fungus, and so far no one seems to have an idea how it reproduces or rather, most people assume it is *rangjung*, "self-manifesting," a term also used for natural rejuvenation of trees, but more commonly used for sacred symbols miraculously manifesting out of a rock, a common feature all over the Tibetan Plateau. I double-checked this point and most interviewees understand the *rangjung* as actually self-manifesting and had not thought about a connection between harvesting intensity and future production. Rather, Tibetan collectors blamed Chinese mining activities somewhere beyond the local mountain range for undermining Mother Nature's

forces and thus weakening her energy and reducing grassland fertility and *Yartsa gunbu* production.

Anyway, once I introduced collectors to the reproductive cycle of *Yartsa gunbu*—and every collector is very familiar with the stages of maturity since they influence the value of *Yartsa gunbu*—no one had a problem accepting the new knowledge. Not too surprising since everything else reproduces via seeds as well. We asked the collectors if they would be willing to forgo picking over-mature low-value *Yartsa gunbu* (only 10% of prime value). Most Tibetans said something to the affect of “when everybody quits picking the old ones, then I will quit too” and many of them suggested such a step would need to be decided by village councils or other political bodies higher up. Such an approach might preempt heavy handed top-down management approaches, like seriously reducing the collectors or completely closing off an area—radical

interventions Tibetan communities frequently have to cope with since “peaceful liberation.” So, right now WWF-China is working on such an information campaign. The fact that making a relatively small sacrifice, giving up picking the least valued product, which is not even desired by the dealers, could make a difference is encouraging and I really hope it will help ensure *Yartsa gunbu* remains a precious and bountiful Tibetan Plateau fungus that can be collected by many generations to come.

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Sources

(for links to all these papers please go to my Cordyceps blog at <http://blog.mushroaming.com/2012/05/02/cordyceps-in-2011.aspx>)

Evans, H.E., S.L. Elliot, and D.P. Hughes. 2011. Hidden diversity behind the zombie-ant fungus *Ophiocordyceps unilateralis*: Four new species described from carpenter ants in Minas Gerais, Brazil. *PloS One* 4(5): 598 – 602.

Giove, C. 2011. New Yorkers paying \$800 an ounce for worms that promise sexual prowess. *The New York Post*,



A carpenter ant carcass killed by *Ophiocordyceps camponoti-balzani*. Photo courtesy D. Hughes.

January 16, 2011.

Halpern, G. 2007. *Healing Mushrooms: Effective Treatment for Today's Illnesses*. Square One Publishers.

Hansen, Eric. 2011 The Killing Fields: The skyrocketing market value of yarchagumba, a rare fungus prized as an aphrodisiac, has led to turf wars—and possibly murder. *Outside Magazine*, September, 2011.

Hoover, K., M. Grove, M. Gardner, D.P. Hughes, J. McNeil and J. Slavicek. 2011. A gene for an extended phenotype. *Science* 333: 1401.

Huffington Post. 2011a. New Zombie-Creating Fungi Discovered (BBC VIDEO) March 2, 2012.

Huffington Post. 2011b. Caterpillar Fungus Transforms Tibet With Huge Cash Influx. October 10, 2011.

Hughes, D.P., S. Andersen, N.L. Hywel-Jones, W. Himaman, J. Bilen, and J.J. Boomsma. 2011. Behavioral mechanisms and morphological symptoms of zombie ants dying from fungal infection *BMC Ecology* 11: 13.

Hughes D.P., T. Wappler, and C.C. Labandeira. 2010. Ancient death-grip

leaf scars reveal ant fungal parasitism. *Biology Letters* 7(1): 67-70.

James, J. 2010. Nepal's Aphrodisiac War. *Men's Journal* volume137, May, 2010.

Jolly, J. 2011. Yarsagumba: Curse of Himalayan Annapurna region. BBC News, Katmandu, January 4, 2011.

Matsuyama, K. 2011. Himalayan Fungus Aids Mitsubishi Tanabe Sales with Multiple Sclerosis Drug. Bloomberg News, February, 2011.

National Geographic Daily News. 2011. Photos: "Zombie" Ants Found With New Mind-Control Fungi, Text Matt Kaplan, March 3, 2011.

National Geographic Radio Weekend. 2011. Feature on *Cordyceps*—Boyd Matson interviews Daniel Winkler, April 16, 2011.

Paterson, R. M. 2008. *Cordyceps*—A traditional Chinese medicine and another fungal therapeutic biofactory? *Phytochemistry* 69: 1469–1495.

Rundle, M. 2011. Zombie Animals: Fungi, Insects and Parasites That Resemble the Walking Dead. *Huffington Post UK*, March 10, 2011.

Science Daily. 2009. European

Evolutionary Biologists Rally behind Richard Dawkins' Extended Phenotype. January 19, 2009.

Silverman, L. 2011. Caterpillar Fungus: The Viagra of The Himalayas. NPR, October 9, 2011.

Stone, M. 2011. Parasite gene makes caterpillars do bidding. *Decode Science Blog*.

Winkler, D. 2008. The Mushrooming Fungi Market in Tibet - Exemplified by *Cordyceps sinensis* and *Tricholoma matsutake*, in *The Shadow of the Leaping Dragon: Demography, Development, and the Environment in Tibetan Areas*. *Journal of the International Association of Tibetan Studies* 4.

Wong Y.Y., A. Moon, R. Duffin, A. Barthelet-Barateig, H.A. Meijer, M.J. Clemens, and C.H. de Moor. 2010. Cordycepin inhibits protein synthesis and cell adhesion through effects on signal transduction. *Journal of Biological Chemistry* 285(4): 2610–2621.

Zimmer, C. 2011. More eldritch ant horror! *Discover Magazine Blogs*, May 9, 2011. 🍄

NYC FUNGI GROUP CELEBRATES 50TH IN SIGHT, SOUND, MUSHROOMS & CAGE

The New York Mycological Society, a not-for-profit membership organization dedicated to educating the public about mushrooms, was founded 50 years ago at The New School as a seminar in mushroom identification taught by the composer John Cage.

The Society is celebrating its anniversary with a presentation—in theater and in exhibition—that explores a life in mushrooms of its founder whose centenary is also this year. Both events will be held at The Cooper Union the weekend of September 7-8, 2012.

The theatrical event, to be held in the Great Hall on Saturday, September 8, will be a grand multi-media Cagean simultaneity featuring live performance, a special realization of Cage's 49 *Waltzes for the Five Boroughs*, and a lively visual backdrop of mushroom stills and movies collected and produced over the last fifty years.

The gallery event will include ephemera from the NYMS archives, original pages from Cage and Lois Long's *Mushroom Book*, mushroom art by present and former NYMS members and a display of mushroom specimens collected from the NYC environment.

The program is entitled **100/50th/Cage/NYMS — Roaming Urban Soundscapes** and is being held as a benefit for the NYMS and the John Cage Trust. 🍄

