Ecofarming
e-Magazine for Agriculture and Allied Sciences
http://www.ecofarming.rdagriculture.in
e-ISSN: 2583-0791

Winter worm summer grass

Himalayan Gold

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Received: November, 2023; Accepted: November, 2023; Published: January, 2024

Introduction

Winter worm summer grass is a parasitic complex of a fungus (*Ophiocordyceps sinensis*) and the caterpillar (*Thitarodes* spp.) which belongs to the family Hepialidae. The caterpillar is initially infected by fungi in the spring and summer seasons, and turn into ‘‘stiff worm’’ in winter, so it is called as winter worm. In the next spring and summer seasons, the stroma germinates and then grows from the head of the larva, which is known as summer grass. The fungus–caterpillar complex resulting from fungal parasitism has a long history of use in traditional Chinese medicine (TCM) as well as in traditional Tibetan medicine for the treatment of asthma, bronchial and lung inflammation, and other diseases. The hand-collected, naturally occurring fungus–caterpillar complex is highly valued by herbalists. Since this insect fungus complex is found in Himalayan region and highly valued in the market it is termed as ‘Himalayan Gold’.

Though the fungus parasitizes on many insect species, The Himalayan bat moth or ghost moth remains as a potential host. It belongs to the genus *Thitarodes* (*Hepialus*), family Hepialidae and the order Lepidoptera. Whereas the fungus *Ophiocordyceps sinensis* belongs to the family Ophiocordyceptaceae, order Hypocreales, class Sordiromycetes and the division Ascomycotina.

In interior mountain areas of Nepal it is locally known as Yarsha Gamboo means summer grass winter worm. Tibetians believe that during winter time it lives as a ‘worm’ and later as metamorphosis occurs at the start of the spring season, this worm transforms into a kind of grass. In Chinese it is called as Dong chong xia cao means winter worm summer grass and in Hindi it

is called as Kheeda jadi, kheedaghas or kheedajhar. In English it is called by various names like winter worm summer grass, Himalayan Viagra, Caterpillar fungus or called by the name of fungus *Cordyceps sinensis* or *Ophiocordyceps sinensis* (Ghanshyam and Manvitha, 2017).

Life cycle and process of infection

Life cycle of host insect

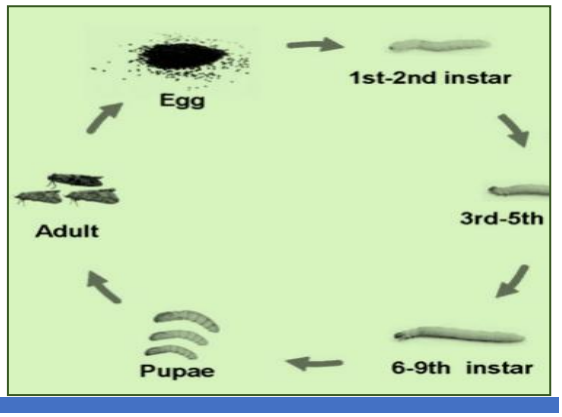
The winter worm summer grass's host insects, Hepialus, have undergone a complete metamorphosis. Its life cycle has four stages: egg, larva, pupa, and adult. All Hepialus species have a lengthy larval stage and a clear generational alternate, despite considerable variances in their biological and ecological characteristics. The life cycles of Hepialus insects typically take 3–4 years, sometimes even 4–5 years.

Between June and August, each female deposited about 500 eggs. Eggs develop throughout the course of roughly 30 to 40 days while being moisturised and incubated. The larvae have a hatchability of about 80%, and the chorion changes from being white during incubation to black.

There are six to eight instars in the larval stage, and the length of the larval development may vary depending on the instar. The larvae's survival rate in natural conditions is often less than 10% since they face several threats from natural enemies throughout their entire developing period. During the adult (or mature) larvae stage, the head capsule will change from milky white to light red or deep yellow with the larvae's growth. Typically, the larvae are dispersed in groups at a soil depth of 5 to 25 cm. Depending on the species involved, the transition from larvae to pupa takes 2-4 years. For example, *H. yushusis* larvae need to develop into pupae in roughly 996 days, *H. kangdingensis* larvae in 1000 days, and *H. gonggaensis* larvae in 875–1040 days. The larvae with different instars can always be found in the soil.

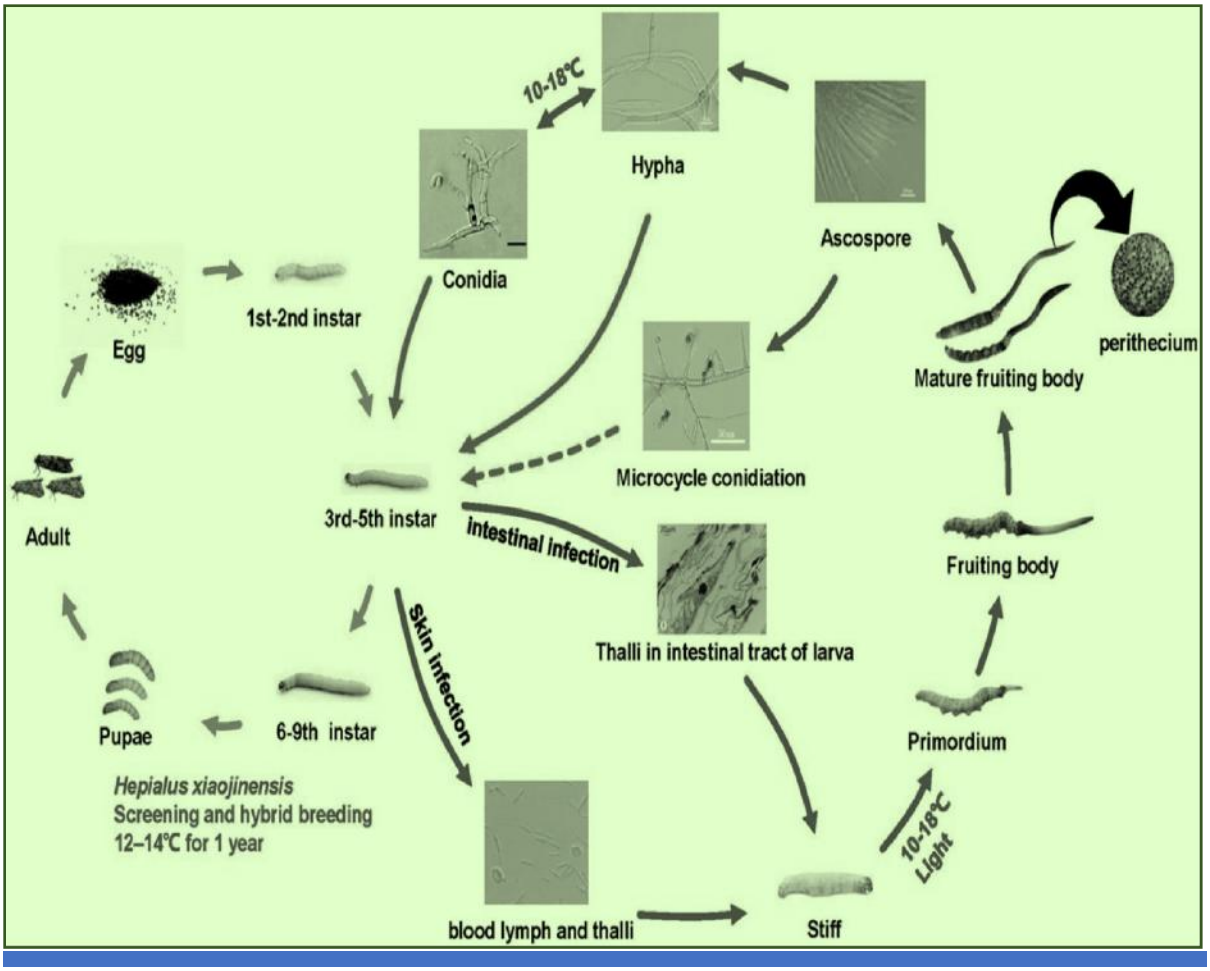
A portion of larvae develop into pupae at the end of each May, while the pupa stage for most of the larvae is from June to July. When the temperature is between 10 and 500C and the relative humidity of the soil is between 40 and 45 percent, the pupa's developmental stage must last for 40 days. The adult emergence's peak period varies depending on altitude. The Hepialus moth's colouring varies from light to dark from pre-pupa to emergence.

During the months of June to August, pupa frequently emerge daily between 17:00 and 20:00. The amount of mature female insects is often more than that of adult male insects in most producing areas. In general, the number of mating is one for females and two to three for males, and the peak of mating generally varies with altitude. It takes 5 to 40 minutes from copulation to oviposition, and copulation helps the females' oviposition. Similarly, to the mating, the peak of ovipositing also varies with the altitude. The females can only lay between 5-45 eggs in a nearby meadow after copulation. Although females live longer than males do, they pass away quickly after giving birth to their eggs. (Liu *et. al*., 2015).

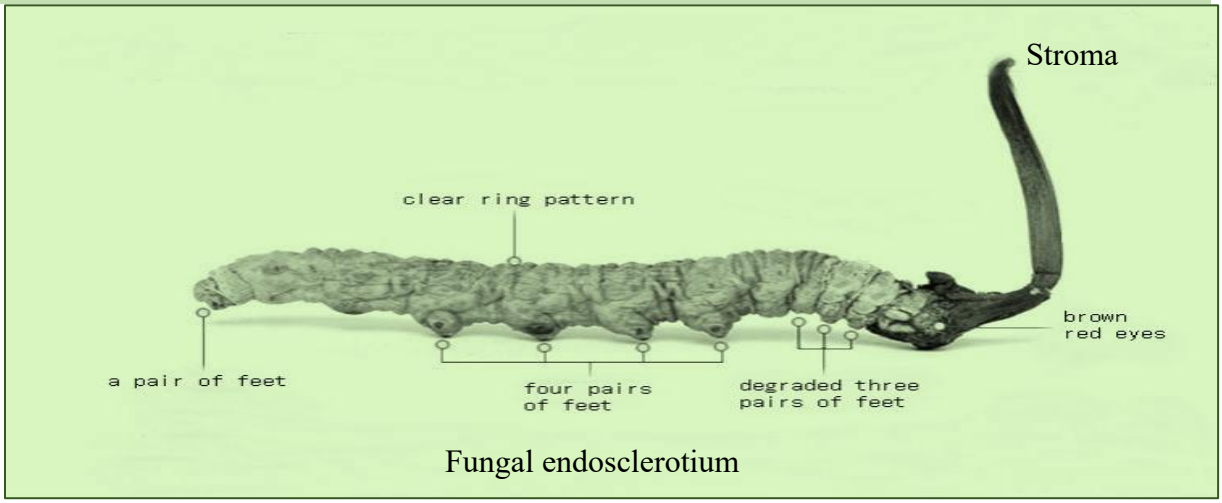


Process of infection

Due to the fungus' complex life cycle, the alpine habitat, and the short host insect lifespan, the infection cycle of the fungus that invades the host is challenging to study and understand. In the late autumn, the below-ground larvae may become infected with ascospores, conidia, and hyphae through the skin and intestine. The 4th to 5th instar larvae or the 3rd to 4th instar larvae that are shedding their old cuticles and developing new ones had the highest infection rates. The larvae in the subsequent instars are immune to infection. The fungus invades the larvae's hemocoel, breaks up into fusiform hyphae, and then grows via yeast-type budding to fill the hemocoel. It was confirmed that the larvae could experience skin and intestinal infection. The diseased larva crawls 2–5 cm beneath the soil's surface and then dies by facing its head upward. The larva gradually stiffens and is covered with mycelia on its remaining exoskeleton. Before the soil freezes, a little stroma bud typically breaks through the sclerotium's (host larvae) head. The stalked fruiting body, with its head containing mature perithecia full of thread-like ascospores, emerges from the soil surface in the spring as the stroma bud expands. The ascospores can be discharged under the right circumstances and transferred by wind or water to infect further larvae. *O. sinensis* colonises the live larva of the host insects and then changes to necrotrophy when the larvae eventually die, proving that it is a facultative saprophyte rather than an obligate biotroph. (Li *et al*., 2019).



Morphological features



Fungal endosclerotium

The fruiting body with the host caterpillar make up the caterpillar-shaped Cordyceps sinensis medicinal mushroom. The ascocarp, or fruiting body, of the *C. sinensis* mushroom begins at the base on an insect larval host (typically a Himalayan bat moth (Hepialus armonicanus) larva, though other insect hosts besides the bat moth are occasionally encountered), and ends at the club-like cap, which includes the stipe and stroma. When it is fresh, the stroma is almost twice as long as the caterpillar. Caterpillar fungus produces fruiting bodies with a head and sack-like components. The portions of the head come in various shapes, including circles, clubs, cotton swab sticks, coral reefs, noodles, and long ovals. The fruit body is dark brown to black, and the mycelium of the mushroom permeates the "root" of the organism, the larval body. The head, body, and legs of the root are worm-like and have numerous small, transverse creases. On the body of the root, there are around eight pairs of legs, and four of the middle pairs are more noticeable than the others. It has a thin lower portion and a somewhat thicker upper portion.

The fruiting bodies of *C. sinensis* were single, double, or triple in appearance as they emerged from the head of the larvae and ranged in length from 4 to 7 cm over the 3 to 4 centimetre caterpillar corpse. They were typically upright, stalked, and somewhat inflated at the tip. The colour varies widely red, yellow, purple, black, green, white, orange and olive. Typically, the young larva lives approximately 6 inches below ground, where it serves as the host plant upon which the *Cordyceps* grows. *Cordyceps sinensis* is a strange and extremely unusual sort of fungus since it parasitizes caterpillar bodies, consumes soft tissue, and mummifies insect larvae. Overall, the insect suffers as it completes its life cycle.

Importance

Constituents for medicinal significance of *Cordyceps sinensis*

- Cordycepin
- Adenosine
- Ergosterol
- Polysaccharides
- Cordyglucans
- Ergone
- Amino acids, zinc, vitamins & trace elements

Important pharmacological activities of *Cordyceps sinensis*

- Anti-asthmatic effect and anti-cancer agent
- Modulate immune responses.
- Enhance hepatic energy.
- Promote the secretion of adrenal Hormones.
- Regulating blood pressure (high or low blood pressue), Anti-aging, lowering raised blood lipid levels, Strengthening the body's immunity
- Inhibit the growth of tumour cells.
- Possess hypotensive and vasorelaxant activities.
- Replenishment of body health
- Anti-oxidation activity
- Alleviates fasting hyperglycaemia and Immunoregulatory activity.
- Anti-tumour activity and stimulating the immune system.
- Anti-apoptotic property
- Enhancement on sexual performance and the restitution of impairment in sexual function
- Reduce fatigue phlegm and stops haemorrhages. Improves the respiratory function, Improves the functioning of the heart, Improves stamina and athletic performance.
- Anti-inflammatory property
- Hypoglycemic and Hypocholesterolemic activity
- Immunomodulator Property
- Improves pulmonary function and treat respiratory disease.
- Antidepressant like activity
- Improves male reproductive dysfunction.

Dietary uses of *Cordyceps sinensis* in Medicinal Dishes

- *Cordyceps* boiled with pork - Cures opium addiction, poisoning, Jaundice and tuberculosis.
- *Cordyceps* cooked with duck - Potency of *Cordyceps* increased.
- *Cordyceps* cooked with chicken or duck soup - Used for the treatment of respiratory diseases, renal dysfunction, hyperlipidemia and hyperglycemia.
- Combination of *C. sinensis* with rhizome of *Dactylorhiza hatagirea*, honey and cow's milk - Used for a tonic and aphrodisiac.
- *Cordyceps* mixed with alcohol or traditional green tea - Used for vitality and to cure stomach ailments.
- Combination with daily dosage one dried *C. sinensis* with half litre of milk and two teaspoons of ghee for a week - Used as a tonic and used for the sexual stimulant.

References

1. Ghanshyam, G. and Manvitha, K., (2017). Yarsagumba: A miracle mushroom its history, cultivation, phytopharmacology and medicinal uses. *Revista International Journal of Herbal Medicine*, *5*(2): 2321-2187.
2. Liu, Y., Wang, J., Wang, W., Zhang, H., Zhang, X. and Han, C., (2015). The chemical constituents and pharmacological actions of *Cordyceps sinensis*. *Evidence-Based Complementary and Alternative Medicine*.
3. Liu, G., Han, R., & Cao, L., (2019). Artificial cultivation of the Chinese cordyceps from injected ghost moth larvae. Environmental entomology, 48(5):1088-1094.