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東半球之洋菇害蟲問題【研究報告】

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Abstract

摘要

洋菇害蟲包括癭蠅、菇蠅、跳蟲及璊類。癭蠅是發生最普遍的害蟲，在適當環境下以處女生殖法大量繁殖，嚴重影響洋菇罐頭品質。為減少癭蠅為害，需要找出不適宜幼蟲繁殖的洋菇品系，努力阻止成蟲侵入菇舍內，及研究洋菇休閒期間的癭蠅習性。蚤蠅、菇蠅、跳蟲及璊類在菇舍外的生存密度、菇舍構造及堆肥後醱酵管理，影響菇舍內諸害蟲的密度。為防治害蟲，必須維持各種徹底的環境衛生。

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INSECT AND MITE PESTS OF CULTIVATED MUSHROOMS – AN OVERVIEW OF THE ARTHROPOD PEST PROBLEMS OF THE EASTERN HEMISPHERE

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Abstract

The pests of mushroom include cecid flies, phorid flies, sciarid flies, springtails and mites. Cecids reproduce rapidly by paedogenesis under favorable conditions, are the commonest pest. Cecid damage in the mushroom industry greatly affects the quality of the canned product. Development of the mushroom strains unfavorable to the reproduction of cecid larvae, efforts of prevention to the entrance of cecids into mushroom houses, and study on the habits of cecids between non-mushroom producing period, must be carried out for reduction of cecid damage. Outside population of phorids, sciarids, springtails and mites, the structure of house, and the management of sweat-out greatly influence the population of those pests in mushroom house. Sanitary measures must be done completely for their control.

MUSHROOM PRODUCTION IN THE EASTERN HEMISPHERE

Mushroom production of Asia and Oceania occupied 19.42% and 1.32%, respectively, of the all world during 1976 (Delcaire, 1978) (Table 1).

Table 1. World mushroom production in 1976.

Area	Mushroom production	
	Metric Ton	%
Asia	131,000	19.42
Oceania	8,900	1.32
America	167,900	24.89
Africa	4,000	0.59
Europe	362,700	53.77
Total	674,500	99.99

Mushrooms (*Agaricus* spp.) are cultivated in Asia (Mainland China, India, Indonesia, Iran, Israel, Japan, Korea, Lebanon, Malaysia, Philippines, Taiwan) and Oceania (Australia, New Zealand). In Asia, mushrooms are produced mostly by Taiwan, South Korea and Mainland China (Delcaire, 1978) (Table 2).

Table 2. Mushroom production in Asia during 1976.

Country	Mushroom production	
	Metric Ton	%
South Eastern Asia		
Taiwan	53,300	40.78
South Korea	34,700	26.55
Mainland China	30,000 (Estimated)	22.95
Japan	7,000	5.36
Indonesia	2,000	1.68
Malaysia	1,300	0.99
North Korea	1,200(Estimated)	0.92
Philippines	500	0.38
India	270	0.21
Thailand	230	0.18
Subtotal	130,700	100
Iran, Israel, Lebanon	300	

There are large difference on the number of mushroom producers and average output between the countries. The scale of mushroom production per producer in Asia is smaller than in America, Africa, Europe (except Spain and Poland), and Oceania. There was 15,000 farmers producing mushrooms in Taiwan during 1976, 19,568 in 1977, 26,174 in 1978, and each farmer produce about 4 metric tons mushrooms in 1976. On the other hand, each mushroom producer of France and USA produce 370 and 215 metric tons, respectively, in 1976 (Delcaire, 1978) (Table 3).

Table 3. The number of mushroom producers and output in 1976.

Country	Number of producers	Average output (MT)
France	325	370
USA	650	215
New Zealand	23	60
South Korea	1,000	35
Taiwan	15,000	4

Most quantity of fresh mushrooms produced in Asia are delivered to processors (Table 4). Consequently, mushrooms sold in fresh form in Asia (10.4%) is lower than in Africa (55.0%), America (49.0%), Europe (56.6%) or Oceania (64.0%) (Delcarire, 1978).

Table 4. Quantity of fresh mushrooms delivered to processors in 1976.

Area or country	Fresh mushrooms delivered to processors (%)
Oceania	36
Japan	36
South Korea	89
North Korea	92
Taiwan	95
Mainland China	98
UK	17
Canada	36
USA	54
France	70
Netherlands	80

Yield per ping (one ping = 35.5895 sq. feet) of fresh mushrooms in Taiwan is lower than that of South Korea and USA (Table 5). The reasons of it may be attributed to the unstable temperature during the production period, methods of cultivation and loss caused by pests and diseases (Hu *et al.*, 1964; Tsai *et al.*, 1964).

Table 5. Yield of fresh mushroom in South Korea, Taiwan and USA.

Year	Yield of fresh mushroom (kg/ping)		
	South Korea	Taiwan	USA
1974–75	42[a]	24[b]	45[c]
1975–76	40	31	44
1976–77	49	34	48

a Mean year of 1974.

b Crop year from Dec. 1, 1974 to March 31, 1975.

c Crop year from July 1, 1974 to June 30, 1975.

MUSHROOM PESTS IN EASTERN HEMISPHERE

The mushroom pests of the Eastern Hemisphere can be considerable and include cecid flies, phorid flies, sciarid flies, springtails and mites. Of which, cecids reproduce rapidly by paedogenesis under favorable conditions, are the commonest and destructive pest. Cecid damage in the mushroom industry not only influences the yield of mushrooms, but also greatly affects the quality of the canned product.

Mites and maggots have been found in can of mushroom. Maggots are including cecids, sciarids and phorids. From the view of processors, mites and cecids are important pests in Korea, and cecids are the most troublesome pest in other areas.

Cecid flies include *Henria* sp., *Heteropeza pygmaea, Jeannisis fungicola, Lastrimia* spp. and *Mycophila speyeri* (Lin, 1972). Of which, *H. pygmaea* and *M. speyeri* are common and frequently found (Lin, 1972; Tsai *et al.*, 1964). Pest problems of the Eastern Hemisphere may be concentrated on cecid flies. Because cecids are limiting factor of canned product for export, and export of canned product is the main purpose of mushroom production in many countries of Asia.

In Taiwan, mushroom pests were primarily studied by Tsai *et al.* (1964), Lin (1967a, 1967b) and Lin *et al.* (1977). The mites were studied by Chen (1967) and Lin (1967c), and the springtails were reported by Pei (1966) and Pei and Toung (1968). Control of cecid fly pests with synergised pyrethrins and with synergised allethrin in Taiwan was reviewed by Chen and Tsai (1972).

SOME DESCRIPTION ON BIOLOGY OF CECID FLIES

As described by Cantelo (1980), reducing fly numbers without using insecticides requires a good understanding of fly biology and behavior. *M. speyeri* has yellow larvae, and is found both in the interior (64%) and exterior (36%) of the mushroom fruitbody. However, *H. pygmaea,* white larvae parasitise the inner part of the mushroom, are difficult to locate if the fruitbody has not been cut. During the mushroom growing period, cecid larvae live in the mushroom bed, casing soil and compost, the population being higher in the compost than in casing soil (Tsai *et al.*, 1965).

Paedogenesis provides numerous cecids by continuous larval reproduction without the intervention of a dispersive adult phase. The larvae of *H. pygmaea* turned darker, puparium-like, and went into dormance when the compost became too dry and the food too scarce or unsuitable. A single larva might have 14 offsprings in average, and most dormant larvae survive for 9 months (Lin and Ni, 1974). The favorable temperature for paedogenesis of *H. pygmaea,* 25–33°c (Jou and Tsai, 1969) is higher than that of *M. speyeri,* 20–28°c (Jou and Tsai, 1968). The population of *H. pygmaea* larvae, in the standard closed polyethylene-sheeted mushroom house at early stage of cultivation in Taiwan, is low then increases gradually (Fig. 1) (Dept. Agr. Forestry and Taiwan Farmer Assoc., 1979).

The larvae of *H. pygmaea* and *M. speyeri* reproduced very vigorously with paedogenestic cycle on the fungi which were isolated from casing soil or compost in the mushroom houses, i.e., *Acremonium* sp., *Monilia* sp., *Trichoderma lignorum,* etc. Other species of fungi provided poor or unsuitable media for the reproduction of cecids (Jou and Tsai, 1968, 1969; Tsai, Yeh and Rong, 1967, Tzeng and Hung, 1973). The cecid larvae, *H. pygmaea* and *Henria* sp., can develop more rapidly and reproduce more profusely on *Trichoderma viride* than on the mycelia of common cultivated mushrooms, *Agaricus brunnescens* (=*A. bisporus*) (Malloch, 1976), and less so on *Humicola* spp. and

Torula spp. They cannot develop and reproduce on *Micromonospora* sp., *Actinomyces* sp. and *Agaricus biterquis* (Lin and Ni, 1974, 1978).

Phototropism of the larvae of *H. pygmaea* is affected by light intensity and wave length of light. The best attraction by light is achieved when DIN = 7 and with blue light. In a moistened environment, a phototropic larva may creep as fast as 4.7 cm per minute. Attraction of the larvae of *H. pygmaea* has also been demonstrated with a solution containing sucrose and the juice of *Trichoderma lignorum*, but this attractant is not yet defind chemically (Jan and Hu, 1976a).

The larvae of *H. pygmaea* can be reared in an artificial medium contaning thiamine-HCl, pyridoxine-HCl, niacin and calcium pantothenate on 2% agar, but the progeny number decreases if any of these four water soluble vitamins is omitted. The mycelia of *Trichoderma lignorum* or its water soluble content also support the growth of the larvae nicely. However, the progeny number decreases if the mycelia are sprayed with the solutions of iodine, tannic acid (both are known to precipitate thiamine) or barium hydroxide, potassium permanganate (both are known to degrate niacin) or if the water soluble content is boiled. These results point out that thiamine and niacin are some of the essential nutrients for the growth of this cecid larva. It is also suggested that chemical inhibition to or generally deficient for any of these vitamins in mushroom may prove to be a way of pest control in mushroom farming (Jan and Hu, 1976b).

PEST PROBLEMS

Development of mushroom strains unfavorable to the reproduction of cecid larvae

According to Lin and Ni(1974, 1978), the mushroom strains, code number of 547, for example, appeared to be less favorable for the larval development and reproductivity of *H. pygmaea* and *Henria* sp. than the other strains, for example, code number 554. Chung and Snetsinger (1964) and Hussey and Wyatt (1962b) pointed out that different strains of mushroom spawn effect paedogenetic reproduction differently. There may be a way to select or breed the mushroom strain that unfavorable to the reproduction of cecid larvae.

The management of peak heat in mushroom house

Kligman (1950) has emphasized that the peak heat (cookout, sweat-out) is the natural and most effective way of dealing with insects and molds carried in with the compost. Peak heat of compost with 50°C for 6 hours was sufficient to kill all larvae of *H. pygmaea* containing therein (Lin and Ni, 1974). All ordinary larvae of *Henria* sp. as well as dormant mother larvae was killed with 45°C for 6 hours (Lin and Ni, 1978). Figure 2 shows the recommended procedure of indoor composting in Taiwan. Keep in 60°C for 24 hours of compost is required, and the range of highest temperature should not be exceed ± 5°C. Well managed peak heat has also decreased the population of spring-tails and mites in mushroom house. How to make essential peak heat in so many small scale mushroom houses is a problem to be solved.

Prevent the entrance of pests into mushroom house

Population of cecids, phorids, sciarids, springtails and mites in outside greatly influence the population of those pests in mushroom house. Cecid larvae may be easily transferred from house to house on cutting knives, brackets on the stump buskets and on other objects(Chung and Snetsinger, 1964). Adult cecid fly could fly from window and door into mushroom house to lay eggs on bed. Adult *M. speyeri* are found to be most abundant in mushroom houses in November, the spawning period (Lin, 1967b). The infestation of *H. pygmaea* was significantly higher at vicinities of ventilation openings of polyethylene-sheeted mushroom house, and the adults (about 0.25 mm wide of body) intrude through the openings of common used mesh (generally 1–3mm of the opening) (Lin and Ni, 1974).

How to prevent the entrance of cecids and other pests into mushroom house after peak heat is a point of pest control. Flies can not enter houses that are fly proofed. In terms of polyethylene-sheeted mushroom house, the ventilation openings, windows and doors must be proofed with fine mesh. Ordinary precautions must be paid after peak heat to prevent the entrance of pests into the mushroom house.

The insecticides, Aldrin, BHC and Lindane, incorporated into compost or casing soil reduced greatly the population of cecids (Hussey and Wyatt, 1960, 1962a; Hussey *et al.*, 1960; Tsai *et al.*, 1966, 1967). However, these treatment decreased the yield of mushroom apparently (Tsai *et al.*, 1966, 1967). Cantelo and McDaniel (1980) have recently reported that incorporating diazinon into mushroom compost to control the phorid flies and sciarid flies breeding there. Diazinon incorporated into compost should be tested on the control of cecids.

Incorporation of calcium cyanamide ($CaCN_2$) into spent compost from mushroom beds reduced the maggot population contained therein (Table 6). Consequently a prompt build-up of the population during the next crop may thus be prevented (Lin and Ni, 1977). After mushroom cultivation, the house must be treated thoroughly with steam heat in order to kill all the pests in the house.

Table 6. Effect of calcium cyanamide on the pests of spent compost, means of 8 replications, 50 grams compost per sample.

Treatment	*Heteropeza pygmaea*	*Henria* sp.	*Mycophila speyeri*	Cecidomylinae	Hypogasturids	Mites	*Bradysia tritici*
$CaCN_2$ 200g per 1.333 ping	0	0	0	0	218.5	0.25	0
Untreated control	2.6	4.5	0.13	0.13	729.6	0.13	0.13

The effect of insecticides on the growth of mushroom mycelium

The synergists of pyrethrins or allethrin, piperonyl butoxide or safroxan, has strongly inhibited the growth of mushroom mycelium in malt extract agar media. However, the active ingredients of synergised pyrethrins (pyramin and pyrethrins) and emulsions (emulsogen and phenylsulfonate) under the concentration of commercial dosage do not

(Tsai and Chen, 1970; Tsai, 1975). Lin (1980) reported that Malathion used as practical concentration could cause mushroom phytotoxicity or inhibiting the mycelial growth of mushroom.

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東半球之洋菇害蟲問題

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台灣香蕉研究所關西柑桔試驗場

洋菇害蟲包括癭蠅、蚤蠅、菇蠅、跳蟲及蟎類。癭蠅是發生最普遍的害蟲，在適當環境下以處女生殖法大量繁殖，嚴重影響洋菇罐頭品質。爲減少癭蠅爲害，需要找出不適宜幼蟲繁殖的洋菇品系，努力阻止成蟲侵入菇舍內，及研究洋菇休閒期間的癭蠅習性。蚤蠅、菇蠅、跳蟲及蟎類在菇舍外的生存密度、菇舍構造及堆肥後醱酵管理，影響菇舍內諸害蟲的密度。爲防治害蟲，必須維持各種徹底的環境衛生。