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INSECTS AND MITES FOUND ON STORED GARLIC IN THAILAND

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ABSTRACT

Samples of garlic bulbs from 6 storages in 3 provinces in northern Thailand were collected and examined each month from August 1983 to June 1984. It was found the storage damage increased with time and was significantly different among storages. The major causes of damage to garlic bulbs were insects and mites.

Of 14 genera of insects ecountered, *Lasioderma serricorne* (Fabricius),*Araecerus fasciculatus* Degeer and *Ephestia cautella* (Walker) were most frequently found. Twenty genera of mites were also identified and among these, *Aceria tulipae* (Keifer) was the most destructive species.

INTRODUCTION

Garlic *(Allium sativum* L.), Family Liliaceae, is known as a traditional medicinal plant. For many centuries, man has used the roots, the bulbs and the leaves of many varieties of garlic, prepared in many ways, either fresh or dried, alone or in combination with other substances such as water, vinegar and honey. In a number of forms garlic has served as an amulet or as food, condiment or medicine. The English Pharmacopia of 1949 listed garlic as an antiseptic, diaphroretic, diuretic expectorant, and also noted that garlic has been used to fight tuberculosis. The Spanish Pharmacopia of 1954 also listed garlic among its drugs.

Most Thai people regularly use fresh garlic as condiment. Since the publication of recent work on the nutritional value, medicinal value and antimicrobial and antifungal properties of garlic (CARPENTER, 1945; SHEIKH & AGNIHOTRI, 1972), there has been increasing interest in the use of fresh garlic as a drug.

Only a single crop of garlic is grown per year in Thailand, and therefore the product has to be stored over the year. Damage occurs during storage, and the quality and quantity of stored garlic are gradually reduced. Because of this, the price of garlic becomes high in the few months preceeding harvest of the next crop. In some years, disease lowers the productivity of the crop (CHARANASRI, 1983). As the result of these problems the amount of garlic in the country does not supply the demands of consumers over the entire year. Some garlic has to be imported from countries such as China and Japan in some years.

The purposes of this work are to (1) evaluate the deterioration of stored garlic over a period of 1 year; (2) investigate the pests which cause damage in storage; (3) provide information to aid further studies in prevention, control and preservation of stored garlic.

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Table 1. The percentages of deteriorated garlic cloves from 6 storages during August 1983 — June 1984.

Month/ Year	Percentage of deteriorated cloves from 6 storages						Average ± S.D.
	1	2	3	4	5	6	
Aug. 83	7.32	6.93	3.69	13.04	5.08	21.33	9.565 ± 6.589
Sept. 83	10.04	13.54	10.65	8.77	9.58	8.64	10.203 ± 1.803
Oct. 83	13.94	21.51	13.46	10.10	4.55	16.47	13.347 ± 5.753
Nov. 83	20.14	22.19	3.91	10.18	6.92	16.80	13.357 ± 7.439
Dec. 83	17.78	25.40	8.33	22.51	13.37	23.44	18.468 ± 6.609
Jan .84	12.93	25.64	12.29	25.15	24.87	24.38	20.877 ± 6.420
Feb. 84	8.95	16.28	7.86	11.11	16.25	22.17	15.253 ± 5.416
Mar. 84	38.04	21.32	10.83	10.47	25.43	17.12	20.368 ±10.288
Apr. 84	10.65	31.78	10.03	16.50	20.14	34.08	20.530 ±10.388
May. 84	17.22	19.50	17.02	11.59	39.50	27.71	22.090 ±10.011
Jun. 84	23.23	27.70	22.52	18.83	36.03	51.32	29.938 ±12.023

METHODS

Samples of garlic bulbs were collected at random and examined each month during August 1983 to June 1984 from 6 storages located in Chiang Mai, Lamphun and Lampang Provinces. The garlic was harvested during February and March, and stored during May and June, 1983. Each sample weighed 200 grams. The deteriorated cloves were separated from the bulbs and the percentage of decayed cloves in each sample was recorded. Pests were preserved in 70% alcohol after observation of some of their natural behavior in the bulbs. We made permanent slides of insects and mites for identification (BAKER, 1975; HINTON & CORBET, 1972; KRANTZ, 1978; LINDQUIST & EVANS, 1965; PHOLBOON,1965; SUMMER, 1966 and R.L.SMILEY, personal communication). Comparisons of damage between storages and between months were made using 1-way analysis of variance.

RESULTS

Deterioration of Garlic Cloves

Samples of garlic bulbs from 6 storages were obtained for each of 11 months. The percentages of damaged garlic cloves from each storage and each month are different at $p < .001$ ($F = 4.750$ and $F = 4.520$, respectively).

Table 2. Roles of insects and small arthropods found in stored garlic.

Order	Scientific Name	Roles
Coleoptera	*Lasioderma serricorne*	Feeds on garlic
	Araecerus fasciculatus	Feeds on garlic
	Thaneroclerus buqueti	Predaceous
	Cryptolestes spp.	Predaceous
	Cryptophagus sp.	Fungivorous
	Dienerella sp.	Fungivorous
	Euchione llus sp.	Fungivorous
	Typhaea stercorea	Fungivorous
	Carpophilus spp.	Scavenger
	Ahasverus advena	Fungivorous
	Silvanus sp.	Fungivorous
Lepidoptera	*Ephestia cautella*	Infests garlic
Psocoptera	*Liposcelis* sp.	Fungivorous and scavenger
Hymenoptera	Unidentified	Parasite of larvae of beetles and moths
Thysanura	*Ctenolepisma* sp.	Bites larvae and pupae of beetles and moths
Hemiptera	unidentified	Predator of larvae of beetles and moths.
Diptera	unidentified	Predator of larvae of beetles and moths
Araneae	unidentified	Predaceous
Pseudoscorpionida	unidentified	Predaceous

The mean percentage damage from storage no. 3 was the lowest (12.2%) and that of storage no. 6 was the highest (22.0%). Over the year, August had the lowest percentage damage (9.6%) and June the highest (29.9%) (Table 1).

Insects and Mites Found on Stored Garlic

Fourteen genera of insects and 20 genera of mites were examined from the 6 storages during the year (Tables 2 and 3). These animals were associated with each other in various roles. Species of insects and mites which destroyed garlic included *Lasioderma serricorne,* cigarette beetle; *Araecerus fasciculatus,* coffee-bean weevil; *Ephestia cautella,* dried currant moth; *Aceria tulipae,* tulip bulb mite; *Rhizoglyphus* spp.; *Suidasia* sp., *Tyrophagus* sp. and *Caloglyphus* sp. Predaceous insects and mites included *Thaneroclerus buqueti, Cryptolestes* spp., *Chelacaropsis moorei, Cheletomorpha*

Table 3. Roles of mites found in stored garlic.

Family	Scientific name	Roles
Eriophyidae	*Aceria tulipae*	Phytophagous, especially on leaves and bulb; destroys the garlic
Acaridae	*Rhizoglyphus* spp. *Suidasia* sp. *Tyrophagus* sp. *Caloglyphus* sp.	Phytophagous; scavenger
Cheyletidae	*Cheyletus fortis* *Cheyletus malaccensis* *Chelacaropsis moorei* *Cheletomorpha lepidopterorum*	Predators of mites, insects and small arthropods
Tydeidae	*Tydeus* spp.	Predaceous; some species are phytophagous, detritivorous or fungivorous.
Cunaxidae	*Cunaxa capreola* *Cunaxa setirostris*	Predators of mites or insects on plants, and small soil arthropods
Ascidae	*Blattisocius* sp. *Melichares* sp.	Predators of mites and insects, expecially of larvae of *E. cautella*
	Kleemannia n. sp.	Fungivorous
Stigmaeidae	*Agistemus* n. sp. *Eryngiopus* n. sp.	Predators of mites and small insects associated with crops in storage.
Sejidae	*Sejus* sp.	Scavenger
Bdellidae	*Spinibdella bifurcata*	Predator of eggs and small arthropods.
Smaridae	*Smaris* sp.	Predator of small insects and mites associated with the crops in storage
Pediculochelidae	*Pediculochelus* sp.	Unknown
Raphignathidae	*Raphignathus* sp.	Unknown
Camerobiidae	Unidentified	Unknown

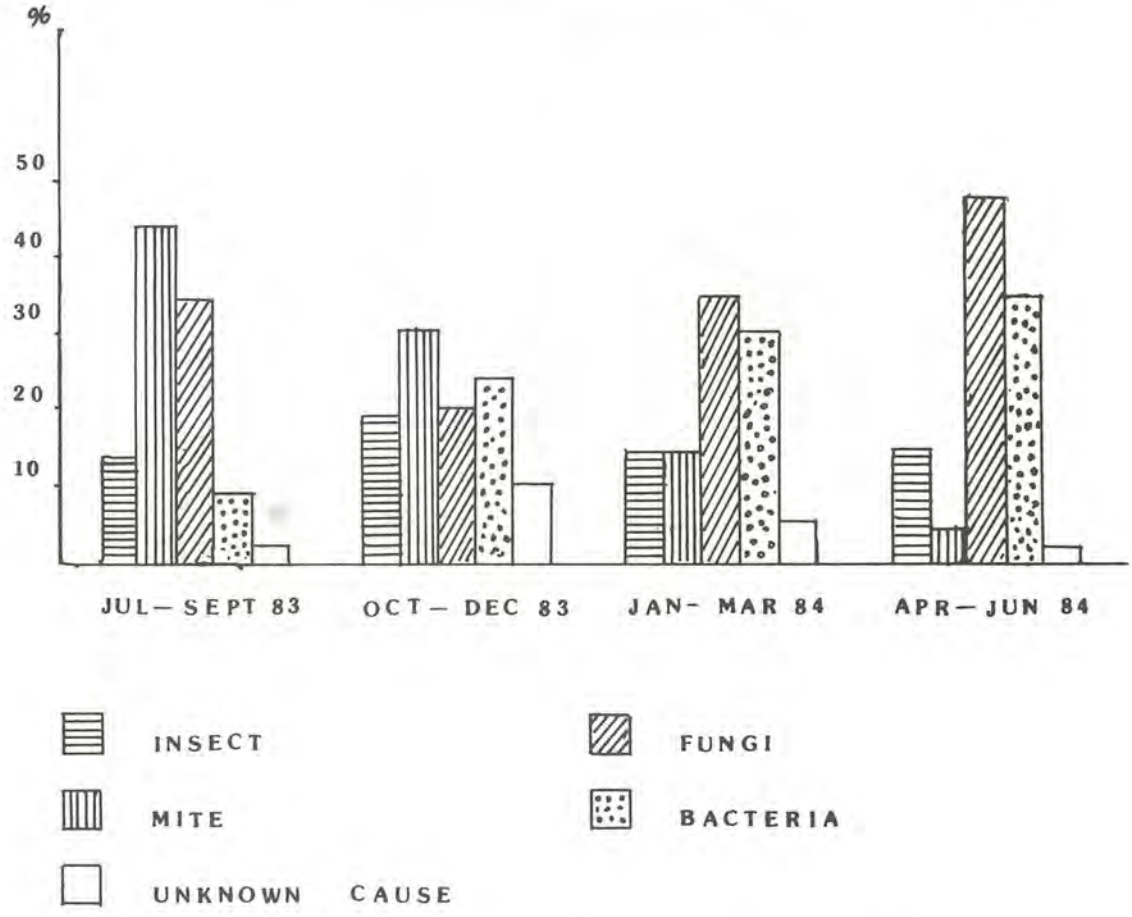

Figure 1. The percentages of spoiled garlic cloves due to different causes in four periods of three months each.

lepidopterorum, Cheyletus fortis, C. malaccensis and *Tydeus* spp. Some insects and mites from bulbs were scavengers, fungivores and detritivores (Tables 2 and 3 and Figure 2). Three new species of mites were found (Table 3). These were confirmed by acarologists at the United States Department of Agriculture, Beltsville, Maryland, and should receive further study.

Damage and Symptoms of Stored Garlic

The cloves of garlic inhabited by the mite *A. tulipae* were dried, shrunken and brown in colour. After *A. tulipae* damaged the cloves by feeding and reproducing

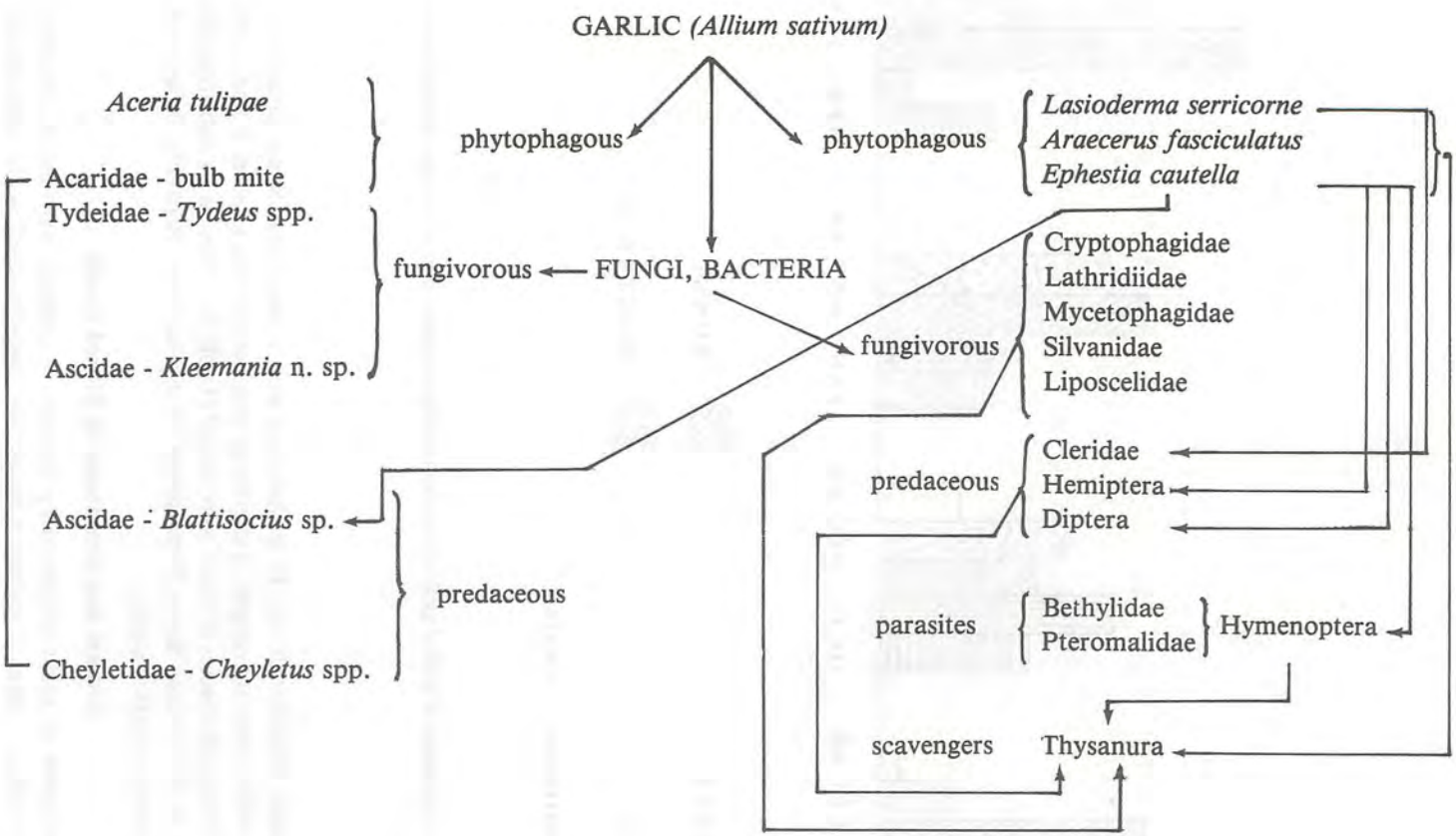

Figure 2. Relationships between garlic, insects, mites, fungi and bacteria. Arrows indicate direction of flow of food energy.

between the layers of skin, causing desiccation of the bulbs, other insects and fungi could enter and cause secondary decay.

A. tulipae also infested the growing plants, and were concentrated on the growing shoots. They were also found where the edges of leaves touch each other (CHARANASRI, 1983; MEYER, 1981) and thus were difficult to see. Infested leaves were stunted and curled, giving the plant a recurved appearance. From folds on the aerial parts of garlic plants, the mites move down into the bulbs, feeding and reproducing between bulb layers after harvest time (CHARANASRI, 1983). During storage, the mites dispersed to adjacent bulbs and continued causing damage after harvest. Damaged cloves changed colour from white to pale yellow and brown. The adults of *L. serricorne* and *A. fasciculatus* caused the tissues of the stems and bulbs to become porous while burrowing out. Their larvae fed on garlic, producing debris between junctions of the cloves in the same or different lamellae of the bulbs. *E. cautella* larvae also fed on garlic and caused deterioration of cloves.

Predators

The beetle *Thaneroclerus buqueti* has been recorded as a predator of *L. serricorne* (HINTON & CORBET, 1972). Some species of Hemiptera are predators of larvae of beetles and moths and of mites (HINTON & CORBET, 1972).

The mites of Family Cheyletidae which were found have been recorded as predaceous. LAWRENCE (1954) and VOLGIN (1960) (cited in KRANTZ, 1978) reported that *Chelacaropsis moorei* was found in the fur of mammals, where it subsisted as a predator of ectoparasitic arthropods sharing the same habitat. *Cheletomorpha lepidopterorum* were often found in association with the acarid mites on which they feed (HUGHES, 1976).

Other Pests in Stored Garlic

Besides insects and mites, fungi and bacteria also infested stored garlic (CHANTARASANIT & PANICHYAKARN, 1986). Spoilage due to microorganism increased gradually from the beginning of storage until the end of the period (Fig 1). Normal looking bulbs often concealed fungal spoilage inside. When pressed, puffs of black dust of fungal spores emerged from bulbs.

DISCUSSION

The deterioration of post-harvest garlic in different storages was caused by *A. tulipae, L. serricorne, A. fasciculatus* and *E. cautella.* It was also damaged by microorganisms. The mite *A. tulipae* (Family Eriophyidae) was one of the most important and injurious species. NEWKIRK & KEIFER (1971) (cited in MEYER, 1981) considered the genus *Aceria* to be a synonym of *Eriophyes.* LINDQUIST (1977) and other acarologists were of the opinion that the name *Aceria* should be retained because it is very well known and has been used for many economically important

species (MEYER, 1981). This mite affects its host plant in two ways. First, it damages the plant by feeding and secondly, it serves as a vector for toxins and viruses (MEYER, 1981). Stunting, twisting and curling of foliage is evidence of viral infestation (LANGE, 1955), and has been found to accompany mite infestation (JEPPSON et, al., 1975; CHARANASRI, 1983). *A. tulipae* caused desiccation and decay of garlic cloves. This mite has been found in association with the mite *Rhizoglyphus callae* (LANGE, 1955), and both were also found in this study. Thus, *A. tulipae* damaged garlic in the field and in storage, but *L. serricorne, A. fasciculatus, E. cautella* infested only stored garlic. The larvae of *E. cautella* also inhabited and fed on the cloves.

Other factors which affect the amount of damage to garlic include the genetic varieties used, maturity at harvest, cultural factors, environmental factors, and type and method of storage. Some storages contained other agricultural products such as onions, chillis, peanuts and soybeans in the same room. These provided alternative foods for the pests and helped maintain their cycles throughout the year, especially in the absence of proper maintenance, cleanliness and measures for prevention and control of the pests. The suggested methods of controlling the pests and reducing damage are: (1) decrease the humidity of garlic bulbs and remaining leaves before storing or packaging; (2) fumigate the garlic cloves, especially the planting stock; methyl bromide at 2.5 lbs. per 1000 cu.ft. for 2 hours at 27°C (80°F) kills all mites with no bulb damage. In the field, dusting the foliage with sulfur or sulfur plus insecticide in combination results in reduction of these mites. But mites in the leaf folds are often not reached by the toxicant (JEPPSON et al., 1975). (3) Improve the maintenance of storages before and after storing the garlic. Prevention and control of the pests in the field and storage are both necessary requirements.

Biological control of herbivorous pests remains a possibility and should receive further study. We discovered at least 13 types of known predaceous insects and mites that certainly must feed on some of the pest species. The biological relationships between these and other forms are shown in Fig. 2.

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