

## National investigations of stored grain arthropods in China

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### Abstract

In the 4th national investigation of storage arthropods (2004 to 2005), 270 species of insects and arachnids were collected and identified (including 44 species of natural enemies). The stored grain insects belonged to 2 classes, 12 orders and 54 families, including many families in each order - Coleoptera (31), Lepidoptera (6), Hymenoptera (5), Blattaria (2), Hemiptera (2), Diptera (2), Corrodentia (1), Thysanura (1), Isoptera (1), Dermaptera (1). The arachnids were Chernetidae of Chelonethida and Uroctidae of Araneida. Of the 270 arthropod species, 56 were found in all four national investigations. Four species were new records on this occasion and for the first time the list of species includes some arachnids, although these are all predatory species not pests. The occurrence of some stored grain insects with potential threats and several major types of stored grain insects are noted.

Keywords: Investigation, Stored grain, Arthropods, China

### 1. Introduction

From 1955 to 2005, there have been four investigations of stored grain arthropods in China. The fourth investigation was lead by CSR (Chengdu Grain Storage Science and Research Institute), and included the Henan University of Technology, Guangdong Institute for Cereal Science Research and Anhui Grain Depot of Chinese Grains and Oils Group with support from the State Administration of Grain (SAG) (Yan Xiaoping et al., 2005, Liu Guolin et al., 1998, Shen Zonghai et al., 2007). The fourth investigation demonstrated a greater variety of insects than previous surveys (Table 1). It can therefore be regarded as a new base line.

**Table 1** Numbers of stored grain insect species and natural enemies observed in four national stored grain insect investigations in China.

Sort	First* (1955-1958)	Second (1974-1975)	Third (1980-1982)	Fourth (2004-2005)
Stored grain insects	109	126	161	226
Natural enemy of stored grain insects	2	6	10	44
<b>Total</b>	<b>111</b>	<b>132</b>	<b>171</b>	<b>270</b>

Note: In 1955-1958, in some reports the first investigation on insects had been confirmed in 1955, the second investigation on insects had been confirmed in 1957 and the third investigation on insects had been confirmed from 1956 to 1958. In order to avoid the overlapping of investigation time and to facilitate the work in future, the investigations on stored grain insects from 1955 to 1958 is viewed as the first large scale investigation in this article.

## 2. Lists of Stored-Grain Insects in China

### 2.1. Stored-grain insects in China (excluding natural enemies)

Insecta

#### Coleoptera

##### Curculionidae

(1) *Sitophilus zeamais* (Motschulsky)

(2) *Sitophilus oryzae* (L.)

(3) *Sitophilus granarius* (L.)

(4) *Caulophilus oryzae* (Gyllenhal)

(5) *Rhyncholus chinensis* Voss

(6) *Euphryum rufum* (Broun)

##### Cyladidae

(7) *Cylas formicarius* F.

(122) *Thylocladius contractus* Motschulsky

(123) *Orphinus fulvipes* (Guenn-Meneville) Thoricidae

(124) *Thorictodes heydeni* Reitter

##### Ipidae

(125) *Coccotrypes dactyliperda* (F.)

##### Lathridiidae

(126) *Lathridius minutus* (L.)

(127) *Migneauxia orientalis* Reitter

(128) *Enicmus histrio* Joy et Tomlin

(129) *Cartodere argus* Reitter

## Insecta

(8) *Araecerus fasciculatus* (Degeer)**Lyctidae**(9) *Lyctus linearis* (Goeze)(10) *Lyctus brunneus* (Stephens)(11) *Lyctus sinensis* Lesne(12) *Lyctus* sp. (not denominated)(13) *Lyctus* sp. (not denominated)(14) *Lyctoxylon japonum* Reitter(15) *Minthea rugicollis* (Walker)**Monotomidae**(16) *Montoma picipes* Herbst(17) *Montoma bicolor* Villa**Bostrychidae**(18) *Rhyzopertha dominica* (F.)(19) *Dinoderus minutus* (F.)(20) *Dinoderus japonicus* Lesne(21) *Sinoxylon anale* Lesne(22) *Sinoxylon japonicum* Lesne(23) *Bostrychus capucinus* (L.)(24) *Bostrychus capucinus* var. *rubriferentis* Zouf**Ostomatidae**(25) *Tenebroides mauritanicus* (L.)(26) *Lophocateres pusillus* (Klug)**Silvanidae**(27) *Oryzaephilus surinamensis* (L.)(28) *Oryzaephilus mercator* (Fauvel)(29) *Monotoma picipes* Herbst(30) *Ahasverus advena* (Walfl)(31) *Silvanus bidentatus* (F.)(32) *Silvanoprus cephalotes* (Reitter)(33) *Silvanoprus angusticollis* (Reitter)(34) *Silvanoprus scuticollis* (Walker)**Cucujidae**(35) *Cryptolestes pusillus* (Schönherr)(36) *Cryptolestes ferrugineus* (Stephens)(37) *Cryptolestes turcicus* (Grouvelle)**Tenebrionidae**(38) *Tribolium castaneum* (Herbst)(39) *Tribolium confusum* Jacquelin du Val(40) *Tribolium madens* (Charpentier)(41) *Tenebrio obscurus* F.(42) *Tenebrio molitor* L.(43) *Palorus cerylonoides* (Pascoe)(44) *Palorus beelsoni* Blair(45) *Palorus ratzeburgi* (Wissmann)(46) *Palorus subdepressus* (Wollaston)(47) *Gnathocerus cornutus* (F.)(48) *Latheticus oryzae* Waterhouse(49) *Coelopalorus foveicollis* (Blair)(50) *Alphitobius diaperinus* (Panzer)(51) *Alphitobius laevigatus* (F.)(52) *Martianus dermestoides* Chevrolat(53) *Alphitophagus bifasciatus* Say(54) *Microdera elegans* Reitter(55) *Microcrypticus scriptum* (Lewis)(56) *Crypticus latiusculus* Menetries(57) *Opatrum subaratum* Faldermann(58) *Mesomorphus villiger* Blanchard(59) *Gonocephalum reticulatum* Motschulsky(60) *Opatrum sabulosum* (L.)(61) *Blaps rugosa* Gebler(62) *Blaps japonensis* Marseul(63) *Lyprops sinensis* Marseul(64) *Leptodes chinensis* Kaszab**Nitidulidae**(65) *Carpophilus dimidiatus* (F.)(130) *Cartodere constricta* (Gyllenhal)(131) *Dienerellaruficollis* (Marsham)(132) *Dienerella beloni* Reitter(133) *Dienerella costulata* (Reitter)(134) *Dienerella costipennis* (Reitter)(135) *Dienerella filiformis* (Gyllenhal)(136) *Corticaria japonica* Reitter(137) *Thes bergrothi* (Reitter)(138) *Coninonus* sp.**Merophyssidae**(139) *Holoparamesus depressus* Curtis(140) *Holoparamesus ellipticus* Wollaston(141) *Holoparamesus signatus* Wollaston(142) *Holoparamesus* sp.**Mycetophagidae**(143) *Typhaea stercorea* (L.)(144) *Mycetophagus hillerianus* Reitter(145) *Mycetophagus antennatus* (Reitter)(146) *Mycetophagus quadricuttatus* Müller**Biphylidae**(147) *Cryptophilus integer* (Heer)(148) *Cryptophilus obliteratus* Reitter**Erotylidae**(149) *Dacne japonica* Crotch**Ciidae**(150) *Cis mikagensis* Nobuchi & Wada(151) *Ennearthron* sp.**Cerylonidae**(152) *Murmidius ovalis* (Beck)(153) *Murmidius stoicus* Hinton(154) *Murmidius* sp.**Histeridae**(155) *Carcinops pumilio* (Erichson)(156) *Carcinops mayeti* Marseul(157) *Saprinus tenuistrius* Marseul(158) *Dendrophillus xavieri* Marseul(159) *Atholus pirithous* (Marseul)**Cleridae**(160) *Necrobia violacea* (L.)(161) *Necrobia rufipes* (Degeer)(162) *Necrobia ruficollis* (F.)(163) *Tarsostenus univittatus* (Rossi)(164) *Thaneroclerus buquet* Lefebvre(165) *Tilloedeia notata* (Klug)**Bruchidae**(166) *Callosobruchus chinensis* (L.)(167) *Callosobruchus maculatus* (F.)(168) *Callosobruchus* sp. (not denominated)(169) *Callosobruchus* sp. (not denominated)(170) *Callosobruchus* sp. (not denominated)(171) *Bruchus rufimanus* Boheman(172) *Bruchus pisorum* (L.)(173) *Bruchidiusdorsalis* (Fahraeus)(174) *Caryedon serratus* (Olivier)(175) *Spesmophagus sericeus* (Geoffrey)**Cryptophagidae**(176) *Atomaria lewisi* Reitter(177) *Cryptophagus dentatus* (Herbst)(178) *Cryptophagus acutangulus* Gyllenhal(179) *Cryptophagus cellaris* (Scopoli)(180) *Cryptophagus affinis* Sturm(181) *Cryptophagus quadrimaculatus* Reitter(182) *Cryptophagus pilosus* Gyllenhal(183) *Cryptophagus distinguendus* Sturm(184) *Cryptophagus scutellatus* Newman(185) *Cryptophagus badius* Sturm

## Insecta

- (66) *Carpophilus mutilates* Erichson  
 (67) *Carpophilus obsoletus* Erichson  
 (68) *Carpophilus flavipes* Murray  
 (69) *Carpophilus pilosellus* Motschulsky  
 (70) *Carpophilus marginellus* Motschulsky  
 (71) *Carpophilus delkeskampii* Hisamatsu  
 (72) *Carpophilus davidsoni* Dobson  
 (73) *Carpophilus* sp.  
 (74) *Carpophilus* sp.  
 (75) *Haptoncus luzonensis* Gillogly  
 (76) *Nitidula bipunctata* L.  
 (77) *Nitidula carnaria* (Schaller)  
 (78) *Urophorus humeralis* (F.)  
 (79) *Omosita colon* (L.)

**Ptinidae**

- (80) *Ptinus japonicus* (Reitter)  
 (81) *Ptinus tectus* Boieldieu  
 (82) *Mezioniptus impressicollis* Pic  
 (83) *Niptus holoeucus* (Faldermann)  
 (84) *Pseudeurostus hilleri* (Reitter)  
 (85) *Mezium affine* Boieldieu  
 (86) *Gibbium psylloides* (Czenpinski)  
 (87) *Gibbium aequinoctiale* Boieldieu  
 (88) *Tipnus unicolor* Piller & Mitterpacher

**Anobiidae**

- (89) *Stegobium paniceum* (L.)  
 (90) *Lasioderma serricornis* (F.)  
 (91) *Ptilineurus marmoratus* (Reitter)  
 (92) *Nicobium castaneum* (Olivier)  
 (93) *Falsolegastrallus sauteri* Pic  
 (94) *Ptilinus fuscus* Geoffroy  
 (95) *Mizodoractoma* sp. (not denominated)  
 (96) *Nicobium* sp.

**Dermestidae**

- (97) *Dermestes maculatus* Degeer  
 (98) *Dermestes frischii* Kugelann  
 (99) *Dermestes undulatus* Brahm  
 (100) *Dermestes tessellatocollis* Motschulsky  
 (101) *Dermestes ater* Degeer  
 (102) *Dermestes ater domesticus* Germar  
 (103) *Dermesteslardarius* L.  
 (104) *Dermestes carnivorus* F.  
 (105) *Dermestes vorax* Motschulsky  
 (106) *Attagenus piceus* (Olivier)  
 (107) *Attagenus brunneus* Faldermann  
 (108) *Attagenus vagepictus* Fairmaire  
 (109) *Attagenus alfireii* Pic  
 (110) *Attagenus cyphonoides* Reitter  
 (111) *Attagenus unicolorjaponicus* Reitter  
 (112) *Attagenus undulatus* (Motschulsky)  
 (113) *Attagenus pellio* L.  
 (114) *Attagenus unicolor simulans* Solskij  
 (115) *Attagenus augustatus* Ballion  
 (116) *Attagenus shaefferi* (Herbst)  
 (117) *Anthrenus verbasci* L.  
 (118) *Anthrenus scrophulariae* (L.)  
 (119) *Anthrenus nipponensis* Kalik et N. Ohbayashi  
 (120) *Evorinea hisamatsui* N. Ohbayashi  
 (121) *Trogoderma variabile* Ballion

- (186) *Cryptophagus pseudoschmidti* Woodroff  
 (187) *Micrambe nigricollis* Reitter

**Anthicidae**

- (188) *Anthicus floralis* (L.)  
 (189) *Anthicus* sp.

**Cerambycidae**

- (190) *Purpuricenus temminckii* (Guerin-Meneville)  
 (191) *Trichoferus campestris* (Faldermann)  
 (192) *Purpuricenus* sp. (not denominated)  
 (193) *Purpuricenus* sp. (not denominated)

**Lepidoptera****Pyralidae**

- (194) *Pyralis farinalis* L.  
 (195) *Pyralis manihotalis* Guenee  
 (196) *Pyralis* sp.  
 (197) *Pyralis tienigialis* Zeller  
 (198) *Aglossa dimidiata* Haworth  
 (199) *Aglossa pinguinalis* L.  
 (200) *Aglossa caprealis* Hübner

**Phycitidae**

- (201) *Plodia interpunctella* (Hübner)  
 (202) *Ephestia kuehniella* (Zeller)  
 (203) *Ephestia cautella* (Walker)  
 (204) *Ephestia elutella* (Hübner)

**Galleriidae**

- (205) *Aphomia gularis* (Zeller)  
 (206) *Corcyra cephalonica* (Stainton)  
 Gelechiidae  
 (207) *Sitotroga cerealella* (Olivier)

**Tineidae**

- (208) *Tinea tuguralis* Meyrick  
 (209) *Tinea metonella* Pierce & Metcalfe  
 (210) *Tineola bisselliella* Hummel  
 (211) *Monopis monachella* Hübner  
 (212) *Homalopsycha agglutinata* Meyrick  
 (213) *Setomorpha rutella* Zeller

**Oecophoridae**

- (214) *Anchonoma xeraula* Meyrick

**Corrodentia****Liposcelidae**

- (215) *Liposcelis entomophilus* Enderlein  
 (216) *Liposcelis bostrychophilus* Badonnel  
 (217) *Liposcelis decolor* (Pearman)  
 (218) *Liposcelis* sp.

**Thysanura****Lepismatidae**

- (219) *Ctenolepisma villosa* F.

**Blattaria****Blattidae**

- (220) *Periplaneta americana* L.  
 (221) *Periplaneta australasiae* (F.)  
 (222) *Periplaneta emarginata* Karny  
 (223) *Periplaneta japonica* Karny

**Phyllodromiidae**

- (224) *Blattella germanica* L.

**Isoptera****Rhinotermitidae**

- (225) *Coptotermes formosanus* Shiraki

**Hymenoptera****Formicidae**

- (226) *Monomorium pharaonis* L.

## 2.2. Natural enemies of stored grain insects

## Insecta

**Hemiptera****Anthracoridae**

- (1) *Xylocoris flavipes* (Reutes)  
 (2) *Xylocoris* sp.  
 (3) *Xylocoris galactinus* (Fieber)  
 (4) *Xylocoris* sp.

**Reduviidae**

- (5) *Peregrinator biannulipes* (Montrouzier & Signoret)  
 (6) *Myiophanes* sp.

## Hymenoptera

## Braconidae

- (7) *Microbracon hebetor* Say

**Pteromalidae**

- (8) *Lariophagus distinguendus* Förster  
 (9) *Aplastomorpha calandrae* Howard  
 (10) *Pteromalus puparum* (L.)  
 (11) *Pteromalus* sp.

**Ichneumonidae**

- (12) *Venturia* sp.

**Evaniidae**

- (13) *Evania appendigaster* L.

**Coleoptera****Carabidae**

- (14) *Harpalus rufipes* De Geer  
 (15) *Harpalus amplicollis* Menetries  
 (16) *Lachnocrepis prolixa* Bates  
 (17) *Chlaenius micans* (F.)  
 (18) *Chlaenius virgulifer* Chaudoir  
 (19) *Chlaenius* sp. (not denominated)  
 (20) *Chlaenius* sp. (not denominated)  
 (21) *Bembidion pogonides* Bates  
 (22) *Bembidion niloticum* Dejean

- (23) *Scarites terricola* Bonelli

- (24) *Hololeius ceylonicus* Nietner

- (25) *Pheropsophous jessoensis* Morawitz

- (26) *Pheropsophous* sp. (not denominated)

- (27) *Pheropsophous* sp. (not denominated)

**Staphylinidae**

- (28) *Paederus fuscipes* Curtis

- (29) *Philonthus nigriventris* Thomson

- (30) *Leptacinus parumpunctatus* Gyllonhyl

- (31) *Anotylus* sp.

- (32) *Philonthus* sp.

- (33) *Omaluim huomerale* Cameron

- (34) *Falagria* sp.

**Diptera****Scenopinidae**

- (35) *Scenopinus fenestralis* L.

## Cecidomyiidae

- (36) *Silvestrina tyrophagi* Domb

**Dermaptera****Psalididae**

- (37) *Labidura japonica* de Haan

- (38) *Anisolabis annulipes* (Lucas)

- (39) *Anisolabis* sp.

**Arachnida****Chelonethida****Chernetidae**

- (40) *Chelifer nodosus* Schrank

- (41) *Chelifer cancroids* L.

- (42) *Chelifer panzeri* Koch

- (43) *Chelifer* sp.

**Araneida****Urocteidae**

- (44) *Uroctea compactilis* Koch

## 3. Discussion

## 3.1. Variation in classes, orders, families, genera and species in all investigations

An analysis of the four investigations shows that the number of classes and orders of stored grain insects and their natural enemies increased gradually, as did families, genera and species (Table 2). It is of note that no arachnids were recorded in the earlier three investigations and on this occasion the only arachnids recorded were natural enemies.

**Table 2** Variation in classes, orders, families, genera and species in the four national stored grain insect investigations in China.

First investigation	Second investigation	Third investigation	Fourth investigation
<b>Insecta</b>	<b>Insecta</b>	<b>Insecta</b>	<b>Insecta</b>
Coleoptera	Coleoptera	Coleoptera	Coleoptera
Lepidoptera	Lepidoptera	Lepidoptera	Lepidoptera
Corrodentia	Corrodentia	Corrodentia	Corrodentia
Thysanura	Thysanura	Thysanura	Thysanura
Blattaria	Blattaria	Blattaria	Blattaria
Isoptera	Isoptera	Isoptera	Isoptera
Hymenoptera	Hymenoptera	Hymenoptera	Hymenoptera
Diptera	Diptera	Diptera	Diptera
	Hemiptera	Hemiptera	Hemiptera
	Dermaptera	Dermaptera	Dermaptera
			Arachnide
			Chelonethida

First investigation	Second investigation	Third investigation	Fourth investigation
Insecta	Insecta	Insecta	Insecta
1 class	1 class	1 class	Araneida
8 orders	10 orders	10 orders	2 class
33 families	41 families	52 families	12 class
78 genus	92 genus	106 genus	54 families
111 species	132 species	171 species	146 genus
			270 species

### 3.2. Stored grain insects found in all 4 investigations

The four investigations had 56 species in common. These species may be consider to be the main stored grain insects in China and are listed as follows.

#### Insecta

##### Coleoptera

##### Curculionidae

- (1) *Sitophilus oryzae* (L.)
- (2) *Sitophilus granarius* (L.)
- (3) *Rhyncholus chinensis* Voss

##### Cyladidae

- (4) *Araecerus fasciculatus* (Degeer)

##### Lycitidae

- (5) *Lyctus brunneus* (Stephens)
- (6) *Lyctus sinensis* Lesne
- (7) *Lyctoxylon japonum* Reitter
- (8) *Minthea rugicollis* (Walker)

##### Bostrychidae

- (9) *Rhyzopertha dominica* (F.)
- (10) *Dinoderus minutus* (F.)

##### Ostomatidae

- (11) *Tenebroides mauritanicus* (L.)
- (12) *Lophocateres pusillus* (Klug)

##### Silvanidae

- (13) *Oryzaephilus surinamensis* (L.)

##### Cucujidae

- (14) *Cryptolestes pusillus* (Schönherr)
- (15) *Cryptolestes ferrugineus* (Stephens)
- (16) *Cryptolestes turcicus* (Grouvelle)

##### Tenebrionidae

- (17) *Tribolium castaneum* (Herbst)
- (18) *Tribolium confusum* J. du Val
- (19) *Tenebrio obscurus* F.
- (20) *Tenebrio molitor* L.
- (21) *Palorus ratzeburgi* (Wissmann)
- (22) *Gnathocerus cornutus* (F.)
- (23) *Latheticus oryzae* Waterhouse
- (24) *Coelopalorus foveicollis* (Blair)
- (25) *Alphitobius laevigatus* (F.)
- (26) *Alphitophagus bifasciatus* Say
- (27) *Mesomorpha villiger* Blanchard

##### Nitidulidae

- (28) *Carpophilus dimidiatus* (F.)

##### Ptinidae

- (29) *Ptinus japonicus* (Reitter)
- (30) *Niptus holoeucus* (Faldermann)

- (31) *Pseudeurostus hilleri* (Reitter)

- (32) *Gibbium aequinoctiale* Boieldieu

- (33) *Stegobium paniceum* (L.)

- (34) *Lasioderma serricorne* (F.)

- (35) *Ptilineurus marmoratus* (Reitter)

##### Lathriidae

- (36) *Dienerellaruficollis* (Marshall)

- (37) *Thes bergrothi* (Reitter)

##### Merophyssidae

- (38) *Holoparamesus depressus* Curtis

- (39) *Holoparamesus ellipticus* Wollaston

##### Mycetophagidae

- (40) *Typhaea stercorea* (L.)

- (41) *Mycetophagus hillerianus* Reitter

##### Cerylonidae

- (42) *Murmidius ovalis* (Beck)

##### Bruchidae

- (43) *Callosobruchus chinensis* (L.)

- (44) *Bruchus rufimanus* Boheman

- (45) *Bruchus pisorum* (L.)

- (46) *Bruchidius dorsalis* (Fahraeus)

##### Lepidoptera

##### Phycitidae

- (47) *Plodia interpunctella* (Hübner)

- (48) *Ephestia cautella* (Walker)

- (49) *Ephestia elutella* (Hübner)

##### Galleriidae

- (50) *Aphomia gularis* (Zeller)

##### Gelechiidae

- (51) *Sitotroga cerealella* (Olivier)

##### Oecophoridae

- (52) *Anchonoma xeraula* Meyrick

##### Corrodentia

##### Liposcelidae

- (53) *Liposcelis bostrychophilus* Badonnel

##### Blattaria

##### Blattidae

- (54) *Periplaneta americana* L.

- (55) *Periplaneta australasiae* (F.)

##### Hemiptera

##### Anthocoridae

- (56) *Xylocoris galactinus* (Fieber)

### 3.3. New records of stored grain insects in China

The following species were recorded for the first time from grain stores in China - *Myiophanes* sp., *Chlaenius* sp. (not validated), *Chlaenius* sp. (not validated), *Mizodoractoma* sp. (not validated).

### 3.4. Stored grain insects with potential threats found in the fourth investigation

Stored grain insects found for the first time in the fourth investigation that present a potential threat are as follows:

- *Necrobia violacea* (L.) and *Necrobia rufipes* (Degeer) can damage silkworm cocoons and meat products such as hams. They can also be a problem in oil seeds.
- *Dinoderus japonicus* Lesne may infest bamboo but can also attack hard Chinese medicinal materials (lanceolata, ginseng and gastrodia) and can damage paddy and maize.
- *Nicobium castaneum* (Olivier) feeds on wooden structures, including wooden architecture, antique furniture, woodcarving (Buddha in temples) etc.

### 3.5. Several major types of stored grain insects

#### 3.5.1. *Sitophilus zeamais* (Motschulsky)

During the first investigation there was no record of maize weevil (now considered the most important pest in Chinese grain stores). This is because the maize weevil and rice weevil were not recognized as separate species before the 1960s but instead as the large and small strains of the same species, *Sitophilus oryzae*. Species identification requires examination of the male or female genitalia.

#### 3.5.2. Tenebrionidae

In the first and second investigation, 11 insects were recorded, including *Palorus depressus* (F.) *Blaps chinensis* Faldermann, *Cyphogenica funesta* Faldermann, *Leptodes sulcicollis* Reitter, which were absent in the fourth investigation. This may have resulted from inadequate investigation in Northwestern China.

#### 3.5.3. Dermestidae

In all four investigations on stored grain insects, many dermestids were observed, although none was recorded in all four investigations. The reasons may be that all the investigations focused on stored grain insects while dermestids are also pests of oil seeds and of animal products (leather, furs, woolen cloth, animal bones, hams etc.)

#### 3.5.4. Importation of quarantine species

China currently recognizes six quarantine species of storage pests, *Prostephanus truncatus* (Horn), *Trogoderma granarium* Everts, *Zabrotes subfasciatus* Boheman, *Callosobruchus analis* F., *Callosobruchus phaseoli* (Gyllenhal) and *Acanthoscelides obtectus* (Say).

In the fourth investigation, none of the six quarantine pests were found. But in the third investigation *T. granarium*, *Z. subfasciatus*, *C. analis* had been found in the inspection of foreign goods. The main reasons may be that the third investigation was conducted by personnel from the Ministry of Commerce and Ministry of Agriculture and Forestry. This made it easy for the investigators to work with the quarantine departments directly under control of the Ministry of Agriculture and Forestry. With the economic development of China and its entry into WTO, all sorts of pests, including stored grain insects are being imported. In order to prevent the importation of hazardous insects by efficient quarantine control, it is necessary to investigate stored grain insects in foreign imported goods with the collaboration of the Ministry of Agriculture.

### 3.6. Prospects for the use of natural enemies of stored grain insects.

In the fourth investigation, 44 species of natural enemies of stored grain insects had been identified and recorded. These natural enemies can limit populations of stored grain insects, offering a means of biological control. It is worthwhile for us to explore ways for making good use of these natural resources. There have been some successful cases recorded in the United States and the Czech Republic. The most promising natural enemies to the stored grain insects are parasitoid, predatory bugs and Chelonethida.

In this investigation 4 species of pseudoscorpion were identified, including *Chelififer cancroids* L., *Chelififer panzeri* Koch, *Chelififer nodosus* Schrank and *Chelififer* sp. Psocids (Psocoptera) are a significant problems in grain warehouse in China. It is believed that the reason for this is that their natural enemy Chelonethida had been killed by the application of chemical pesticide including PH<sub>3</sub> fumigation, and then psocids propagate causing a great nuisance in stored grain.

Predatory bugs - this research found and recorded six kinds of predatory bugs, including *Xylocoris flavipes* (Reutes) etc. Those predatory bugs can prey on many kinds of adults and larvae of stored grain insects.

Parasitoids - In this research seven kinds of parasitoid were recorded, including *Lariophagus distinguendus* Förster, *Aplastomorpha calandrae* Howard and *Microbracon hebetor* Say etc. These parasitoids are natural enemies of important stored grain insects, especially, stored grain moths and in the United States have been used to control the larvae of moths in groundnut stores.

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