



Original/Investigación animal

The density and species of mite breeding in the stored products in China

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Abstract

Objective: The aim of our study was to investigate the species and breeding density of acaroid mites in stored products in China.

Methods: We tentatively harvested the samples from the products stored in warehouses, commercial stores and civilian houses, and the products.

Results: The results suggested the mites varied a lot in species regarding their ecological habitus and habitat. Still, the breeding density in different samples was associated with the sampling conditions.

Conclusions: These discrepancies may be associated with the samples collected in diverse environment for the mites, and the findings easily suggest that acaroid mites are in universal distribution.

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Key words: *Stored products. Acaroid mites. Habitat. Allergic diseases. Anhui province.*

DENSIDAD Y ESPECIES DE ÁCAROS REPRODUCIDAS EN LOS PRODUCTOS ALMACENADOS EN CHINA

Resumen

Objetivo: El objetivo de nuestro estudio fue investigar las especies y la densidad de reproducción de ácaros en productos almacenados en China.

Métodos: Provisionalmente, se recogieron muestras de productos almacenados en naves, locales comerciales y viviendas.

Resultados: Los resultados sugirieron que los ácaros variaban mucho en cuanto a especies respecto a sus hábitos y habitats ecológicos. Aún así, la densidad de reproducción en distintas muestras estuvo asociada a las condiciones de muestreo.

Conclusiones: Estas discrepancias pueden estar asociadas con las muestras recogidas en diversos ambientes para los ácaros, y los resultados sugieren visiblemente que los ácaros tienen una distribución universal.

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Palabras clave: *Productos almacenados. Ácaros. Hábitat. Enfermedades alérgicas. Provincia de Anhui.*

Introduction

Hypersensitivity disease was ranked by the World Health Organization (WHO) as one of the four major noninfectious diseases for targeted prevention in the 21st century. Annually, this disease affects 10% to 30% of global population and is growing an important public health concern¹. Allergen plays a key role in the development of allergic disorders, furthermore, mite allergen, a naturally extensive airborne allergen, is

widely recognized as a primary substance to induce hypersensitive reaction^{2,3}, and has been the focus of much interest and subject of intensive research due to its universal and specific nature⁴⁻⁶. Therefore, a thorough understanding of the breeding status of acaroid mites in the civil houses and stored products is of great significance to prevent the acarinoses, reduce the mite infestation and make full appreciation of the ecology of such mite species. Between Nov. 2009 and 2011, we investigated the mite breeding conditions in 17 cities in Anhui province, including HuaiBei, Fuyang, Bozhou, Bengbu, Huainan, Wuhu and Xuangcheng, etc. The present study was undertaken to report our findings on the total 150 species breeding in the stored products.

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Materials and methods

Materials preparation

Reagents and apparatus used in this study included permanent mounting medium (distilled water 50ml, 10% Hydration chlorine aldehyde 5ml, Glycerol 20ml, gum arabic 30g) and anhydrous alcohol (analytical reagent, Shanghai product), light microscope (Nikon E-400), zoom stereo microscope (Nikon SMZ-800), Tullgren (HN-89), vibration screener (85A-B), sample sieve (ZNS-200), balances, etc.

Specimen collection

In compliance with the inhabiting nature of acaroid mites, we tentatively harvested the samples from the products stored in warehouses, commercial stores and civilian houses, and the products were associated with cereal products (paddies, wheat, rice, flour and maize), dry fruits (juglans regia, preserved date jujube, longan, persimon cake and hawthorn) and house dust (cloth dust, bed sheet dust, floor dust and furniture dust). The product samples of corns and dry fruits had been kept for 6 months or longer upon the sample collection. Ten aliquots of specimens were taken from each sample product, sealed in separate sampling bag and transported to the laboratory, where each sample was measured with the balance by 10 g. Vibration sieve was used to separate the dusts from solid samples before final isolation of the acaroid mites.

Isolation of the acaroid mite specimens

Mites in the solid samples were extracted using Tullgren funnel and directicopy, while those in the dusts

were isolated with waternacopy and redricopy⁷. The mite slides were prepared from the specimens isolated as previous description⁸ for light microscopic observation of the morphology and species identification as well as the count.

Classification of the acaroid mites

Classification of the acaroid mites was in compliance with the taxonomic system described by Hughes (1976).

Data process

The total acaroid mites were counted on individual sample basis of the stored products, and calculated as the formula of $D=N/T \times 100\%$ for the breeding density (N stands for the number detected in each sample, T for the weight of the sample and D for the breeding density).

Results

The breeding density of mites in individual sample and the species

The breeding density of the mites in separate 150 samples and the classification/species were illustrated in table I. The results suggested the mites varied a lot in species regarding their ecological habitus and habitat. Still, the breeding density in different samples was associated with the sampling conditions. Table II showed the classification of acaroid mites (Acari: Astigmata) in 150 samples of stored products.

Table I
The numbers and mite species found in 150 samples of stored products

NO.	Sample sorts	Breeding density (No./g)	Species
1	Rice	10.37	<i>Acarus siro</i> , <i>Tyrophagus putrescentiae</i> , <i>Tyrolichus casei</i> , <i>Acarus farris</i> , <i>Tyrophagus longior</i> , <i>Suidasia nesbitti</i> , <i>Glycyphagus domesticus</i>
2	Millet	15.65	<i>Acarus siro</i> , <i>Tyrophagus putrescentiae</i> , <i>Lepidoglyphus michaeli</i> , <i>Mycetoglyphus fungivorus</i>
3	Flour	400.14	<i>Chortoglyphus arcuatus</i> , <i>Blomia freemani</i> , <i>Glycyphagus domesticus</i> , <i>Caloglyphus berlesei</i> , <i>Thyreophagus entomophagus</i> , <i>Tyrophagus putrescentiae</i>
4	Sticky rice	20.31	<i>Tyrophagus putrescentiae</i> , <i>Acarus siro</i> , <i>Dermatophagoides farinae</i>
5	Rice bran	45.13	<i>Acarus siro</i> , <i>Tyrophagus putrescentiae</i> , <i>Acarus immobilis</i> , <i>Mycetoglyphus fungivorus</i> , <i>Dermatophagoides pteronyssinus</i> , <i>Euroglyphus maynei</i> , <i>Aleuroglyphus ovatus</i>
6	Broken rice	169.31	<i>Tyrophagus putrescentiae</i> , <i>Blomia freemani</i> , <i>Lepidoglyphus michaeli</i> , <i>Suidasia nesbitti</i> , <i>Euroglyphus maynei</i>

Table I (cont.)
The numbers and mite species found in 150 samples of stored products

NO.	Sample sorts	Breeding density (No./g)	Species
7	Unhusked rice	12.18	<i>Tyrophagus putrescentiae</i> , <i>Caloglyphus berlesei</i> , <i>Caloglyphus mycophagus</i> , <i>Lepidoglyphus destructor</i>
8	Wheat	18.14	<i>Acarus siro</i> , <i>Tyrophagus longior</i> , <i>Lepidoglyphus destructor</i> , <i>Chortoglyphus arcuatus</i> , <i>Aleuroglyphus ovatus</i>
9	Malt	21.53	<i>Acarus siro</i> , <i>Lepidoglyphus destructor</i> , <i>Glycyphagus domesticus</i> , <i>Caloglyphus berlesei</i>
10	Corn germ	538.26	<i>Tyrophagus putrescentiae</i> , <i>Acarus siro</i> , <i>Blomia freemani</i> , <i>Aleuroglyphus ovatus</i>
11	Corn	217.69	<i>Austroglycyphagus geniculatus</i> , <i>Tyrophagus putrescentiae</i> , <i>Lepidoglyphus michaeli</i>
12	Peanut	24.19	<i>Rhizoglyphus callae</i> , <i>Lardoglyphus konoii</i> , <i>Euroglyphus maynei</i>
13	Sesame	19.72	<i>Tyrophagus putrescentiae</i> , <i>Aleuroglyphus ovatus</i> , <i>Lardoglyphus konoii</i> , <i>Dermatophagoides farinae</i>
14	broomcorn	35.87	<i>Acarus siro</i> , <i>Tyrophagus putrescentiae</i> , <i>Lepidoglyphus michaeli</i> , <i>Suidasia nesbitti</i> , <i>Euroglyphus maynei</i>
15	Highland barley	16.36	<i>Tyrophagus putrescentiae</i> , <i>Aleuroglyphus ovatus</i> , <i>Glycyphagus domesticus</i> , <i>Lepidoglyphus destructor</i>
16	Bran	193.31	<i>Dermatophagoides farinae</i> , <i>Rhizoglyphus callae</i> , <i>Tyrophagus putrescentiae</i> , <i>Suidasia nesbitti</i> , <i>Aleuroglyphus ovatus</i>
17	Soybean	46.18	<i>Tyrophagus putrescentiae</i> , <i>Acarus siro</i> , <i>Tyrollichus casei</i> , <i>Lepidoglyphus michaeli</i>
18	Mung bean	73.42	<i>Tyrophagus putrescentiae</i> , <i>Tyrophagus longior</i> , <i>Lepidoglyphus destructor</i>
19	Broad bean	64.32	<i>Tyrophagus putrescentiae</i> , <i>Acarus farris</i> , <i>Tyrollichus casei</i> , <i>Dermatophagoides farinae</i>
20	Cowpea	30.26	<i>Tyrophagus putrescentiae</i> , <i>Thyreophagus entomophagus</i> , <i>Acarus siro</i> , <i>Tyrophagus longior</i>
21	Pea	31.94	<i>Tyrophagus putrescentiae</i> , <i>Aleuroglyphus ovatus</i> , <i>Lepidoglyphus destructor</i>
22	Adzuki bean	104.21	<i>Gohieria fuscus</i> , <i>Tyrophagus putrescentiae</i> , <i>Tyrophagus tropicus</i>
23	Bean cake	48.38	<i>Tyrophagus putrescentiae</i> , <i>Acarus farris</i> , <i>Mycetoglyphus fungivorus</i>
24	Feeds	266.36	<i>Dermatophagoides farinae</i> , <i>Thyreophagus entomophagus</i> , <i>Acarus siro</i> , <i>Tyrophagus putrescentiae</i> , <i>Acarus farris</i>
25	Rice contaminated with dust	124.19	<i>Dermatophagoides farinae</i> , <i>Tyrophagus putrescentiae</i> , <i>Blomia freemani</i>
26	Flour contaminated with dust	983.37	<i>Acarus siro</i> , <i>Blomia freemani</i> , <i>Dermatophagoides farinae</i> , <i>Tyrophagus putrescentiae</i>
27	Dust in wheat bin	14.06	<i>Dermatophagoides farinae</i> , <i>Tyrophagus putrescentiae</i> , <i>Thyreophagus entomophagus</i>
28	Fine dried noodles	253.59	<i>Tyrophagus putrescentiae</i> , <i>Caloglyphus berlesei</i> , <i>Chortoglyphus arcuatus</i> , <i>Blomia freemani</i> , <i>Dermatophagoides farinae</i> , <i>Glycyphagus domesticus</i>
29	Sweet potato	79.36	<i>Acarus siro</i> , <i>Tyrophagus putrescentiae</i> , <i>Blomia freemani</i> , <i>Caloglyphus berlesei</i>
30	Dried sweet potato	124.27	<i>Acarus siro</i> , <i>Tyrophagus putrescentiae</i> , <i>Dermatophagoides farinae</i> , <i>Caloglyphus berlesei</i> , <i>Acarus farris</i> , <i>Glycyphagus domesticus</i> , <i>Lepidoglyphus destructor</i>
31	Bread	52.83	<i>Tyrophagus putrescentiae</i> , <i>Glycyphagus domesticus</i> , <i>Lepidoglyphus destructor</i>
32	Crumbs	107.51	<i>Tyrophagus putrescentiae</i> , <i>Acarus siro</i> , <i>Glycyphagus domesticus</i> , <i>Glycyphagus ornatus</i> , <i>Dermatophagoides farinae</i>
33	Mildewed fried dough twist	93.26	<i>Acarus siro</i> , <i>Austroglycyphagus geniculatus</i> , <i>Chortoglyphus arcuatus</i> , <i>Lardoglyphus konoii</i>

Table I (cont.)
The numbers and mite species found in 150 samples of stored products

NO.	Sample sorts	Breeding density (No./g)	Species
34	Old silk noodles	329.15	<i>Tyrophagus putrescentiae</i> , <i>Acarus siro</i> , <i>Blomia freemani</i> , <i>Dermatophagoides farinae</i> , <i>Caloglyphus berlesei</i> , <i>Acarus farris</i> , <i>Glycyphagus domesticus</i>
35	Starch	77.68	<i>Dermatophagoides farinae</i> , <i>Acarus siro</i> , <i>Tyrophagus putrescentiae</i> , <i>Acarus farris</i> , <i>Glycyphagus domesticus</i> , <i>Caloglyphus berlesei</i> , <i>Austroglycyphagus geniculatus</i>
36	Mildewed rapeseed	52.94	<i>Austroglycyphagus geniculatus</i> , <i>Tyrophagus putrescentiae</i> , <i>Acarus siro</i> , <i>Lepidoglyphus destructor</i>
37	Rape seed cake	72.56	<i>Glycyphagus ornatus</i> , <i>Tyrophagus putrescentiae</i>
38	Cotton seed kernel	85.32	<i>Blomia freemani</i> , <i>Caloglyphus berlesei</i> , <i>Acarus siro</i> , <i>Lardoglyphus konoii</i>
39	Cottonseed hull	109.46	<i>Chortoglyphus arcuatus</i> , <i>Dermatophagoides farinae</i> , <i>Tyrophagus putrescentiae</i> , <i>Caloglyphus berlesei</i>
40	Cottonseed cake	184.25	<i>Tyrophagus putrescentiae</i> , <i>Blomia freemani</i> , <i>Caloglyphus berlesei</i> , <i>Lepidoglyphus destructor</i>
41	Sesame oil slag	73.68	<i>Lardoglyphus konoii</i> , <i>Tyrophagus putrescentiae</i> , <i>Dermatophagoides farinae</i>
42	Peanut cake	59.94	<i>Austroglycyphagus geniculatus</i> , <i>Acarus siro</i> , <i>Tyrophagus putrescentiae</i>
43	Wheat koji	162.27	<i>Tyrophagus putrescentiae</i> , <i>Glycyphagus domesticus</i> , <i>Austroglycyphagus geniculatus</i> , <i>Acarus siro</i>
44	Dried bean curd	83.74	<i>Acarus siro</i> , <i>Blomia freemani</i> , <i>Dermatophagoides farinae</i>
45	Beancurd skin	67.58	<i>Acarus siro</i> , <i>Tyrophagus longior</i> , <i>Blomia freemani</i> , <i>Glycyphagus ornatus</i>
46	Soya bean power	163.85	<i>Tyrophagus putrescentiae</i> , <i>Acarus siro</i> , <i>Lardoglyphus konoii</i>
47	Milk powder	459.56	<i>Mycetoglyphus fungivorus</i> , <i>Tyrophagus putrescentiae</i>
48	Ginkgo nut	71.46	<i>Acarus siro</i> , <i>Chortoglyphus arcuatus</i> , <i>Dermatophagoides farinae</i> , <i>Tyrophagus longior</i>
49	Hawthorn	116.24	<i>Carpoglyphus lactis</i> , <i>Glycyphagus domesticus</i> , <i>Tyrophagus putrescentiae</i>
50	Haw jelly	248.14	<i>Glycyphagus domesticus</i> , <i>Tyrophagus putrescentiae</i> , <i>Austroglycyphagus geniculatus</i> , <i>Tyrophagus longior</i>
51	Haw flakes	92.36	<i>Glycyphagus domesticus</i> , <i>Carpoglyphus lactis</i> , <i>Tyrophagus putrescentiae</i> , <i>Acarus siro</i>
52	Sugarcane	56.75	<i>Carpoglyphus lactis</i> , <i>Acarus siro</i> , <i>Tyrophagus putrescentiae</i> , <i>Glycyphagus ornatus</i>
53	Melon seeds meat	192.69	<i>Tyrophagus putrescentiae</i> , <i>Thyreophagus entomophagus</i>
54	Sunflower seed	85.27	<i>Tyrophagus putrescentiae</i> , <i>Acarus siro</i> , <i>Suidasia nesbitti</i> , <i>Caloglyphus berlesei</i>
55	Cucurbitae semina	82.69	<i>Glycyphagus domesticus</i> , <i>Tyrophagus tropicus</i>
56	Pine nut	25.94	<i>Lardoglyphus konoii</i> , <i>Tyrophagus putrescentiae</i> , <i>Acarus siro</i>
57	Red dates	48.9	<i>Glycyphagus domesticus</i> , <i>Carpoglyphus lactis</i>
58	<i>Dateplum persimmon</i>	35.26	<i>Carpoglyphus lactis</i> , <i>Glycyphagus ornatus</i> , <i>Glycyphagus domesticus</i> , <i>Acarus siro</i>
59	Honey date	362.14	<i>Glycyphagus domesticus</i> , <i>Carpoglyphus lactis</i>
60	Zizyphus jujube	152.38	<i>Glycyphagus domesticus</i> , <i>Glycyphagus ornatus</i> , <i>Austroglycyphagus geniculatus</i> , <i>Carpoglyphus lactis</i>
61	Brown sugar	589.19	<i>Carpoglyphus lactis</i>
62	Peach dry	121.49	<i>Carpoglyphus lactis</i>
63	Honey lotus root dry	96.81	<i>Carpoglyphus lactis</i> , <i>Tyrophagus putrescentiae</i> , <i>Glycyphagus ornatus</i>
64	Dried persimmon	66.45	<i>Tyrophagus putrescentiae</i> , <i>Acarus siro</i> , <i>Suidasia nesbitti</i>

Table I (cont.)
The numbers and mite species found in 150 samples of stored products

NO.	Sample sorts	Breeding density (No./g)	Species
65	Dried apricot slices	163.37	<i>Carpoglyphus lactis</i>
66	Almond	86.28	<i>Glycyphagus domesticus</i> , <i>Acarus siro</i> , <i>Carpoglyphus lactis</i>
67	Raisin	18.72	<i>Glycyphagus domesticus</i> , <i>Carpoglyphus lactis</i> , <i>Caloglyphus mycophagus</i>
68	The fruit of Chinese wolfberry	72.5	<i>Tyrophagus putrescentiae</i> , <i>Caloglyphus berlesei</i>
69	Ginseng	48.52	<i>Tyrophagus putrescentiae</i> , <i>Acarus siro</i> , <i>Suidasia nesbitti</i>
70	Honey	238.63	<i>Carpoglyphus lactis</i> , <i>Glycyphagus domesticus</i> , <i>Tyrollichus casei</i>
71	Moon cake	438.06	<i>Glycyphagus domesticus</i> , <i>Suidasia nesbitti</i> , <i>Mycetoglyphus fungivorus</i>
72	Haw sweetmeat	341.57	<i>Caloglyphus mycophagus</i> , <i>Euroglyphus maynei</i>
73	Preserved peach	33.81	<i>Carpoglyphus lactis</i> , <i>Glycyphagus ornatus</i> , <i>Acarus siro</i>
74	Prune	36.94	<i>Glycyphagus domesticus</i> , <i>Carpoglyphus lactis</i>
75	Sugared mandarin	18.94	<i>Glycyphagus domesticus</i>
76	Semen juglandis	62.65	<i>Tyrollichus casei</i> , <i>Mycetoglyphus fungivorus</i>
77	Malted milk	407.8	<i>Tyrophagus putrescentiae</i> , <i>Tyrophagus longior</i> , <i>Chortoglyphus arcuatus</i>
78	Jam	247.56	<i>Carpoglyphus lactis</i> , <i>Glycyphagus domesticus</i> , <i>Glycyphagus ornatus</i>
79	White granulated sugar	92.65	<i>Glycyphagus domesticus</i> , <i>Carpoglyphus lactis</i>
80	Dried longan pulp	215.33	<i>Tyrophagus putrescentiae</i> , <i>Glycyphagus ornatus</i>
81	Cake	487.75	<i>Tyrophagus longior</i> , <i>Tyrophagus putrescentiae</i> , <i>Acarus farris</i>
82	Cracknel	169.4	<i>Tyrophagus putrescentiae</i>
83	Bean paste cake	145.24	<i>Glycyphagus domesticus</i> , <i>Carpoglyphus lactis</i> , <i>Glycyphagus ornatus</i> , <i>Tyrophagus putrescentiae</i>
84	Biscuit	72.95	<i>Tyrophagus putrescentiae</i> , <i>Glycyphagus domesticus</i> , <i>Carpoglyphus lactis</i> , <i>Glycyphagus ornatus</i>
85	Saqima	135.24	<i>Tyrophagus putrescentiae</i> , <i>Glycyphagus domesticus</i> , <i>Acarus siro</i> , <i>Carpoglyphus lactis</i>
86	Onion	58.62	<i>Tyrophagus putrescentiae</i> , <i>Histiostoma feroniarum</i> , <i>Acarus siro</i>
87	Potato	127.24	<i>Tyrophagus putrescentiae</i> , <i>Acarus siro</i> , <i>Glycyphagus domesticus</i>
88	Chinese yam	24.78	<i>Lardoglyphus zacheri</i> , <i>Tyrophagus putrescentiae</i> , <i>Acarus siro</i>
89	Carrot	57.83	<i>Tyrophagus putrescentiae</i> , <i>Acarus siro</i> , <i>Carpoglyphus lactis</i> , <i>Glycyphagus ornatus</i>
90	Dry moss	14.11	<i>Glycyphagus domesticus</i>
91	Dried turnip	69.38	<i>Tyrophagus putrescentiae</i> , <i>Acarus siro</i> , <i>Chortoglyphus arcuatus</i>
92	Mushroom	48.36	<i>Tyrophagus putrescentiae</i> , <i>Histiostoma feroniarum</i>
93	Pleurotus sajur-caju	9.94	<i>Histiostoma feroniarum</i>
94	<i>Flammulina</i>	68.51	<i>Tyrophagus putrescentiae</i> , <i>Caloglyphus berlesei</i> , <i>Histiostoma feroniarum</i>
95	Tremella	24.75	<i>Caloglyphus berlesei</i> , <i>Euroglyphus maynei</i>
96	Black fungus	18.19	<i>Caloglyphus berlesei</i> , <i>Tyrophagus putrescentiae</i>
97	<i>Hericium erinaceus</i>	29.36	<i>Caloglyphus berlesei</i> , <i>Histiostoma feroniarum</i>
98	Winter bamboo shoots	62.18	<i>Tyrophagus putrescentiae</i> , <i>Acarus siro</i> , <i>Glycyphagus ornatus</i>
99	<i>Dityophora</i>	59.23	<i>Acarus siro</i> , <i>Chortoglyphus arcuatus</i> , <i>Tyrophagus putrescentiae</i>

Table I (cont.)
The numbers and mite species found in 150 samples of stored products

<i>NO.</i>	<i>Sample sorts</i>	<i>Breeding density (No./g)</i>	<i>Species</i>
100	Dried bamboo shoots	34.85	<i>Tyrophagus putrescentiae</i> , <i>Tyrophagus longior</i>
101	Pineapple	73.42	<i>Tyrophagus putrescentiae</i>
102	Banana	46.37	<i>Acarus siro</i>
103	Apple	29.56	<i>Tyrophagus putrescentiae</i> , <i>Tyrophagus longior</i>
104	Tangerine	52.32	<i>Caloglyphus berlesei</i> , <i>Glycyphagus domesticus</i>
105	Grapefruit	33.56	<i>Tyrophagus putrescentiae</i> , <i>Tyrolichus casei</i> , <i>Carpoglyphus lactis</i>
106	Coconutmeat	76.14	<i>Tyrophagus putrescentiae</i> , <i>Acarus siro</i> , <i>Chortoglyphus arcuatus</i>
107	Plum powder	81.38	<i>Glycyphagus domesticus</i> , <i>Carpoglyphus lactis</i>
108	Orange powder	54.72	<i>Glycyphagus domesticus</i>
109	Gammon	316.84	<i>Tyrophagus putrescentiae</i> , <i>Lardoglyphus konoi</i> , <i>Tyrophagus longior</i> , <i>Acarus siro</i>
110	Casing for sausages	129.45	<i>Lardoglyphus konoi</i> , <i>Tyrolichus casei</i> , <i>Tyrophagus putrescentiae</i>
111	Preserved duck gizzard	83.62	<i>Lardoglyphus zacheri</i> , <i>Tyrophagus putrescentiae</i>
112	Shelled fresh shrimps	67.38	<i>Tyrophagus putrescentiae</i> , <i>Tyrophagus longior</i>
113	Fillet	122.4	<i>Lardoglyphus konoi</i> , <i>Tyrophagus putrescentiae</i>
114	Sausage	59.46	<i>Lardoglyphus konoi</i> , <i>Tyrophagus putrescentiae</i>
115	Cured meat	72.16	<i>Lardoglyphus zacheri</i>
116	Bacon	92.42	<i>Lardoglyphus zacheri</i> , <i>Tyrophagus putrescentiae</i>
117	Jellied meat	142.85	<i>Lardoglyphus konoi</i> , <i>Tyrophagus putrescentiae</i> , <i>Tyrolichus casei</i>
118	Jerky	64.19	<i>Lardoglyphus konoi</i> , <i>Tyrophagus putrescentiae</i>
119	Dried pork slice	98.35	<i>Lardoglyphus konoi</i> , <i>Tyrophagus putrescentiae</i>
120	Fried pork flakes	72.96	<i>Lardoglyphus konoi</i> , <i>Tyrophagus putrescentiae</i>
121	Butter	68.47	<i>Tyrophagus putrescentiae</i> , <i>Acarus siro</i> , <i>Tyrophagus longior</i>
122	Fermented soybean	132.63	<i>Tyrophagus putrescentiae</i> , <i>Tyrolichus casei</i> , <i>Euroglyphus maynei</i>
123	Spiced pork	61.45	<i>Lardoglyphus zacheri</i> , <i>Tyrophagus putrescentiae</i> , <i>Acarus siro</i>
124	Chilli sauce	28.94	<i>Tyrophagus putrescentiae</i> , <i>Acarus siro</i>
125	Pickled cucumbers	57.82	<i>Tyrophagus putrescentiae</i> , <i>Tyrolichus casei</i>
126	Fermented beancurd	76.24	<i>Tyrophagus putrescentiae</i> , <i>Acarus siro</i>
127	Squids	147.86	<i>Lardoglyphus zacheri</i> , <i>Tyrophagus putrescentiae</i>
128	Sea cucumber	52.55	<i>Lardoglyphus konoi</i>
129	Abalone	68.52	<i>Lardoglyphus konoi</i> , <i>Tyrophagus putrescentiae</i>
130	Sea-tent	48.36	<i>Tyrophagus putrescentiae</i> , <i>Tyrophagus longior</i>
131	Laver	27.85	<i>Tyrophagus putrescentiae</i>
132	Jellyfish	78.57	<i>Acarus siro</i> , <i>Tyrophagus putrescentiae</i>
133	Scallop	32.62	<i>Tyrophagus putrescentiae</i>
134	Conch	59.42	<i>Tyrophagus putrescentiae</i> , <i>Tyrolichus casei</i>
135	Room dust	2.75	<i>Dermatophagoides pteronyssinus</i> , <i>Euroglyphus maynei</i>

Table I (cont.)
The numbers and mite species found in 150 samples of stored products

NO.	Sample sorts	Breeding density (No./g)	Species
136	Soy sauce residue	26.76	<i>Tyrophagus putrescentiae</i> , <i>Acarus siro</i>
137	Wine lees	142.83	<i>Acarus siro</i> , <i>Glycyphagus ornatus</i> , <i>Tyrophagus longior</i>
138	Distiller's yeast	62.18	<i>Acarus siro</i> , <i>Tyrolichus casei</i>
139	Designing fur	38.62	<i>Acarus siro</i> , <i>Tyrolichus casei</i> , <i>Euroglyphus maynei</i>
140	Rot leather	93.56	<i>Tyrophagus putrescentiae</i> , <i>Acarus siro</i> , <i>Tyrophagus longior</i> , <i>Tyrolichus casei</i>
141	Cotton lint	38.27	<i>Caloglyphus berlesei</i> , <i>Tyrophagus putrescentiae</i> , <i>Blomia freemani</i>
142	Cattail mat	318.47	<i>Acarus siro</i> , <i>Tyrophagus putrescentiae</i> , <i>Euroglyphus maynei</i> , <i>Chortoglyphus arcuatus</i>
143	Light straw	152.64	<i>Tyrophagus putrescentiae</i> , <i>Tyrophagus longior</i> , <i>Caloglyphus berlesei</i> , <i>Euroglyphus maynei</i>
144	Straw	526.43	<i>Tyrophagus putrescentiae</i> , <i>Acarus siro</i> , <i>Chortoglyphus arcuatus</i> , <i>Dermatophagoides farinae</i> , <i>Tyrophagus longior</i> , <i>Euroglyphus maynei</i> , <i>Tyrolichus casei</i>
145	Wheat straw	385.56	<i>Acarus siro</i> , <i>Tyrophagus longior</i> , <i>Tyrolichus casei</i> , <i>Acarus siro</i> , <i>Euroglyphus maynei</i> , <i>Dermatophagoides farinae</i>
146	Paper	63.85	<i>Acarus siro</i> , <i>Dermatophagoides pteronyssinus</i> , <i>Euroglyphus maynei</i>
147	Bedding	382.64	<i>Acarus siro</i> , <i>Tyrophagus putrescentiae</i> , <i>Dermatophagoides pteronyssinus</i> , <i>Euroglyphus maynei</i> , <i>Tyrophagus longior</i>
148	Clothing	53.74	<i>Dermatophagoides pteronyssinus</i> , <i>Euroglyphus maynei</i>
149	Carpet dust	638.24	<i>Dermatophagoides pteronyssinus</i> , <i>Euroglyphus maynei</i> , <i>Dermatophagoides farinae</i> , <i>Tyrophagus putrescentiae</i> , <i>Blomia freemani</i> , <i>Acarus siro</i>
150	Mattess dust	284.53	<i>Dermatophagoides pteronyssinus</i> , <i>Dermatophagoides farinae</i> , <i>Euroglyphus maynei</i> , <i>Acarus siro</i>

Table II
Classification of acaroid mites (Acari: Astigmata) in 150 samples of stored products

Family	Genus	Species	Habitats
Acaridae	<i>Acarus</i>	<i>Acarus siro</i>	Rice, wheat, starch, ginseng, peanut cake, feed, gammon, cake, etc.
		<i>Acarus farris</i>	rice, feed, starch, etc.
		<i>Acarus immobilis</i>	rice bran, etc.
	<i>Tyrophagus</i>	<i>Tyrophagus putrescentiae</i>	rice, flour, sticky rice, mushroom, fried pork flakes, etc.
		<i>Tyrophagus longior</i>	rice, wheat, cake, malted milk, etc.
	<i>Tyrolichus</i>	<i>Tyrophagus tropicus</i>	adzuki bean, cucurbitae semina, etc.
		<i>Tyrolichus casei</i>	rice, semen juglandis, grapefruit, fermented soybean, etc.
	<i>Mycetoglyphus</i>	<i>Mycetoglyphus fungivorus</i>	rice bran, milk powder, semen juglandis, moon cake, etc.
	<i>Aleuroglyphus</i>	<i>Aleuroglyphus ovatus</i>	wheat, rice bran, pea, sesame, etc.
	<i>Caloglyphus</i>	<i>Caloglyphus berlesei</i>	flour, the fruit of Chinese wolfberry, black fungus, tremella, etc.
<i>Caloglyphus mycophagus</i>		unhusked rice, haw sweetmeat, etc.	

Table II (cont.)
Classification of acaroid mites (Acari: Astigmata) in 150 samples of stored products

Family	Genus	Species	Habitats
Acaridae	<i>Thyreophagus</i>	<i>Thyreophagus entomophagus</i>	flour, feed, Melon seeds meat, dust in wheat bin, pea, etc.
	<i>Suidasia</i>	<i>Suidasia nesbitti</i>	rice, broken rice, bran, dried persimmon, moon cake, etc.
	<i>Rhizoglyphus</i>	<i>Rhizoglyphus callae</i>	peanut, bran
Lardoglyphidae	<i>Lardoglyphus</i>	<i>Lardoglyphus konoii</i>	peanut, fillet, jerky, dried pork slice, sesame oil slag, etc.
		<i>Lardoglyphus zacheri</i>	preserved duck gizzard, bacon, squids, Chinese yam
Glycyphagidae	<i>Glycyphagus</i>	<i>Glycyphagus domesticus</i>	rice, flour, red dates, white granulated sugar, orange powder, bread, etc.
		<i>Glycyphagus ornatus</i>	rape seed cake, brown sugar, Honey lotus root dry, preserved peach, winter bamboo shoots, etc.
	<i>Lepidoglyphus</i>	<i>Lepidoglyphus michaeli</i>	corn, soybean, broken rice, millet, etc.
		<i>Lepidoglyphus destructor</i>	unhusked rice, wheat, corn, etc.
Chortoglyphidae	<i>Austroglycyphagus</i>	<i>Austroglycyphagus geniculatus</i>	corn, peanut cake, wheat koji, starch, etc.
	<i>Blomia</i>	<i>Blomia freemani</i>	flour, broken rice, rice contaminated with dust, beancurd skin, sweet potato, cotton lint, etc.
	<i>Gohieria</i>	<i>Gohieria fuscus</i>	adzuki bean
Carpoglyphidae	<i>Chortoglyphus</i>	<i>Chortoglyphus arcuatus</i>	flour, wheat, malted milk, ginkgo nut, Dityophora, etc.
Carpoglyphidae	<i>Carpoglyphus</i>	<i>Carpoglyphus lactis</i>	red dates, brown sugar, Peach dry, Honey lotus root dry, grapefruit, plum powder, etc.
Histionstomidae	<i>Histiostoma</i>	<i>Histiostoma feroniarum</i>	Pleurotus sajuraju, mushroom, Hericium erinaceus, etc.
	<i>Euroglyphus</i>	<i>Euroglyphus maynei</i>	broken rice, peanut, haw sweetmeat, straw, designing fur, fermented soybean, etc.
Pyroglyphidae	<i>Dermatophagoides</i>	<i>farinae</i>	sticky rice, feed, bran, rice contaminated with dust, dust in wheat bin, wheat straw, etc.
		<i>pteronysinus</i>	room dust, rice bran, mattress, paper, bedding, clothing, etc.

Discussion

The mites in houses and stored products are numerous. In general, these mites belong to suborders of Acarida, Oribatida, Actinedida and Gramasida, in which Acarida accounts for more than half of the mite species⁹⁻¹¹, including 7 families of Acaridae, Lardoglyphidae, Glycyphagidae, Chortoglyphidae, Carpeglyphidae, Histionstomidae and Pyroglyphidae¹². In our study, 29 acaroid species isolated from the 150 samples of the stored products were consistent on the whole with Hughes's description, but the number of species was fewer. This may be associated with the territory distribution, storage setting, sample difference or varied sampling. Acaroid mites are the major house dust mites, widely distributed in environment of moistness, darkness and favorable temperature and potentially cause serious damage to the stored products and humans besides animals. Shen ZP (1985) conducted investigations on the distribution of acaroid mites in areas of Beijing, Shanghai and Sichuan

province, China, and the results showed that acaroid mites were found in sugar, dry fruits, conserves and feeds, and worse enough, serious infestation of the mites was seen in workshop of drug plant where penicillin and tetracycline were being processed¹³. Acaroid mites have far-ranging food habit that may be either phytophagous, mycetophagous, saprophagous, predacious or parasitic, and are the primary pest for the stored products such as dry fruits, wooden furniture, clothing, animal furs, paper, drugs, tea and sugar¹⁴⁻¹⁶. They also occur in grain seeds, animal feeds, foodstuff and medicinal herbs, causing significant damage to the quality of the storages or even unpleasant results of retardant growth, disease, toxic effects and abortion, once the livestock fed with the feeds contaminated by the mites¹⁷⁻¹⁹. In addition, the secretions and metabolic products of mites as well as their dead lysate are liable to cause poisoning of animals and induce the allergic conditions with humans such as allergic asthma, allergic rhinitis, atopic dermatitis and chronic urticaria^{20,21}.

It was reported that acaroid mites were commonly found in houses and different product stores in high concentration, and may flourish in quilt, pillow, beds, kang (kind of warm bed popular in north China), inner wall of the house and window dusts¹³. Once people are exposed to the previous articles in daily life and activities, the mites together with their secretions and discharges tends to get in the body, thus causing allergic disease²²⁻²⁴. Therefore, general investigation on the mite infestation in stored products not only has economic significance but contributes to prevention of allergic disease from mite allergen. In current study, we found that acaroid mites were breeding in large quantity in the house carpet, sofa, mattress, pillow, quilt and different products in stores. It is possible for the individuals to be exposed to, either by handling, inhaling or/and ingestion of their secretions, discharges or dead mites, that eventually leads to poisoning of humans and animals or allergic disorder.

In present study, we exclusively performed the identification for the acaroid mites partially extracted from the samples, yet failed to include other species. Actually, it is hard to totally isolate acaroid mites from certain samples, for which the actual species number might be greater than our description. Since our estimation of the breeding density relied on indirect calculation of the sampling, the results only revealed general density of the mites breeding in certain samples. Meanwhile, the findings showed that the breeding density of acaroid mites was the highest in the dust at the tail margin of houses, which accounted for 983.37 heads/g. This implied that the tail margin dust in product stores should be managed well to prevent the mites from spreading, when the breeding density of mites mounted higher to a certain extent, they are likely to migrate around, thus causing diffusion of the bacteria, fungi or other micro-organisms.

For this survey, we found that the acaroid mites were extensively distributed in dry fruits, preserved fruits, grains, feeds, cookies, products of meat origin, bean and fishes, dried edible fungi, clothes, leather, furniture, house dust, raw straw and straw products. However, our findings were somewhat inconsistent with the results described by Hughes (1976) on the mite habitats such as barn, flour, animal feeds, dry fruits, pudding, dried meat slice, rangeland, flaxseed, cheese and house dust. Previous studies²⁵⁻²⁹ reported that *Aleuroglyphus ovatus* primarily infest various grains, especially the products rich in protein and fat stored in damp environment. *Acarus siro* often causes damage to embryo bud of cereals, leading to loss of grain output; *Tyrophagus* commonly occurs in products in stores such as stock fish, peanut, jerked meat, flax, banana, wheat, flour, rice husk, soybeans, red date, persimon cake, white sugar and longan; *Caloglyphus* are frequently seen in the decayed, damp wheat, grains, peanut, corn and flaxseed; *C. mycophagus* primarily occurs not only in the flour and domestic animal feeds kept too long and with high water content but in insects, paddy, broken rice and haystack; *Suidasia*

often compromises various grains and the products of grain origin as well as medicines; *Lardoglyphus* occurs on leather and sheepskin; Certain species of glycyphagidae infest the products in stores such as cereals, flour, peanut, beans, sesame, tobacco, sugar of variety, red date, ham and dried fishes; One species in chortoglyphidae affecting the grains in storage is often seen in flour, wheat and maize as well as feeds; *C. lactis* frequently brings harm to dry fruits, white sugar, sweet wine, flour, red jujube, orange cake, cakes and pastry, hawthorn, cookies, longan, dried almond, conserves, fruit jam and decayed foodstuff. The previous descriptions on the mite infestation of stored products are consisting with ours. Nevertheless, we found that *Acarus siro* occurs more frequent in such stored products as ginseng, peanut cake, various feeds, ham and cookies except for cereals; *Caloglyphus* occurred in flour, medlar, black fungus, white tremella, rough rice and hawthorn besides rotten or mouldy wheat, rough rice, peanut, maize and flaxseed. *Lardoglyphus* was seen in peanut, fillet, jerky, preserved pork slice, residues of sesame oil, preserved duck gizzard, smoked meat, squid and common yam rhizome except for leather and sheepskin.

Conclusions

Although our findings are partly compatible with the previous documents regarding the species and the habitus and frequent habitats, yet difference existed. These discrepancies may be associated with the samples collected in diverse environment for the mites, and the findings easily suggest that acaroid mites are in universal distribution. Accordingly, expanded sample collection remains necessary for full understanding of the breeding status of acaroid mites in the stored products in areas throughout Anhui province.

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Conflicts of Interest

The authors declare no conflict of interest.

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