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Gohieria fusca (Acari : Astigmata) found in the filter dusts of air conditioners in China

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Abstract

Objective: ***Gohieria fusca*****(Oudemans, 1902) is recognized to breed in wheat flour, rice, corn, feeds, wheat bran and herbal medicines as well as other stored products, and capable of having mild to moderate cross reactivity with allergens of house dust mites, an important source of indoor allergens associated with asthma and other allergic conditions. Air-conditioning systems are indispensable in public and civil buildings, and the screens of the air conditioners are the most places to accumulate dusts. In order to investigate whether *Gohieria fusca* can breed in the screens of air-conditioners equipped at either public spaces or civil dwellings in Wuhu city, Anhui province, China.**

Methods: **We collected 430 dust samples from the filters of air-conditioning systems at the school cafeteria, marketplaces, hotels and civil buildings between June and September of 2013, and isolated *Gohieria fusca* from the previous samples.**

Results: **The results suggested that *Gohieria fusca* was present in 98 of the 430 samples (22.79%), and the breeding rate was significant in the air-conditioning filters from different spaces (c^2=18.294, *P*<0.05). A total of 783 carpets of *Gohieria fusca* were detected in the 510.5g samples, and the mean breeding density was 1.53 carpets/g.**

Conclusions: **Our findings indicate that *Gohieria fusca* is prevalent in the screens of air-conditioners in Wuhu area, and its breeding status appears serious.**

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Key words: *Acaroid mites*. Gohieria fusca. *Air conditioner filter. Breeding surroundings*. *Allergy.*

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GOHIERIA FUSCA (ACARI: ASTIGMATA) ENCONTRADO EN EL POLVO DE LOS FILTROS DE APARATOS DE AIRE ACONDICIONADO EN CHINA

Resumen

Objetivo: **La *Gohieria fusca* (Oudemans, 1902) se reproduce en la harina de trigo, arroz, maíz, piensos, salvado de trigo y los medicamentos a base de hierbas, además de en otros productos almacenados; este ácaro puede tener una reactividad cruzada de leve a moderada con alérgenos de los ácaros del polvo domésticos, una importante fuente de alérgenos de interior asociada al asma y otras afecciones alérgicas. Los sistemas de aire acondicionado son indispensables en edificios públicos y civiles, y las pantallas de estos aparatos son los lugares donde más se acumula el polvo. Se realizó este estudio con el fin de investigar si la *Gohieria fusca* puede reproducirse en las pantallas de los acondicionadores de aire instalados en espacios públicos o viviendas en la ciudad de Wuhu, provincia de Anhui, China.**

Métodos: **Se recogieron 430 muestras de polvo de los filtros de los sistemas de aire acondicionado en la cafeterías de centros educativos, mercados, hoteles y edificios civiles entre junio y septiembre de 2013, y se aisló la *Gohieria fusca* de dichas muestras.**

Resultados: **Los resultados indicaron que la *Gohieria fusca* estaba presente en 98 de las 430 muestras (22,79%), y la tasa de reproducción fue significativa en los filtros del aire acondicionado de diferentes espacios (c^2=18.294, *P*<0.05). Se pudo detectar un total de 783 cabezas de *Gohieria fusca* en los 510,5 gr. de muestras, y la densidad de cultivo era de 1,53 cabezas/gr.**

Conclusiones: **Nuestros resultados confirman la prevalencia de la *Gohieria fusca* en las pantallas de los aparatos de aire acondicionado en la zona de Wuhu, y la situación de su reproducción parece grave.**

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Palabras clave: *Ácaros*. Gohieria fusca. *Filtro del aire acondicionado*. *Entornos de reproducción*. *Alergia.*

Introduction

Gohieria fusca (Oudemans, 1902), also known as brown flour mite, is frequently breeding in wheat flour, rice, corn, feeds, wheat bran and herbal medicines as well as other stored products[1]. This species exhibits mild to moderate cross reactivity with allergens of house dust mites[2], eventually resulting in various allergic disorders, including asthma, allergic rhinitis, atopic dermatitis and urticaria[3]. Nevertheless, few data are available on the presence of *Gohieria fusca* in the filters of an air conditioner. In order to determine whether *Gohieria fusca* can be present in such equipments, we conducted an investigation on the filter dusts of air conditioning units equipped at the school dining-room, marketplaces, hotels and civil dwellings in Wuhu city of Anhui province, China, between June and September of 2013.

Materials and methods

Dust sample collection

The dust samples from the air conditioner filters were collected in the school cafeteria, marketplaces, hotels and civil houses. The collection was performed as previous description[4] by initially removing the screens from the air conditioning unit and gently dusting the dusts with a hairbrush into a white porcelain dish. The samples were separately sealed in a plastic pouch, label with details, including the collection time, places, location of the air conditioning units and collector, and taken back to the laboratory to isolate the mites.

Mite isolation

The dust samples were measured and separated the fine dusts from larger particles with a sample sieve. The larger particles were detected with directicopy, i.e., the samples were contained in a plate and examined directly under the zoom-stereo microscope by moving the particles from one side to another with a zero-sized hairbrush. Once the mite being identified, it was taken with a new brush to prevent mis-count. The mites in the fine dust samples were isolated with water floatation by the following procedures: 1) The dust samples were mixed with clean water; 2) The mites floated on the water surface were not collected until the mixture became still and clear.

Mite sample preparation

Temporary mite samples were prepared for the current investigation because of longer time for permanent specimen. The preparation procedure was modified somewhat on the previous technique basis[5] . The acaroid mites harvested were directly sealed in a plate with the pink sodium lactate solution and stored in the incubator for 30 min at 37°C. Then the mites were directly identified and classified under the microscope, and the specimens were removed back into the preservation solution after observation.

Mite identification

Classification and identification of the mite species were performed as previous definition[6] in terms of the family, genus and species.

Data processing

Average number of the mite breeding in the samples was expressed by B=*N*/*T*, where *N* indicates the total count for the samples and *T*, the total weight of the samples.

The breeding rate was calculated as (the acaroid mites detected in the dust samples from the air conditioning unit/the total samples collected in the same space)×100%. χ^2 was used to compare the breeding rate in different samples.

Constituent ratio was enumerated by (the total number of the *Gohieria fusca* developing in a certain period/the total number of *Gohieria fusca* harvested in the total samples)×100%.

Results

Identification of the mite species

The idiosoma of the male *Gohieria fusca* measures approximately 300μm in length, both dorsal and ventral surfaces of the body are well tanned and covered with pinkish-brown pitted cuticle. The genital opening is situated between coax IV, and the tip of the straight tubular-like penis extends backward. The anal opening stretches to the posterior border of the body and a pair of anal setae arise from the anterior margin. The external verticals (ve) are horizontal to the pectinate supracoxal seta (ps) that arise from a small groove. The legs are thicker and shorter, and the pretarsus arise from the ventral side of the apex of each trasus. The tips of the genua and the femor are expanded and surrounding the adjacent segment and the valla are visible at the dorsal genua and tibiae.

Female *Gohieria fusca* is approximately 400μm long, and has weaker body color and finer setae. Ventrally, a larger genital fold is situated at between the coxae I and IV. The apodemes I are fused into the transverse plate anterior to the genital opening, and the

apodemes II are proximal to the circumgenital ring and internally connected with the apodemes III and IV. The smaller genital sense organs are situated at the posterior border of the genital fold. The folds at either side of the anal opening overgrow the posterior border of idiosoma, and have two pairs of anal setae at both sides. The opening of the bursa copulatrix is shielded by a small prominence and connected by a tube with the seminal receptacle. The legs of the female *Gohieria fusca* are slenderer, with more developed longitudinal ridges than the males (Fig. 1).

Breeding rate of Gohieria fusca in the filters of air conditioning units in different spaces

Gohieria fusca was detected in 98 of the 430 filter samples, with a breeding rate of 22.79 %(98/432). In 109 samples from the school dinning-room, 37 were positive and the breeding rate was 33.94%. Ten of the 93 filter samples from marketplaces were positive, with a breeding rate of 10.75%. Of the 118 samples from hotels, 21 were positive, and the breeding rate was 17.80%. Thirty of the 110 filter dusts from civil dwellings were positive and the breeding rate accounted for 27.27%. The results showed that the breeding rate was statistically significant for the air conditioners in different spaces (χ^2=18.294, P<0.05).

Breeding density of Gohieria fusca in the filters of air conditioning units in different spaces

The 430 samples were measured 510.5g in total, in which 783 carpets of *Gohieria fusca* were detected. The average breeding density was 1.53 heads/g(783/510.5). The breeding density of *Gohieria fusca* varied a lot in filter dusts from the air conditioning units in different rooms, and was maximal for the school cafeteria(2.39 heads/g; 318/132.8) and minimal for the marketplaces(0.78 heads/g; 115/146.7). The breeding density in filter dusts was 1.51 heads/g (217/144.6) for hotels and 1.53 heads/g (133/86.4) for civil houses.

Constituent ratio for Gohieria fusca in dissimilar development stage

Pool statistics was performed for the identified *Gohieria fusca* in different life cycles. We totally detected 533 eggs, 70 protonymph, 151 tritonymph and 426 adults. The constituent ratio was maximum for the eggs(45.16%) and minimum for the protonymph(5.9%).

Discussion

The grain or flour mite, belonging to Acariformes and Acaridida, includes 7 families: Acaridae, Lardoglyphidae, Glycyphagidae, Chortoglyphidae, Carpoglyphidae, Pyroglyphidae, Histiostomidae. In recent years, Krantz, G.W *et al*[7] re-labeled the Acari as 2 superorders (Parasitiformes and Acariformes), 125 superfamilies and 540 families in their newly published *A Mannual of Acarology,* in which Opilioacarida, Holothyrida, Ixodida and Mesostigmata are listed under the Parasitiformes, and Trombidiformes and Sarcoptiformes under the Acariformes. Additionally, Oribatida was down-graded as suborder. Astigmata, known as Acaridida, was also down-graded as Oribatida, which includes Desmonomatides (Desmonomata) and Astigmatina (OConnor 2009). Ten superfamilies and 76 families, including two major species of *Acaridia* and *Psorptidia*, are listed under the Astigmatina[7].

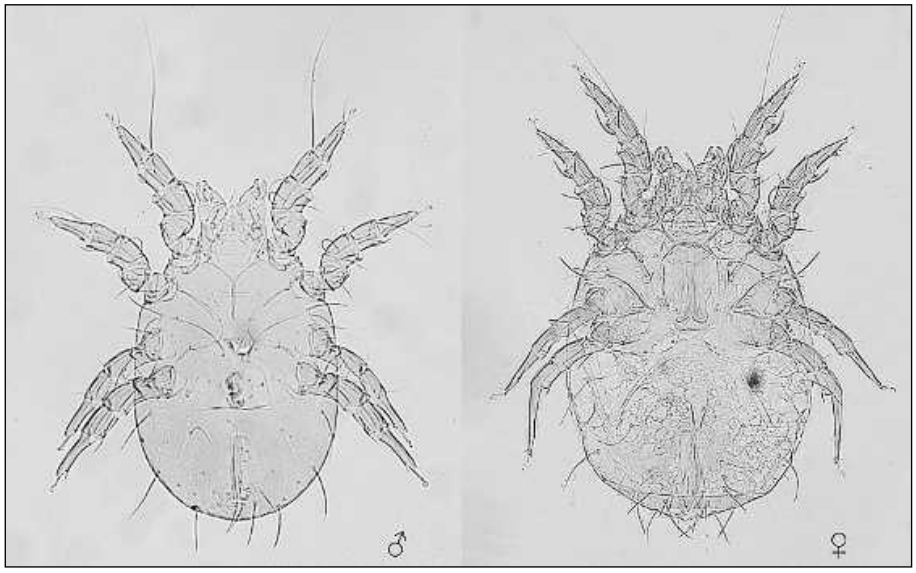

Fig. 1.—Gohieria fusca (Adult).

The flour mites are one of the most important mites that proliferate in the stored foods and other stored products, and may eventually lead to degradation of the food products. Early research interests are primarily involved in the prevention and control of the flour mites[8]. Yet some studies in recent years found that the grain or flour mites are strongly associated with the human health, for exposure to the flour mites may cause acarodermatitis(skin rash) or anaphylactic reaction, and worse enough, the flour mite can get into the human body[9], and result in other serious conditions.

Previous studies considered that the flour mites responsible for allergic diseases were inquilinous in the dusts of beds, clothing and floors or other articles[10] However, recent work found that the flour mites may breed in the filters of an air conditioner[11,12], and this shall call our great attention. Now that this species are health association, the current study was focused on description and discussion of the *Gohieria fusca* found in the filter dusts from air conditioning units, with respect to the breeding rate, breeding density and constituent ratio of the *Gohieria fusca* in its dissimilar life cycles. Some scholars described the cross-reactivity of the allergen in *Gohieria fusca* with the antigen of dust mites[2], and mite-allergic individuals may be sensitized by various species. A study done in the subtropical Canary Islands of Spain through positive skin tests to several storage mite species showed that the sensitization rates was 28% for *Goheria fusca*[13].Thus, we detected the *Gohieria fusca* in the filter dust of air conditioners that are widely involved in human living environment in order to generate further study in this field. As is known to us all, when people clean their rooms, the dusts, together with the fiber shed from the clothing or body scurf would be stirred and remained drift in the indoor air, and are eventually sucked into the internal unit of the conditioner when it is in operation and accumulated in its filters, where is an optimal environment for the flour mites breeding, because of the filters being warm and moisture as well as a shady place with rich organic materials. Furthermore, when the air conditioner is in repeated use, the mites and their discharges, secretions and lysates would be ventilated into the air indoors, thus causing allergic disorders such as asthma. Our results showed that the *Gohieria fusca* are densely proliferated in the filters of air conditioning system, and their discharges, secretions and lysates from their dead bodies shall be one of the potent indoor allergens.

Our investigation also demonstrated that the breeding rate of *Gohieria fusca* varied a lot in filter dusts from air conditioners in different places (χ^2=18.294, P<0.05). The maximal breeding rate was found in the filters of air conditioning units in school dining-rooms, and minimal breeding rate was in marketplaces. The research show that developmental stages, fecundity, reproduction and life table parameters of *Gohieria fusca* were affected by different food types, whereas, total immature stages lasted days for female and male. This may be associated with more flour, flavorings and other food products accommodated in the refectory, for these stored products are excellent food origins for *Gohieria fusca* to proliferate in large quantity. Certain laboratory work showed that 25°C and 65%RH is favorable to mites[14], and air-conditioned room happened to provide such optimal environment. To make matters worse, the filters of air conditioners in such warm and moisture conditions can easily promote a shelter for the mites to grow in. Contrarily, the marketplaces can be brighter and equipped with better ventilation and dust removal facilities besides rapid circulation of commodities. This is attributable to the lower breeding rate of *Gohieria fusca* found in such place. Although the breeding density was highest in the filter dusts of air conditioners in school cafeteria and lowest in those of marketplaces, yet the breeding density and breeding rate appear relative high for civil dwellings, which is consistent with the total breeding level and further proves that the breeding of flour mites is involved in environmental factors and the richness extent of organic matters[15].

We also conducted a statistics on the dissimilar development stages of *Gohieria fusca*, and found that the constituent ratio was maximum for the eggs. Laboratory observation showed that only copulated female laid eggs, this is attributed to the fact that *Gohieria fusca* can lay eggs in large number at a time. The number of protonymph and tritonymph appears lower; this may be explained by that the *Gohieria fusca* creeping on the filters are easily blown off while the machine is operating, since the mites are relatively small in those two stages. And the immature stages of *Gohieria fusca* are short.

Apart from the *Gohieria fusca* detected in the four places in our work, we also found other mite species in the filters of air conditioners. This is consistent with the previous description on the mite species found in living environment[16]. The flour mite, including *Gohieria fusca*, is one of the important allergens in human living rooms, and in early 1921, Kern for the first time described that the dust extracts gave positive cutaneous reactions in sensitive patients. In 1964, Voorhorst *et al*[17] further reported that the dust mites were the major allergic sources, and the mite body and its metabolites were potent indoor allergens as well as the allergenic activity in house dusts was positively related to the density of mites in a specific space. Currently, the relationship between the presence of flour mites in a room environment and prevalence of allergic disorders, frequent and common diseases in clinic, has been well recognized[18]. It was estimated that the over 10 million children were affected by asthma, more than 50 million individuals by allergic rhinitis and above 30 million by sensitization dermatitis in China[19]. Such serious condition must be great concerns in our studies.

Conclusions

Briefly, our investigation for the first time demonstrated that the *Gohieria fusca* did prevail in the filter dusts of air conditioners, which implies that the filter dusts must add the risks of antigen from *Gohieria fusca* to the room environment. Since mites represent the major source of allergens and main risk factors for allergic diseases in exposed individuals, our findings may supply theoretical basis for prevention and control of the anaphylactic diseases resulted from the flour mites.

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Author Disclosure Statement

The authors declare no conflict of interest.

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