Habitat preference of cockroaches in urban environments in Shanghai, China

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Abstract: The habitat preference of domiciliary cockroaches in urban environments in Shanghai, China was evaluated with sticky traps. Residential houses ($N=40$), one-room restaurants ($N=20$) and hotel restaurants ($N=8$) were sampled with 1 sticky trap/15 m², for 2 nights/month for 2 years. *Blattella germanica* was the most common (96%) species trapped in hotel restaurants, and *Periplaneta fuliginosa* was the most common (94%) cockroach trapped in households. *P. americana* was limited to 2-6% of the total cockroaches trapped in the three environments sampled. The one-room restaurant environment was intermediate in terms of heat, food, and water between the other two environments. *B. germanica* (76%) and *P. fuliginosa* (19%) were the most common species in one-room restaurants. The presence of German and smokybrown cockroaches in urban environments in Shanghai may be determined by availability of heat in buildings in winter, and abundance of food and water throughout the year. Hotel restaurants are heated in winter, and German cockroaches are common year round. Houses are not heated in winter and smokybrown cockroaches are most common during summer. In residences the number of smokybrown cockroaches trapped peaked in July 1987, and July and October 1988.

INTRODUCTION

Cockroaches are common pests in urban environments around the world. Nineteen species have been reported in urban buildings in The People's Republic of China (Woo, 1981, 1982, 1987; Woo and Guo, 1984; Chen *et al.*, 1986; Robinson and Bao, 1988). The *Periplaneta* species: *P. americana* (L.), *P. australasiae* (F.), *P. brunnea* (Burmeister), and *P. fuliginosa* (Serville) are the most common cockroach pests in China. *Blattella germanica* (L.) and *Blatta orientalis* (L.)

have a limited distribution in China (Robinson and Bao, 1988). Liang (1981) reported the distribution and infestation level of *P. fuliginosa* (as *P. emarginata*), *P. americana*, and *B. germanica* in Shanghai. Xu and Zhang (1983) also reported on the distribution and abundance of these three species over a four-month period in various buildings in Shanghai. Robinson and Bao (1988) reported the pest status of *P. fuliginosa* in apartments in Hangzhou, China. Although there are some data on the geographic distribution of pest cockroaches, there is little information on the distribution and seasonal

abundance of the major cockroach pests in urban environments in China.

The objective of the research reported here was to determine habitat preferences of three domiciliary cockroach species in urban environments in Shanghai, China.

MATERIALS AND METHODS

Study site. Shanghai (latitude 31°N, longitude 121°E) has the second largest population of any city in the world, and the largest population of any city in China. There are approximately 12.5 million people living in 6,100 km² in the Shanghai urban area. This coastal city has an average summer (June–August) temperature of 28°C, and an average winter (December–February) temperature of 3°C.

Forty households, 20 one-room restaurants, and 8 hotel restaurants were selected for sampling. The majority of residential environments sampled were houses built adjacent to one another, forming one large building. The household sites contained two or three rooms. The majority of the houses were without a bathroom or running water indoors, and with kitchens located outside. The rooms were unheated in the winter.

The commercial environments sampled were one-room and hotel restaurants. The one-room restaurants were usually located in residential areas, with single- or multiple-family dwellings adjacent to, or a part of them. Dining areas usually consisted of several small tables and chairs. These restaurants had running water indoors, but no bathroom facilities. A limited amount of heat in winter was provided by the kitchen and cooking activities. Hotel restaurants were large and isolated from residential build-

ings. Kitchen areas had running water, large stoves and storage areas, and were heated in the winter months.

Sampling. Cockroach populations were sampled with sticky traps (9×15 cm) baited with fresh bread, and placed 1 trap/15 m². Two traps were placed in each household room, four traps were used in each of the one-room restaurant kitchens, and five traps were placed in each hotel restaurant kitchen. The traps were set out for about 12 hr (1900 to 0700) each night on two successive nights. Traps were returned to the laboratory where the cockroaches were identified and counted. A small number of traps were not recovered each month.

Cockroach trapping was conducted from January 1987 through December 1988. Trapping data collected from June to December 1986 were used to select suitable sites and cooperators.

Insecticide use. A limited amount of cockroach-control insecticide was applied to the sites sampled. In hotel restaurants pyrethroid insecticides (aerosol) were applied approximately twice each month in 1988 and less regularly in 1987. In one-room restaurants and households there was limited insecticide use. In these locations pyrethroids were used only during summer months.

RESULTS AND DISCUSSION

1. Household environment

The smokybrown cockroach, *P. fuliginosa* was the most common (94%) cockroach in the households sampled (Table 1). *P. americana* was not common in households, and made up only 6% of the total cockroaches collected in this environment. The German cockroach, *B. germanica*, was not abundant

Table 1 Composition of the pest cockroach populations collected in households, one-room and hotel restaurants in Shanghai, China.

Species	Environment		
	Households No. (%)	One-room rest. No. (%)	Hotel rest. No. (%)
<i>B. germanica</i>	20 (0.8)	3,765 (75.9)	15,379 (95.8)
<i>P. fuliginosa</i>	2,200 (93.6)	961 (19.4)	418 (2.6)
<i>P. americana</i>	131 (5.6)	235 (4.7)	261 (1.6)

in the households sampled. It represented only about 1% of the total cockroaches collected in houses.

The dominance of *P. fuliginosa* in household environments in Shanghai may reflect its tolerance for warm and humid summer conditions, and cool and damp winter conditions (Yamaguchi, 1963; Tsuji and Mizuno, 1973; Tsuji, 1975; Appel and Tucker, 1984). The smokybrown cockroach probably can successfully overwinter in the unheated houses in Shanghai, and the German cockroach can not. Tsuji and Mizuno (1973) reported that the reason *B. germanica* was not common in Japanese houses, and that *P. fuliginosa* was a most common pest cockroach in Japan was due to the differences in their ability to overwinter in unheated buildings. *B. germanica* and *P. americana* were unable to survive 40 days at 5.5°C, but middle and late instar nymphs of *P. fuliginosa* were able to survive 90 days at 5.5°C (Tsuji and Mizuno, 1973). Yamaguchi (1963) reported that the 3rd through the 7th instar, and the adult smokybrown cockroach could survive in unheated buildings in winter.

The ability of the smokybrown cockroach to live both indoors and outdoors may be a factor in successful household infestations in Shanghai. This species has been reported to move between outdoor and indoor areas of residential and commercial structures (Appel and Tucker, 1984). Fleet and Frankie (1978) reported the home range of *P. fuliginosa* to be 177–401 m. This species is capable of flying short distances, and can easily crawl or fly into houses to forage and oviposit (Appel and Tucker, 1984). Apartment residents questioned by Robinson and Bao (1988) reported *P. fuliginosa* flying into their apartments from outside.

The number of smokybrown cockroaches trapped in households fluctuated between summer and winter. From December to April very few smokybrown cockroaches were collected in households (Table 2). However, trap catches began to increase in May and the number trapped continued to increase in the following months, and peaked in August (Table 2). Smokybrown cockroach abundance corresponds to hot and humid weather (Takagi, 1974). Fleet and Frankie

(1978) reported that the population of *P. fuliginosa* increased when temperatures reached or exceeded 20°C, and decreased when temperatures dropped below 20°C in southeast Texas. The number of smokybrown cockroaches trapped in urban buildings in Shanghai corresponded to variations of temperature during the year. The numbers of cockroaches trapped in households peaked in July and August when the temperatures were highest, and the fewest cockroaches were trapped in January when temperatures were lowest.

The occurrence of the German cockroach in the urban buildings sampled in Shanghai is consistent with the reported temperature and humidity preferences of this species. Cornwell (1968) reported the German cockroach preferred humid environments, and a temperature range of 24–33°C. Ebeling *et al.* (1967) reported the importance of proximity of food and water to German cockroach survival. In urban areas in the United States the German cockroach is a common household pest throughout the year, with a preference for infesting kitchens and bathrooms (Akers and Robinson, 1981). This is probably because households in the U.S. are heated, and there is ample food and water

Table 2 Seasonal abundance of *P. fuliginosa* in households in Shanghai, China.

Month	1987		1988	
	No. trapped	Mean	No. trapped	Mean
Jan	—	—	0	0
Feb	3	0.02	—	—
Mar	6	0.04	—	—
Apr	5	0.03	17	0.11
May	13	0.11*	66	0.55*
Jun	51	0.32	100	0.65
Jul	69	0.43	152	0.98
Aug	38	0.24	176	1.14
Sep	46	0.29	130	0.84
Oct	23	0.14	185	1.19
Nov	11	0.07	35	0.23
Dec	2	0.01	4	0.03

* Based on 120 traps.

Based on an average of 155 (1988) to 159 (1987) traps.

for cockroaches. In households sampled in Shanghai the conditions were not favorable for German cockroach survival. Dwellings were not heated in winter, and because of the absence of indoor water and cooking facilities, there may have been an inadequate amount of water and food available to support German cockroach infestations. Ogata (1976) reported that *B. germanica* adults and nymphs could not overwinter successfully in unheated buildings in Japan.

2. One-room restaurants

Nineteen percent of the cockroaches collected in this environment were *P. fuliginosa*. The German cockroach was common in hotel environments, and made up 76% of the cockroaches collected in the one-room restaurants sampled.

The one-room restaurant environment may have been intermediate between the austere (little food, water, and harborage) household environment, and the more favorable hotel restaurant environment. One-room restaurants had a limited amount of water available in the kitchen, and received some heat in winter. However, these restaurants are adjacent to houses in which food, water and heat were not available. Because of these limiting factors, German cockroach infestations in one-room restaurants may remain small.

3. Hotel restaurants

The German cockroach was the most common cockroach collected in this environment, 96% of the total cockroaches collected were this species. *P. fuliginosa* and *P. americana* were collected infrequently in this environment, and comprised only 3 and 2% of the total, respectively.

Hotel restaurants were heated in winter, had water available indoors, and probably contained ample food and harborage for domiciliary cockroaches. Large German cockroach infestations were common in this environment. Sources of this species in hotel restaurants may include boxes and packaging of imported food materials (Zhai, unpublished). These infestation sources can regularly provide additions to German cockroach populations in hotel restaurants.

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摘要

上海の都市環境におけるゴキブリの生息場所の選択

上海の都市環境に生息する家住性ゴキブリの生息場所の選択について、集合住宅、ワンルームレストラン、およびホテルレストランにおいて1カ月に2日間、粘着トラップを15 m²に1トラップの割合で配置して、2年間調査を行った。

ホテルレストランでは、チャバネゴキブリが全捕獲数の96%を占めたのに対し、集合住宅では94%がクロゴキブリであった。ワンモンゴキブリはいずれの環境下でも2~6%しか捕獲されなかった。ワンルームレストランは、温度、食料、水との関係で他の場所との中間的な環境であり、チャバネゴキブリは76%、クロゴキブリは19%捕獲された。

上海の都市環境におけるチャバネゴキブリとクロゴキブリの生息は、冬季のビル内の温度条件や年間を通じての豊富な食料と水によって決定されると思われ、ホテルレストランは冬季加温されるのでチャバネゴキブリが周年見られる。また冬季加温されない集合住宅ではクロゴキブリが夏期の間最も普通に見られ、捕獲数は1987年では7月に、1988年では7月と10月にピークを示した。