INFESTATIONS OF INSECT AND RODENT PESTS IN MULTI-OCCUPANCY DWELLINGS IN A LONDON BOROUGH - A STUDY TO INVESTIGATE FACTORS AFFECTING CONTROL

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Abstract - Records of visits to 22,615 dwellings in the London Borough of Southwark, for period October 1993 to December 1998, were examined. Data were analysed for ghost ants (*Tapinoma melanocephalum* Fab.), pharaoh ants (*Monomorium pharaonis* L.), house mice (*Mus musculus* L.) and brown rats (*Rattus norvegicus* Berk.). Factors identified as likely to influence infestation were block size, block height, heating type, standard of hygiene, turnover of tenancies and presence or absence of children in dwellings. Control methods using approved rodenticides and insecticides were applied during the study period. Correlations were established using chi square test. Results showed that high-density infestations of ghost ant, pharaoh ant and rat were associated with smaller blocks whilst house mice were associated with large blocks. High density of ghost ant, house mouse and rat infestations were associated with district heating but pharaoh ants favoured individual heating. The trend showed that ghost ant and pharaoh ant infestations were increasing over time whilst house mouse and rat infestations remained relatively stable. There was a correlation between density and persistence of infestation. Bad hygiene and infestation of ghost ants, house mice and rats were correlated, but pharaoh ants were not. Ghost ant and pharaoh ant infestations did not show a correlation with changes in tenancies. Mice infestation correlated with tenancy changes but rat infestation correlated with no tenancy changes. Presence of children in dwellings correlated with infestation of pharaoh ants, mice and rats, but not with that of ghost ants. Environmental factors increase the problems of pest control operators controlling infestations in multi-occupancy dwellings. Some infestations persisted in blocks despite five years of intensive and targeted control measures.
Key words - Ghost ants, pharaoh ants, house mice, brown rats

INTRODUCTION

Many pests are associated with man and cause particular problems in high-density urban housing. Multi-occupancy dwellings provide an ideal environment for the pest and present many problems in control (Robinson, 1996). Once infestations are established, many factors contribute to the subsequent severity of the problem and the level of success achieved in controlling infestations. A number of studies have identified key factors relating to the incidence and control of German cockroaches in multi-occupancy dwellings (Shah *et al.*, 1996; Lea, 1995 and 1996; Rivault and Cloarec, 1996). These studies concluded that major influences on population growth and difficulty of treatment were; standard of hygiene in dwellings, block size and type of heating system. Additional factors that seem to influence infestation were the presence or absence of children, standard of maintenance and presence of voids and service ducts. The present study in the London Borough of Southwark sought to extend the investigation on distribution of German cockroaches (Shah *et al.*, 1996) to include analysis of infestations of ghost ants, pharaoh ants, house mice and brown rats.

Ghost ants (*Tapinoma melanocephalum* Fab.) are a relatively recent pest problem in the United Kingdom and have now become established in a number of Boroughs in London since 1993 (Pinniger, 1996). They are a major pest in parts of the Southern USA and are one of the most common house-infesting ants. There are some similarities to pharaoh ants in that they frequent hot urban dwellings. However, differences in behaviour and biology have meant that ghost ants can be extremely difficult to control and eradicate in multi-occupancy dwellings.

Pharaoh ants (*Monomorium pharaonis* L.) are a major world-wide pest where they cause problems in hospitals, food preparation areas and multi-occupancy dwellings. The biology and behaviour of the pest enables it to survive and multiply in buildings, which have suitable sources of food, high temper-

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ature and harbourage spaces. Large colonies will inhabit voids and the workers then forage into dwellings searching for food. Most successful control strategies are based on the use of toxic baits.

House mice (*Mus musculus* L.) are probably the most destructive urban pest in the UK and despite extensive use of rodenticides are present in large numbers in multi-occupancy dwellings in London. Brown rat (*Rattus norvegicus* Berk.) has been associated with urban and rural communities in the United Kingdom. The majority of rat infestations in high-density housing have been associated with drains and sewers. Because of a change in responsibilities, many local authorities in London that previously carried out programs of sewer rat control no longer carry out such treatments. This has resulted in local authorities not having an overall picture of current state of rat populations within sewers. There is continued pressure on dwellings of rats coming from sewers.

The records of inspection and treatment visits were analysed in respect of factors that would influence infestation and the success of control measures used. The importance of these factors is discussed in relation to the planning and execution of control strategies within the Borough.

MATERIALS AND METHODS

The data were collected using a standard report form as used in the previous study (Shah *et al.*, 1996). Blocks with infestation of the four pests were isolated and number of dwelling in all such blocks assessed. All blocks that had less than six dwellings were disregarded for this study. This process produced a total of 22,615 dwellings in 469 blocks. Additional information on heating and tenancy changes was obtained from the Housing IT Department. Companies contracted to carry out pest control by the Council Housing Department collected the data and inputted information from hand-written forms into various databases over different contractual periods. Therefore, there are different periods for which data has been collated for this study. The periods were:1 October 1993 to 31 December 1994; 1 January 1995 to 31 December 1995; 1 January 1996 to 31 December 1996; 1 January 1997 to 31 December 1997; 1 January 1998 to 31 December 1998.

Block size and heating type

Housing blocks were categorised according to their size. Blocks were classified as small when they contained 6-30 dwellings, medium when they contained 31-80 dwellings and large if they contained 81 or more dwellings. Data were also analysed to relate the distribution of infestation to number of floors in blocks. Blocks were then categorised depending on whether or not they had individual or district heating. The tenants in dwellings with district heating paid at a standard rate regardless of how much heat they used. Occupants of such dwellings tend to have their heating at higher levels and for longer periods compared to those in flats with individual heating.

Infestation

Visual observations of the dwellings visited were made to detect any signs of pests. Occupants were also questioned as to whether pests had been sighted between visits. Where visual observations by occupants and pest controllers showed no evidence of pest presence, it was recorded as being not infested. Where the occupier or the technician had sighted pests, then it was recorded as infested for that visit.

The blocks of dwellings that consistently continued to have infestation for period January 1996 to December 1998 were classed as blocks with persistent infestation. All remaining blocks were classed as non-persistent. The number of dwellings that were found infested during period October 1993 to December 1998 in each block were compared to the total number of dwellings in that block. This was expressed as a percentage of infestation in a block. Blocks were categorised as having a density of infestation with <10% or >=10% infested dwellings.

Hygiene

Hygiene levels in each dwelling were also recorded and classified, based on the following criteria: Good - floors and surfaces were clear of food and uncluttered; Bad - food spillages, pet food and unwashed

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dishes were left out overnight or where there were heavy deposits of grease and grime in kitchens along with clutter.

Tenancy turnover and children

Data to show number of new tenancies in each dwelling for period October 1993 to December 1998 was compared with occurrence of infestation. Presence or absence of children in dwellings was compared with occurrence of infestation.

Analysis of data

Data in tables were analysed using Chi Square Test and only those correlations that were significant at p=0.001 or greater have been considered.

RESULTS

Block size and heating type

Data were analysed to relate infestation to size of block. Table 1 shows the number of dwellings in blocks with >=10% infestation compared to <10% infestation for the four pest species. There is a strong correlation between block size and density of infestation. Unexpectedly, for ghost ants, pharaoh ants and rats there was a tendency for smaller blocks to have more of the high-density infestations (p=0.001). High-density infestations of mice were more frequent in the large blocks (p=0.001).

Table 1 shows results for density of infestation in relation to heating type for the four pest species. There is a strong correlation between type of heating and infestation density. High density infestations of ghost ants, mice and rats were associated with district heating whereas pharaoh ants were more associated with individual heating (p=0.001).

Table 1. Number of dwellings in relation to pest species, density of infestation, block size and heating type.

Pests	Ghost Ants		Pharaoh Ants		Mice		Rats	
Infestation level	<10%	>=10%	<10%	>=10%	<10%	>=10%	<10%	>=10%
Block Size								
Large	711	155	4551	2365	5168	4489	4865	509
Medium	346	141	3701	2314	4602	3015	3920	593
Small	78	30	1001	1127	1538	1260	1345	814
Heating								
District	422	255	5204	2604	5272	6051	5852	1433
Individual	713	71	4049	3202	6036	2713	4278	483

Table 2. Infested dwellings in relation to pests, density and persistence of infestation.

Pest	Ghost ants		Pharaoh ants		Mice		Rats	
Persistence (years)	<3	>=3	<3	>=3	<3	>=3	<3	>=3
Infestation Level								
<10%	1134	1	8757	496	9997	1311	9116	1014
>=10%	121	205	1706	4100	2296	6468	1455	461

Table 3. Dwellings with or without infestations, children or tenancy changes and Visits with good or bad hygiene.

Number of	Dwellings				Visits with Hygiene	
	Children Absent	Children Present	No Tenancy Change	Tenancy Change	Good	Bad
Ghost ants						
Clear	755	525	689	591	3409	212
Infested	97	84	116	65	2585	295
Pharaoh ant						
Clear	7694	4463	7065	5092	60873	4215
Infested	1553	1349	1686	1216	36041	2550
Mice						
Clear	11548	5672	8479	8741	99412	5608
Infested	1497	1355	1176	1676	32539	2748
Rats						
Clear	7125	4178	5037	6266	6361	169
Infested	382	361	696	47	1098	64

Figures 1-4 show the distribution of infestation in relation to number of floors in blocks. The data are presented as the percentage of infested flats in blocks containing a given number of floors compared to total number of infested flats. The results indicate that 93% of ghost ant infestation was found in blocks with seven, five and three floors. 68% of pharaoh ants infestation was distributed in blocks with three to five and seven floors. 69% of mice infested flats were found in blocks with two to four and seven floors. 78% of rat infestation was found in blocks with two to five floors.

Infestation and its persistence

There is a strong correlation between the density of infestation and persistence for more than three years. Table 2 and Figure 5 show that all four pest species were persistent in blocks with >10% infestation ($p=0.001$). When the data for persistent infestation is examined on a yearly basis from 1993 to 1998 (Figure 6), it is clear there has been a steady increase in dwellings infested with ghost ants. Infested dwellings with pharaoh ants have increased since 1996 whereas those with mice and rats have stayed relatively stable.

Hygiene

Infestations of ghost ants, mice and rats were associated with visits to flats with bad hygiene (Table 3) ($p=0.001$). There was no apparent correlation between levels of hygiene and infestation of pharaoh ants.

Tenancy and children

Data to show number of new tenancies in each dwelling for period October 1993 to December 1998 was compared with occurrence of infestation (Table 3). There was a strong correlation between infestations of mice and frequency of tenancy change. There is no correlation for ghost ants and pharaoh ants relating to tenancy change. There were more infestations of rats in dwellings with no tenancy

change (p=0.001). The presence of children in dwellings was unrelated to infestation of ghost ants but strongly correlated with infestations of pharaoh ants, mice and rats (Table 3) (p=0.001).

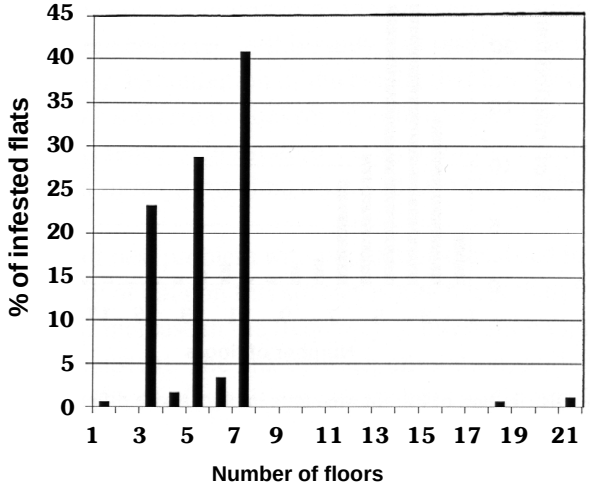

Figure 1. Distribution of ghost ant infested falts in blocks with different numbers of floors.

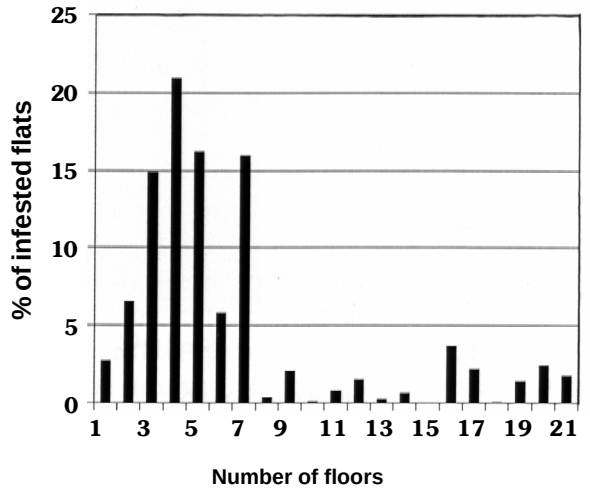

Figure 2. Distribution of pharaoh ant infested falts in blocks with different numbers of floors.

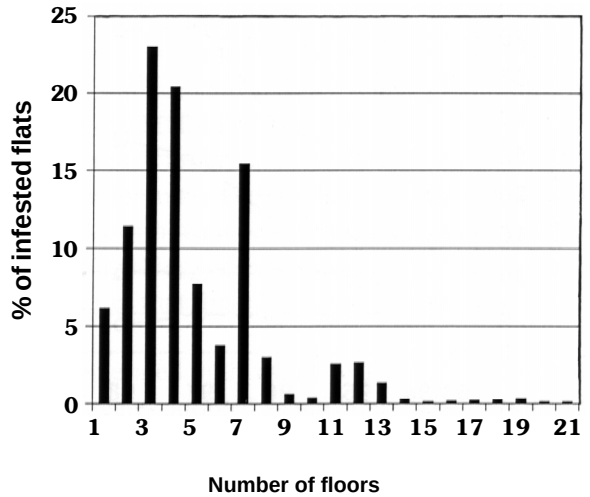

Figure 3. Distribution of Mice infested falts in blocks with different numbers of floors.

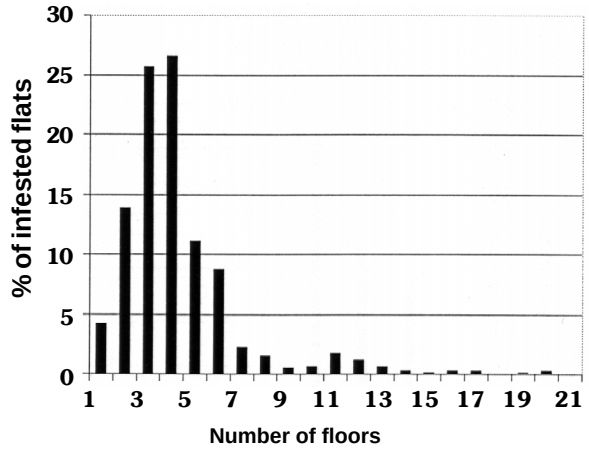

Figure 4. Distribution of Rath infested falts in blocks with different numbers of floors.

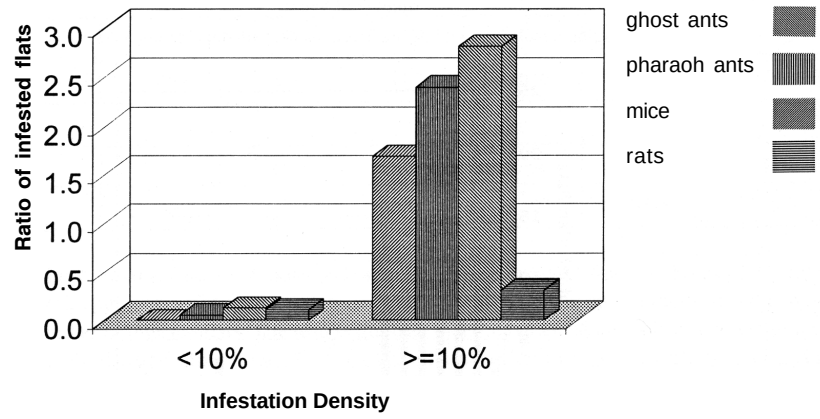

Figure 5. Ratio between falts in persistence blocks against other blocks.

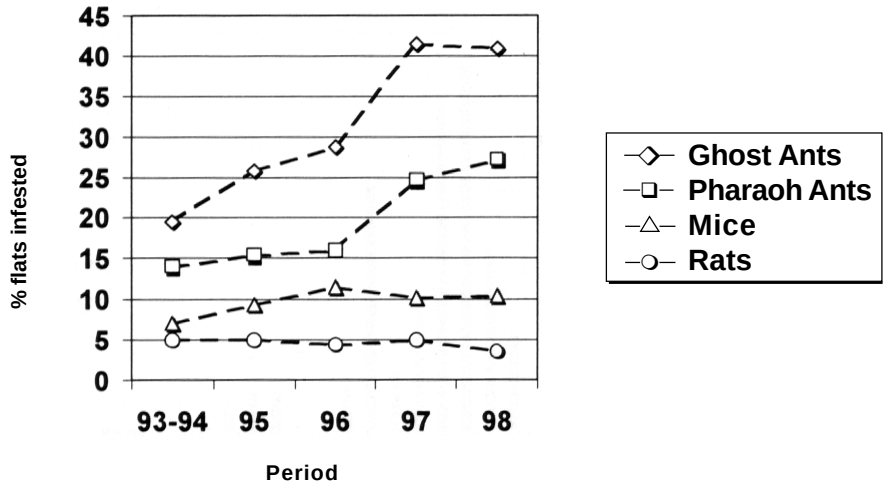

Figure 6. Blocks with Persistent and High Density Infestation over time.

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DISCUSSION

There are many difficulties in assessing infestations in multi-occupancy dwellings because of the complexities of the environment. These are compounded by the problems of access into individual dwellings. Although non-access data were collected in this study, the results have not so far been analysed and cannot be included in this paper. Examination of the results that have been analysed show that, as expected from the previous study on German cockroach (Shah *et al.*, 1996), there are correlations between various factors and the presence of infestation. Analysis of the effects of environment on the infestations of the four pest species shows some similarities but also clear differences between the pests due to the behaviour and biology.

Ghost ants are a relatively recent pest problem with populations localised in certain areas (Pinniger, 1996). This meant that the quantity of data on this species is much less than for the other three pests. However, these results show a clear increase in the frequency of infestation together with an indication that these infestations are more persistent. The link between infestations and district heating with generally higher temperatures reflects the need of this species for hot conditions. Ghost ants appear to be associated with medium sized blocks, which probably reflects that two out of the three blocks with >10% infestation are medium sized blocks. Bad hygiene, also as expected, is associated to increased frequency of infestation. There appeared to be no association between tenancy changes and presence or absence of children. This could be due to the fact that this is a relatively new pest in the multi-occupancy environment and therefore is not distributed widely enough to be spread further with movement of tenants or children.

Pharaoh ants have long been established in dwellings in London and the large amount of data generated reflects this. Numbers of persistent infestations have increased since 1996 and still appear to be increasing in 1998. The link between infestations and district heating with generally higher temperatures reflects the need of this species for hot conditions. It is not clear why pharaoh ants appear to be associated with smaller blocks. Bad hygiene was expected to be associated with increased frequency of infestation but the data did not support this for pharaoh ants. There appeared to be no association between tenancy changes but there was an increase in infestation when children were present.

Mice were the most frequently found pests in this study and much of the large amount of data generated has still to be analysed. There has been a slight increase in frequency of persistent infestation since 1993 but it now appears to be steady with about 13% of dwellings infested. Mouse infestations were strongly associated with large blocks and district heating. Bad hygiene, as expected, is also associated to increased frequency of infestation. There appeared to be strong association between tenancy changes and mouse infestation although the reasons for this could be complex. A very large number of blocks that are persistently infested are built using pre-cast materials that allow many cavities and ducts within the structure of such buildings. Some of the blocks were built in the past ten years and therefore have cavity walls that allow mice to move unhindered from floor to floor and into lofts. It is possible that persistent mouse infestation is in itself a reason for tenants requesting moves. There was also an increase in infestation of mice when children were present.

Levels of rat infestations were much lower than mice, involving about 3% of dwellings. Because of this the quantity of data is less than for mice. The strongest correlation was between rat infestation and small blocks. There were also links with hygiene and the presence of children. There appeared to be more infestations associated with dwellings with no tenancy changes, the reasons for this is not clear. It has been observed on some estates that there are occupiers who feed pigeons and the food also attracts rats in the vicinity.

Further analysis of the data generated in this study will allow us to investigate the relationship of various control measures and strategies adopted against the pests. Although it is too soon to yet draw firm conclusions, the stability or change in levels of infestations, seem to be linked to the success or otherwise of control measures. The increase in ghost ants reflects the spread of the pest in the Borough but also the failure of the various control measures to eradicate persistent infestations from blocks. Most baits

are designed for use against pharaoh ants and appear to be much less effective against ghost ants. Initially, misidentification of ghost ants as pharaoh ants also contributed to treatment failure. The recent increase in pharaoh ants may reflect the difficulty of maintaining success with bait such as hydramethylnon when one formulation is used exclusively and continuously for over 5 years. It may also indicate the declining use of the successful methoprene-based hormone bait due to the attraction of quick control using toxic-based bait. Mouse levels are stable reflecting some sort of equilibrium between infestation pressure and control success. It would not take a great change in reduction of efficacy of one of the major control products to tip the balance in favour of mouse increase. The dynamics of rat infestations in this situation are less well understood because of the importance of population reservoirs in the drains and sewers. Further reduction in integrated sewer rat control will undoubtedly lead to increase rat pressure on dwellings. It will be of value to continue monitoring the rat population in the multiple-occupancy environment over the next five years to see the effect of continually reducing level of sewer baiting by the water authority each year.

This study, although incomplete, shows that environmental factors increase the problems of pest control operators controlling infestations in multi-occupancy dwellings. Some infestations persisted in blocks despite five years of intensive and targeted control measures. Design of blocks, standards of heating and hygiene all need to be improved in order to enable control measures to decrease pest numbers.

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