Psocid infestations and domestic kitchens

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Abstract

Infestation of dry food products in domestic kitchens by psocids is a common cause of complaint to food manufacturers and retailers. The natural assumption is that the infestation arrived in the contaminated food products. The primary psocid species involved is *Liposcelis bostrychophila*, a 1mm–long brown wingless species of tropical origin. This psocid is parthenogenetic, needs temperatures around 20°C to reproduce and so cannot persist out of doors in the UK and is uncommon in food manufacturing and retail establishments but is frequently found in domestic premises.

To test whether dry goods, specifically flour, is contaminated prior to purchase, pairs of bags of flour were randomly bought from a range of retail outlets in a number of locations in England and Northern Ireland. One of the two bags was immediately sealed inside a plastic bag whilst the other was placed in a typical domestic kitchen in the location. After one week this bag too was sealed in plastic and both bags were sent to King's College where they were "incubated" for three months. Twenty two of the 133 bags that spent a week in kitchen cupboards were infested with psocids. None of the 135 control bags sealed immediately on purchase contained psocids.

Thus, the commonly held idea that bags of flour purchased from shops are sometimes contaminated with psocids is not supported by this study. Psocids already present in the dwelling are attracted to the fresh flour, which then appears to be the source. It is suggested that psocid infestations in sea containers is a potential source, so that anything might carry individuals in its packaging into the home.

Keywords: Domestic kitchens; environmental health; flour; *Liposcelis bostrychophila*; psocids; supermarkets.

Introduction

Infestations of psocids, specifically the booklouse *Liposcelis bostrychophila* (Badonnel), are common causes of consumer complaints to retailers and manufacturers of stored food held in domestic kitchens in the UK (Turner, 1987; Turner and Ali, 1996; Turner and Bishop, 1998). Turner and Bishop (1998) showed that the incidence of psocids in households generally was increasing, almost doubling in England within the 10 years from 1987 to 1997. Previous studies by this author have looked at the range of materials that psocids have infested, the growth of the problem of psocid related complaints both in the UK and elsewhere (Turner, 1987), factors of their biology (Turner and Maude-Roxby 1988; Turner 1998), population dynamics (Turner 1994), insecticide resistance and genetics (Turner *et al*., 1991; Ali and Turner, 2001) and relationships with bacteria (Yusuf *et al*., 2000; Yusuf and Turner, 2004). These studies chart the highly adaptable and resilient nature of the liposcelid and the qualities that make it so successful as a domestic pest. In addition, and in conjunction with NABIM and the Chartered Institute of Environmental Health, the author has produced a pamphlet for the public on the prevention and control of psocids (distributed to manufacturers, retail outlets, EHOs and the public – details from *www.fabflour.co.uk* or *www.kcl.ac.uk/psocids*).

Since *Liposcelis bostrychophila* is parthenogenic (no males), it is capable of very rapid population growth in comparison with similar, native, bisexual species, where typically half the eggs are males. Originally from the tropics, it needs temperatures above 20°C to thrive and for populations to grow. It is not found out of doors in the UK and is typically only found in domestic situations (Turner and Ali, 1996). Egg to adult at 25°C takes one month and below 15°C egg development ceases (Turner, 1994). They are quite tolerant of dry conditions, needing only six hours per day with a relative humidity above 60% (Rudolf, 1982) which is found in most domestic situations during the night time.

Although a wide range of materials can be colonised, bagged flour in particular is highly attractive and is targeted. A key reason for this lies in the way flour is manufactured and packaged. To be successfully milled, wheat needs to have a specific moisture content (12-14% ww). This moisture is then present in the final flour. To allow the flour to lose some of this water and prevent the development of musty smells and taste due to fungal contamination, the flour is packed in paper bags rather than sealed in plastic. Thus to a psocid, a bag of flour represents a source both of moisture and food and they can detect the moisture emanating from it and use the moisture gradient to home in on the bag of flour. In time, as the flour ages and desiccates, it becomes less attractive to psocids.

Methods

People were recruited across a number of areas in England and Northern Ireland (Table 1.0) to visit local supermarkets and other retail outlets and purchase pairs of bags of flour (Table 2.0). One of the bags was

Table 1.0
The geographic areas where bags were purchased

Belfast
Cumbria
Lincolnshire
Greater Manchester
Northamptonshire
Bedfordshire
Hertfordshire/Essex
NE London/Essex
Berkshire/Hampshire
Buckinghamshire

immediately sealed inside a "zip top" plastic bag and the other treated as a normally purchased bag, taken home and placed in a kitchen cupboard for one week. From experience this period will provide time for the bags to be "discovered" if any psocids are in the kitchen. Exactly where in the kitchen the bag should be placed was not defined, although many described whether the cupboards used were head height or floor mounted types, or if the bag was placed in a walk-in pantry. The contents of the cupboards were not defined or mentioned. Importantly, none of the householders' kitchens used was knowingly infested with psocids. After one week the "kitchen" bag was also sealed in a "zip top" plastic bag and both bags were then sent by parcel post to King's College London. Here they were kept in warm conditions (25°C) for three months, this being sufficient time for psocid populations to develop from any single eggs or individuals in the bags. The plastic bags were kept sealed and in separate incubation facilities to ensure no possible contamination in the laboratory. Furthermore the "kitchen" and control samples were kept in separate incubators. At the end of the three month incubation period the bags were disassembled and any psocids present noted. For logistical reasons the survey took place during the autumns of 2003 and 2004, this being the season of the year when the greatest numbers of complaints about psocids are received (Turner and Ali, 1996). There was no significant difference between the findings for the two years and so the data for both years were combined.

Results

A total of 268 bags of flour of 16 different types from 25 trade labels was purchased during this study. Of those 135 bags were controls, bagged as soon as purchased and 133 bags were located in kitchens for one week. In the kitchens 51% of bags were in eye level cupboards, 30% in below the counter cupboards, 9% in pantries and the rest in a variety of other locations. In total 22 bags were infested with *Liposcelis bostrychophila* after the three months incubation period, all of which were bags that had been exposed in kitchens. None of the control bags showed any sign of psocid presence. Although the numbers of psocids were not counted, in all but one of the 22 cases the infestations were very obvious with psocids running over the outside of the paper flour bags within the plastic sealed bag. There were no trends as to the types of flour that were infested (8 Plain flour, 7 Self-raising, 7 speciality and bread flours). The greatest number of infestations was in the South Midlands – but this area was best represented in the study (Table 1.0). Infestations were also found in Carlisle, Stockport, South Essex and North London. Analysis of infestations by geographic area, however, is unlikely to be of any great significance since the study's coverage of the country was very patchy and uneven.

A χ^2 association analysis was carried out to see if there was a significant association between the psocids and the kitchen samples and the converse, no psocids with the control samples. The null hypothesis being that the infested bags would be equally spread between the control and the kitchen samples. This analysis gave a χ^2 value of 22.23, greatly in excess of the 95% probability value of 3.84, indicating a strong association between psocids and kitchens and not with bags of flour at the point of purchase.

Discussion and Conclusions

These findings are in accordance with other, largely unpublished, work carried out by the author in which there is a partitioning of psocid species found in homes compared to warehouses (Turner and Ali, 1996). *Liposcelis bostrychophila*, although ubiquitous, needs warm conditions, in excess of 20°C, to reproduce. It cannot live outdoors throughout the year in the UK and is the normal species found in domestic property. Most if not all situations of consumer complaints of psocids on new flour and other farinaceous products are caused by the attraction and concentration of undetected scattered

psocids in kitchens onto the product. This occurs rapidly within a few days. If a reasonable number of psocids colonise the new bag by the time it is used, it will be seen to be infested and the natural explanation is that the product arrived in the house already infested. If that scenario was an option, then at least some of the control bags in this small study would also have been infested.

This study does not help to answer the wider question as to how the psocids spread from one household to another – how did the primary infestation of the property occur if not via contaminated foods? In addition there is the unanswered question as to why the numbers of houses that have psocids is increasing. It is highly likely that almost anything that is bought into a home may carry psocids. In the case of *L. bostrychophila* it is important to note that it is parthenogenetic so a single egg or a juvenile or adult can found a new population. This idea that they may be on anything derives from an unpublished study made by the author for a company that makes plastic packaging, who were finding their product contaminated with psocids. The psocids in this case were moving on to pallets of cardboard boxes of product during overseas transportation in sea containers. Every one of five sea containers sampled contained psocids, living in the crevices of the floor of the container and feeding on spillages of powdered food from previous transhipments which had been swept into the cracks between the floor boards between uses. The plastic packaging is totally inedible and its only attraction to wandering psocids within the sea container may have been the insulation effect on temperature changes. As the sea containers are shipped into warmer conditions, the metal containers quickly heat up, whilst conditions in the depths of the boxes of packaging will stay, at least for a time, relatively cooler.

Commercial shipping containers carry all sorts of products including foods all over the world. The containers used by this specific packaging company are now pre-treated with an insecticide fog to prevent contamination of their product but that is not a standard practice, and therefore the possibilities for cross contamination of the type described are very high.

Aldi	8*
Asda	14
Caulfields	2
Co-op	10
Costcutter	16
Kwiksave	4
Lidl	8
Morrisons	20
Netto	2
Safeway	2
Sainsburys	56
Salisbury Healthfoods	6
Sawers	2
Somerfield	6
Spar	2
Tesco	94
Waitrose	16

* number of bags of flour

Table 2.0
The retail outlets where the bags of flour were purchased

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References

Ali N and Turner B D (2001). Allozyme polymorphism and variability in permethrin tolerance in British populations of the parthenogenetic stored product pest *Liposcelis bostrychophila* (Liposcelididae, Psocoptera). *Journal of Stored Products Research,* 37, 111-125.

Rudolph D (1982). Occurrence, properties and biological implications of the active uptake of water vapour from the atmosphere in Psocoptera. *Journal of insect Physiology*, 28, 111-121.

Turner B D (1987). Forming a clearer view of *L. bostrychophilus*. *Environmental Health,* 95, 9-13.

Turner B D (1994). *Liposcelis bostrychophila* (Psocoptera, Liposcelididae), a stored food pest in the UK. *International Journal of Pest Management*, 40,179-190.

Turner B D (1998). Psocids as nuisance problem in the UK. *Pestcide Outlook*, 9, 27-30.

Turner B D and Ali N (1996). The pest status of Psocids in the UK. 2nd International Conference on Insect Pests in the Urban Environment, Edinburgh, UK.

Turner B D and Bishop J (1998). An analysis of the incidence of psocids in domestic kitchens: the PPFA 1997 household survey (What's bugging your kitchen). *Environmental Health Journal,* 106, 310-14.

Turner B D and Maude-Roxby H (1988). Starvation survival of the stored product pest *Liposcelis bostrychophilus* Badonnel (Psocoptera, Liposcelidae). *Journal of Stored Products Research,* 24, 23-28.

Turner, B D, Maude-Roxby, H and Pike V (1991). Control of the domestic insect pest *Liposcelis bostrychophila* Badonnel (Psocoptera): an experimental evaluation of the efficiency of some insecticides. *International Pest Control,* 33,153-157.

Yusuf M, Turner B D, Whitfield P, Miles R and Pacey J (2000). Electron microscopical evidence of a vertically transmitted Wolbachia-like parasite in the parthenogenetic, stored-product pest *Liposcelis bostrychophila* (Psocoptera: Insecta). *Journal of Stored Products Research,* 36: 169-175.

Yusuf M, and Turner B (2004). Characterisation of Wolbachia-like bacteria isolated from the parthenogenetic stored product pest psocid *Liposcelis bostrychophila* (Badonnel)(Psocoptera). *Journal of Stored Products Research*, 40, 207-225.