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PRECISION TARGETING: REDUCED PESTICIDE USE STRATEGY FOR PHARAOH'S ANT (HYMENOPTERA: FORMICIDAE) CONTROL

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Abstract - Pharaoh's ants, *Monomorium pharaonis*, are one of the more difficult indoor pest ants to control. We studied if routine exterior monitoring and initiating baiting when infestations are incipient, will prevent infestations inside a building. The study was conducted at a 7,841 m^2 two-level building with 4 separate wings. Monitoring techniques to determine Pharaoh's ant foraging distribution were conducted with attractant-baited index cards placed on the exterior ground floor window sills. All treatment were with Combat Superbaits® (Clorox Company, Pleasanton, CA, USA). Monitoring and treatments were performed on both the exterior and the interior floors to assess success of the exterior treatments on interior infestations. This was followed by exterior monitoring and baiting with assessments of only those interior locations corresponding to exterior sites positive for foraging ants. Numbers of foraging ants were lower 1 month post initial treatment, and continued to drop showing an 88% reduction in foraging ants by the second month. A survey at this time of the interior of the building showed only 3 locations positive for foraging ants. Monitoring showed that the exterior treatment of this location eliminated the interior population for the remainder of the study. Three months post initial survey there was a population increase of foraging ants on the exterior of the building with 14 positive sites. Of these 14 sites only 1 spatially correlated to an interior foraging population. Exterior treatments again eliminated this population. During the final survey of the exterior of the building, only 1 Pharaoh's ant was found with no interior corresponding population. This study confirmed that the vast majority of populations present inside the structure could be eliminated with exterior bait treatments.

Key words - Baits, pest control, social insects, exterior treatments

INTRODUCTION

The Pharaoh's ant, *Monomorium pharaonis* (Linnaeus) is cosmopolitan in its distribution having been carried by commerce to inhabit all regions of the earth (Wheeler, 1910). This ant, a major indoor pest in the United States and many parts of the world, normally does not nest outdoors except occasionally in warmer climates (Edwards, 1986). The ant infests almost all areas of a building, principally where food routinely is available. Pharaoh's ants also infest areas where food is normally not found such as intensive care units, burn units, and neonatal units in health care facilities. In hospitals, this pest ant has become a major problem by contaminating sterile equipment, penetrating intravenous solutions, feeding on dressed wounds, and even carrying pathogenic bacteria (Beatson, 1972; Wilson and Booth, 1981).

Toxic baits, combined with conventional applications of residual insecticides, presently are used to control the Pharaoh's ant. Commercial toxic baits contain methoprene, an insect growth regulator, or boric acid, hydramethylnon, or sulfluramid which are stomach poisons as the active ingredients. Although the present-day baits produce control in some situations, there are still many control failures. There is a need not only for the development of safe and effective chemicals for use in baits for the control of the Pharaoh's ant.

The behavior of this pest in southern climates may be amenable to reduced-pesticide risk strategies because most populations occur in the voids of exterior walls, and forage both inside and outside structures. Previous studies indicated that placing baits around the exterior of buildings offered some control (Haack, 1991; Oi *et al.*, 1996; Vail *et al.*, 1996). Therefore, we hypothesized that a routine exterior monitoring and baiting procedure, initiated when infestations are incipient, will prevent or minimize infestations inside. This study was designed to determine: 1) whether spatial statistical analysis could be used to document the impact of toxic ant baits placed on exterior window sills of a facility

on the number of Pharaoh' ants foraging inside the building (routine standardized, monitoring), and 2) whether population distributions for ants foraging on the outside window sills could accurately predict interior infestations.

MATERIALS AND METHODS

Study site

The study site was the Bachelor Officers Quarters (BOQ), building at the U.S. Naval Air Station, Jacksonville, Florida. The building (7,841 m^2) is a two-level structure designed with 4 separate wings on the ground floor, and 3 wings on the second floor. The study was initiated with preliminary sampling on 2 October 1996 and ended 18 November 1997.

Monitoring

Monitoring consisted of baiting 249 exterior ground floor window sills to determine Pharaoh's ant foraging distribution. A formulated liquid multiple-species ant bait (MAB)(Vail *et al.*, Patent Pending) was used. The MAB's consisted of a Gelman petri dish lined with a cotton pad moistened with 2 mls of the liquid formulation. They were placed on the exterior of the building and left for 1 hour and then retrieved and the number of foraging Pharaoh's ants on each MAB was recorded. Monitoring and treatments were performed for 2 months on the exterior of the building. In August 1997 both the exterior and the 2 interior floors of the BOQ were monitored to assess success of the previous 2 months exterior treatments on interior infestations. This was followed by 2 months of exterior monitoring and baiting with assessments of only those interior locations corresponding to exterior sites positive for foraging ants. The final assessment was performed in November 1997.

Spatial analysis

Spatial analysis was applied to the data using ArcView Geographic Information System (GIS) (ver. 3.1, Environmental Systems Research Institute, Redlands, CA, 92373 USA). As a measure of risk assessment, MAB counts were reduced to a presence or absence (i.e, "indicator"). These data were then geostastically gridded using the inverse distance weighted method, and resultant grid values provided contour lines ranging in values from 0 to 1, representing probabilities of detecting foci of ant foraging (Brenner *et al.*,1998). Sites positive for foraging ants were then treated with Combat Superbaits®. Probability contour maps of population distribution were generated to assess success of treatments. Our customized software also calculated area (ft^2) of the structure at risk (probability >0.5) for foraging ants.

RESULTS

Assessments in June, 1997 revealed fairly high exterior populations which is consistent with biology of Pharaoh's ants, a high population growth in the summer months (Fig. 1). Numbers of foraging ants were lower 1 month post initial treatment, and continued to drop showing an 88% reduction in foraging ants by the second month (August, 1997; Fig. 2). A survey at this time of the interior of the building showed only 3 locations positive for foraging ants. Of those 3 locations 1 was spatially oriented directly above an exterior positive site (Figs 3, 4). Monitoring showed that the exterior treatment of this location eliminated the interior population for the remainder of the study. At 3 months post initial survey (September 1997) there was a population increase of foraging ants on the exterior of the building with 14 positive sites. Of these 14 sites only 1 spatially correlated to an interior foraging population (Figs. 5, 6). Exterior treatments again eliminated this population. By 4 months post-initiation (October 1997) (Fig. 7) 4 positive external sites were detected, but no internal. During the final survey of the exterior of the building only 1 Pharaoh's ant was found with no interior corresponding population.

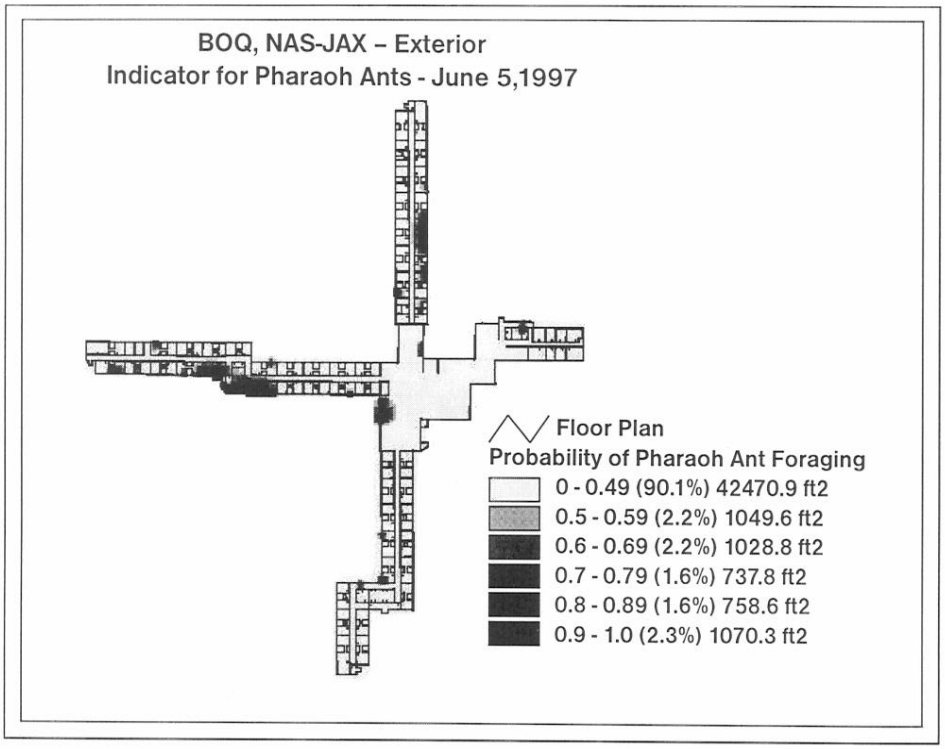

Figure 1. Spatial patterns of exterior infestations showing areas at risk indoors. Shown are the surface contours from MAB monitors showing probability that any given area may have foraging ants. Number in parenthesis is percentage of floor space defined by each probability contour. Probability scale indicates that ca. 10% of the interior surface was at risk; i.e., those areas with probability >0.5 of including foraging ants.. Treatments were applied to outside positive sites only.

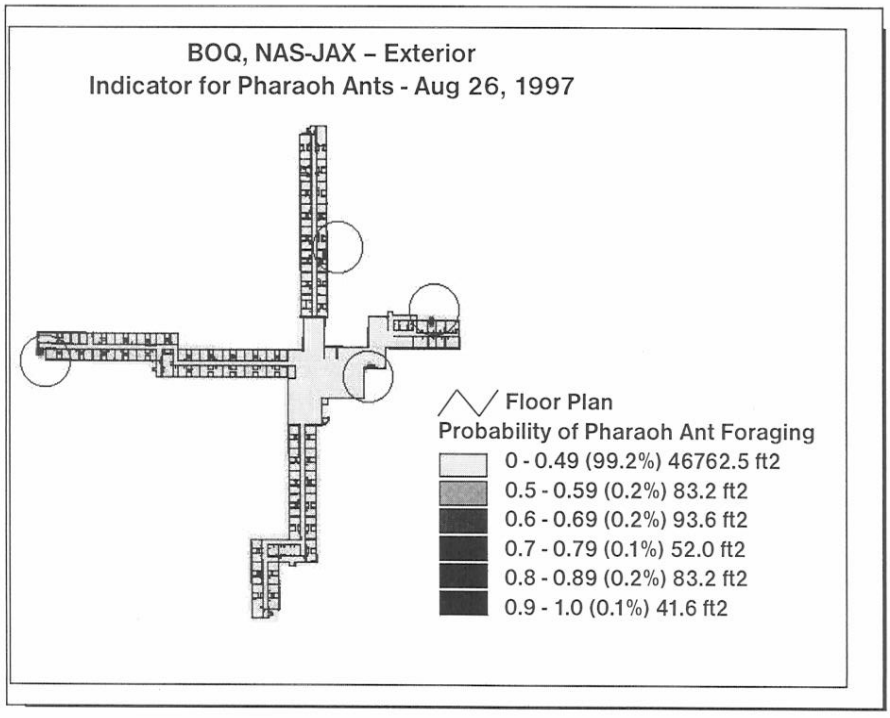

Figure 2. Exterior treatments in July had resulted in a substantial decrease in exterior populations by August. See Figure 1 for explanation of legend. Circles show regions with foraging activity.

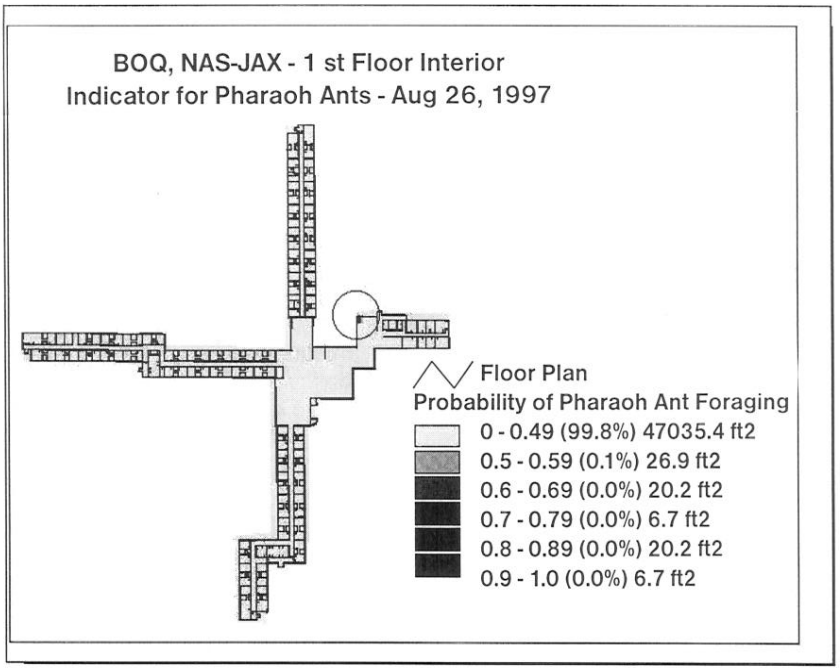

Figure 3. Only 1 positive site (circle) was noted on the interior first floor in August.

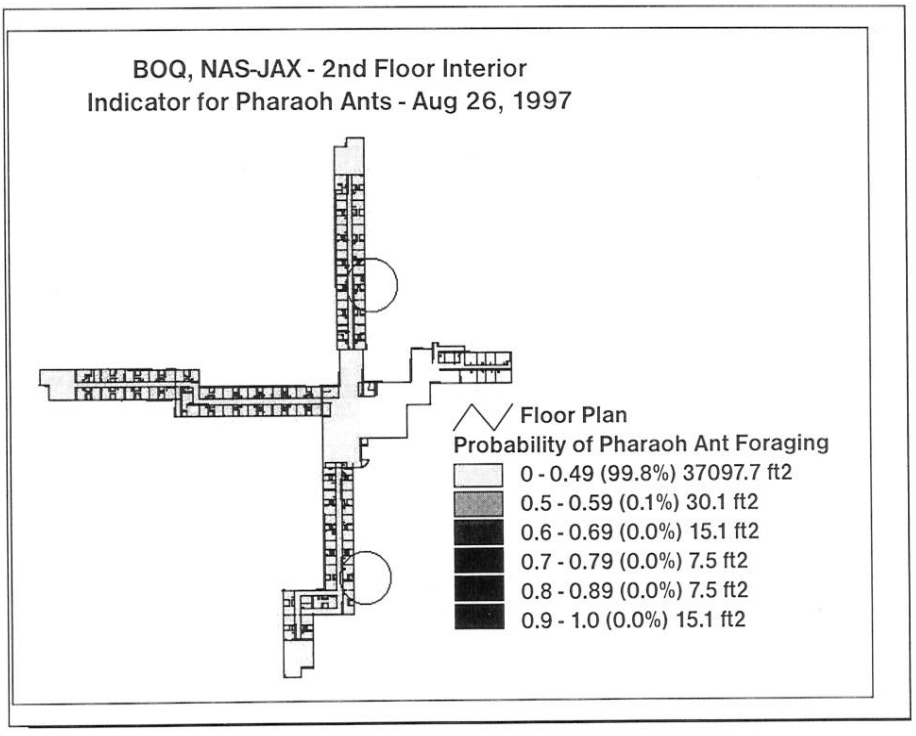

Figure 4. Two positive sites (circles) were noted on the second floor in August, with one correlating spatially to an externally-detected infestation. See Figure 1 for explanation of legend.

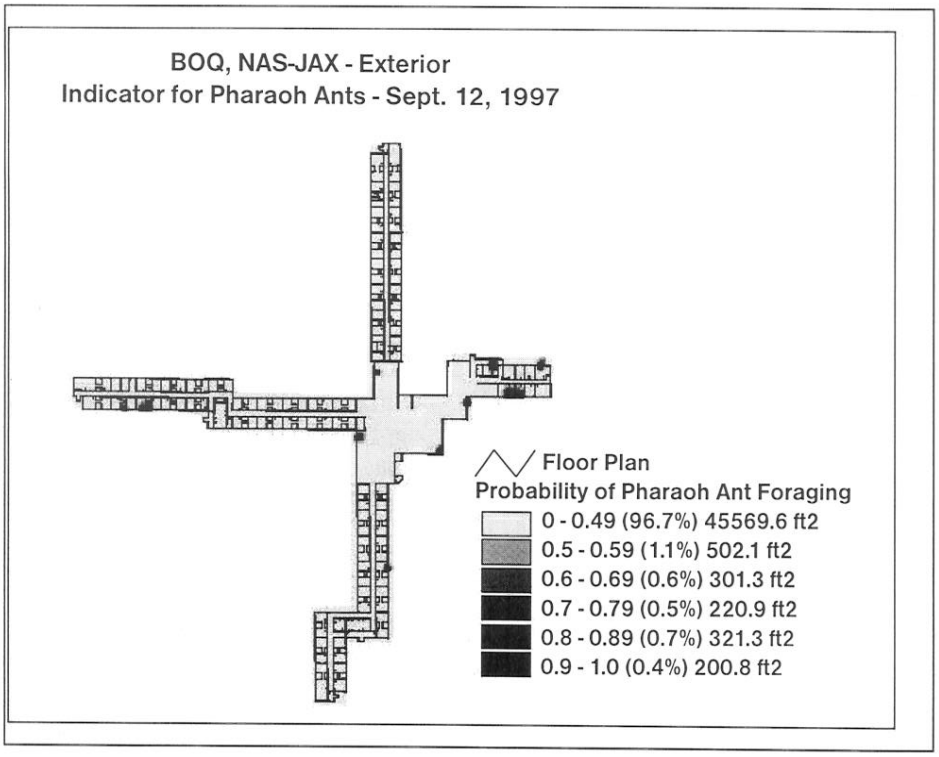

Figure 5. Exterior populations rebounded in September, but only about 3% of interior floor spaces was at risk.

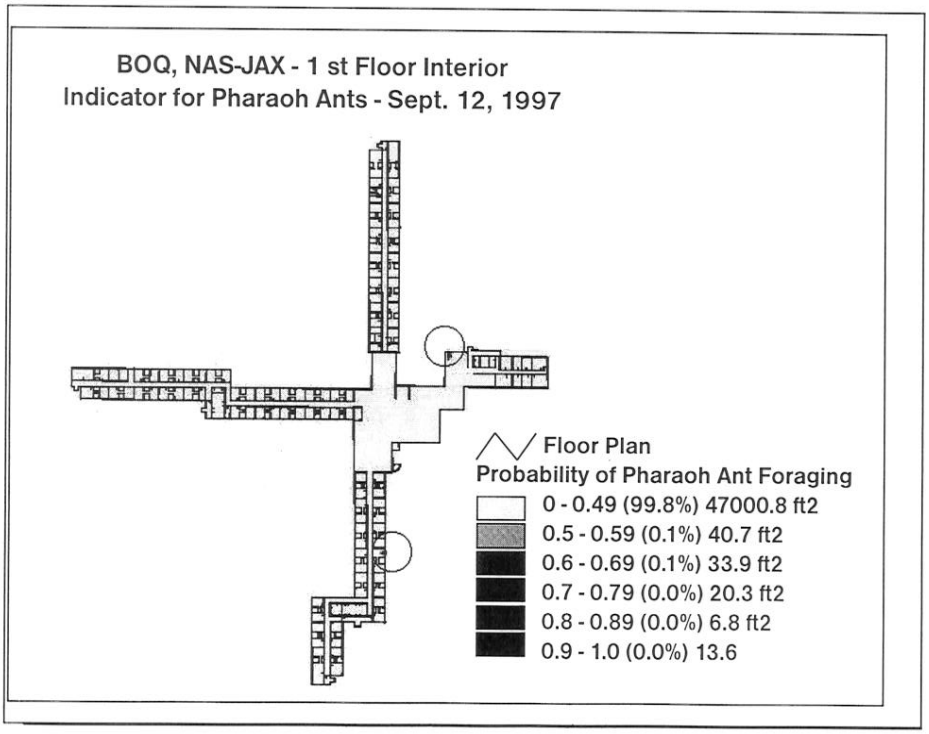

Figure 6. Population declines continued, presumably as a result of the exterior baiting, combined with the seasonal onset of slightly cooler weather. Circles show regions with foraging activity.

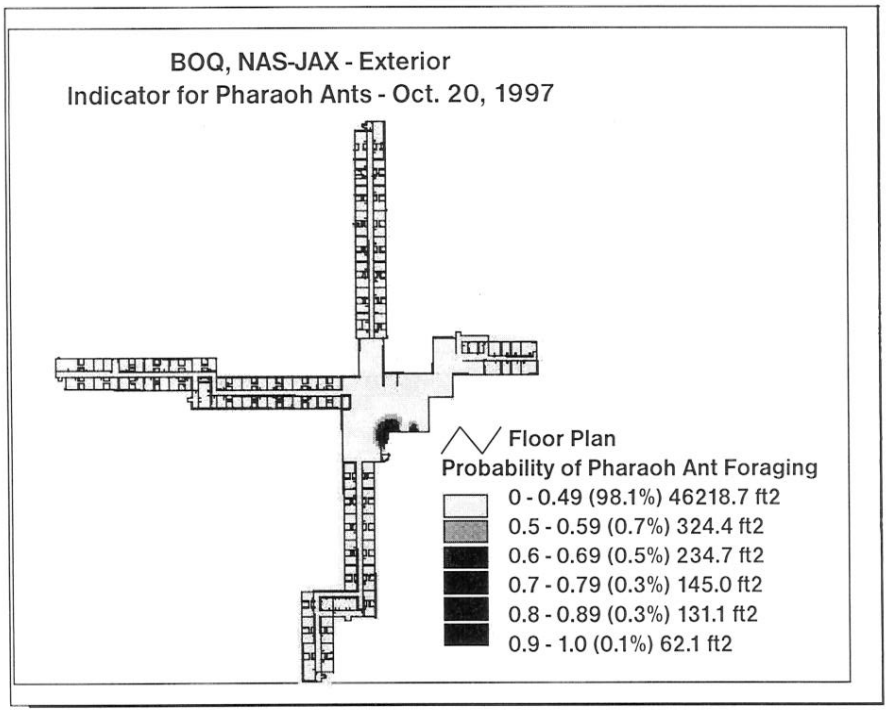

Figure 7. Only 2 positive 1st floor infestations were detected, despite the increased external population. Exterior treatment eliminated these within a month.

CONCLUSIONS

External monitoring with the MAB, and treatment with commercially-available baits, resulted in a dramatic reduction in interior populations. No pesticides were used indoors during this phase of the research. These data suggest that such a program of proactive monitoring is sufficient to detect incipient threats to indoor infestation, and allows mitigation externally. For professional pest control companies, this simplifies the process by eliminating the need for access internally at regular intervals. This building, however, has a shape (minimal internal width) that is conducive to this protocol.

Multi-story structures represent a challenge to sustained proactive monitoring and management to reduce pesticide use. Pharaoh's ants are likely to invade the structure in two manners. The first is by breach of the exterior perimeter by local ant populations. The second is by random introduction into the structure through belongings of employees and clients, and through supplies and materials. Results from the BOQ should be directly applicable to the former, but these random events of infestations will require a dynamic component of the mitigation plan. Therefore, based on the results from the BOQ, we developed a procedure with 2 components: (1) monitor and mitigate the external perimeter of the structure on a periodic basis, and (2) monitor and mitigate internally according to any complaints provided to the pest management practitioners from the building occupants.

A strong value of a GIS-based precision targeting strategy is the institutional memory that develops with each sampling date, and the ability to relate data from one floor with spatially-analogous regions of other floors.

This study demonstrates that a precision targeting approach to Pharaoh's ant infestations can be implemented, especially in buildings with no more than 3 levels, however, even complex multi-story structures with a large amount of interior floor space may benefit from this method of control. This

approach resulted in no residual toxicants being applied indoors and only a small amount of toxic bait enclosed in child-proof containers precisely positioned around the exterior was necessary to reduce populations to extremely low levels. We believe that the adoption of these procedures at structures similar to the BOQ, would eliminate Pharaoh's ants, problems and result in the establishment of a truly proactive management plan to detect and eliminate any incipient infestations.

ACKNOWLEDGMENT

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