Short Communication

The Ability of Spiderlings of the Widow Spider *Latrodectus hesperus* (Araneae: Theridiidae) to Pass Through Different Size Mesh Screen: Implications for Exclusion From Air Intake Ducts and Greenhouses

RICHARD S. VETTER,[1,2] CHRISTOPHER P. FLANDERS,[3] and MICHAEL K. RUST[1]

J. Econ. Entomol. 102(3): 1396–1398 (2009)

ABSTRACT Experiments tested the ability of newly emerged spiderlings of a black widow spider, *Latrodectus hesperus* Chamberlin & Ivie (Araneae: Theridiidae), to crawl through brass screen of various mesh size. The purpose was to determine whether immatures of these medically important spiders could be excluded from buildings. In horizontal orientation, black widow spiderlings were able to easily pass through mesh with openings of 0.83 mm and were prevented from passing in four of five tests with mesh of 0.59-mm openings. Spiderlings also readily pass through 0.83-mm mesh in vertical orientation. Our laboratory studies indicate that the mesh size sufficient for exclusion is too small for practical use in most cases, although there are some specialized situations where such small mesh might be useful. The results are discussed in regard to actual conditions found in typical commercial building situations.

KEY WORDS black widow spider, *Latrodectus*, Arachnida, pest control, urban entomology

Because of their potent venom, distinctive black-and-red coloration, and synanthropic proclivity, widow spiders (genus *Latrodectus*) are well known worldwide (Vetter and Isbister 2008). Because they take diurnal refuge around human structures and also use airborne ballooning for long-distance dispersal, widow spiderlings could be introduced into buildings via air intake ducts or ventilation screens. Although this is a concern for the homeowner attempting to minimize personal risk, there is greater interest for commercial facilities with much larger square footage of the facility, increased need for ventilation, increased transport of commercial or industrial materials, and less surveillance for nocturnal pests. Commercial facilities want to prevent injury to workers; they also need to avoid the shipment of infested merchandise, which might result in the unpleasant discovery of toxic spiders by customers. In addition, the mere belief that medically important spiders exist in a commercial building can cause minor hysteria among employees, impacting productivity.

As the result of a specific pest control industry inquiry, we investigated the ability of widow spiderlings to pass through various mesh sizes of screen as a means to exclude them from buildings.

[1] Department of Entomology, University of California, Riverside, CA 92521.

[2] Corresponding author, e-mail: rick.vetter@ucr.edu.

[3] Physical Plant, University of California, Riverside, CA 92521.

Materials and Methods

Adult females or egg sacs of *Latrodectus hesperus* Chamberlin & Ivie (Araneae: Theridiidae) were collected in Riverside, CA, or in nearby cities. Females were fed German cockroaches (*Blattella germanica* L.) two to three times per week to induce egg sac production. After oviposition, *Latrodectus* eggs require ≈2 wk to hatch to the first instar inside the sac (Kaston 1970). During this period, the spiderlings do not feed, are typically colorless, and are not highly mobile. Like all spider species, the spiderlings undergo their first molt inside the egg sac. They reside in the sac for another 2 wk, whereupon they chew an exit hole, emerge, and are fully functional. We removed egg sacs from vials containing female *L. hesperus* after the sac darkened, indicating that the spiderlings had molted to their second instar and were developing toward emergence.

A series of precision brass-screen sieve pans were used. Although manufactured by several companies (W. S. Tyler Company, Cleveland, OH; Humboldt Manufacturing Company, Chicago, IL; Thermo Fisher Scientific, Waltham, MA), the mesh opening for a particular size was equivalent, as reported by its standard United States Sieve Equivalent (USSE) number (Table 1).

Horizontal Orientation. We tested egg sacs and different sized sieves positioned in a horizontal orientation to determine the minimum size of mesh through which second-instar spiderlings could pass. A darkened egg sac was placed on a piece of white paper toweling on the bottom of a solid bottom pan (the

0022-0493/09/1396–1398$04.00/0 © 2009 Entomological Society of America

Table 1. Mesh size of screens used in experiments and standard household aluminum screen

USSE mesh size	Mesh opening size (mm)
8	2.36
10	1.98
12	1.65
14	1.40
16	1.17
18	1.00
20	0.83
30	0.59

Standard aluminum screen 1.2 by 1.5 mm.

collection pan for the series of sieves). A cardboard tube from an exhausted roll of paper towels was placed upright over the egg sac. The lengths of the tubes (15–60 mm) were various depending on the pan depth, but each tube was a flush fit from the pan bottom to the mesh above. In this setup, once spiderlings hatched, they were either confined to the tube by the mesh or crawled upward and passed through the mesh into the second pan. A third pan of very small mesh, which was too small to allow spider passage, was placed on top of the mesh sieve pan being tested. This arrangement confined spiderlings but still allowed airflow into the chamber. Initially, we intended to check spiderlings daily for a week once they emerged in case there was a tendency to stay close to the egg sac. However, spiderlings passed through the screen on the first day of emergence. For the mesh size that was too small to allow spiderling passage, the spiderlings were left inside the set up for 2 d to ensure that exclusion occurred.

For the initial series, we tested each mesh screen of size 0.59–2.36 mm (Table 1) once to determine the approximate threshold for passage. We then tested each of the mesh screens above and below the threshold four more times to allow for clutch size variation of spiderlings. The 10 egg sacs that were tested above and below the threshold were deposited by 10 different females.

Vertical Orientation. Because most screens on windows or intake vents are in a vertical, not horizontal, orientation, we chose the smallest size through which spiderlings readily passed. A darkened egg sac was placed in a pan with a solid bottom. The pan with the upper threshold mesh (USSE size 20, 0.83-mm openings) was placed on top. A third pan with very small mesh size of impenetrability was placed on top of this. The three-pan setup was taped together so there would not be inadvertent escape and placed such that the mesh was in vertical orientation. Pans were checked every day to determine whether spiders hatched and whether passage occurred. This trial was only run three times because of consistency of the results.

Measurements. We measured the abdomen diameters of subsamples of 16 newly emerged spiderlings from each of three egg sacs from different mothers. The measurements were performed on a MZ16 microscope (Leica Microsystems, Deerfield, IL) with an

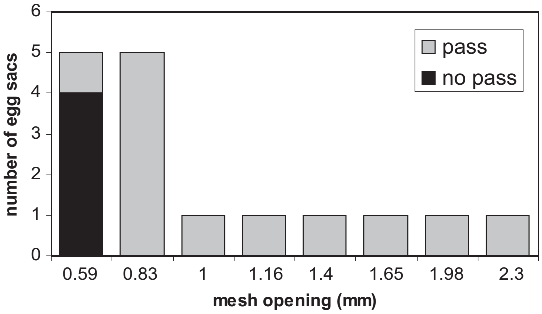

Fig. 1. Mesh screen of various opening size tested for ability of *L. hesperus* spiderlings to pass. Household aluminum screen openings are 1.2 by 1.5 mm.

ocular micrometer. Openings of standard household aluminum screen purchased from a hardware store were measured using a micrometer slide and an AMZ-10 microscope (Nikon, Tokyo, Japan).

We measured 10 vents on eight buildings on the University of California–Riverside campus to determine airflow rates in actual ventilation systems: office, laboratory, and mixed use buildings between two and six stories tall. Intake vents were rectangular and ranged from a few centimeters to several meters in width and length, in a variety of configurations. Three to seven airflow readings were taken along a transect across each vent opening (the number of readings increased proportionally with vent size). Airflow was measured with a hand-held velometer grid and electronic micromanometer (Airdata model ADM-870C, Shortridge Instruments, Inc. Scottsdale, AZ), which was calibrated on 29 August 2003.

Results

In horizontal orientation, *Latrodectus* spiderlings readily passed through brass screen of 0.83-mm openings (USSE 20 mesh) or larger (Fig. 1). Those passing through did so on the first day after emerging from the egg sac. The next smallest mesh size (USSE 30, 0.59-mm openings) (Fig. 2) completely contained four of the five clutches; in the last clutch, a few individuals were able to squeeze through although

Fig. 2. Mesh with 0.59-mm openings (USSE 30) that prevented passage of *L. hesperus* spiderlings in four of five clutches. The coin has a diameter of 18.5 mm. The scale of the figure is actual size if the figure width is 72 mm.

most were restricted from passing. In the USSE 20 and 18 meshes, some spiderlings were prevented from moving across the screen because they had larger, rounder abdomens than their siblings. This indicated that they probably had fed on a sibling in the egg sac before or just after emergence and hence were too large to pass through the mesh. When held in a vertical orientation, three clutches of spiderlings passed through mesh with 0.83-mm openings similar to the horizontal orientation.

Spiderling subsamples ($N = 16$) from each of three *L. hesperus* egg sacs had abdominal widths of 0.66 ± 0.11, 0.62 ± 0.03, and 0.58 ± 0.01 mm; the overall average was 0.62 ± 0.07 mm. Household aluminum screen had rectangular openings of 1.2 by 1.5 mm.

The linear airflow rates of ventilation ducts for eight campus buildings averaged 3.16 ± 2.13 m/s (range, 1.11–7.42). The highest flow rates were found at fresh air intakes of small air conditioning units, whereas the largest building vents (≥ 9 m^2) generally had flow rates <2.5 m/s.

Discussion

Spiderlings of the widow spider *L. hesperus* can pass through mesh screen openings of very small sizes. The cutoff threshold lies between 0.59- and 0.83-mm openings, although the threshold is probably closer to the lower limit considering the spiders' abdominal diameter. This abdominal width seems to be the restricting morphological feature that prevents movement across the mesh. Therefore, spiderlings would readily pass through openings in aluminum screen used in typical household windows and doors. Our initial speculation was that because black widows are web spinners (not hunting spiders that routinely crawl into small crevices) they might be behaviorally excluded from passing through a mesh size larger than they physically could crawl through; however, that is not the case. Kaston (1970) mentions that newly emerged *L. hesperus* spiderlings are 1.5–1.8 mm in length, whereas those of the black widow spider *Latrodectus mactans* (F.) are smaller, measuring 1.2–1.5 mm. *L. mactans* is the most prominent synanthropic widow spider in the eastern United States; hence, even the 0.59-mm mesh might not be capable of excluding them.

With respect to actual conditions found in typical commercial buildings situations, mesh that excludes black widow spiderlings is impractical for use with ventilation equipment. The typical screening on air intake ducts is one-fourth inch hardware cloth (4.76-mm openings), for excluding birds, rodents, and large debris. Generally, spiderling-excluding mesh on an air intake duct would quickly clog with fine to large-grain detritus, thus restricting airflow. Overcoming this restriction in retrofits of existing filtration systems would require increased fan power and more frequent maintenance. This would translate into potentially costly changes to mechanical equipment and higher electrical and maintenance operating costs. Screening as a requirement for new construction would likewise result in significant architectural and engineering cost to construction and future operation. In either case, existing or new buildings, the high cost of providing this type of filtration is not usually justifiable from a cost-versus-benefit perspective. Also, an unlucky spiderling would probably not survive passing through the additional high-velocity equipment downstream of the air filter. Finally, in systems where fresh air passes through an equipment room before reaching the fan filters, the machine room door into the building proper still presents an intrusion barrier similar to other exterior doors.

There are, however, some unique situations where excluding spiderlings might be practical such as in greenhouses. Bethke and Paine (1991) tested greenhouse pests (e.g., leafminers, aphids, thrips, whiteflies) for screen exclusion and found that for most insects, passage occurred in mesh that was 1.5 times larger than each specific insect's thoracic width. Thrips were able to pass through mesh with 0.19-mm openings. Reduction of airflow by such small mesh size is a significant consideration (Baker et al. 1994, Bethke et al. 1994). However, Baker et al. (1994) mentioned that screens in real application worked more effectively in excluding pest species than the laboratory tests demonstrated. Greenhouse construction can sometimes be flexible enough to permit the installation of sufficiently large areas of mesh to make periodic cleaning more manageable, and without requiring expensive mechanical revisions or renovations.

Acknowledgments

We thank S. Hedges (Terminix, Memphis, TN) for asking the initial question that led to this study. Our collection of black widows was augmented by donations from L. Robinson (University of California-Riverside).

References Cited

Baker, J. R., J. A. Bethke, and E. A. Shearin. 1994. Insect Screening, pp. 155–170. *In* W. Banner and M. Klopmeyer [eds.], New Guinea impatiens: a ball guide. Ball Publishing, Batavia, IL.

Bethke, J. A., and T. D. Paine. 1991. Screen hole size and barriers for exclusion of insect pests of glasshouse crops. J. Entomol. Sci. 26: 169–171.

Bethke, J. A., R. A. Redak, and T. D. Paine. 1994. Screens deny specific pests entry to greenhouses. Calif. Agric. 48: 37–40.

Kaston, B. J. 1970. Comparative biology of American black widow spiders. Trans. San Diego Soc. Nat. Hist. 16: 33–82.

Vetter, R. S., and G. K. Isbister. 2008. Medical aspects of spider bites. Annu. Rev. Entomol. 53: 409–421.

Received 15 January 2009; accepted 17 March 2009.