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Pseudacteon curvatus (Diptera: Phoridae) Laboratory Parasitism, Release and Establishment in Mississippi[1]

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Pseudacteon curvatus Borgmeier is one of two species of parasitic phorid flies currently approved for release in the U.S. as classical biological control agents for suppression of red, black, and hybrid imported fire ants, *Solenopsis invicta* Buren, *S. richteri* Forel, and *S. invicta* X *richteri* (respectively). Phorid fly attacks alter fire ant behavior and worker ants will often exhibit "freezing" behavior, reduce foraging rates, and assume defensive postures (Porter et al. 1995, Environ. Entomol. 24: 475-479; Porter et al. 1995, Ann. Entomol. Soc. Am. 88: 570-575; Cônsoli et al. 2001, Ann. Entomol. Soc. Am. 94: 97-109; Wuellner et al. 2002, Ann. Entomol. Soc. Am. 95: 257-266). Because of this, establishment of these flies in fire ant-infested areas may allow native ant species to better compete with fire ants.

The study site (231 ha) was a grazed pasture containing a mixture of black and hybrid imported fire ants at a mound density of about 50 mounds ha^{-1}. The site was surveyed for the presence of parasitic phorid flies in Fall 2001 by disturbing 20 fire ant mounds and closely watching for ovipositing flies. No parasitic phorids were noted prior to beginning our release. One area of pasture (3.25 ha, 33°40′05.87″ N, 88°34′48.02″ W, about 60 m elevation), containing two small ponds and adjacent to a riparian buffer zone, was selected as the release site and georeferenced. All GPS measurements were taken using a Starlink Invicta® 210 DGPS / Beacon Receiver (Starlink Inc., Austin, TX) and recorded using a Compaq® Pocket PC with SoloField CE software (Tripod Data Systems, Corvallis, OR).

Host ants were collected from the release site and returned to the laboratory for exposure to attacking flies. On each collection day, six active mounds were collected. Each mound was georeferenced with an accuracy of <1 m and collected by shoveling as much mound soil into a bucket as possible. The inner top edge of each bucket was

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lightly dusted with talcum powder to prevent ant escape, and buckets were returned to the laboratory. Ants were floated out of the soil (Jouvenaz et al. 1977, Florida Entomol. 60: 275-279), then passed through a 20-mesh sieve to separate smaller workers that are preferred by *P. curvatus* (Morrison and Gilbert 1998, Ecol. Entomol. 23: 409-416). Smaller workers were exposed to attack by *P. curvatus;* the remainder of each colony was held in the laboratory at about 27°C under a 12:12 L:D photoperiod, and given water, sugar water, and crickets (*Acheta domestica* L.) *ad libitum.*

Each group of smaller workers collected from a colony was weighed and placed in a tray (56 cm × 44 cm × 12 cm) lined with Fluon® (Asahi Glass Ltd., Chadds Ford, PA) to prevent escape. Trays (6 total) were housed in a large (244 cm L × 56 cm H × 96 cm W) plywood "attack box," with a Plexiglas top to facilitate observation of hosts and parasitoids. Each tray contained a pair of inverted Petri dish bottoms (125 × 25 mm), painted black and mounted to dowels, and attached by string to a cam driven by a pneumatic motor. An inverted, plastic cup was mounted to the top of each dowel and coated with Fluon to prevent ants from climbing up the string. The inverted dishes alternated up and down at 15-min intervals to induce ants to trail back and forth, exposing them to attacking flies (e.g., Porter 2000, Biol. Control 19: 35-37) (Fig. 1).

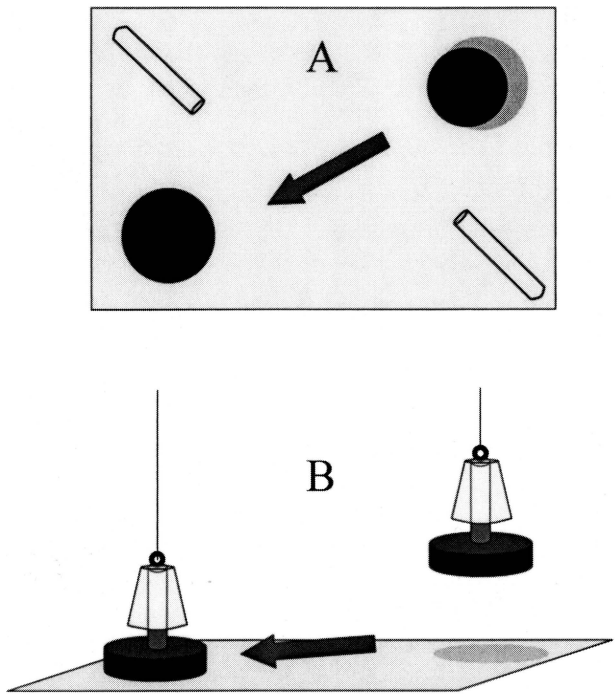

Fig. 1. Each group of host ants was confined in a tray which was configured as illustrated from the top (A) and side (B). Black arrow shows direction of ant movement, from the Petri dish in the "up" position to the dish in the "down" position. Small culture tubes (illustrated in A) contained water and sugar water. The large attack box held 6 of these trays.

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Each group of ants was provided with a small amount of brood (range 2 to 4 g), salvaged from their respective colonies and/or obtained from laboratory colonies, to help induce trailing behavior. Ants were exposed to attacking flies for 7 d, then reintroduced to their nestmates; as ants were returned to their respective colonies in the field, newly-collected ants were placed into the attack box. When necessary during hot, dry conditions, water (2 to 4 L) was poured on mounds and allowed to soak in prior to releasing exposed ants. This prevented ant mortality due to desiccation and high temperature. Four groups of colonies were exposed to attack, for 1 continuous month of release (6 colonies per week). Each day, 300 *P. curvatus* flies were allowed to emerge into the attack box, resulting in a level of exposure equal to 50 flies per colony per day. Percent parasitism was estimated by taking 20 workers from 6 trays upon removal from the box and recording the number of developing phorid pupae.

The last group of exposed workers was returned to the field on 22 May. Under our laboratory conditions, *P. curvatus* pupate in 9 to 14 d, and adults emerge 13 to 14 d later. Monitoring began on 11 and 12 July, 50 d after the last release. Ten white trays (27.5 cm W × 42 cm L × 12 cm H), lined with Fluon on the inner edge, were placed directly beside fire ant mounds. A small group of workers (about 1 g) was placed in each tray, and a few were crushed to release semiochemicals attractive to the adult phorids (R. K. Vander Meer, pers. comm.). Trays were observed for 30 min for presence of attacking phorid adults. The center of the area sampled was georefer-

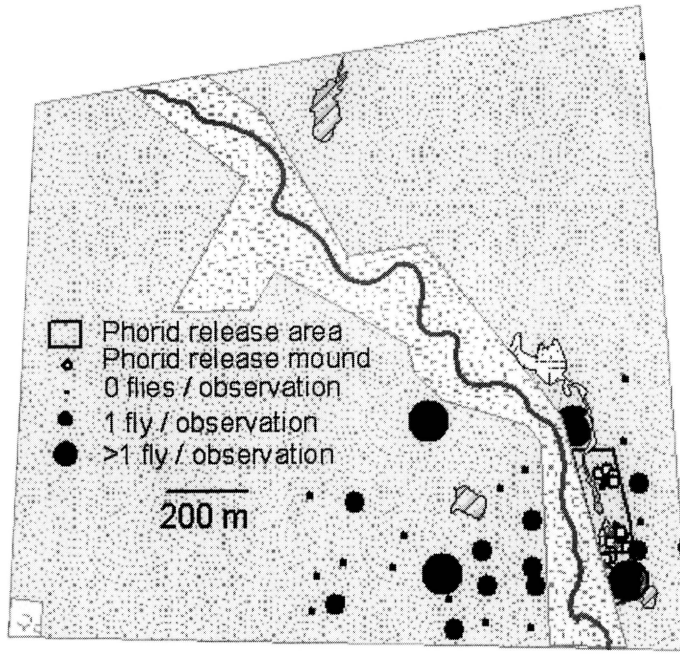

Fig. 2. Map representing status of phorid fly (*Pseudacteon curvatus*) release and establishment in Clay Co., MS, as of September 2002. Area is pasture and scrub with a riparian buffer running from northwest to southeast.

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enced, and general notes taken on time of day, temperature, and weather conditions. Although sampling was curtailed on these 2 days because of inclement weather, 13 flies were observed attacking ants, as far as 300 m from the original release site. By late July, attacking flies were recovered as far as 400 m from the release site; by September, flies were recovered about 600 m from the release site (Fig. 2).

This study represents the first successful establishment of *P. curvatus* in Mississippi. On average, phorid pupae developed in 8.3% of exposed ants. Assuming a live weight of 0.0007 g per minor worker, about 15,573 pupae per week were released (7.4 pupae per adult fly released into the attack box). *Pseudacteon curvatus* flies have successfully overwintered in Alabama in an area of slightly more southerly latitude (about 33°27′ N) (L. C. Graham, pers. comm.); monitoring will continue in MS to document overwintering and continued spread of the flies. Additional releases are underway in Alabama and Tennessee. It is hoped that successful establishment of this and other phorid species will reduce the competitive ability of imported fire ants throughout their range in the U.S., allowing native ant species to compete more effectively for resources.

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