Comparison of Two Fly Traps for the Capture of Horse Flies (Diptera: Tabanidae)[1]

D. W. Watson,[2] S. S. Denning, D. I. Calibeo-Hayes, S. M. Stringham and R. A. Mowrey[3]

Veterinary Entomology Program, Department of Entomology, College of Agriculture and Life Sciences, North Carolina State University, Raleigh, North Carolina 29695 USA

J. Entomol. Sci. 42(2): 123-132 (April 2007)

Abstract A 2-yr study was conducted to examine differences between two commercially available horse fly traps, the Epps® Biting Fly Trap (Farnum Co., Phoenix, AZ) and the Horse Pal® (Newman Enterprises, Omro, WI), placed on three horse farms located in central North Carolina. Traps captured over 8,422 tabanids, representing 4 genera and 19 species. *Tabanus quinquevittatus* Wiedemann was the most abundant fly collected (2345), followed by the *T. lineola* F. species complex (2087), *T. fulvulus* Weidemann (1397) and *T. petiolatus* Hine (839). Although the Horse Pal captured more flies than the Epps trap, fly capture differences between traps were not significant for the 2000 and 2001 summer seasons ($F = 1.39$; df = 3, 143; $P \leq 0.249$). The Epps trap was most efficacious for early-season (June and July) trapping of *T. quinquevittatus* and the *T. lineola* complex in 2000. In contrast, the Horse Pal was more efficacious for these species during the same period in 2001. The Horse Pal was the preferred trap for relative ease in handling.

Key Words IPM, biting fly, horse fly, fly traps, Epps Trap, Horse Pal, tabanids, Tabanidae

Horse flies and deer flies (Diptera: Tabanidae) are among the more common pest flies associated with horses. Both sexes acquire carbohydrates from nectar sources whereas only the female takes blood (Magnarelli et al. 1979). Known for their painful bite, feeding female tabanids cause severe irritation for horses, and their persistent attack may make horses unmanageable, perhaps endangering themselves or their handlers. In response to the feeding activity of flies, horses dislodge flies by tail switching, muscle twitch and head tossing, as a result the larger flies may feed on several host animals in the area (Davies 1990). Frequent and interrupted feeding increases the horse fly's efficacy as a vector of Equine Infectious Anemia and other diseases (Issel and Foil 1984, Foil et al. 1983, Buxton et al. 1985). Presumably, the relatively short feeding time limits fly exposure to insecticides topically-applied to livestock. As a result, management strategies for these flies have focused on alternatives to conventional insecticide-based programs.

The Tabanidae are attracted to a variety of visual cues including color and shape (Allan and Stoffolano 1986a). Whereas contrasting colors play an important role in tabanid attraction to two-dimensional panels, these flies appear to be more attracted

[1]Received 03 January 2006; accepted for publication 20 April 2006.

[2]Address inquires (email: Wes_Watson@ncsu.edu).

[3]Extension Horse Husbandry, Department of Animal Science

to dark 3-dimensional objects (Allan and Stoffolano 1986b, Bracken et al. 1962). Novel and innovative trapping systems appear to be the most common approaches to reducing horse flies in the environment (Mizell et al. 2002).

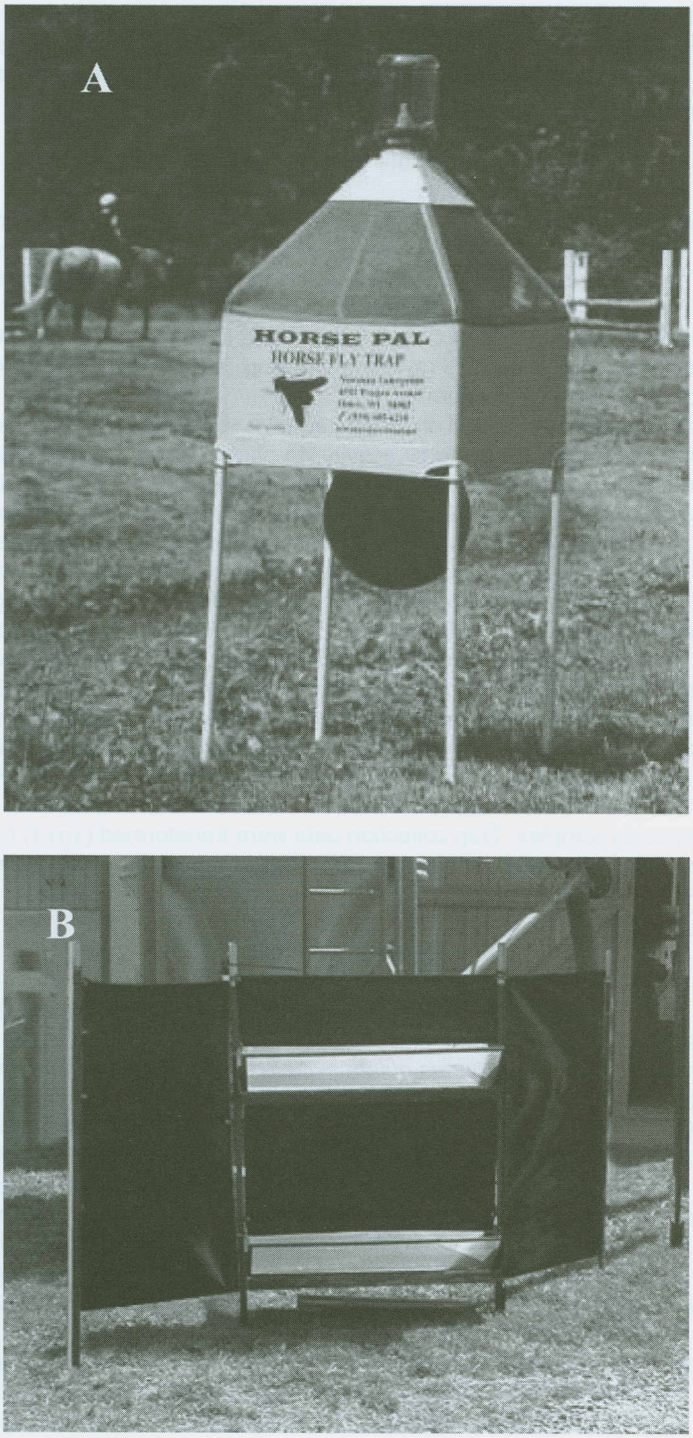
The Manitoba trap, as developed by Thorsteinson et al. (1965), was a cone trap that relied on a dark decoy to attract the flies. The trap consisted of a cone-shaped canopy open on the bottom and standing on three legs. A black ball was suspended from the peak through the center of the trap to the open area below. Flies, attracted to the black sphere, entered the trap through the opening beneath, were captured in the upper reaches of the trap and funneled into a collection chamber. Hansens et al. (1971) modified the original Manitoba trap design from the cone to a four-sided-pyramid configuration on four legs.

Granger (1970) directly compared the Manitoba trap to the Manning trap with and without decoys. Similar to the Manitoba trap, the Manning trap was a four-sided-pyramid with a skirted base and four legs. Flies attracted to a brown decoy placed beneath the pyramid were trapped as they flew up into the pyramid to be funneled into a chamber positioned at the top. Manning traps with decoys caught significantly more horse flies than traps without decoys or Manitoba traps (Granger 1970). A modified Manning trap was developed by Neil Newman (US Patent 6,604,317; 2003), and named the Horse Pal® fly trap. It is a four-sided-pyramid with a skirted base and a decoy and four legs (Fig. 1). The trap is commercially available (Newman Enterprises, Omro, WI, http://www.bitingflies.com/).

Although the flies were attracted to moving and stationary decoys used in the traps described above, some tabanid species also have been collected from simple panel traps of various hues and colors (Allan and Stoffolano 1986a). They also found blue or black colors were most attractive to *Tabanus nigrovittatus* Macquart. Large numbers (>23,000) of *T. nigrovittatus* and *Chrysops fuliginosus* Wiedemann were captured with Williams traps made of black 30 by 30 cm panels positioned at 90° angles on a single stake (Williams 1973, Dale and Axtell 1976).

The Epps Biting Fly trap is a stationary, passive horse fly trap designed and developed by Alan Epps (US Patent 5,836,104; 1998). The Epps trap is a large segmented panel trap comprised of a centralized upper panel and a lower panel suspended between two temporary supports (Fig. 1). Synclinal transparent deflectors positioned beneath the upper and lower panels force the flies downward. Immediately beneath the deflectors are shallow trays filled with soapy water to capture and drown the flies. These trays spanned the width between the lateral supports. On the outward side of each support member is a side panel positioned at a 45° angle from the center panel. Side panels are extended out in opposing directions, giving the trap a zig-zag appearance when viewed from above. As an approaching horse fly attempts to pass through the transparent deflector it falls into the soapy water tray. The Epps® Biting Fly Trap was commercially available through Farnam Companies, Inc., Phoenix, AZ.

Fig. 1. (A) A modified Manning trap, the Horse Pal® fly trap is a four-sided pyramid with a skirted base and a decoy, standing on four legs. Flies attracted to the color and movement of the decoy fly up and into the trap. (B) The Epps Biting Fly Trap® is a stationary trap comprised of two side panels, and centralized upper and lower panels separated by transparent deflectors suspended above trays of soapy water. Investigating horse flies collide with the transparent deflector and drop into the soapy water.


A
HORSE PAL
HORSE FLY TRAP
B

Because tabanid trapping devices are popular among horse owners in North Carolina, our objective was to compare capture rates of the Epps and Horse Pal traps on the same farms. Furthermore, data collected in this study provided much needed information about the seasonal variation of the horse fly fauna.

Materials and Methods

Flies were collected from two farms: Farm A was located in Johnston Co. and Farm B in Cumberland Co., NC. Flies were collected over 15 wks during the summer of 2000. The Johnston Co. farm was used again in 2001 and flies were collected over 18 wks. The Cumberland Co. farm was withdrawn at the completion of the 2000 season and a similar farm (Farm C) located in Wake Co. was chosen for 2001. Each farm had 5-10 horses on pasture (average stocking rate of 1 horse per 0.4 ha.) and acknowledged a horse fly problem.

Trap site selection was based on where tabanids were observed to be a problem. By observing the horses for biting fly activity we placed the fly traps to directly intercept approaching flies moving to and from daily resting areas and possible larval breeding sites. The Epps fly-trap was placed in the pasture with the horses. The Horse Pal was placed in the fly pathway, but outside the pasture fence where horses would not damage the trap. Traps were placed approx. 50 m apart. The traps were examined twice weekly during peak season and weekly thereafter. The grass was kept clipped around both traps. Specimens collected from the Horse Pal required no additional preparation before pinning and identification. Flies were removed from the water-filled trays of the Epps trap with a modified window screen sieve and placed in 95% ethanol. Collected specimens were removed from the ethanol and spread on toweling to air-dry prior to identification. Collected flies were counted and identified to species using the keys of Goodwin et al. (1985), Tidwell (1973) and Pechuman (1973). Identification of *T. lineola* F. included *T. lineola*-like-members and, thus, represents a species complex. Trap collection data were transformed ($\sqrt{n+1}$) for analysis of variance using general linear model and one-way analysis of variance (Minitab 1997).

Results and Discussion

During two summer seasons (2000 and 2001), 8,422 specimens in the Family Tabanidae, representing 4 genera and 19 species, were captured using the Epps and Horse Pal traps (Table 1). *Tabanus quinquevittatus* Wiedemann was the most abundant fly collected (27.8%, 2345), followed by the *T. lineola* F. species complex (24.7%, 2087), and *T. fulvulus* Weidemann (16.5%, 1397) (Table 2). Other species, *T. petiolatus* Hine, *T. gladiator* Stone, *T. melanocerus* Weidemann, *T. nigripes* Weidemann, *T. pumilus* Macquart, *T. sulcifrons* Macquart and *Chrysops callidus* Osten Sacken were not as abundant, but comprised more than 5% of the trap captures (Table 2). Species comprised of 1-5% of the population included *T. americanus* Forster, *Leucotabanus annulatus* Say, *T. sparus* Whitney, *T. atratus* F, and *T. trimaculatus* Palisot de Beauvois. Least common species included *C. univittatus* Macquart and *C. vittatus* Wiedemann.

The Epps traps collected 1456 in 2000 and 1923 tabanids in 2001 (Fig. 2). The Horse Pal captured 1507 in 2000 and 3,536 in 2001 (Fig. 2). Although the Epps trap appeared to collect more flies during weeks 3-5 of 2000, the Horse Pal trap captured

Table 1. Tabanidae collected from horse farms in Cumberland, Wake and Johnston Co, NC

Tabanus americanus Forster	*Leucotabanus annulatus* Say
Tabanus atratus atratus F.	*Tabanus fulvulus* Weidemann
Tabanus gladiator Stone	*Tabanus lineola* F.
Tabanus melanocerus Weidemann	*Tabanus nigripes* Weidemann
Tabanus nigrovittatus Macquart	*Tabanus petiolatus* Hine
Tabanus pumilus Macquart	*Tabanus quinquevittatus* Wiedemann
Tabanus sparus milleri Whitney	*Tabanus subsimilis* Bellardi
Tabanus sulcifrons Macquart	*Tabanus trimaculatus* Palisot de Beauvois
Chrysops callidus Osten Sacken	*Chrysops univittatus* Macquart
Chrysops vittatus Wiedemann	

the most flies during the same period of 2001. Fly capture differences between traps were not significant for the 2000 and 2001 summer season (F = 1.39; df = 3, 143; $P \leq$ 0.249). Generally tabanid densities declined after 7 wks (Fig. 2).

During the summer of 2000, *T. quinquevittatus* predominated the collections on Farm A with a total trap capture of 575 (29.6%) for the Epps trap and 338 (52.7%) flies for the Horse Pal trap (Table 2). Although *T. quinquevittatus* was most abundant for little more than a month in 2000, it was collected throughout the summer of 2001 (Fig. 3). As a result, there was a 2-fold increase in the number of *T. quinquevittatus* collected from the Horse Pal in 2001, but a similar increase was not observed from the Epps trap (Table 2).

The *T. lineola* species complex was least abundant on Farm B, with only 149 specimens captured during 2000 (Table 2). In contrast, this complex was very active on Farm C in 2001, making up 44.3% (468) and 54.7% (329) of the total captures for the Horse Pal and Epps traps. Collections of these species were similar for Farm A both years.

Tabanus fulvulus was the third most common species captured in this study, making up 13.8% (158) and 25.52% (633) of the Horse Pal collections during 2000 and 2001, respectively. Epps trap collections of this species were similar, 17.7% (65) and 25.79% (155) for Farm B in 2000 and Farm C in 2001, respectively. Although *T. fulvulus* was active from midJune to early August in 2001, its period of activity was shorter in 2000 (Fig. 3).

Trap captures were significantly different for three species. The Epps trap caught more *T. pumilus* (F = 32.12; df = 1, 26; $P \leq$ 0.0001) and *L. annulatus* (F = 5.23; df = 1, 26; $P \leq$ 0.031). The Horse Pal trap caught significantly more *T. petiolatus* (F = 6.83; df = 1, 26; $P \leq$ 0.015).

Some fly species display a predilection for sites on the host, feeding on the lower body, belly or backline (Allan et al. 1987). We suspected feeding site preference of some species may be reflected in the specimens collected from the upper and lower trays of the Epps trap. The upper tray of the Epps trap caught significantly more horse flies than the lower tray (F = 8.88; df = 1,65; $P \leq$ 0.004). Species most commonly

Table 2. Species number and percentage of total of Tabanidae captures on three farms using the Horse Pal (HP) and Epps biting fly trap during the summers of 2000 and 2001. Differences were not significant ($F = 1.39$; df = 3, 143; $P \leq 0.249$)

	2000								2001							
	Farm A		Farm B		Farm A		Farm B		Farm A		Farm C		Farm A		Farm C	
Species	HP	%	HP	%	Epps	%	Epps	%	HP	%	HP	%	Epps	%	Epps	%
L. annulatus	2	0.18	1	0.27	37	3.39	2	0.55	3	0.12	3	0.28	8	0.61	7	1.16
T. americanus	1	0.09	7	1.92	1	0.09	7	1.91	0	0.00	0	0.00	0	0.00	0	0.00
T. sparus	10	0.88	0	0.00	8	0.73	5	1.37	2	0.08	0	0.00	1	0.08	2	0.33
T. atratus	13	1.14	2	0.55	7	0.64	4	1.09	16	0.65	7	0.66	3	0.23	1	0.17
T. fulvulus	158	13.84	6	1.64	81	7.43	65	17.76	633	25.52	152	14.39	147	11.12	155	25.79
T. gladiator	15	1.31	13	3.56	2	0.18	9	2.46	75	3.02	87	8.24	0	0.00	1	0.17
T. lineola	205	17.95	47	12.88	277	25.41	102	27.87	269	10.85	468	44.32	390	29.50	329	54.74
T. melanocerus	39	3.42	93	25.48	1	0.09	40	10.93	8	0.32	6	0.57	0	0.00	0	0.00
T. nigripes	10	0.88	12	3.29	2	0.18	25	6.56	17	0.69	10	0.95	0	0.00	1	0.17
T. nigrovitattus	32	2.80	3	0.82	1	0.09	6	1.64	0	0.00	0	0.00	0	0.00	0	0.00
T. petiolatus	199	17.43	94	25.75	9	0.83	51	13.93	363	14.64	78	7.39	34	2.57	11	1.83
T. pumilus	65	5.69	1	0.27	56	5.14	13	3.55	94	3.79	49	4.64	83	6.28	26	4.33
T. quinquevittatus	338	29.60	56	15.34	575	52.75	21	5.74	760	30.65	8	0.76	552	41.75	35	5.82
T. sulcifrons	31	2.71	26	7.12	15	1.38	9	2.46	79	3.19	176	16.67	23	1.74	23	3.83
T. trimaculatus	6	0.53	4	1.10	3	0.28	3	0.82	28	1.13	9	0.85	6	0.45	7	1.16
C. callidus	8	0.70	0	0.00	14	1.28	1	0.27	125	5.04	2	0.19	69	5.22	2	0.33
C. univittatus	9	0.79	0	0.00	0	0.00	2	0.55	7	0.28	1	0.09	4	0.30	1	0.17
C. vittatus	1	0.09	0	0.00	1	0.09	2	0.65	1	0.04	0	0.00	2	0.15	0	0.00
Total	1142		365		1090		366		2480		1056		1322		601	

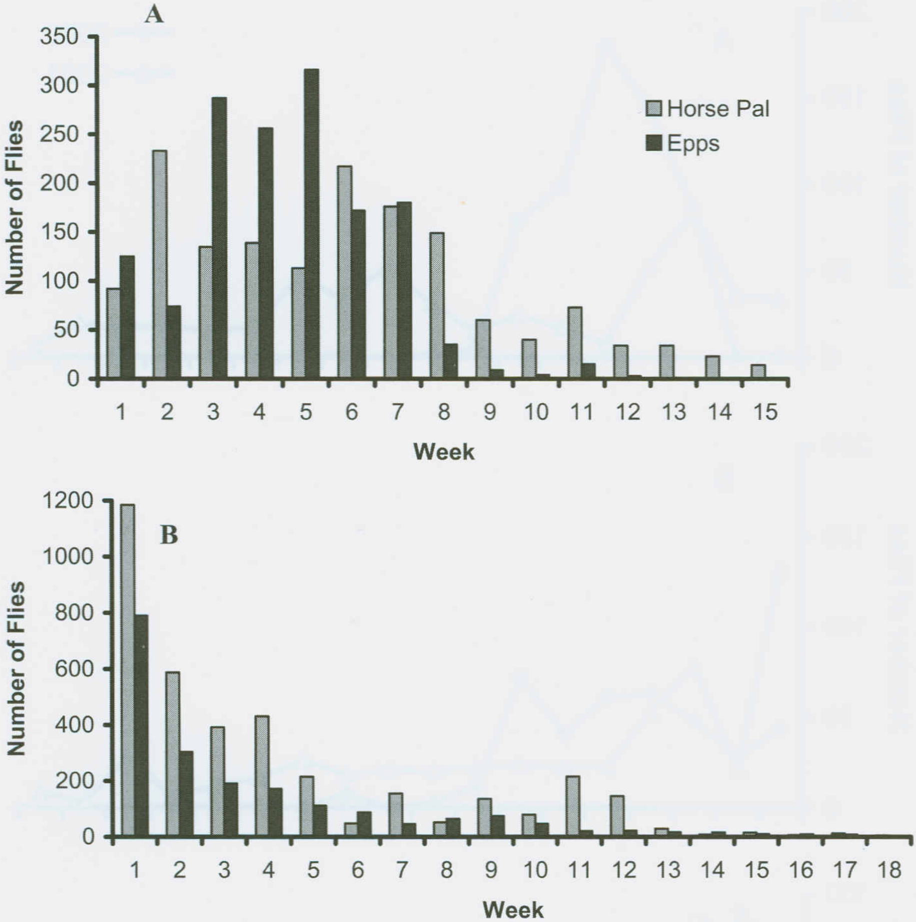


Fig. 2. Total number of horse flies and deer flies captured with Epps and Horse Pal traps on central North Carolina horse farms during the summers of 2000 (A) and 2001 (B).

recovered from the upper tray included *T. lineola*, *T. pumilus*, and *T. sucifrons*. In contrast, *T. quinquevittatus*, *T. fulvulus*, *T. petiolatus*, and *T. melanocerus* were captured in equal numbers from both upper and lower trays. Interestingly, differences between trays relative to fly species captured do not correspond well to on-animal observations by Thompson and Pechuman (1970). They observed fly predilection sites on horses, finding *T. lineola* and *T. pumilus* fed on the lower legs and belly, respectively, whereas *T. quinquevittatus* most commonly fed on the sides and back of the horse.

In our study, environmental temperatures were similar during the 2000 and 2001 seasons (SCO 2003). Four-month average high temperatures were 29.05 and 29.11°C, with the average low temperatures of 18.77 during the 2000 and 18.72°C in

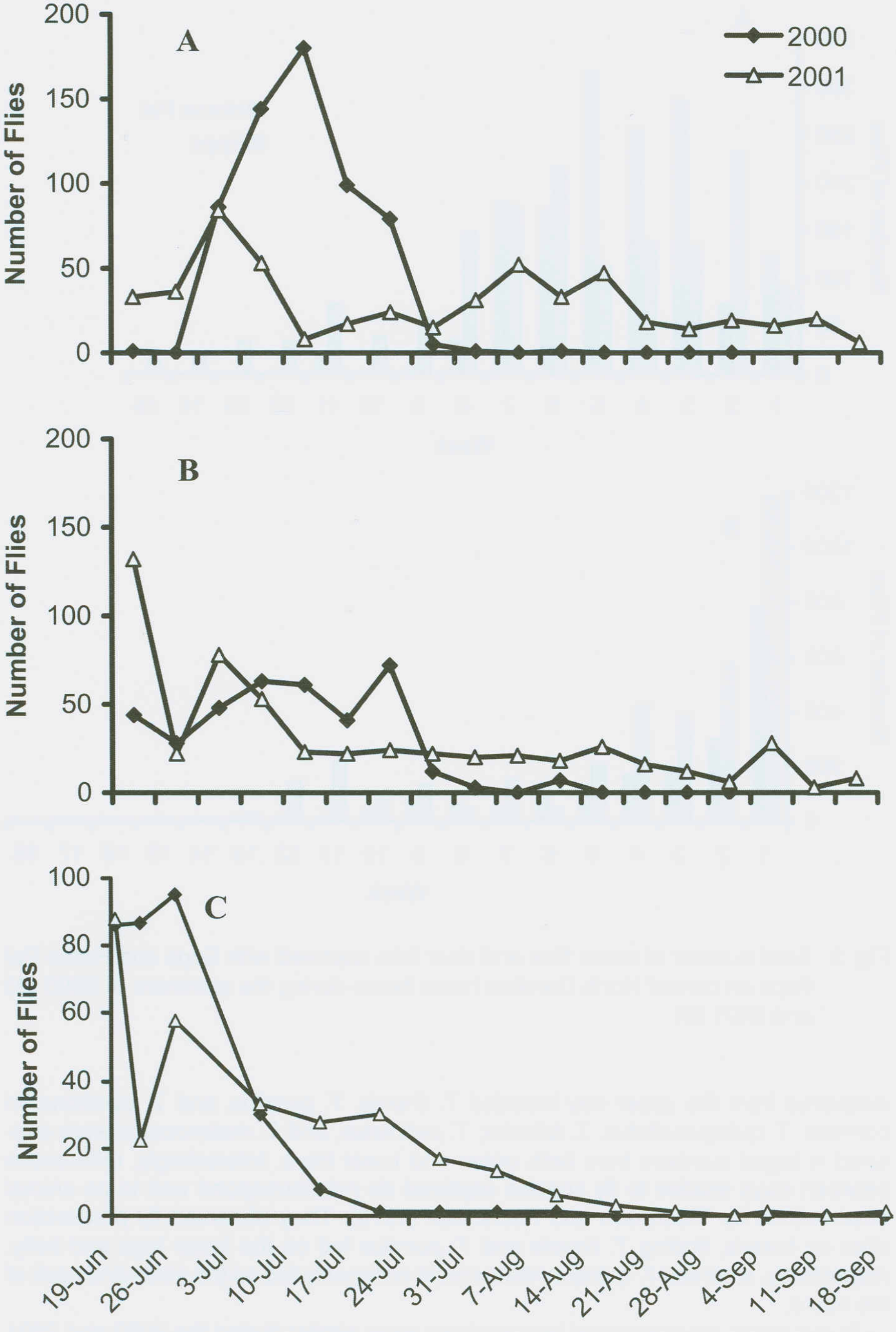


Fig. 3. Seasonal activity of the most abundant horse flies, *T. quinquevittatus* (A), *T. lineola* (B), and *T. fulvulus* (C) on three central North Carolina horse farms.

2001. However, precipitation was 15.12 cm in 2000 and 8.42 cm in 2001, representing a 55% reduction.

Trap placement requires some consideration and may have bearing on trap captures. Several factors influence horse fly flight activity including temperature, light intensity, and air moisture (Dale and Axtell 1975). We found that observing horse behaviors relative to horse fly activity provided insights to trap placement. Although over 6,000 of the specimens (71%) were collected from Farm A, the fly densities observed in our study were low relative to other studies. For example, >7,000 flies were captured per day in a Louisiana study (Leprince et al. 1991) and >12,000 over two seasons in Michigan (Strickler and Walker 1993).

The Epps Biting Fly Trap and Horse Pal Trap effectively captured horse flies, but few deer flies. Although the trap captures between the Epps and Horse Pal traps were the same, the Horse Pal trap was easier to use. Because the Epps trap was stationary and required about 20 min to assemble, moving the trap was relatively difficult. In contrast, once assembled the Horse Pal could be moved by one person to a new location without disassembling the trap. During peak summer temperatures, evaporation required that we provision the Epps trap trays with water twice weekly. Occasionally, spiders occupied the funnel of the Horse Pal and, unless cleaned regularly, the webbing prevented flies from entering the capture jar. Cooperators using these traps are encouraged to service the traps regularly.

Initially some horses were frightened by the movement of the black ball suspended from the Horse Pal but became accustomed to the trap within a few days. Horses were not frightened of the Epps trap and grazed comfortably around the device for most of the test. However, late in September, horses that had left the trap unmolested all summer destroyed one Epps trap. The Horse Pal trap is relatively light-weight and could be easily damaged by horses unless protected by a fence.

A number of insecticides and repellents are currently available to manage horse flies. The horse fly trap has great appeal to those producers wishing to remove flies from the environment without using an insecticide. These traps or others designed to capture horse flies may provide some relief to pastured livestock from biting flies and could be included in any pasture fly management plan in the absence of insecticides.

Acknowledgments

The authors thank L. Sewell, L. Mack, and G. Kennedy for allowing us to use their farms for study sites and E. Honeycutt and J. Barnes for technical assistance. This project was funded by North Carolina IPM.

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