SEASONAL OCCURRENCE AND DAILY ACTIVITY CYCLES OF THE HORSE FLIES (DIPTERA: TABANIDAE) OF NORTH CENTRAL OKLAHOMA

By

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THE HORSE FLIES (DIPTERA: TABANIDAE)

OF NORTH CENTRAL OKLAHOMA

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CHAPTER I

INTRODUCTION

Tabanids are formidable pests of man and livestock in North America and many other areas of the world. Tabanids are efficient mechanical vectors of *Anaplasma marginale* (anaplasmosis), *Bacillus anthrasis* (anthrax), equine infectious anemia virus and hog cholera virus, (Krinsky 1976). The transmission of these agents is facilitated by the erratic blood feeding behaviour of tabanids. Often when disturbed during feeding, the fly will return to finish feeding on the same or other convenient animal nearby.

Blood loss from tabanid bites is another source of damage caused by horse flies. Only a few studies have been made on the amount of blood imbibed by any particular species of tabanid, but these studies have indicated that these flies take between one and two times their own weight in blood, therefore the amount of blood loss from many fully engorged tabanid females could be considerable. One of the objectives of this study was to determine the average blood meal size for certain selected pest species of tabanids in this area. In addition to this, there is blood loss from the bite wounds after the flies have finished feeding.

Constant attack by horse flies can produce enough irritation in dairy cattle to substantially reduce the amount of butterfat produced (Decker 1955). Tabanids can also keep range cattle on the move, not allowing them to rest or eat during the daylight hours. This may result in loss of weight or reduction of the rate of weight gain. In a study done in southern Illinois, Bruce and Decker (1951) reported steers protected from tabanids for a 28 day period gained from 20 to 30 pounds more than unprotected comparison steers. Roberts and Pund (1974) showed that steers sprayed to deter the attack of biting flies, primarily tabanids, gained 0.2 pounds or more per animal per day than a control group. At this time, no economic threshold data has been presented for any species of Tabanidae and research to obtain such data is needed.

In an effort to learn more about the tabanids themselves, several areas of interest were chosen for this study. A major objective was to determine seasonal distribution and relative abundance of each species in the Lake Carl Blackwell ranges. Such information is required to establish life histories of the species involved and is needed before any type of control procedures can be planned.

There is little information currently available on the diurnal activity cycle of most tabanid species. An important aspect of this study was the determination of the diurnal activity pattern of the major blood sucking tabanids of the area. Traps were used as indirect indicators of the level of activity during the day. Trap catches were compared with quantitative observations of tabanid feeding activity on a cow.

It should be noted that not all species of horse flies will be captured in the traps at the same rate in relation to their actual population density. In other words, species abundance is not comparable between different species when using traps. Even so, the types and numbers of traps were kept constant during 1978, so data from different times of the year will be comparable for the same species.

CHAPTER II

REVIEW OF THE LITERATURE

Trapping Methods

The most commonly used types of traps for tabanids are the Manitoba trap (Thorsteinson 1958), the animal trap (Thompson 1969), the canopy trap (Catts 1970), the Gressett trap (Gressett and Gressett 1962) and the Malaise trap (Townes 1962). These traps and their variants have been very useful in the collection of the tabanids and have even been proposed by some as possible control measures (Hansens, et al. 1971, Wilson 1968).

The permanent traps used in this study were similar to the Stoneville Malaise trap (Roberts 1970b). This type of trap was used because it has been reported to be the most effective, both as a flight trap and when used with an attractant (Roberts 1972b). It has also been used as a standard trapping method in medical entomology (Smith et al. 1965). Natural saran screen was used for the trap material due to its resiliency (Roberts 1975b) and because more tabanids were collected by traps made out of this material than materials of other colors in a study by Roberts (1970a).

Several methods have been employed to increase the attractancy of traps for tabanids. Silhouettes and other forms have been placed in and near traps to draw flies by shape or other attractive property (Bracken et al. 1962, Thorsteinson et al. 1965, Neys et al. 1971, Snoddy 1970). CO_2 in either the form of bottled gas or as sublimating dry ice will significantly increase the number of female tabanids captured over a period of time in almost any type of trap (Anderson et al. 1974, Blume et al. 1972, DeFoliart and Morris 1967, Everett and Lancaster 1968, Knox and Hays 1972, Roberts 1970b, 1971, 1972a, 1975a, 1976, 1977, Wilson et al. 1966). Dry ice in a styrofoam bucket with holes in its sides to allow for the release of CO_2 gas (Anderson et al. 1974) was used as the attractant for all the traps in this study.

Several efforts have been made to quantify the attractiveness of CO_2 baited traps with the attraction of tabanids to host animals. Everett and Lancaster (1968) and Roberts (1972a) compared animal baited traps with CO_2 baited traps. Both used cows as a bait animal and both collected more tabanids using CO_2 than with the cow. Roberts (1969) conducted a study of the host seeking activity of tabanids by catching the flies that came to a cow with sweep nets. A limited study of daily activity cycles was made, but it is not known what effect the proximity of people had on tabanid activity, as has been reported for tsetse flies (Hargrove 1976).

Blood Meal Size

Only a few studies have been done to determine the volume of blood taken by female tabanids. Tashiro and Schwardt (1949) captured horse flies taking blood meals on a cow and weighed them immediately after engorgement. The average weight of unfed tabanids was subtracted from the average weight of engorged individuals for each species. In this manner, the average blood meal size of _Tabanus sulcifrons_ Marquart and _T. quinquevittatus_ Wiedemann were determined to be 344 mg and 71 mg respectively. The same technique was employed by Tashiro and Schwardt

(1953) in a later study, and blood meal sizes for *T. sulcifrons*, *T. quinquevittatus* and *Hybomitra lasiophthalma* (Marquart) were 354.8 mg, 85.8 mg and 116.0 mg respectively. Schomberg and Howell (1955) in the only Oklahoma study of this nature used this technique to find that *T. abactor* Philip imbibed 178.0 mg (168.0 μl) of horse blood. This technique was used to determine blood meal size in this study.

Other methods that have been used to determine blood meal size taken by tabanids were capturing and weighing nonfed specimens and allow the fly to feed and reweigh it (Miller 1951, Thomas and Gooding 1976), weighing the blood meal directly by dissecting out the midgut with blood meal (Wiesenhutter 1975) and placing the excised midgut and blood meal in a volumetric tube and recording the displacement (Clark et al., 1976).

CHAPTER III

METHODS AND MATERIALS

Location

All observations and collections were made in a study area located on the Oklahoma State University Animal Sciences Ranges, near Lake Carl Blackwell in Payne County, Oklahoma, 36° 7'30" N. latitude 97° 14'30" W. longitude. The area consisted of scruboak association with improved pasture land near the lake. The three sites were located in separate areas within two adjoining pastures. The first (#1) was placed near a small intermittent stream, the second (#2) on top of a hill with a large area of open pasture, and the third (#3) in a scruboak area overlooking Lake Carl Blackwell (Fig. 1). All three traps were shaded from the western sun by trees.

Observation and Trapping Techniques

During 1977, modified portable canopy traps (Catts 1970) (Fig. 2), one portable California Malaise trap (Anderson et al. 1974) and one Gressett trap (Gressett and Gressett 1962) were used to sample tabanid populations. During 1978, three permanent modified Stoneville Malaise traps (Fig. 3) were used in addition to the previous trapping methods. Malaise traps were constructed from 20 X 20 mesh saran screen following Roberts (1972b) design, except for the use of a structural steel frame for support and a different trap top design (Fig. 4). Trap tops were

Fig. 1. Aerial View of the Study Area at Lake Carl Blackwell with Trap Sites Labeled 1, 2, and 3

Fig. 2. Modified Portable Canopy Trap

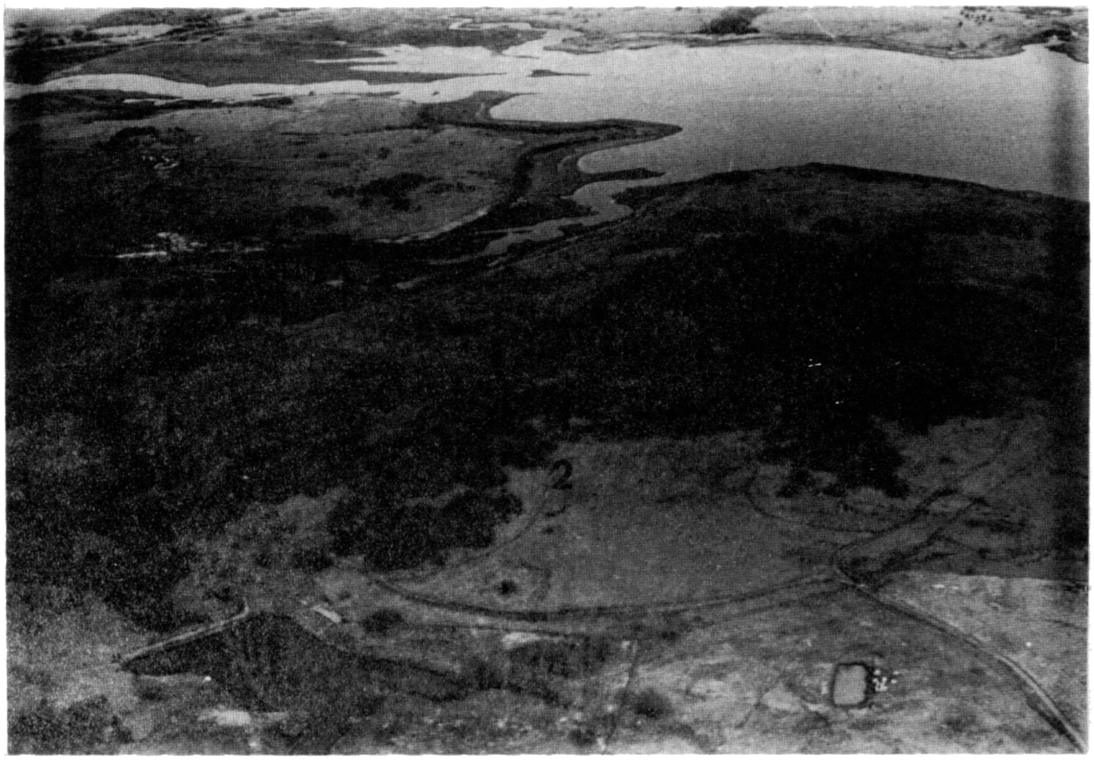
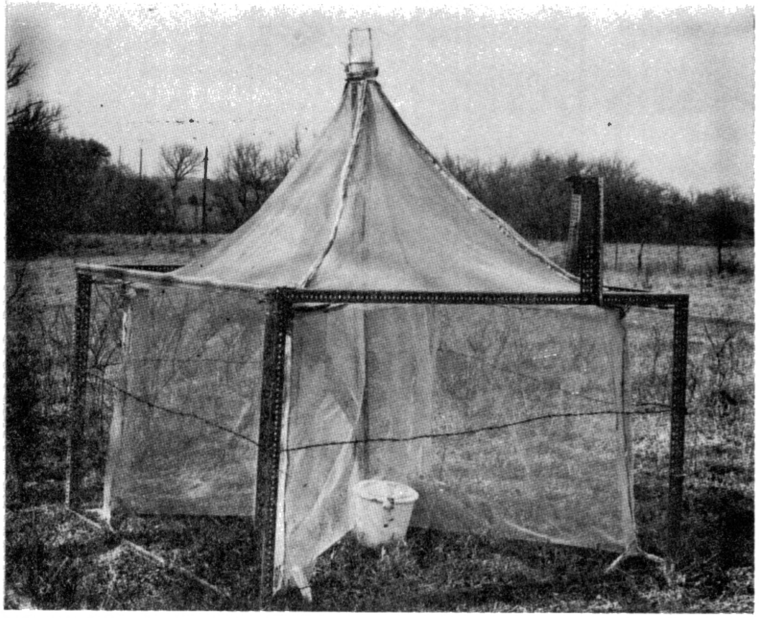
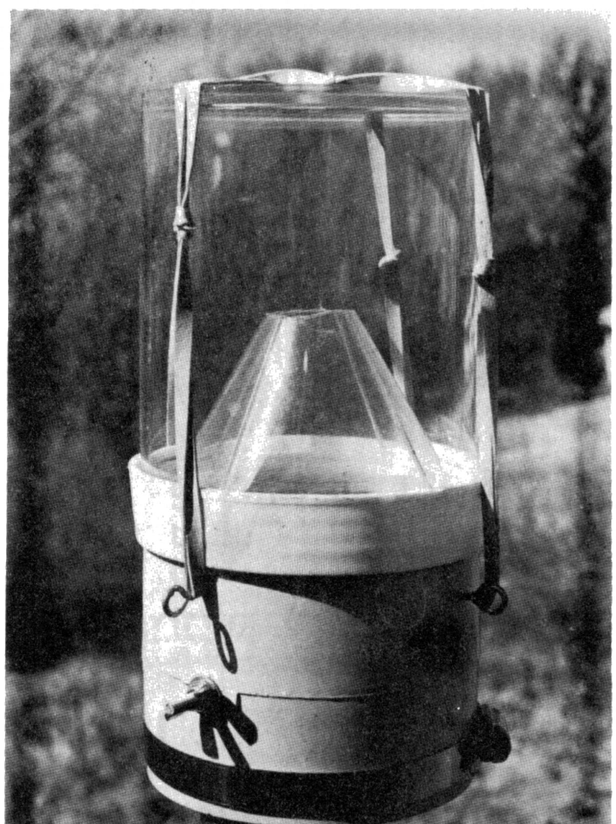

2

Fig. 3. Modified Stoneville Malaise Trap

Fig. 4. Trap Top Configuration Used on the Stoneville Malaise Trap





provided with dichlorvos resin pieces, approximately one inch square, to kill the flies shortly after entering the trap top. This reduced the number of flies escaping after capture and prevented specimen damage.

CO_2 was used as an attractant in all traps. Dry ice was placed in styrofoam buckets, each with four 3/4 inch holes approximately halfway up the sides. These buckets were placed as near the center of the traps as possible to reduce directional bias.

In 1978, observations were made of tabanid feeding activity on a tethered Jersey cow, one day a week for a 15 minute period each hour from 6:30 AM to 8:30 PM CDT. Observations were made on one side of the cow at a distance of three to five meters. A pair of binoculars was used in identification of flies and records were kept as to time of observation, species, location on cow, and a qualitative estimate of blood meal size, ie: 1 = none, 2 = bitten, but no blood taken, 3 = partial blood meal, 4 = completely engorged. The cow was tethered approximately 50 meters from the respective Malaise trap, under relatively the same conditions as the trap. For the first 12 weeks, the cow was led around to a different observation site each hour, so a complete circuit was made once every three hours. The pattern of the circuit was picked at random from the six possible patterns each day of data collection. During the final 11 weeks, the cow was placed at one randomly selected site for the entire day of observations.

Seasonal Occurrence

Collection of tabanids were made weekly with modified canopy traps, California Malaise trap, and occasionally with a Gressett trap, in pick-up cabs and with sweep nets between 8 June and October 1977. In 1978, weekly collections by three modified Stoneville Malaise traps baited with CO_2, and cow observations were made from 21 March to 26 October. Voucher specimens and records were kept as to the first observed appearance and activity through the season.

Diurnal Host Seeking Acitvity Patterns

Between 18 April 1978 and 21 September 1978, diurnal activity patterns of species present were sampled for 24 hr each week. The traps were set at 9 PM CDT and checked at 6 AM, 9 AM, Noon, 3 PM, 6 PM and 9 PM the following day to replace the trap tops and remove ice from the holes in the styrofoam bucket. Dry ice was replenished as necessary at 9 AM and 3 PM. The captured flies were placed in ice cream cartons until they could be taken to the laboratory to be identified and recorded.

To determine if the CO_2 baited Malaise traps were accurately sampling the tabanid populations that were attacking cattle, observations of tabanid activity on a tethered Jersey cow were made on the same day during the same periods as traps were operated, as described earlier.

Determination of Blood Meal Size

Blood fed tabanids were collected from a tame Jersey cow, tethered to allow flies to land and feed without being disturbed by the movements of the cow. The tabanids were captured by placing a pair of conical, clear plastic cups, 50 mm high, open end diameter of 44 mm and bottom diameter of 30 mm, one inside the other, over the fly after it had started feeding. The outer cup had a rubberband running through holes in the small end with spring paper clips on either end (Tashiro and Schwardt 1949). These fasteners were clipped to the hair of the cow to hold the cups in place. When the fly was observed to be full of blood and no longer attempting to feed, a cardboard lid for the cup was slipped between the inner cup and the cow, thereby containing the fly. The replete tabanids were placed in a cooler to reduce their metabolic activity to preclude digestion or excretion of the blood meal or other material before they could be weighed in the laboratory. Nonblood fed tabanids were collected from Malaise and Gressett traps and a truck cab at the same time as blood engorged flies were being captured. These flies were also placed in a cooler until taken to the laboratory. Each fly was identified to species, differentiated as to blood or nonblood fed and weighed with a Mettler Type-H 16 Balance with a sensitivity of $\pm$ 0.05 mg.

To determine blood meal size, the average weight of nonblood fed flies was subtracted from the average weight of blood fed flies of the same species. The standard error for the average blood meal weight was determined by pooling the variances of the blood fed and nonblood fed weights. From this, a 95% confidence interval on the mean blood meal weight was calculated.

CHAPTER IV

RESULTS AND DISCUSSION

Species Present

During the spring, summer and fall of 1977 and 1978, the species listed in Table I were collected in the area around Lake Carl Blackwell. Of these, *Anacimas dodgei* (Whitney), *Eisenbeckia incisuralis* (Say), *Tabanus colon* Thunberg, *T. fairchild* Stone, and the *T. nigripes* Wiedemann, *T. melanocerus* Wiedemann, *T. petiolatus* Hine complex were never observed on cows, and only a few were collected in the traps (Table I). Five of the species observed taking blood meals, *Chrysops callidus* Ostensacken, *C. flavidus* Fairchildi, *C. sequax* Williston, *Tabanus venustus* Ostensacken, and *Silvius quadrivittatus* Say were seldom seen or trapped, and were not abundant enough to be considered important pests of cattle in this area during 1977 and 1978. *Hybomitra lasiophthalma* (Macquart), *Tabanus abactor* Philip, *T. atratus* Fabricius, *T. equalis* Hine, *T. mularis* Stone, *T. subsimilis* Bellardi, *T. sulcifrons* Macquart and *T. trimaculatus* Palisot de Beauvoir were very abundant (Table II). They were often observed biting cows producing discomfort and/or blood loss, and were obviously important pests of cattle in this area.

TABLE I

TABANID SPECIES COLLECTED AND OBSERVED IN THE LAKE CARL BLACKWELL AREA, PAYNE CO. OKLAHOMA DURING 1977 AND 1978

Species Trapped	Observed Biting Cow	Most Abundant Species
Anacimas dodgei (Whitney)		
Chrysops callidus Osten Sacken	X	
Chrysops flavidus Fairchild	X	
Chrysops sequax Williston	X	
Eisenbeckia incisuralis (Say)		
Hybomitra lasiophthalma (Macquart)	X	X
Tabanus abactor Philip	X	X
Tabanus atratus Fabricius	X	X
Tabanus colon Thunberg		
Tabanus equalis Hine	X	X
Tabanus fairchildi Stone		
Tabanus mularis Stone	X	X
Tabanus melanocerus Wiedemann		
Tabanus nigripes Wiedemann		
Tabanus petiolatus Hine		
Tabanus subsimilis Bellardi	X	X
Tabanus sulcifrons Macquart	X	X
Tabanus trimaculatus Palisot de Beauvoir	X	X
Tabanus venustus Osten Sacken	X	
Silvius quadrivittatus (Say)	X	

TABLE II

NUMBER OF SPECIMENS COLLECTED IN TRAPS IN 1977 AND 1978

Species	1977	1978
Anacimas dodgei	--	5
Chrysops callidus	6	56
Chrysops flavidus	9	57
Chrysops sequax	10	38
Eisenbeckia incisuralis	--	2
Hybomitra lasiophthalma	--	635
Tabanus abactor	1147	10890
Tabanus atratus	5	61
Tabanus colon	1	--
Tabanus equalis	10	317
Tabanus fairchildi	--	1
Tabanus mularis	312	4089
Tabanus melanocerus		
Tabanus nigripes	3	13
Tabanus petiolatus		
Tabanus subsimilis	385	1445
Tabanus sulcifrons	108	2264
Tabanus trimaculatus	5	51
Tabanus venustus	2	1
Silvius quadrivittatus	4	11
Total	1980	19936

Seasonal Occurrence and Abundance

Date of first and last observed activity for the tabanid species present in 1977 and 1978 are shown in Table III and Fig. 5. Systematic trapping was not initiated in 1977 until June 8. All species except *Tabanus sulcifrons* were active before this date. The data on species collected in 1978 are probably more accurate due to the greater efficiency of the Malaise traps as compared to the traps used in 1977. Less than 15 specimens of *Eisenbeckia incisuralis*, *Tabanus colon*, *T. fairchildi*, the *T. nigripes*, *petiolatus*, *malanocerus* group and *T. venustus* were captured and an accurate representation of the seasonal cycles of these species could not be made.

Two species, *Anacimas dodgei* and *Hybomitra lasiophthalma*, were present for only a short period of time in April and May. Only five specimens of *A. dodgei* were collected between 24 April and 10 May 1978, and were not observed on the cow. *H. lasiophthalma* was present from 12 April to 23 May (Fig. 5), but 557 of the total 635 specimens captured were caught on one day, 27 April (Fig. 6A). In Mississippi, Hoffman (1963) observed this species at approximately the same time, whereas in the north, *H. lasiophthalma* is abundant one to two months later in New York (Tashiro and Schwardt 1949, 1953) and in Ontario (Golini and Wright 1978). This species is a serious pest of cattle for a four week period from late April to early May in Oklahoma.

Only three species of *Chrysops* were found in the Lake Carl Blackwell study area. Six and 56 specimens of *Chrysops callidus* were collected in 1977 and 1978 respectively from 10 May 1978 to early August of both years (Fig. 6B). The greatest number trapped (30) was in the first two weeks of June, with zero to four specimens collected weekly

TABLE III

DATES OF FIRST AND LAST OBSERVED ACTIVITY OF TABANIDS IN 1977 AND 1978

Species	Dates First Observed 1977	1978	Dates Last Observed 1977	1978
Anacimas dodgei	--	April 24	--	May 10
Chrysops callidus	--	May 10	August 6	August 15
Chrysops flavidus	--	May 23	September 20	October 18
Chrysops sequax	--	May 10	August 10	August 22
Eisenbeckia incisuralis	--	June 13	June 8	June 20
Hybomitra lasiophthalma	--	April 12	--	May 23
Tabanus abactor	--	May 31	September 20	September 14
Tabanus atratus	--	May 16	September 21	October 19
Tabanus colon	--	--	June 9	--
Tabanus equalis	--	May 30	June 22	July 15
Tabanus fairchildi	--	May 23	--	May 23
Tabanus mularis	--	May 30	September 8	September 7
Tabanus melanocerus, *nigripes*, *petiolatus*	--	June 13	August 6	August 8
Tabanus subsimilis	--	April 26	October 14	October 18
Tabanus sulcifrons	June 28	July 6	September 21	October 18
Tabanus trimaculatus	--	May 10	June 22	August 15
Tabanus venustus	--	June 27	June 29	July 17
Silvius quadrivittatus	--	May 31	July 13	August 15

Fig. 5. Seasonal Occurrence of the Common Tabanid Species in the Lake Carl Blackwell Study Area in 1977 and 1978

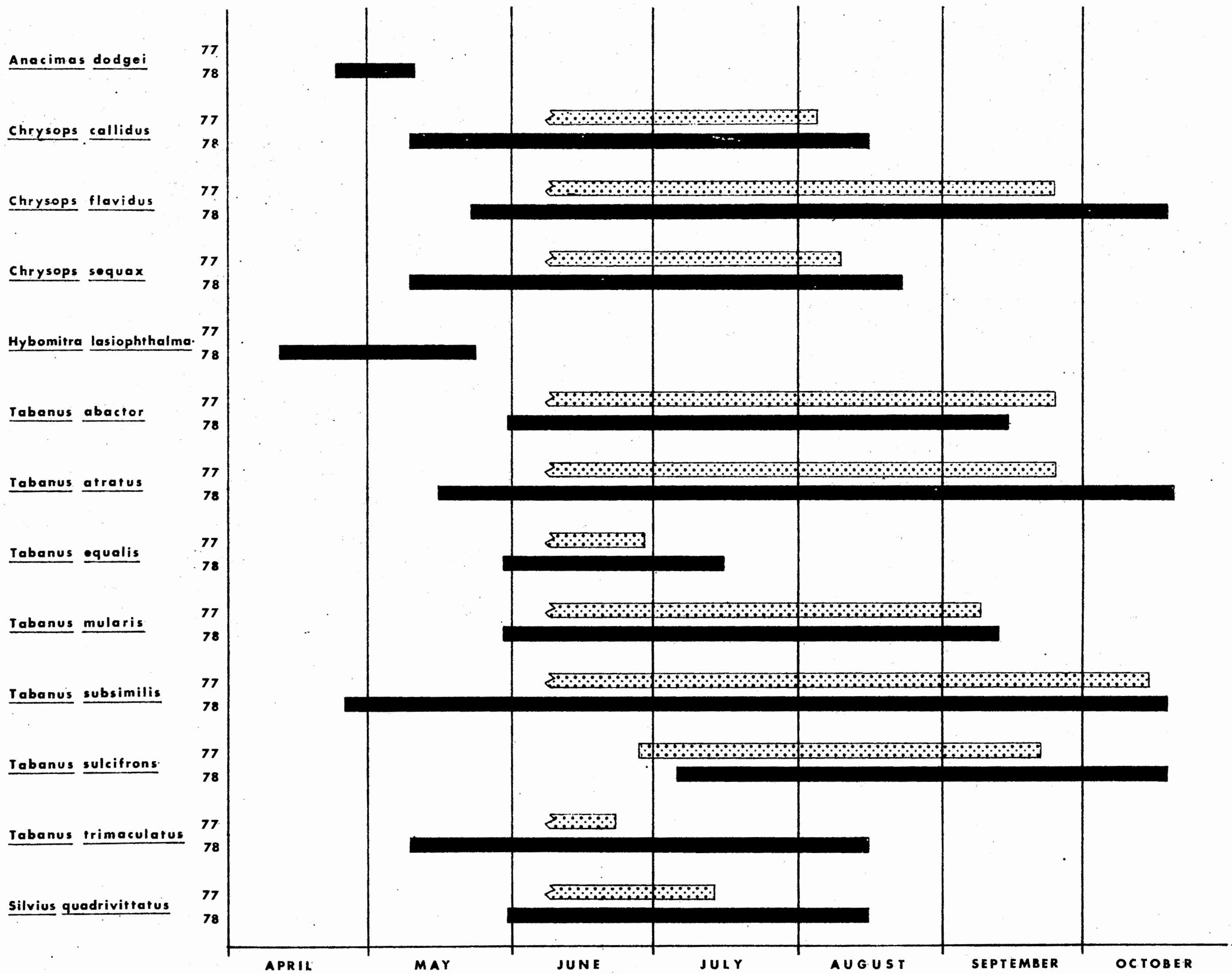
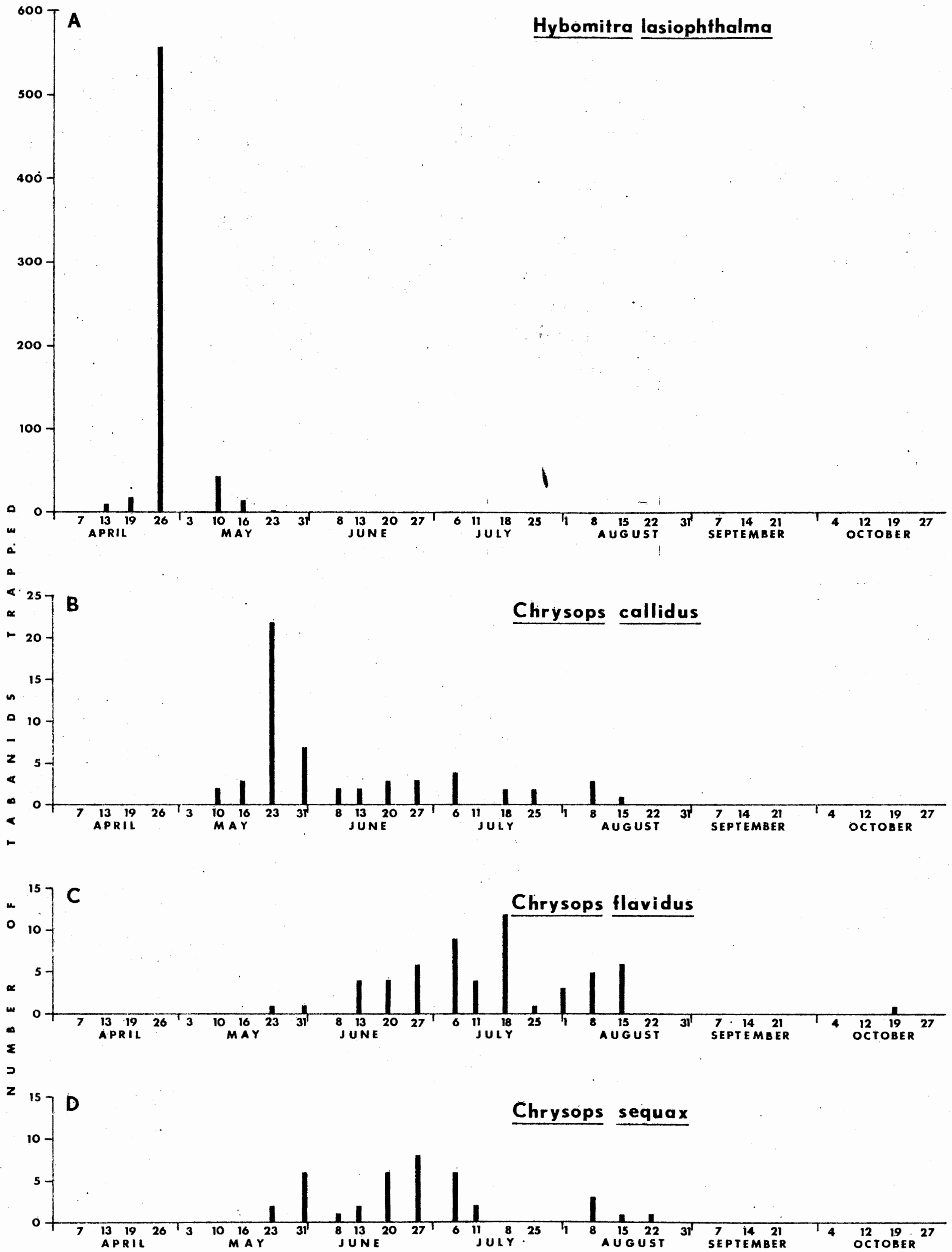

Anacimas dodgei
Chrysops callidus
Chrysops flavidus
Chrysops sequax
Hybomitra lasiophthalma
Tabanus abactor
Tabanus atratus
Tabanus equalis
Tabanus mularis
Tabanus subsimilis
Tabanus sulcifrons
Tabanus trimaculatus
Silvius quadrivittatus
77
78
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER

Fig. 6. Total Number of Tabanids Collected in all Three Malaise Traps in 1978 in the Lake Carl Blackwell Area,

A. *Hybomitra lasiophthalma*;
B. *Chrysops callidus*;
C. *Chrysops flavidus*;
D. *Chrysops sequax*


A
Hybomitra lasiophthalma
B
Chrysops callidus
C
Chrysops flavidus
D
Chrysops sequax
NUMBER OF TABANIDS TRAPPED
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER

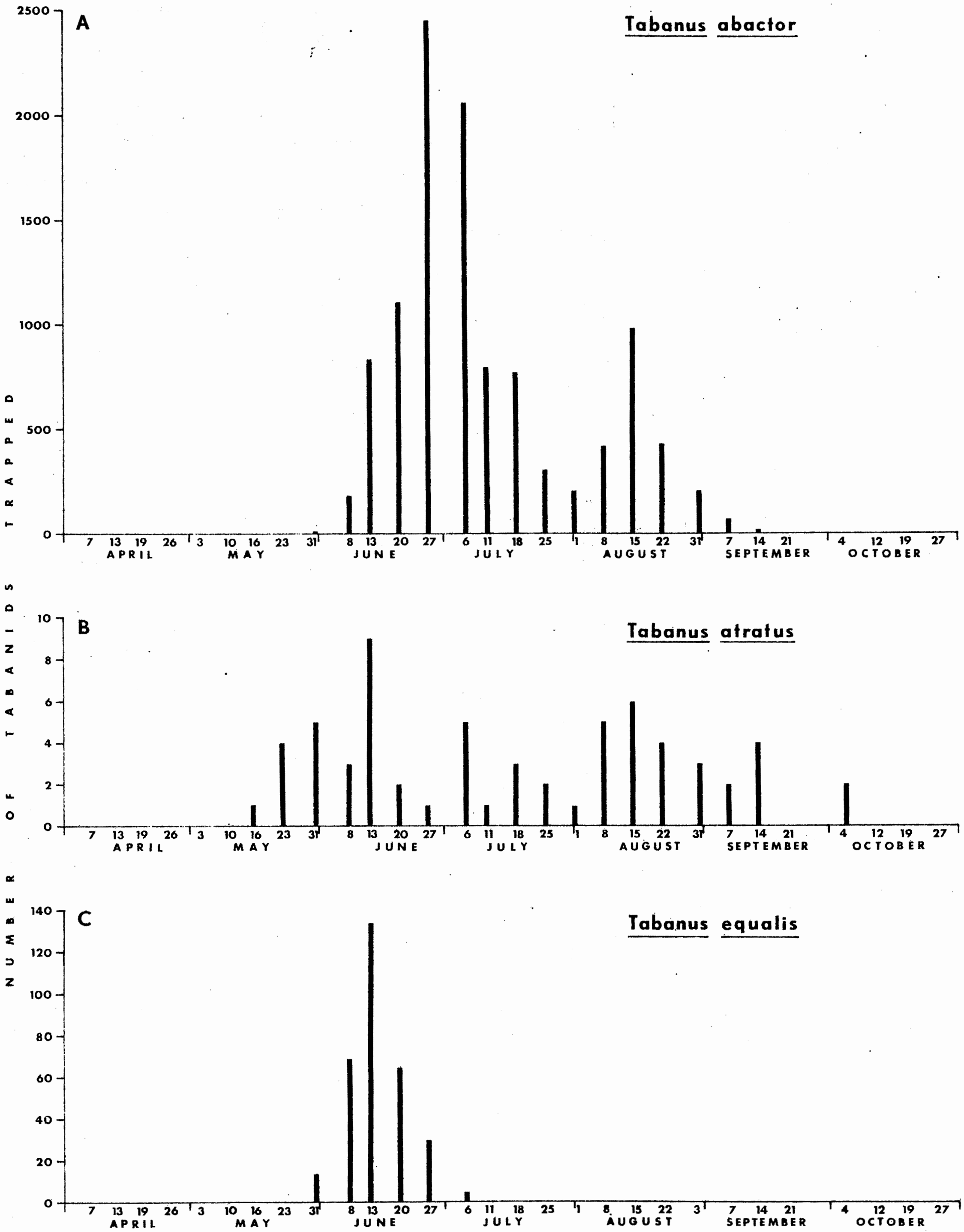
until 13 August 1978, when the last specimens of the season were observed. This is similar to the seasonal occurrence of this species in Maryland (Uebel and Bickley 1976). Chrysops flavidus was present from late May to early August in 1978, although one specimen was collected on 19 October (Fig. 6C). This species was never abundant. Fifty seven specimens were captured during 12 of 13 weeks of collecting from 23 May to 14 August 1978 (Fig. 6C). Uebel and Bickley (1976) found C. flavidus in Maryland from mid June to early August. Thirty eight Chrysops sequax were collected from 10 May to 22 August 1978, most in the eight week period from late May to early July (Fig. 6D). In Maryland, C. sequax was found for only one week, 4 to 11 August, by Uebel and Bickley (1976).

Tabanus abactor was the most abundant species with 1147 and 10,890 specimens collected in 1977 and 1978 respectively. This species was first observed at the end of May in 1978 and was present until mid September (Fig. 5). It was most abundant from early June to late August. Two distinct population peaks, in June and August, were observed during 1978 (Fig. 7A). The author speculates that the decrease of the first was due to high average daily temperatures with little rainfall in July, and a second emergence was stimulated by decreased temperatures and rainfall in early August.

Tabanus atratus was never very abundant, with only 61 specimens captured from 15 May to 5 October 1978 (Fig. 5). This species was active, but no distinct period of peak abundance occurred (Fig. 7B). Burnett and Hays (1977) collected T. atratus over a much shorter period of time, 30 August to 4 October, in Alabama.

A total of 317 specimens of Tabanus equalis were collected in the traps from 30 May to 6 July (Fig. 7C). One specimen was captured on 15

Fig. 7. Total Number of Tabanids Collected in all Three Malaise Traps in 1978 in the Lake Carl Blackwell Area, A. *Tabanus abactor*; B. *Tabanus atratus*; C. *Tabanus equalis*


NUMBER OF TABANIDS TRAPPED
A
Tabanus abactor
2500
2000
1500
1000
500
0
7 13 19 26 3 10 16 23 31 8 13 20 27 6 11 18 25 1 8 15 22 31 7 14 21 4 12 19 27
APRIL MAY JUNE JULY AUGUST SEPTEMBER OCTOBER
B
Tabanus atratus
10
8
6
4
2
0
C
Tabanus equalis
140
120
100
80
60
40
20
0

July on the cow (Fig. 5). Hoffman (1963) noted an even more restricted activity period for this species, from early to late June, in Mississippi.

Tabanus mularis was very abundant with 4089 individuals being collected in the traps in 1978. They first appeared in late May with a peak activity period from early June to early July. Some specimens were collected into early September of 1978 (Fig. 8A).

Tabanus subsimilis was present for the longest period of time, from 26 April 1978 to mid October of both years (Fig. 5), with peak levels in May, June and again in September (Fig. 8B). In contrast, Uebel and Bickley (1976) found this species in Maryland from the first of June to the end of September.

Tabanus sulcifrons was the last species to appear with the first specimen collected on 28 June and 5 July in 1977 and 1978 respectively (Fig. 5). This species was most abundant from mid July to late August (Fig. 9A) with the last specimens captured on 21 September 1977 and 19 October 1978. Burnett and Hays (1977) found this species from 23 August to 4 October in Alabama; whereas Tashiro and Schwardt (1953) in New York observed this species from late July to early September. A total of 2264 specimens of T. sulcifrons were collected in the traps during 1978.

There were 51 specimens of Tabanus trimaculatus collected from early May to early July, although one specimen was collected on 15 August (Fig. 5). The major portion of the population was found from mid May to late June (Fig. 9B). Burnett and Hays (1977) found T. trimaculatus to be present for about one month longer, from 3 May to 30 August, in Alabama.

Fig. 8. Total Number of Tabanids Collected in All Three Malaise Traps in 1978 in the Lake Carl Blackwell Area, A. *Tabanus mularis*; B. *Tabanus subsimilis*

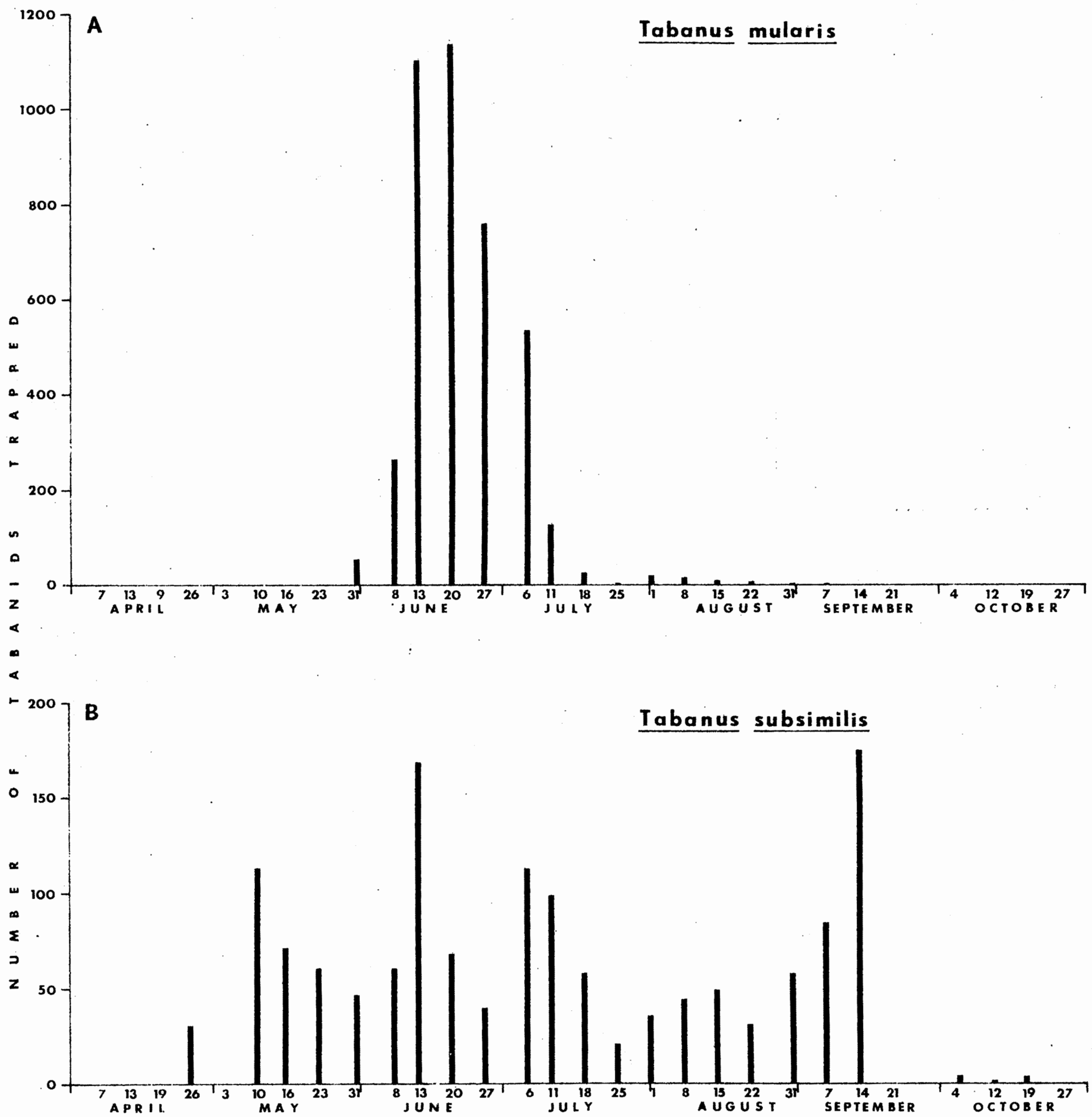
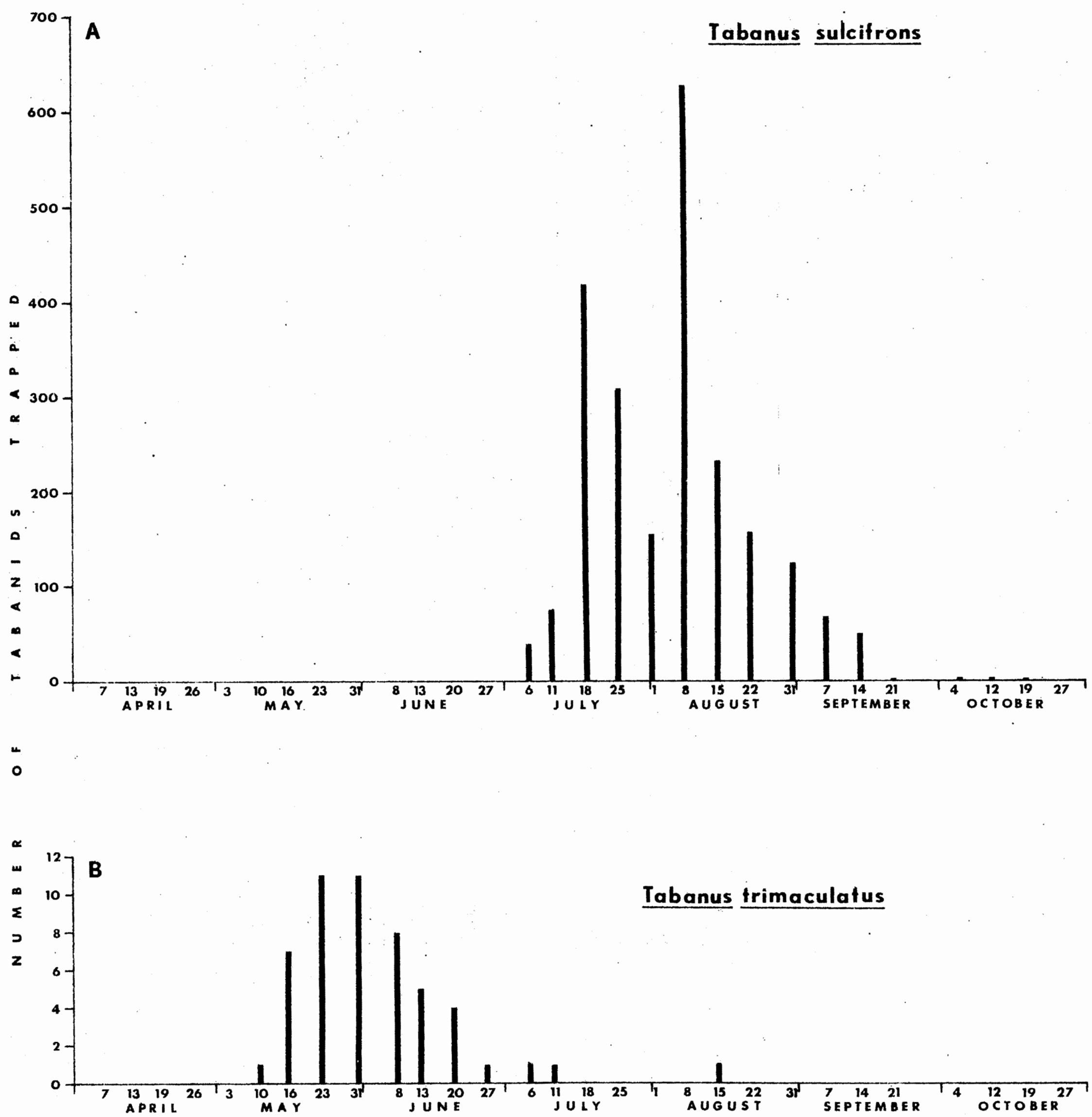

A
Tabanus mularis
B
Tabanus subsimilis
NUMBER OF TABANIDS TRAPPED
1200
1000
800
600
400
200
0
150
100
50
7 13 9 26 3 10 16 23 31 8 13 20 27 6 11 18 25 1 8 15 22 31 7 14 21 4 12 19 27
7 13 19 26 3 10 16 23 31 8 13 20 27 6 11 18 25 1 8 15 22 31 7 14 21 4 12 19 27
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER

Fig. 9. Total Number of Tabanids Collected in all Three Malaise Traps in 1978 in the Lake Carl Blackwell Area, A. *Tabanus sulcifrons*; B. *Tabanus trimaculatus*


A
Tabanus sulcifrons
NUMBER OF TABANIDS TRAPPED
0
100
200
300
400
500
600
700
7 13 19 26 3 10 16 23 31 8 13 20 27 6 11 18 25 1 8 15 22 31 7 14 21 4 12 19 27
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
B
Tabanus trimaculatus
0
2
4
6
8
10
12
7 13 19 26 3 10 16 23 31 8 13 20 27 6 11 18 25 1 8 15 22 31 7 14 21 4 12 19 27
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER

Diurnal Activity Patterns

Based on trap catches and feeding activity on the tethered cow, diurnal activity patterns were determined for eight species.

The first three bars in each time period in Part A of Fig. 10 through 17 represent the percentage of the total trap catch for Trap 1, 2 and 3 respectively, collected during each time period over 24 hr. The fourth bar in each group represents the percentage of the total number of flies, collected by all three traps, during each time period. The data for these graphs may be found in Table V.

Part B of Figures 10 through 17 compares the percentage of flies trapped and percentage of activity on the cow by each species of fly over three hour segments of the period from 6 AM to 9 PM CDT. In most cases, there was little difference between the percentage of flies trapped and observed tabanid activity on the cow. This data may be found in Table VI and VII.

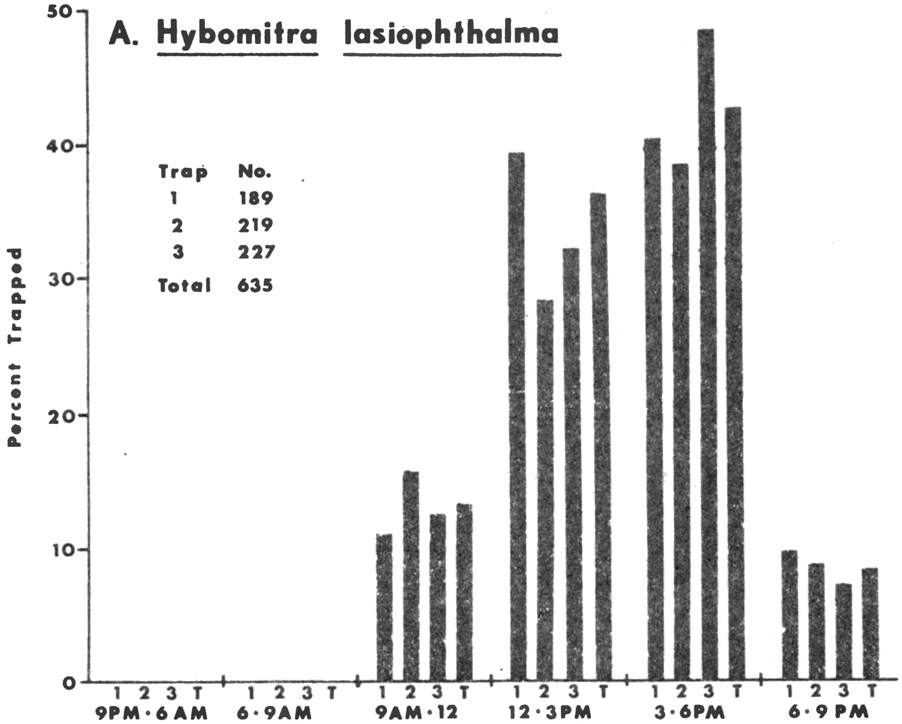
Hybomitra lasiophthalma

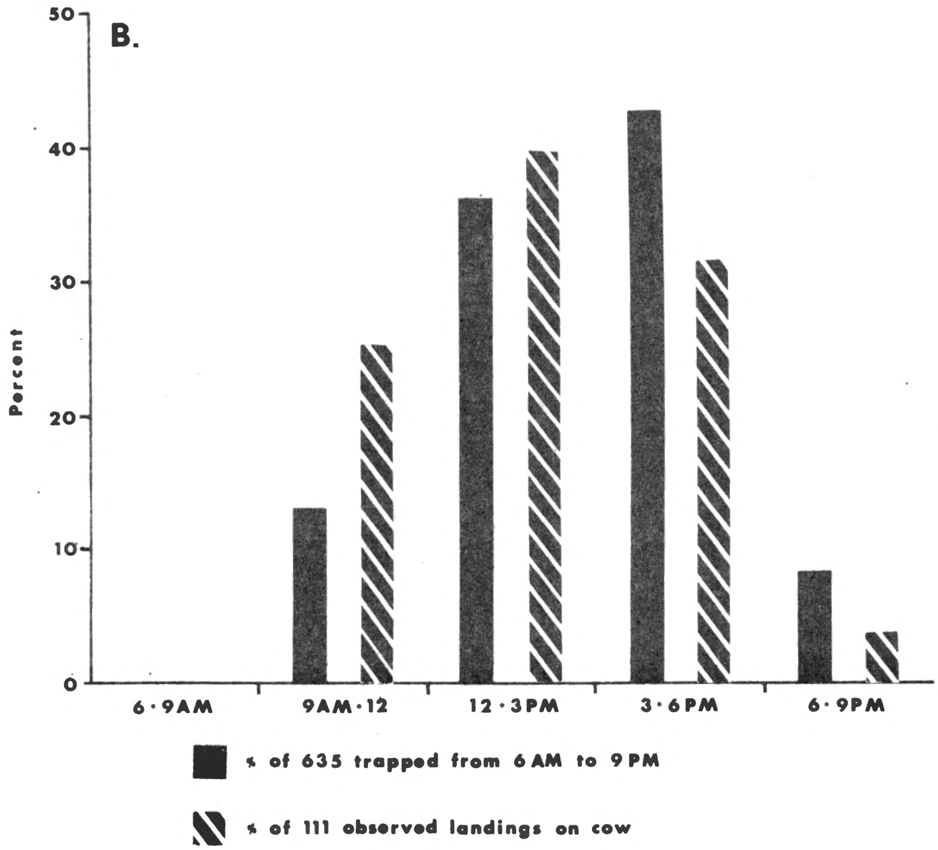
This species was most active from noon to 6 PM (Fig. 10) although it was attacking cattle before noon. There was no activity before 9 AM and less than 10% of the activity occurred after 6 PM. Since this species was present only in April and May, it was obvious that the daily temperature affected its activity and it was never active on cool spring days. This species was trapped at approximately the same rate at all three sites.

Tabanus abactor

This species comprised over 50% of all the Tabanids collected, and was most active from 3 PM to darkness. There were substantial differences between the number of flies captured in each trap, but the

Fig. 10. Diurnal Activity Cycle of _Hybomitra lasiophthalma_. A. Comparison of Percentage of Total Trap Catch by Each of the Three Malaise Traps and Total Trap Catch for Each Period; B. Comparison of Percentages of Flies Trapped and Observed Landings on Cow for Each Period


A. Hybomitra lasiophthalma
Trap No.
1 189
2 219
3 227
Total 635
Percent Trapped
0
10
20
30
40
50
1 2 3 T
9PM·6AM
6·9AM
9AM·12
12·3PM
3·6PM
6·9 PM


B.
Percent
0
10
20
30
40
50
6·9AM
9AM·12
12·3PM
3·6PM
6·9PM
% of 635 trapped from 6 AM to 9 PM
% of 111 observed landings on cow

proportion of activity at each time period at each trap was very similar (Fig. 11A). This species biting activity pattern on the cow followed the same daily cycle as shown in the traps (Fig. 11b).

Tabanus atratus

Only 61 *T. atratus* were collected in the traps during 1978; therefore it was difficult to determine a daily cycle, but Fig. 12A shows that peak activity occurred between noon and 6 PM. Fig. 12B, depicting the biting activity on the cow, indicated that there was a higher attack rate on cows between 9 AM and noon than was indicated by the traps and a reduction in feeding between 3-6 PM.

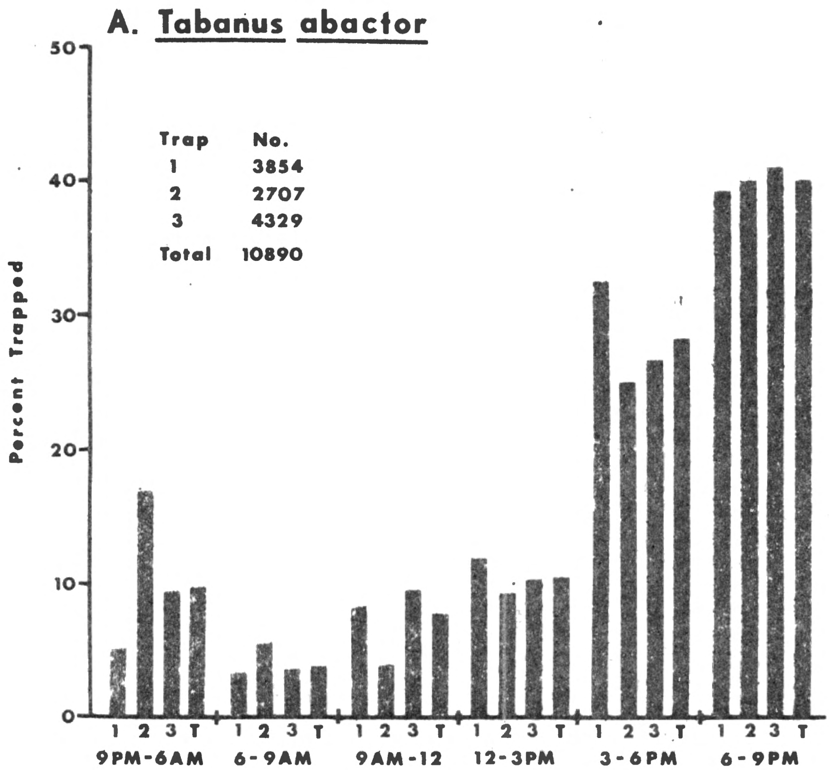
Tabanus equalis

This species exhibited a definite crepuscular activity pattern with the highest percentage of the activity being between 6 PM and dark. Of a total of 317 specimens collected in the traps, 152 were collected from 6 AM and 9 PM. The other 165 specimens were collected during the short time between 9 PM and darkness. This is shown in the 9 PM to 6 AM period of Fig. 13A. There were distinct site differences with respect to the number of specimens collected, but the proportions of the catches per period were relatively the same. Cow observations (Fig. 13B) show the greatest activity from 6 PM to 9 PM, but general observations indicated the highest level of activity was between 9 PM and dark and no activity by *T. equalis* was observed after twilight. The crepuscular activity of this species was alluded to by Schnorrenberg (1932) who found them in greatest abundance between 7 and 9 PM CST.

Tabanus mularis

Trapping data and cow observations (Fig. 14) show some activity shortly after dawn and the greatest portion of activity between noon and

Fig. 11. Diurnal Activity Cycle of <u>Tabanus abactor</u>. A. Comparison of Percentage of Total Trap Catch by Each of the Three Malaise Traps and Total Trap Catch for Each Period; B. Comparison of Percentages of Flies Trapped and Blood Meals Taken from the Cow for Each Period


A. Tabanus abactor
Percent Trapped
50
40
30
20
10
0
Trap No.
1 3854
2 2707
3 4329
Total 10890
1 2 3 T 1 2 3 T 1 2 3 T 1 2 3 T 1 2 3 T 1 2 3 T
9PM-6AM
6-9AM
9AM-12
12-3PM
3-6PM
6-9PM

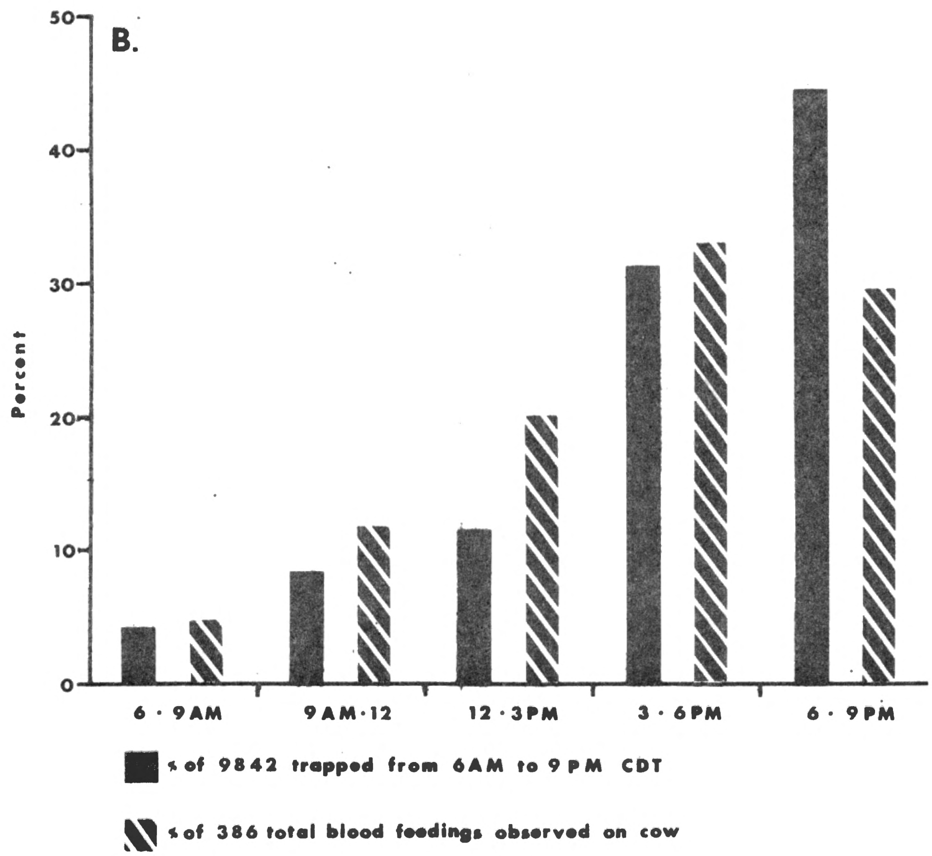
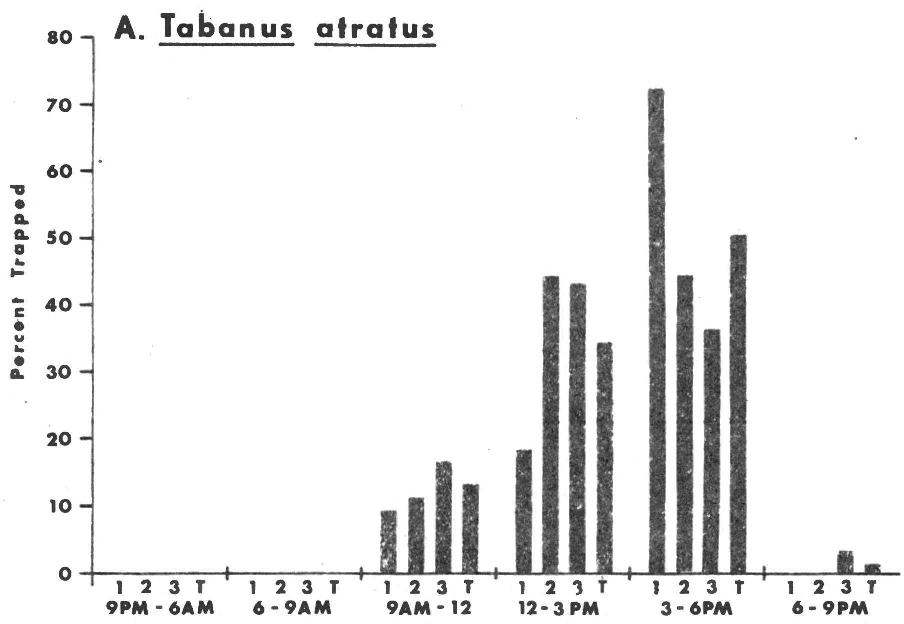

B.
Percent
50
40
30
20
10
0
6 · 9AM
9AM·12
12 · 3PM
3 · 6PM
6 · 9PM
% of 9842 trapped from 6AM to 9 PM CDT
% of 386 total blood feedings observed on cow

Fig. 12. Dirunal Activity Cycle of _Tabanus atratus_. A. Comparison of Percentage of Total Trap Catch by Each of the Three Malaise Traps and Total Trap Catch for Each Period; B. Comparison of Percentages of Flies Trapped and Observed Landings on Cow for Each Period


A. Tabanus atratus
Percent Trapped
80
70
60
50
40
30
20
10
0
1 2 3 T
9PM - 6AM
6 - 9AM
9AM - 12
12 - 3 PM
3 - 6PM
6 - 9PM

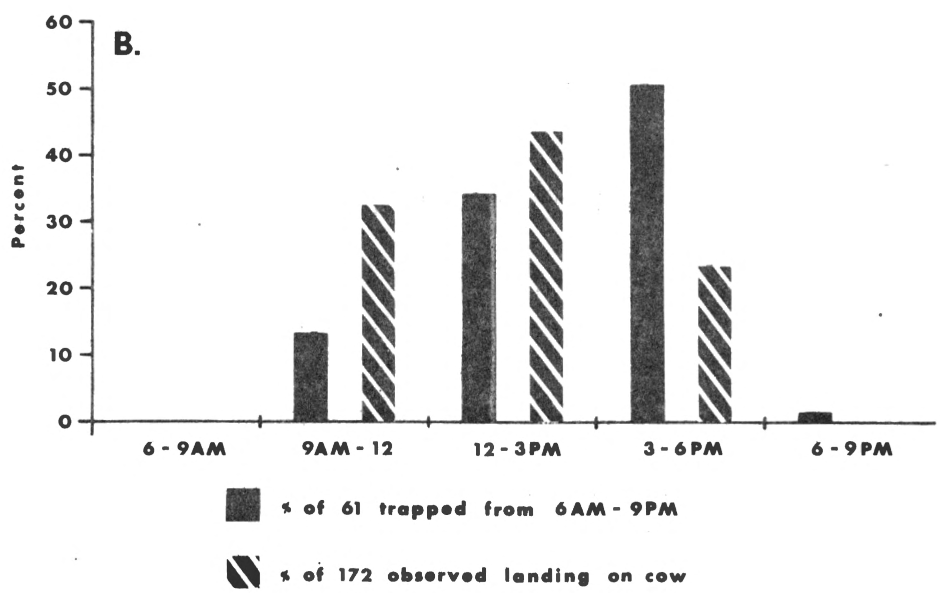

B.
Percent
60
50
40
30
20
10
0
6 - 9AM
9AM - 12
12 - 3PM
3 - 6PM
6 - 9PM
% of 61 trapped from 6AM - 9PM
% of 172 observed landing on cow

Fig. 13. Dirunal Activity Cycle of *Tabanus equalis*. A. Comparison of Percentage of Total Trap Catch by Each of the Three Malaise Traps and Total Trap Catch for Each Period; B. Comparison of Percentages of Flies Trapped and Observed Landings on Cow for Each Period

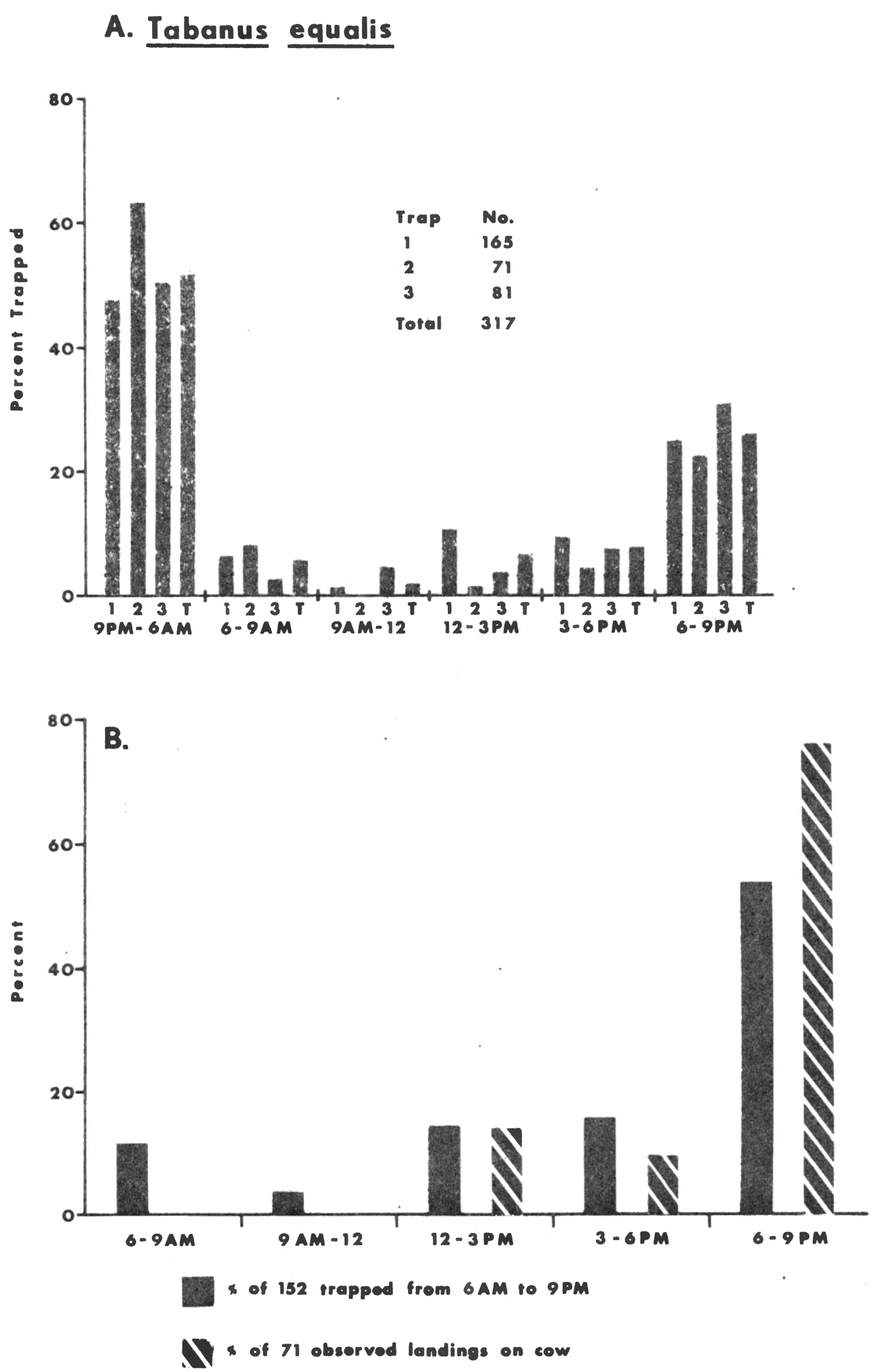
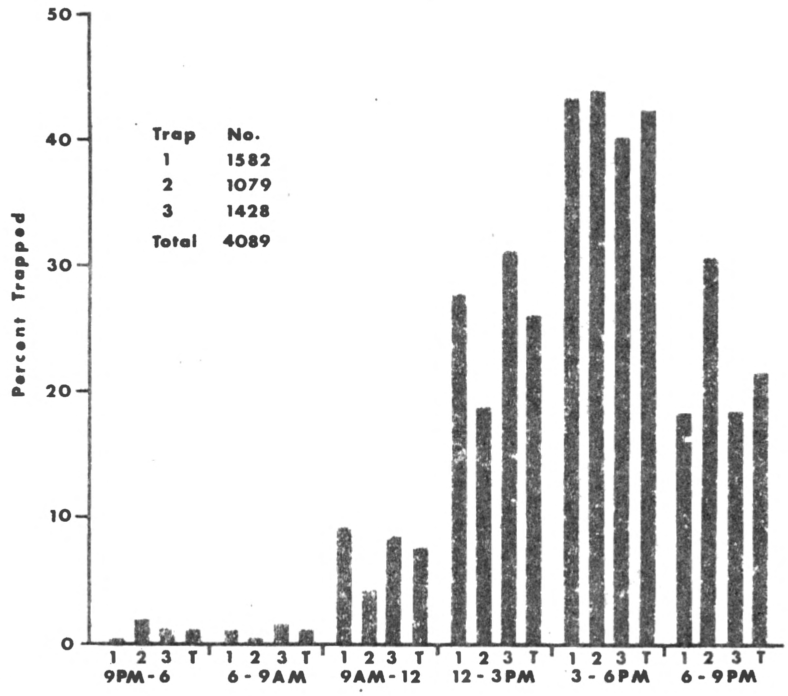
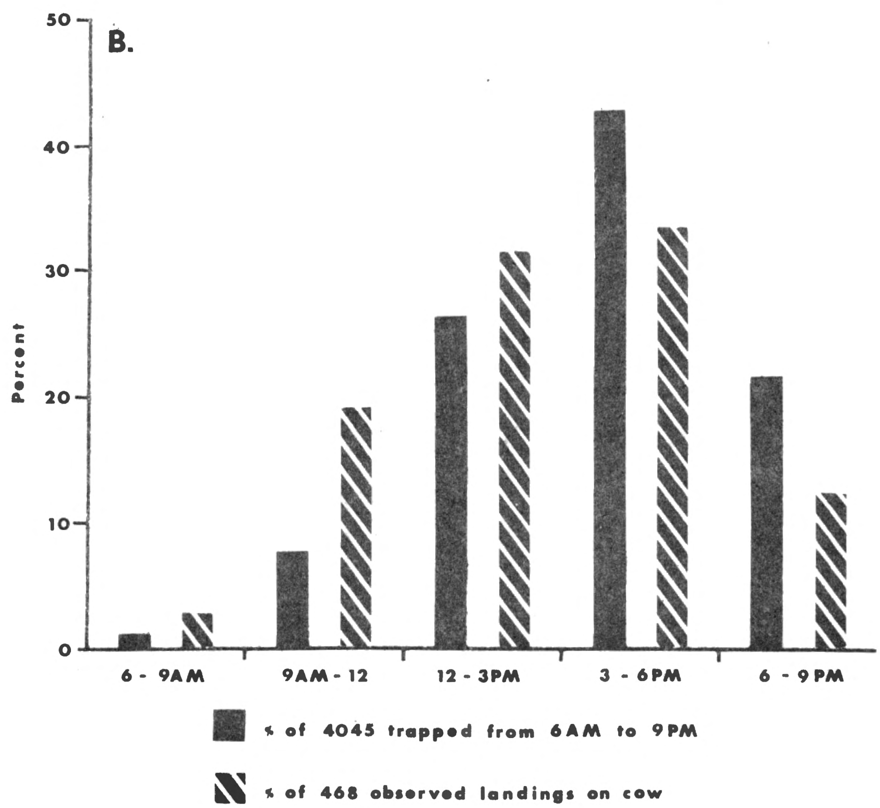

A. Tabanus equalis
80
60
40
20
0
Percent Trapped
Trap No.
1 165
2 71
3 81
Total 317
1 2 3 T
9PM-6AM
6-9AM
9AM-12
12-3PM
3-6PM
6-9PM
B.
Percent
6-9AM
9AM-12
12-3PM
3-6PM
6-9PM
% of 152 trapped from 6AM to 9PM
% of 71 observed landings on cow

Fig. 14. Diurnal Activity Cycle of _Tabanus mularis_. A. Comparison of Percentage of Total Trap Catch by Each of the Three Malaise Traps and Total Trap Catch for Each Period; B. Comparison of Percentage of Flies Trapped and Observed Landings on Cow for Each Period

A. Tabanus mularis





9 PM. There was a distinct peak of activity between 3 PM and 6 PM. There were slight site differences observed in numbers collected, but daily activity cycles were consistant from one site to the next.

Tabanus subsimilis

This species was very evenly distributed over the study area with nearly no difference between the numbers of tabanids collected in each trap. Little activity was noted before 9 AM, the major portion being between 9 AM and dark, peaking between 3 and 6 PM (Fig. 15A). The cow observations showed a very similar diurnal activity cycle (Fig. 15B).

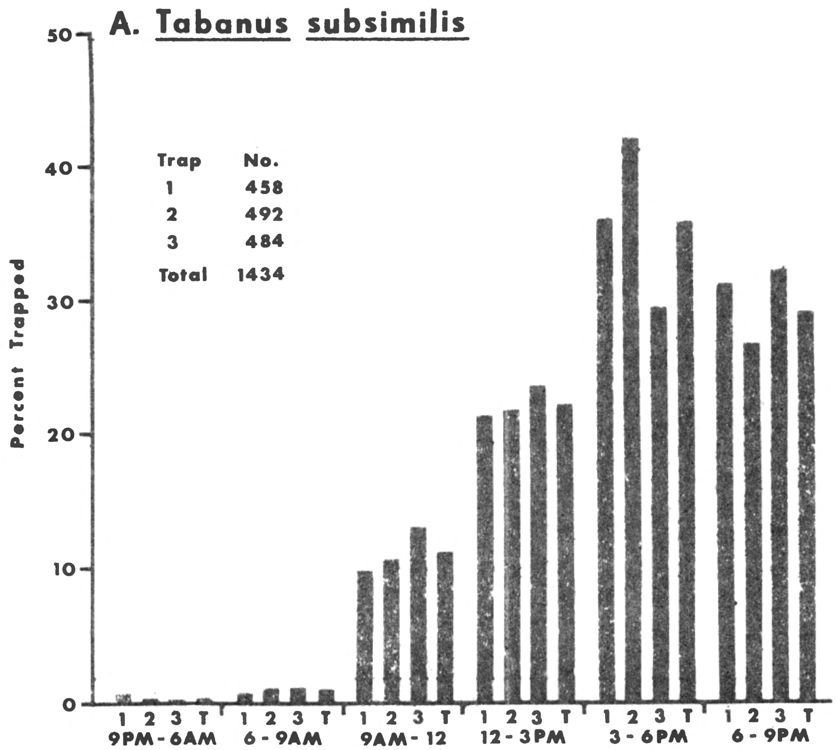
Tabanus sulcifrons

Less than 10% of T. sulcifrons activity was observed before 9 AM. From 9 AM until darkness a nearly constant level of activity was indicated by both the traps and observations on the cow (Fig. 16). There were definite differences in sites as indicated by the numbers collected by the traps, but the levels of activity were nearly identical.

Tabanus trimaculatus

Only 51 specimens of this species were collected. The diurnal activity pattern as shown by trap catches and cow observations exhibited similar cycles, although, the cow observations point out that there were more flies coming to the cow in the morning than the trap data would have indicated. The major portion of the activity by T. trimaculatus occurred between noon and 9 PM (Fig. 17). Comparisons of traps show inconsistancies, which were most likely due to the few specimens collected by the traps.

Fig. 15. Diurnal Activity Cycle of *Tabanus subsimilis*. A Comparison of Percentage of Total Trap Catch by Each of the Three Malaise Traps and Total Trap Catch for Each Period; B. Comparison of Percentages of Flies Trapped and Observed Landings on Cow for Each Period


A. Tabanus subsimilis
Trap No.
1 458
2 492
3 484
Total 1434
Percent Trapped
50
40
30
20
10
0
1 2 3 T
9PM-6AM
6-9AM
9AM-12
12-3PM
3-6PM
6-9PM

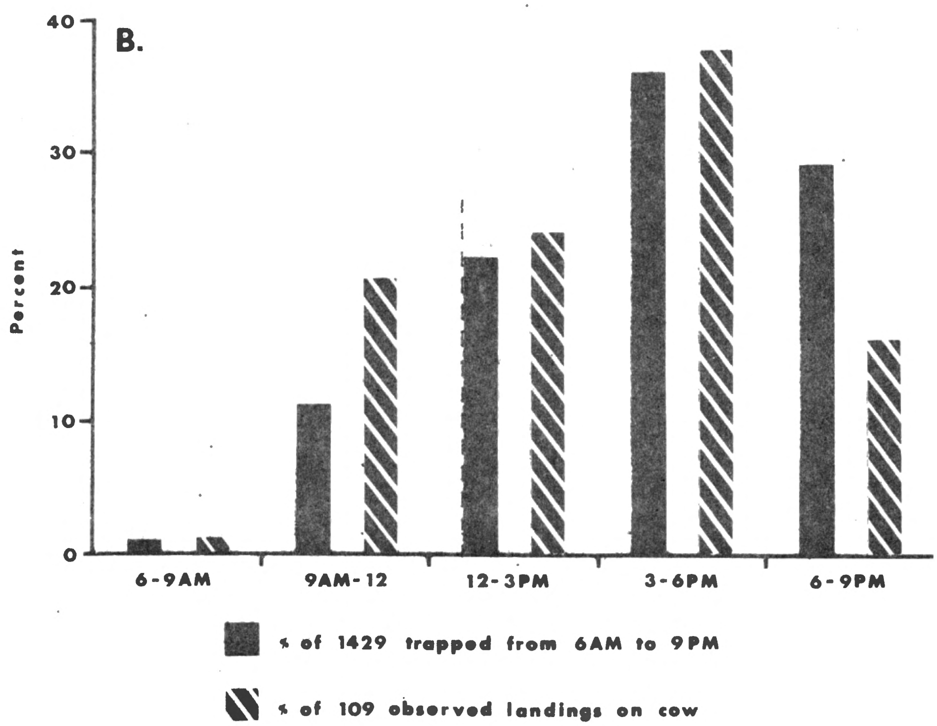
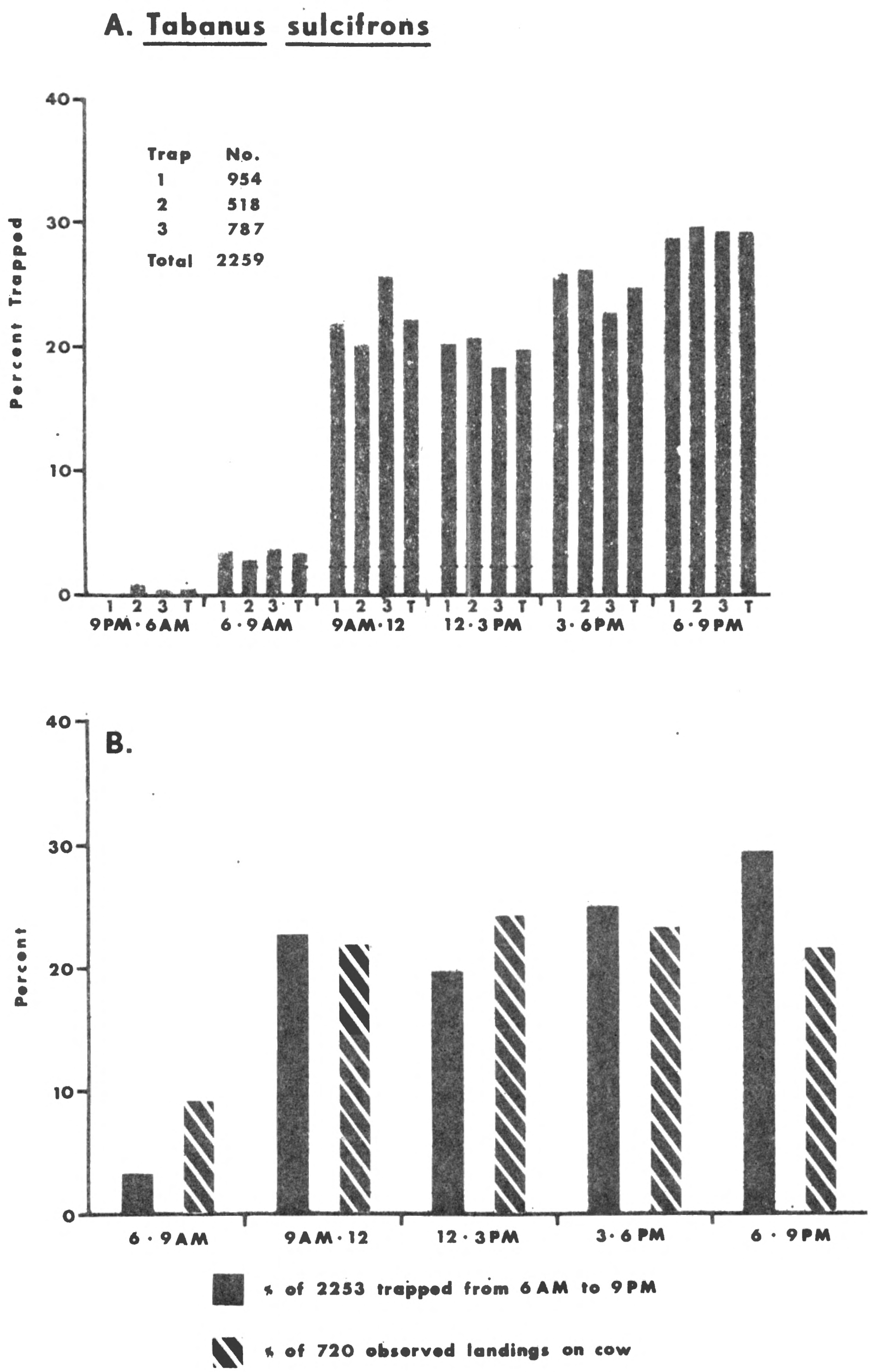
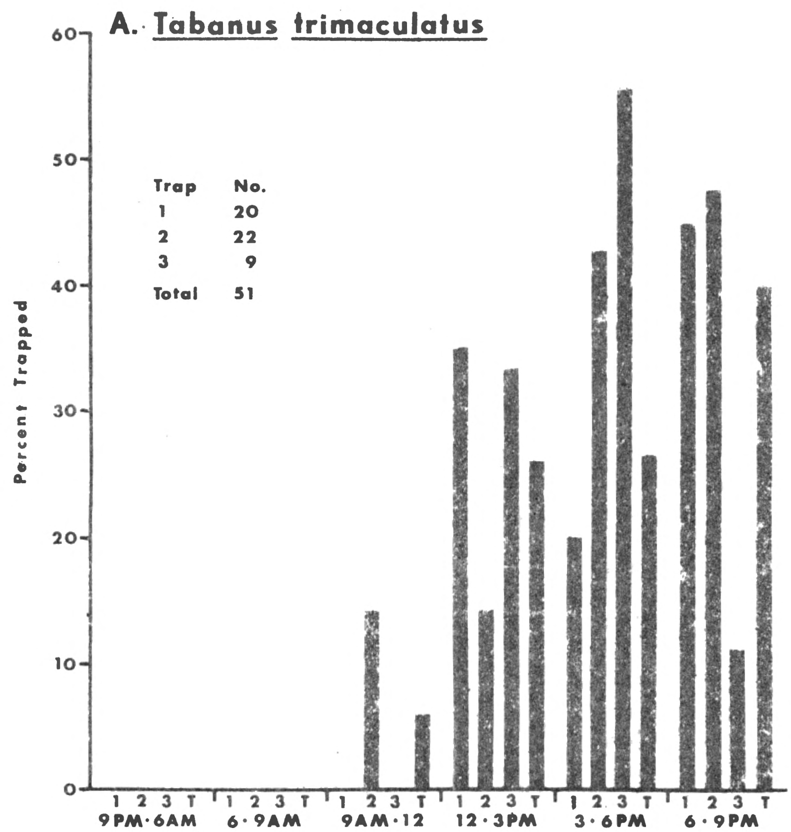

B.
Percent
40
30
20
10
0
6-9AM
9AM-12
12-3PM
3-6PM
6-9PM
% of 1429 trapped from 6AM to 9PM
% of 109 observed landings on cow

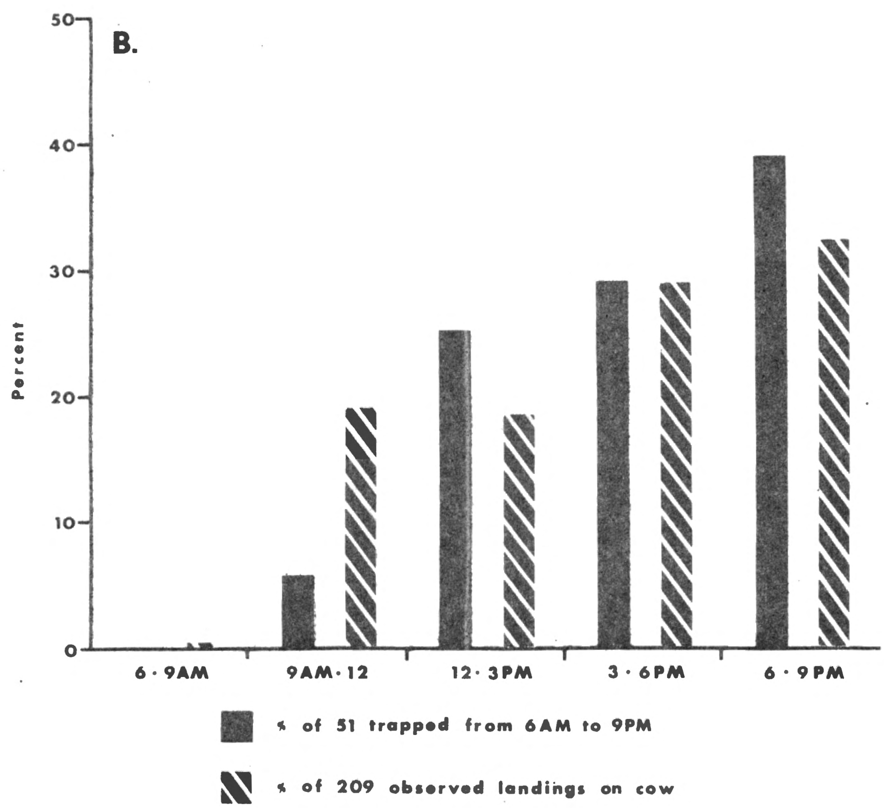
Fig. 16. Diurnal Activity Cycle of *Tabanus sulcifrons*. A. Comparison of Percentage of Total Trap Catch by Each of the Three Malaise Traps and Total Trap Catch for Each Period; B. Comparison of Percentages of Flies Trapped and Observed Landings on Cow for Each Period



A. Tabanus sulcifrons
Trap No.
1 954
2 518
3 787
Total 2259
Percent Trapped
40
30
20
10
0
1 2 3 T
9PM-6AM
6-9AM
9AM-12
12-3PM
3-6PM
6-9PM
B.
Percent
6-9AM
9AM-12
12-3PM
3-6PM
6-9PM
% of 2253 trapped from 6AM to 9PM
% of 720 observed landings on cow

Fig. 17. Diurnal Activity Cycle of <u>Tabanus trimaculatus</u>. A. Comparison of Percentage of Total Trap Catch by Each of the Three Malaise Traps and Total Trap Catch for Each Period; B. Comparison of Percentages of Flies Trapped and Observed Landings on Cow for Each Period


A. Tabanus trimaculatus
Percent Trapped
60
50
40
30
20
10
0
Trap No.
1 20
2 22
3 9
Total 51
1 2 3 T
9PM-6AM
6-9AM
9AM-12
12-3PM
3-6PM
6-9PM


B.
Percent
50
40
30
20
10
0
6-9AM
9AM-12
12-3PM
3-6PM
6-9PM
% of 51 trapped from 6AM to 9PM
% of 209 observed landings on cow

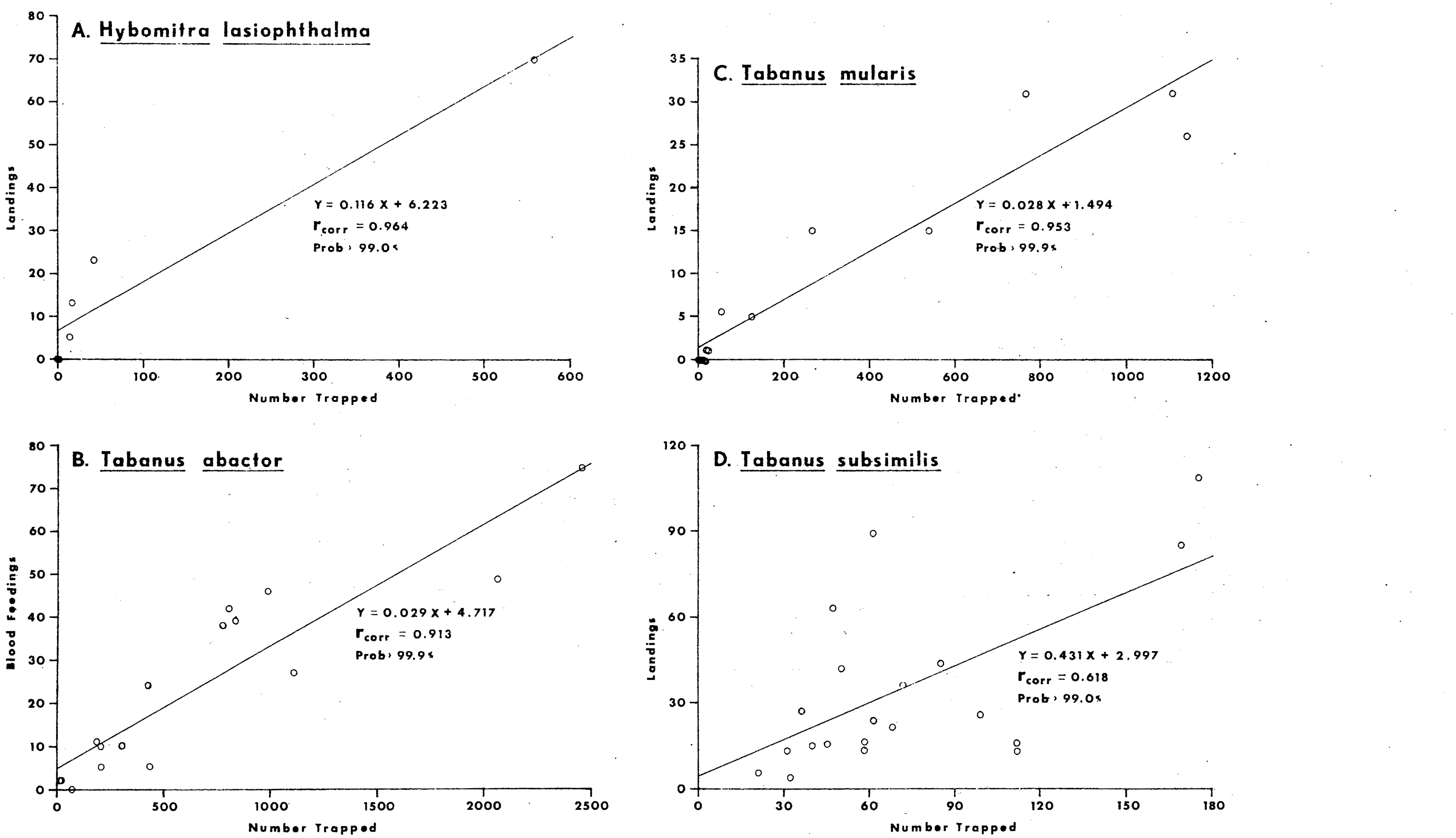
Comparison of Trap and Cow Observations

Determinations of the level of correlation between the number of tabanids collected in Malaise traps and the numbers attacking the cow were made for Hybomitra lasiophthalma, Tabanus abactor, T. equalis, T. mularis, T. subsimilis, T. sulcifrons and T. trimaculatus. These were the only species abundant enough over a sufficient length of time for such correlations to be made. Data used in this section may be found in Table VI, VII and VIII.

In Fig. 18 and 19, the number of tabanids collected in all three Malaise traps on given days were plotted against the number of tabanid landings on the cow, during the same day and the correlation coefficient calculated. The measure of activity on the cow was the number of landings observed for each species except Tabanus abactor. T. abactor was too numerous to count all the landings, so the numbers of completely engorged specimens were used as the indicator of activity. These comparisons showed very high levels of correlations for a relationship between activity on the cow and numbers collected by the trap for seasonal activity. Probabilities were all over 99.0% so the traps were accurately measuring the degree of host seeking activity when each species was present.

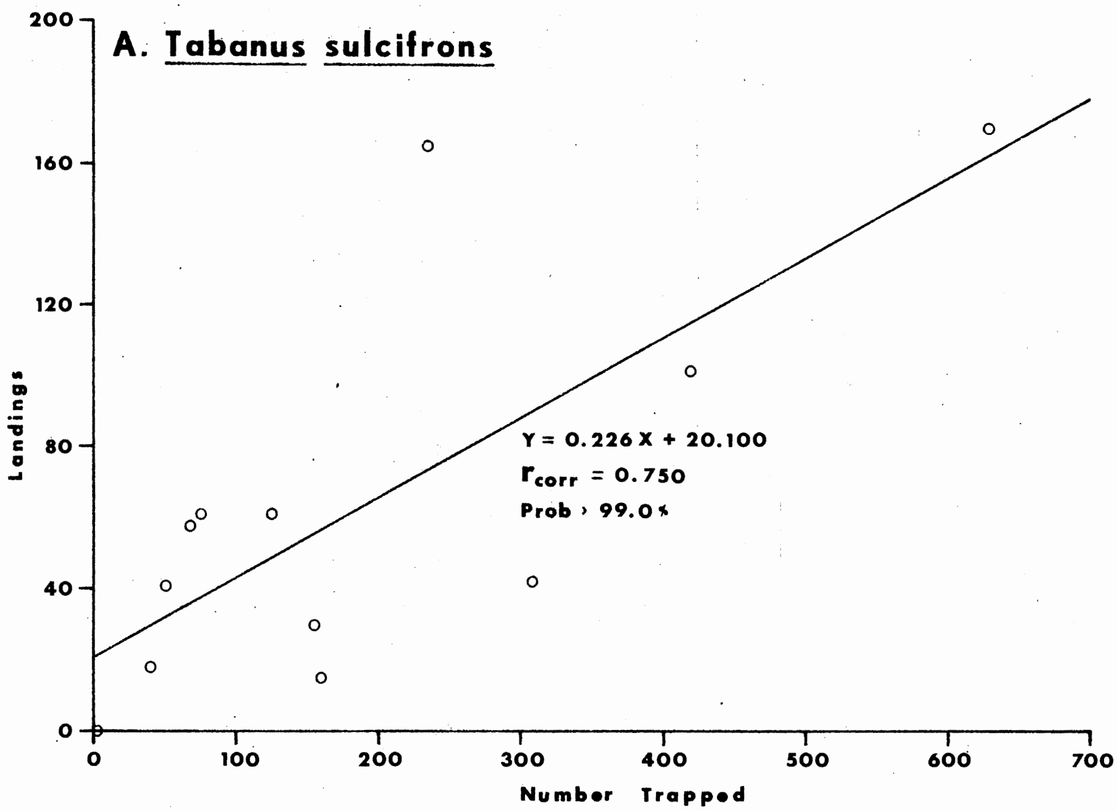
Comparisons of the diurnal host seeking activity of tabanids on the cow were made with the number of tabanids collected in the traps in each of the five, three hour periods for the day in Fig. 20 and 21. Probabilities ranged from 91.1% to over 99.0%. This indicates that the traps were accurately measuring the daily activity cycle of these species.

Fig. 18. Relationships Existing Between the Number of Tabanids Collected in Traps and Activity Observed on the Cow by Days. A. *Hybomitra lasiophthalma*; B. *Tabanus abactor*; C. *Tabanus mularis*; D. *Tabanus subsimilis*



A. Hybomitra lasiophthalma
Y = 0.116 X + 6.223
r_{corr} = 0.964
Prob > 99.0%
Landings
Number Trapped
B. Tabanus abactor
Y = 0.029 X + 4.717
r_{corr} = 0.913
Prob > 99.9%
Blood Feedings
Number Trapped
C. Tabanus mularis
Y = 0.028 X + 1.494
r_{corr} = 0.953
Prob > 99.9%
Landings
Number Trapped
D. Tabanus subsimilis
Y = 0.431 X + 2.997
r_{corr} = 0.618
Prob > 99.0%
Landings
Number Trapped

Fig. 19. Relationships Existing Between the Number of Tabanids Collected in Traps and Activity Observed on the Cow by Days. A. *Tabanus sulcifrons*; B. *Tabanus trimaculatus*


A. Tabanus sulcifrons
Y = 0.226 X + 20.100
r_{corr} = 0.750
Prob › 99.0%
Landings
Number Trapped
0
40
80
120
160
200
0
100
200
300
400
500
600
700

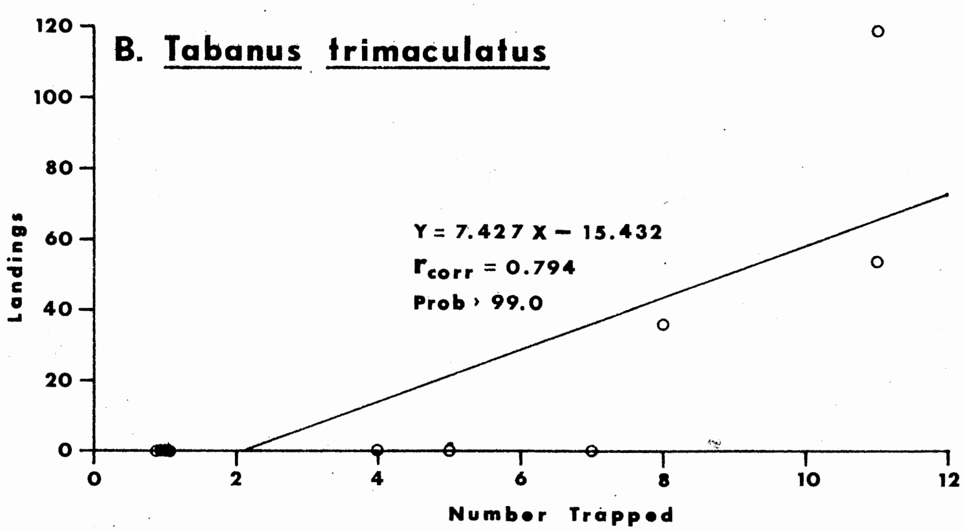

B. Tabanus trimaculatus
Y = 7.427 X − 15.432
r_{corr} = 0.794
Prob › 99.0
Landings
Number Trapped
0
20
40
60
80
100
120
0
2
4
6
8
10
12

Fig. 20. Relationships Existing Between the Number of Tabanids Collected in Traps and Activity Observed on the Cow by Three Hour Periods. A. *Hybomitra lasiophthalma*; B. *Tabanus abactor*; C. *Tabanus equalis*; D. *Tabanus mularis*

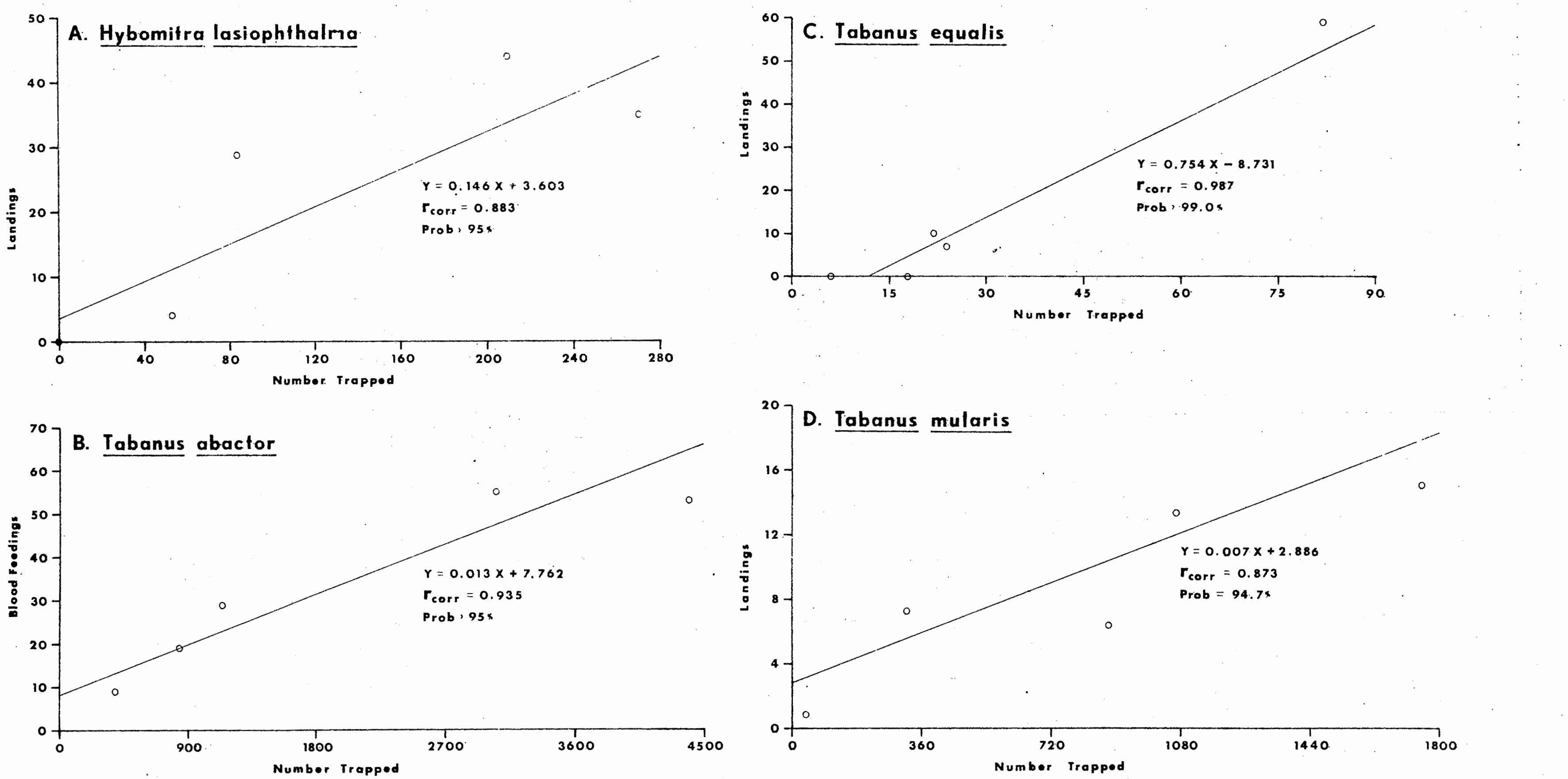
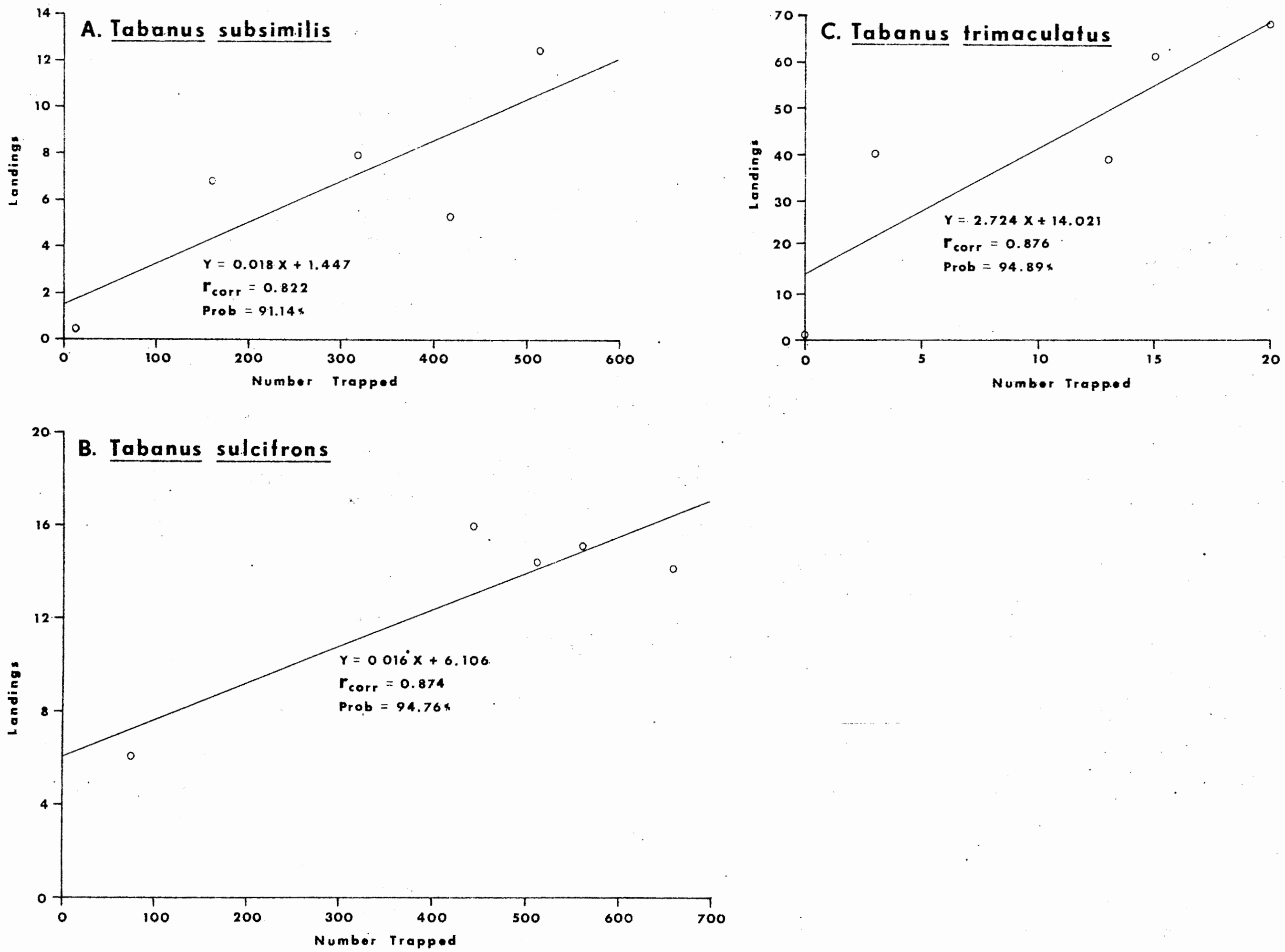

A. Hybomitra lasiophthalma
Landings
Number Trapped
Y = 0.146 X + 3.603
r_{corr} = 0.883
Prob > 95%
B. Tabanus abactor
Blood Feedings
Number Trapped
Y = 0.013 X + 7.762
r_{corr} = 0.935
Prob > 95%
C. Tabanus equalis
Landings
Number Trapped
Y = 0.754 X − 8.731
r_{corr} = 0.987
Prob > 99.0%
D. Tabanus mularis
Landings
Number Trapped
Y = 0.007 X + 2.886
r_{corr} = 0.873
Prob = 94.7%

Fig. 21. Relationships Existing Between the Number of Tabanids Collected in Traps and Activity Observed on the Cow by Three Hour Periods.
A. *Tabanus subsimilis*;
B. *Tabanus sulcifrons*;
C. *Tabanus trimaculatus*


A. Tabanus subsimilis
Y = 0.018 X + 1.447
r_{corr} = 0.822
Prob = 91.14%
Landings
Number Trapped
B. Tabanus sulcifrons
Y = 0.016 X + 6.106
r_{corr} = 0.874
Prob = 94.76%
Landings
Number Trapped
C. Tabanus trimaculatus
Y = 2.724 X + 14.021
r_{corr} = 0.876
Prob = 94.89%
Landings
Number Trapped

Blood Meal Size

The data for blood meal sizes of five species of tabanids and related statistical data may be found in Table IV.

Tabanus abactor

This medium sized species imbibed the largest quantity of blood with respect to its own size, with an average blood meal size 2.17 times its own body weight. The average blood meal size was 156.1 $\pm$ 6.9 mg as calculated from 153 nonblood fed and 145 blood fed individuals. Schomberg and Howell (1955) determined this species took 178.0 mg of blood in an average meal.

Tabanus atratus

T. atratus had an average blood meal size of 694.0 $\pm$ 204.5 mg, based on eight nonblood fed and four blood fed specimens. This was the largest species in the area and had the largest average blood meal size, which was 1.71 times its average body weight.

Tabanus equalis

This species imbibed the smallest quantity of blood with respect to its own size, with an average blood meal size 1.27 times its own body weight. *T. equalis* took 243.8 $\pm$ 59.9 mg of blood in an average meal as was determined from the weights of six nonblood fed and 23 replete flies.

Tabanus mularis

An average blood meal size of 63.2 $\pm$ 6.1 mg was calculated for this small fly, based on 86 nonblood fed and 17 blood fed specimens. *T. mularis* had the smallest average blood meal size of the species examined and was 1.94 times the average body weight of the fly.

TABLE IV

AVERAGE WEIGHTS OF NONBLOOD FED, BLOOD FED AND BLOOD MEAL SIZE FOR FIVE TABANID SPECIES FROM NORTH CENTRAL OKLAHOMA

Species	Nonblood Fed			Blood Fed		
	n	Average Wt. (in mg)	St. Dev.	n	Average Wt. (in mg)	St. Dev.
Tabanus abactor	153	71.9	13.1	145	227.9	41.2
Tabanus atratus	8	406.2	68.9	4	1100.1	244.1
Tabanus equalis	6	191.4	28.3	23	435.2	70.3
Tabanus mularis	86	32.5	7.8	17	95.7	22.3
Tabanus sulcifrons	21	276.0	50.4	28	633.8	110.4

	Blood Meal Size			
	Weight (in mg)	St. Dev. (pooled)	Ratio of Blood Meal Wt.:Average Body Wt.	95% C.I. (in mg)
Tabanus abactor	156.1	3.5	2.17:1	± 6.9
Tabanus atratus	694.0	92.9	1.71:1	±204.5
Tabanus equalis	243.8	29.3	1.27:1	± 59.9
Tabanus mularis	63.2	3.1	1.94:1	± 6.1
Tabanus sulcifrons	357.8	25.9	1.30:1	± 52.1

Tabanus sulcifrons

The mean blood meal size for this species was 357.8 $\pm$ 52.1 mg based on weights from 21 nonblood fed and 28 engorged specimens. *T. sulcifrons* had a relatively small blood meal size with respect to its own weight, with an average blood meal size of 1.30 times its average body weight. This mean blood meal size was very close to the 354.8 mg found for this species in New York (Tashiro and Schwardt 1953).

CHAPTER V

SUMMARY AND CONCLUSION

Eighteen species of Tabanidae were collected at Lake Carl Blackwell, Payne County Oklahoma in 1977 and 1978. Eight species were numerous enough to be serious pests of cattle. A total of 1980 and 19936 specimens were collected during 1977 and 1978 respectively. The great difference in numbers collected in the two years was due to trapping started in June of 1977 and the use of more efficient Malaise traps in 1978.

Hybomitra lasiophthalma was the first species to emerge in the spring and was present from 12 April to 23 May 1978. It was most active during the warmest part of the day, from noon to 6 PM CDT and was the fifth most abundant species collected.

Tabanus abactor was the most abundant species, comprising over 50% of the individuals collected in 1977 and 1978. It was observed from 31 May to 8 September 1978 and was most active from 3 PM to dark. This species had an average blood meal size of 156.1 $\pm$ 6.9 mg as determined from 145 engorged individuals.

Tabanus atratus was active from 16 May to 19 October 1978 with peak daily activity occurring between noon and 6 PM. Four blood fed individuals had an average blood meal size of 694.0 $\pm$ 204.5 mg. This was the seventh most abundant species in the study area during 1978.

Tabanus equalis was crepuscular in nature with its peak activity observed from 8:30 PM to dark. A relatively short seasonal occurrence was noted, from 30 May to 15 July in 1978. The average blood meal size was 243.8 $\pm$ 59.9 mg from 23 replete specimens. T. equalis was the sixth most abundant species listed.

Tabanus mularis was the second most abundant species with 4089 specimens collected in 1978. This species occurred from 30 May to 7 September in 1978, but few were captured after early July. The peak of diurnal activity was observed between noon and 9 PM. An average blood meal size for 17 engorged specimens was 63.2 $\pm$ 6.1 mg.

Tabanus subsimilis was collected from 26 April to 18 October in 1978 and was present for the longest period of time of all the species. This species was active during the day from 9 AM to dark, peaking between 3 and 6 PM. This was the fourth most abundant species in the study area.

Tabanus sulcifrons was the latest species to emerge, being present from 6 July to 18 October 1978. A nearly constant level of activity was observed from 9 AM until 9 PM, comprising over 90% of the observed activity. This was the third most abundant species observed in 1978. Twenty eight blood fed specimens were used to determine the average blood meal taken by T. sulcifrons to be 357.8 $\pm$ 52.1 mg.

Tabanus trimaculatus was the 8th most abundant species, but was extremely persistent in its attempts to gain a blood meal, even though it was seldom successful. This species occurred from 10 May to 15 August 1978, but most were observed before early July. The greatest portion of daily activity of T. trimaculatus occurred between noon and 9 PM.

Both trap catches and general observations indicated that there was no host seeking activity by these tabanid species during total darkness.

Comparisons of trap catches and observations made of host seeking activity by most of these species showed very high levels of correlation. This indicated that the traps were good indirect indicators of host seeking activity for these species of horse flies.

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APPENDIX

TABLE V

NUMBER OF TABANIDS IN TRAPS DURING EACH THREE HOUR PERIOD

Time Period		9 PM - 6 AM			6 AM - 9 AM			9 AM - Noon			Noon - 3 PM		
Trap Number		1	2	3	1	2	3	1	2	3	1	2	3
Hybomitra lasiophthalma	#	--	--	--	--	--	--	21	34	28	74	82	73
	%							11.11	15.53	12.33	39.15	37.44	32.16
Tabanus abactor	#	190	455	403	117	139	152	314	104	408	459	246	434
	%	4.93	16.81	9.31	3.04	5.13	3.51	8.15	3.84	9.42	11.91	9.09	10.03
Tabanus atratus	#	--	--	--	--	--	--	2	1	5	4	4	13
	%							9.09	11.11	16.67	18.18	44.44	43.33
Tabanus equalis	#	79	45	41	10	6	2	2	--	4	18	1	3
	%	47.88	63.38	50.62	6.06	8.45	2.47	1.21		4.94	10.91	1.41	3.70
Tabanus mularis	#	7	21	16	16	5	22	145	46	121	438	202	430
	%	0.44	1.95	1.12	1.01	0.46	1.54	9.17	4.26	8.47	27.69	18.72	30.11
Tabanus subsimilis	#	3	1	1	4	5	6	45	53	64	98	107	114
	%	0.66	0.20	0.21	0.87	1.02	1.24	9.83	10.77	13.22	21.40	21.75	23.55
Tabanus sulcifrons	#	--	4	2	33	14	28	208	104	201	192	104	145
	%		0.77	0.25	3.46	2.70	3.56	21.80	20.08	25.54	20.13	20.66	18.42
Tabanus trimaculatus	#	--	--	--	--	--	--	--	3	--	7	3	3
	%								13.64		35.00	13.64	33.33

TABLE V (Continued)

Time Period		3 PM - 6 PM			6 PM - 9 PM			Trap Totals			Total
Trap Number		1	2	3	1	2	3	1	2	3	
Hybomitra lasiophthalma	#	76	84	110	18	19	16	189	219	227	635
	%	40.21	38.36	48.46	9.52	8.68	7.06	29.76	37.49	35.75	
Tabanus abactor	#	1254	679	1150	1520	1084	1782	3854	2707	4329	10890
	%	32.54	25.08	26.57	39.44	40.04	41.16	35.39	24.86	39.74	
Tabanus atratus	#	16	4	11	--	--	1	22	9	30	61
	%	72.72	44.44	36.67			3.33	36.07	14.75	49.18	
Tabanus equalis	#	15	3	6	41	16	25	165	71	81	317
	%	9.09	4.23	7.41	24.85	22.54	30.86	52.05	22.40	25.55	
Tabanus mularis	#	687	474	576	289	331	263	1582	1079	1428	4089
	%	43.43	43.93	40.34	18.27	30.68	18.42	38.69	26.39	34.92	
Tabanus subsimilis	#	165	207	143	143	119	156	458	492	484	1434
	%	36.03	42.07	29.55	31.22	24.19	32.23	31.94	34.31	33.75	
Tabanus sulcifrons	#	246	136	179	275	153	232	954	518	787	2259
	%	25.79	26.25	22.74	28.83	29.54	29.48	42.23	22.93	34.84	
Tabanus trimaculatus	#	4	6	5	9	10	1	20	22	9	51
	%	20.00	27.27	55.55	45.00	45.45	11.11	39.22	43.14	17.65	

TABLE VI

NUMBER AND PERCENTAGE OF TABANIDS TRAPPED IN 3 HOUR PERIODS FROM 6 AM TO 9 PM CDT BY THREE MALAISE TRAPS

Time Periods		6 - 9 AM	9AM - Noon	Noon - 3 PM	3 - 6 PM	6 - 9 PM	Total
Hybomitra lasiophthalma	#	--	83	229	270	53	635
	%		13.07	36.06	42.52	8.35	
Tabanus abactor	#	408	826	1139	3083	4386	9842
	%	4.15	8.39	11.57	31.32	44.56	
Tabanus atratus	#	--	8	21	31	1	61
	%		13.11	34.43	50.82	1.64	
Tabanus equalis	#	18	6	22	24	82	152
	%	11.84	3.95	14.47	15.79	53.95	
Tabanus mularis	#	43	312	1070	1737	883	4045
	%	1.06	7.71	26.45	42.94	21.83	
Tabanus subsimilis	#	15	162	319	515	418	1429
	%	1.05	11.34	22.32	36.04	29.25	
Tabanus sulcifrons	#	75	513	444	561	660	2253
	%	3.33	22.77	19.71	24.90	29.29	
Tabanus trimaculatus	#	--	3	13	15	20	51
	%		5.88	25.49	29.41	39.22	

TABLE VII

PERCENTAGE OF TABANID ACTIVITY OBSERVED ON COW BY 3 HOUR PERIODS

Time Periods	6 - 9AM	9AM - Noon	Noon - 3 PM	3 - 6 PM	6 - 9PM
Hybomitra lasiophthalma (Landings)	--	25.23	39.64	31.53	3.60
Tabanus abactor (Blood Meals)	5.36	10.44	22.56	36.68	23.41
Tabanus atratus (Landings)	--	32.56	43.60	23.84	--
Tabanus equalis (Landings)	--	--	14.08	9.86	76.06
Tabanus mularis (Landings)	2.11	17.69	31.61	32.41	16.19
Tabanus subsimilis (Landings)	1.22	20.72	24.07	37.87	16.12
Tabanus sulcifrons (Landings)	9.24	21.92	24.27	23.03	21.54
Tabanus trimaculatus (Landings)	0.48	19.14	18.66	29.19	32.54

TABLE VIII

DAILY TOTALS OF TABANIDS TRAPPED AND OBSERVED ON COW IN 1978

Month		April		May					June				July	
Day		19	26	3	10	16	23	31	8	13	20	27	6	11
Hybomitra lasiophthalma	Trap	17	558	-	43	15	2	-	-	-	-	-	-	-
	Cow	13	70	-	23	5	-	-	-	-	-	-	-	-
Tabanus abactor	Trap	-	-	-	-	-	-	15	188	836	1106	2455	2061	801
	Cow	-	-	-	-	-	-	2	11	39	27	76	49	42
Tabanus atratus	Trap	-	-	-	-	1	4	5	3	9	2	1	5	1
	Cow	-	-	-	-	1	12	17	6	7	8	23	7	2
Tabanus mularis	Trap	-	-	-	-	-	-	56	267	1104	1139	764	539	127
	Cow	-	-	-	-	-	-	6	15	32	27	32	15	5
Tabanus subsimilis	Trap	-	31	-	113	72	61	47	61	169	68	40	113	99
	Cow	-	13	-	16	36	89	63	24	85	22	15	13	26
Tabanus sulcifrons	Trap	-	-	-	-	-	-	-	-	-	-	-	39	75
	Cow	-	-	-	-	-	-	-	-	-	-	-	18	61
Tabanus trimaculatus	Trap	-	-	-	1	7	11	11	8	5	4	1	1	1
	Cow	-	-	-	-	-	119	54	36	-	-	-	-	-

TABLE VIII (Continued)

Month		July		August					September		
Day		18	25	1	8	15	22	31	7	14	21
Hybomitra lasiophthalma	Trap	-	-	-	-	-	-	-	-	-	-
	Cow	-	-	-	-	-	-	-	-	-	-
Tabanus abactor	Trap	776	304	206	420	894	437	205	76	20	-
	Cow	38	10	5	24	46	5	10	-	22	-
Tabanus atratus	Trap	3	2	1	5	6	4	3	2	4	-
	Cow	10	3	1	11	15	6	9	16	18	-
Tabanus mularis	Trap	27	3	21	17	11	9	3	2	-	-
	Cow	2	-	2	1	-	-	-	-	-	-
Tabanus subsimilis	Trap	58	21	36	45	50	32	58	85	175	-
	Cow	13	5	27	16	42	4	16	44	109	
Tabanus sulcifrons	Trap	418	308	155	628	234	158	125	68	50	1
	Cow	101	42	30	170	165	15	61	48	41	-
Tabanus trimaculatus	Trap	-	-	-	-	1	-	-	-	-	-
	Cow	-	-	-	-	-	-	-	-	-	-

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