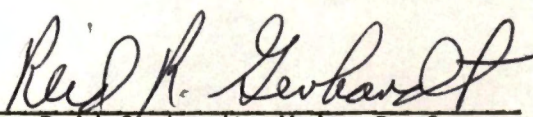
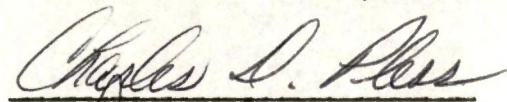
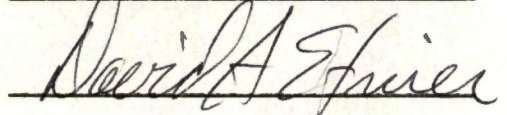


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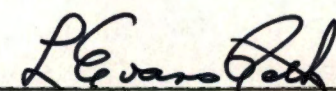
I am submitting herewith a thesis written by Bradley Alan Mullens entitled "Seasonal Abundance and Species Diversity of Tabanidae in Selected Areas of Tennessee and Some Notes on Their Biologies." I recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Agricultural Biology.


Dr. Reid Gerhardt, Major Professor

We have read this thesis
and recommend its acceptance:

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Thesis

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SEASONAL ABUNDANCE AND SPECIES DIVERSITY OF TABANIDAE IN
SELECTED AREAS OF TENNESSEE AND SOME
NOTES ON THEIR BIOLOGIES

A Thesis

Presented for the

Master of Science

Degree

The University of Tennessee, Knoxville

Bradley Alan Mullens

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ABSTRACT

A total of 32,545 tabanids in 71 species, 2 subspecies, and 10 genera were collected and identified during a two-year Tennessee study. Seasonal abundance and species diversity data were compiled in the counties of Fayette, Madison, Cumberland, Knox, Blount, and Monroe. The principal collecting tools were 12 modified Manitoba canopy traps supplemented with collections from sticky panel traps, netting from livestock, and overhead netting. Some tabanid larval sampling was done and notes on the biologies of some species were recorded. Five species and one genus are new Tennessee records.

The most common Tennessee horse flies were found to be Tabanus quinquevittatus Wiedemann, Hybomitra lasiophthalma (Macquart), Tabanus sparus milleri Whitney, Tabanus pallidescens Philip and Tabanus fulvulus Wiedemann. The most common deer flies were Chrysops callidus Osten Sacken, Chrysops niger Macquart, and Chrysops vittatus vittatus Wiedemann. The tabanid fauna was found to vary greatly among study areas. The greatest species diversity was present in most areas in late June and July.

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CHAPTER I

INTRODUCTION

The family Tabanidae, most commonly known as horse flies and deer flies, contains some extremely noxious pests of humans and livestock. They are very widespread and are known from every continent except Antarctica. Because of their painful biting habits, tabanids have received considerable attention through the years, and common names abound. They may be called clegs, greenheads, may flies, gadflies, earflies, and bulldogs, among others.

Studies of Tabanidae in Tennessee are limited. Pechuman (1954) gave the seasonal distribution of 25 species and one subspecies of Tabaninae collected from Morgan County. Snow et al. (1957) published a list of Tabanidae collected in the Tennessee Valley watershed. These were mostly collected with a hand net, and the majority were deer flies (Chrysops spp.). They listed 51 species and seven subspecies. In a 1965 study at the Land Between the Lakes area in northwest Tennessee and southwest Kentucky, Smith, Breeland, and Pickard collected 40 species and one subspecies of Tabanidae (Pickard, personal communication). Goodwin (1966) published an annotated list of Tennessee Tabanidae that listed 81 species and five subspecies. Knowledge of the larval taxonomy of Tennessee tabanids was greatly expanded by Goodwin (1967). Five additional state records were reported by Goodwin (1976).

The present study was initiated in 1977 and continued in 1978 to study in detail the seasonal abundance and species diversity of

Tabanidae in selected areas of the state. Some larval sampling was done and notes on the biologies of some species were taken, particularly relating to those attacking cattle.

CRANES  CREST

CHAPTER II

LITERATURE REVIEW

I. GENERAL BIOLOGY

The general biology of Tabanidae has been dealt with on numerous occasions, and some of the more comprehensive treatments are presented by Jones and Anthony (1964), Teskey (1969), and Axtell (1976).

Eggs of Tabanidae are most often found on emergent vegetation, sticks, and overhanging branches around ponds or moist soil areas in late spring or summer. They are deposited in masses which may contain from 100 to 800 eggs and may have from one to several tiers. They are white when laid (Figure 1), soon darkening to various shades of black or brown (Figure 2).

Larvae usually hatch within several days and move down into the soil. While the Tabanidae are considered aquatic or semi-aquatic as a group, certain species, such as Tabanus sulcifrons Macquart, have been found in dry soil (Schomburg, 1952) and others, such as T. subsimilis subsimilis Bellardi, have been shown to utilize a wide range of soil habitats (Thompson, 1975). Tabanid larvae (Figure 3) are morphologically similar and distinctive. The torpedo-shaped body has rings of pseudopodia on the abdominal segments, a posterior respiratory siphon, and is usually whitish to brownish, sometimes with dark pubescent markings. Tabanine larvae are considered cannibalistic and carnivorous on various soil invertebrates. Larvae of Chrysops have often been



Figure 1. Tabanus atratus
Ovipositing.

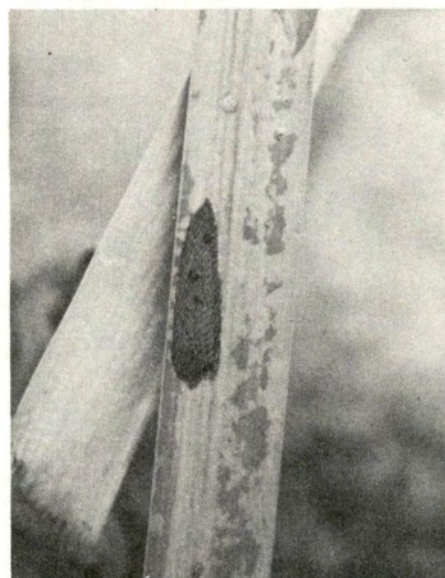


Figure 2. Egg Mass of Chrysops sp.
(Probably C. callidus).



Figure 3. Larva of Tabanus atratus.

referred to as feeding on vegetable material, but, while they apparently are not as cannibalistic as the tabanine species, they have been observed to feed on chironomid and tipulid larvae (Goodwin, 1967 ; Logothetis and Schwardt, 1948).

Tabanid larvae undergo a series of six to ten molts and pass the winter in that stage. They move to a drier substrate the next spring or summer to pupate and emerge as adults some four days to three weeks later, depending on species and temperature. Most species have a one year life cycle, but some, such as I. subsimilis subsimilis, may have two broods during a season (Schwardt, 1931), and others may require as long as two or three years to complete development.

Adult males begin to emerge slightly in advance of the females. Mating apparently takes place on the wing. Males are plant feeders and are less common in collections than females, most of which are blood feeders on mammals and birds. The females of many species require a blood meal for each gonotrophic cycle and may lay several batches of eggs (Wilson, 1967). Studies have shown some species to be autogenous, i. e., capable of laying a batch of eggs without first taking a blood meal, but there is evidence that survival may be enhanced in anautogenous species (Thomas, 1972).

Adult tabanids are powerful fliers and may disperse 1.61 kilometers from their breeding area, though many do not seem to travel that far (Thornhill and Hays, 1972). In mark-and-release studies, Tabanus lineola was captured 6.8 km away (Sheppard and Wilson, 1976). Macreary (1940) noted the collection of tabanids at lighthouses in Delaware Bay up to 13.5 km from shore, although it is possible they were carried there by

passing boats. Most tabanids are diurnal feeders, but some are crepuscular or nocturnal, and many show definite activity periods (Roberts, 1974; Burnett and Hays, 1977). Their activity patterns have been shown to be linked to various meteorological factors, notably barometric pressure and temperature (Alverson and Noblet, 1977; Burnett and Hays, 1974).

II. TAXONOMY

The family Tabanidae (order Diptera, suborder Brachycera) contains approximately 3,800 species in 125 genera worldwide (L. L. Pechuman, personal communication). Philip (1965) lists 292 species in 26 genera in North America north of Mexico. He divides the family into three subfamilies. The subfamilies with known Tennessee genera are as follows:

Pangoniinae - Goniops and Stonemyia;

Chrysopsinae - Chrysops, Mercomyia, Neochrysops and Silvius;

Tabaninae - Atylotus, Chlorotabanus, Diachlorus, Haematopota,
Hamatabanus, Hybomitra, Leucotabanus, Tabanus and
Whitneyomyia.

Adult taxonomy has been well studied. Osten Sacken (1875-8) provided the first detailed treatment of the Tabanidae in North America. Excellent keys are provided by Stone (1938) for the Nearctic Tabaninae and Brennan (1935) for the Pangoniinae. Brennan included Chrysops, Neochrysops, and Silvius, which have since been placed in the Chrysopsinae.

For Tennessee Tabanidae the most useful key is Pechuman's Horse Flies and Deer Flies of Virginia (1973). Another useful source is

Schwardt's Horse Flies of Arkansas (1936). Species found in other southeastern states may be located in Ezell et al., 1974 (South Carolina); Hays, 1968 (Alabama); Fattig, 1949 (Georgia); Jones and Anthony, 1964 (Florida); Brimley, 1908 (North Carolina); Andrews and Wingo, 1975 (Missouri); Tidwell, 1973 (Louisiana); and Townsend, 1955 (Kentucky). No comprehensive taxonomic study of Tennessee Tabanidae is available.

Larval taxonomy has received less attention. One of the best early treatments was given by Marchand (1920). Hennig (1952 In Teskey, 1969) reviewed the literature up to that time. A firm basis for larval taxonomy was established by Teskey (1969). He reviewed the literature, provided biological notes, and described 81 species of Tabanidae, using a uniform format that has served as a model for future workers (Goodwin, 1972).

Traditional taxonomy based on morphological characters is constantly being supplemented by ecological information. The recent application of biochemical techniques such as electrophoresis (Hudson and Teskey, 1977) is proving useful as well.

III. ECONOMIC IMPORTANCE

The vicious biting habits of female tabanids can make them very annoying to both man and animals. People involved in outdoor industries such as logging may lose efficiency when tabanids, especially Chrysops, are prevalent. Other outdoor activities, such as fishing or swimming, may be inhibited. This can cause loss of revenue to resort and recreation industries and may affect property values (Gerhardt et al., 1973).

Cattle and other livestock may suffer severely from heavy attacks of tabanids, and nervous activity may supplant normal grazing. Tashiro and Schwardt (1949) estimated the blood loss from 40 Tabanus sulcifrons feeding on a cow per hour at 115 cc per eight-hour day. Considering the blood that often oozes from the puncture wound after feeding has ceased (Figure 4), they stated that the actual loss was probably considerably greater. Steelman (1976) discussed the need of further studies to determine the economic impact of tabanids on livestock. In 1965, USDA estimates of tabanid losses in the U. S. cattle industry were \$30,000,000 for beef cattle and \$10,000,000 for dairy cows for the period 1951-1960.

Tabanids may also serve as vectors of pathogens, mostly by mechanical transmission of organisms. Several excellent reviews are given by Anthony (1962) and most recently by Krinsky (1977). Axtell (1976) lists Loa loa (a filarial worm transmitted by Chrysops), trypanosomiasis, tularemia (deer fly fever), anaplasmosis, equine infectious anemia, and hog cholera as the major diseases whose causative organisms may be vectored by tabanids.

IV. CONTROL

The prospects for control of tabanids are not particularly good, due to the appreciable number of species usually present in an area, their varying seasonal abundance, the fact that the flies spend little actual time on the host (e. g., cattle), and their relative insusceptibility to insecticides (Brown and Lancaster, 1973).



Figure 4. Late Season Form of Tabanus sulcifrons Feeding on Cow.

Bay et al. (1977) demonstrated the toxicity of pyrethroid sprays to tabanids exposed to treated horses and cattle. Brown and Lancaster (1973) achieved one-to-three-week control on cattle with a residual spray. Axtell (1974) used ULV sprays and mentioned that tabanids were harder to kill than mosquitoes. Two large-scale tests with DDT were done by Gerry (1949) and Brown and Morrison (1955). The earlier test achieved excellent control of salt marsh tabanids, which the later one did not. Pechuman (1972) stressed the possible danger to non-target organisms of large-scale larval and adult tabanid control with chemicals. Larval control, which is especially tricky in a fragile marsh ecosystem, has been attempted by several workers with partial success (Hansens, 1956) or little success (Wall and Marganian, 1973).

Water management in marsh areas has been used by Anderson and Kneen (1969) for the control of tabanids in Connecticut, but such manipulation may not be possible or desirable. On farms with only small ponds and seepage areas, it may be possible to remove most emergent vegetation, leaving only a few available oviposition sites to be destroyed with their loads of eggs (Pechuman, 1972).

Trapping devices are ecologically attractive due to their lack of environmental pollution and are relatively low cost and easy to use (Axtell, 1976). Spencer (1971) discussed the use of box traps for the control of salt marsh greenheads. Wilson (1968) caught over 95,000 tabanids in five days on 20 sticky traps which had been situated around a cattle pasture. These were baited with CO_2 and depressed populations temporarily. Snoddy (1974) used red and black weather balloons coated

with adhesive to catch large numbers of Chrysops on beaches and mentioned their potential for control. Pechuman (1972) stated that canopy traps are used on golf courses and horse stud farms in New York and are considered successful by the users. Morgan and Lee (1977) showed that tabanids would fly around tall vegetative barriers if possible, rather than over them. They suggested a combination of vegetative barriers between humans and tabanid breeding sites and strategically-placed traps for possible control of salt marsh greenheads.

Tabanids have a number of parasites, predators, and pathogens, and a list of these is given in Jenkins (1964). Goodwin (1968) listed several dipteran larval parasites in the families Tachinidae and Bombyliidae, as well as hymenopteran and dipteran pupal parasites. Stone (1953) and Dukes and Hays (1971) discussed wasp parasites of tabanid egg masses. Thompson (1978) discussed parasitism of adult tabanids by a sarcophagid fly. Parman (1928) used egg parasites to help control horsefly numbers in Texas.

Predators of tabanid eggs are discussed in Jackson and Wilson (1965). Johnson and Hays (1973) discussed larval predators, such as shore birds, and Roberts and Wilson (1967) discussed bembicine wasp predation on adult tabanids.

Anthony (1977) gives a discussion of pathogens, mostly fungi, affecting Tabanidae.

V. COLLECTING METHODS

Larvae

Collecting larval Tabanidae is a tedious and time-consuming task, but can provide invaluable ecological information and allow association

of larval, pupal and adult forms. Anthony (1957) treated marsh surface areas with pyrethrins and lindane, which irritated the larvae and caused them to surface, but he noted the poor larval retrieval and high mortality involved. Soil drying racks, which induce tabanid larvae to crawl from the substrate into a tray below, have been used with some success (Jones and Anthony, 1964), as have Burlese funnels. Soil washing racks, in which soil is washed through a series of screens and the remaining material searched for larvae, are very effective in high-mineral soils but not in soils of high organic content (Edwards et al., 1974). One of the best methods for some species is to search through the habitat (streamside leaves, etc.) by hand. Larvae obtained by any of these methods may be saved for individual rearing. They may be reared on glass beads or agar (Roberts, 1966), but Teskey (1969) states that survival may be enhanced if the larvae are kept in a portion of their original substrate.

Adults

Jones and Anthony (1964) stated that one of the simplest methods of determining presence and abundance was by netting from a host. Thompson (1969) wrote that overhead netting was particularly effective in collecting anthropophilic Chrysops. Sweeping vegetation and flowers with a hand net can yield good specimens of both sexes (Pechuman, 1972). Net collections from a host can yield abundance and ecological data if done systematically (Thompson and Pechuman, 1970; Wilson, 1963).

Emergence traps such as those used by Macreary (1940) may provide both good adult specimens and larval habitat information.

A surface coated with adhesive can be very effective. Roth and Lindquist (1948) trapped thousands of ovipositing Chrysops discalis on long, adhesive-coated boards placed along a lake edge and mentioned their potential for survey and control. Dale and Axtell (1976) used sticky traps as a measure of horizontal distribution and abundance of Tabanidae in a salt marsh. Tabanids recovered from sticky traps can be difficult to retrieve and identify, requiring a solvent to remove the adhesive (Roberts, 1978).

A type of trap intended to be carried atop a truck or boat was designed by Steelman et al. (1968). The collapsible trap, made of fiberglass screen, is the shape of a pyramid and is carried base-forward. Tabanids may be swept into the moving trap and into a collecting bag at the apex.

Easton et al. (1968) devised an animal-baited trap that consisted of a lard can covered with black muslin. It was suspended four to six feet above the ground, had a one-way cone entrance at each end, and had a transparent collecting device on top. They used live rabbits, rats, squirrels, and guinea pigs as bait inside the can, but were unable to capture tabanids. Roberts (1965) used a modification of the Magoon trap (Magoon, 1935), and this steer-baited trap proved effective for collecting host-seeking tabanids.

Food baits such as molasses and beef liver were used by Jones and Anthony (1964) with limited success. The liver attracted large numbers of Diachlorus females, and the molasses attracted low numbers of both sexes of three Tabanus species. Frost (1936) collected tabanids with various baits, including soap and syrup.

Light traps may be used to collect males and females of some species. Frost (1953) collected 17 species at a light trap in Pennsylvania, and Anthony (1960) collected 23 species in an ultraviolet light trap in Florida.

Malaise (1937) published plans for a novel insect trap that has been widely used and modified. An insect is intercepted in flight by a net curtain or baffle, whereupon it flies upward into a collecting device or trap area. The most commonly used traps are based on Townes' design (1962). Numerous workers have shown this type of trap to be very effective for many species of Tabanidae (Roberts, 1976; Burnett and Hays, 1977; Drees, 1977), and the trap may take males as well as females.

The Manning trap or boxtrap (Hansens et al., 1971) appears to be related to the animal silhouette trap of Morris and Morris (1949), which was used for tsetse flies and tabanids in Africa. The Manning trap consists of a rectangular box set on four legs, possibly to imitate an animal. Within the trap an inverted "V" of screen opens on the bottom and narrows to an entrance slit that prevents escape. It is effective in collecting the females of a number of species, but is a poor collector of Chrysops (Roberts, 1978).

The Manitoba trap (Thorsteinson et al., 1965) is a widely used and modified design that dates from Thorsteinson's original heliothermal trap (Thorsteinson, 1958). It basically consists of a clear plastic cone with a no-return collecting device fixed at the apex about two meters above the ground. The bottom of the cone, or canopy, is about 0.6 to 1.0 meters above the ground. The canopy is suspended by metal or

wooden legs or by a center pole with guy ropes. A visually attractive object, such as a black sphere, is suspended near the bottom of the canopy. Tabanids attracted to the object fly under the canopy and then upward by positive phototaxis into the collecting head.

Bracken et al. (1962) discussed the role of color in the attraction of tabanids. Black, red, and blue were especially attractive, while green and yellow were not. Tashiro and Schwardt (1953) and Wilson (1963) observed that dark colored cattle were more severely attacked by tabanids than light colored cattle. A black "skirt" around the base of a Manitoba canopy trap is an effective modification (Catts, 1970). Hansens et al. (1971) showed that a pattern of a white square on a black sticky panel caught more tabanids than black alone. Barrass (1960) found a black cloth screen was progressively less attractive to Haematopota as white stripes on it were widened.

Reflectance of a trap is also important and should be greater or less than the background reflectance to attract the most tabanids (Bracken et al., 1962). The angle of a Manitoba trap canopy may help to reflect light into tabanid flight lanes (Thorsteinson et al., 1966). Thorsteinson et al. (1966) showed that the shape of a decoy was related to attractiveness. A glossy sphere was an excellent decoy and the attractiveness of a polyhedron increased with the number of faces.

Roberts (1976) collected most tabanids at a height of .9-1.5 meters above the ground, and Bracken (1960) stated that a height of three to four feet was best for general tabanid collecting. Hansens et al. (1971) showed a canopy height of 20 inches was effective with Manitoba traps.

Decoy motion was shown by Bracken (1960) to enhance visual attractiveness to tabanids, and he stated that thermal factors, such as heat emanating from a dark object in the sun, probably came into play as tabanids flew closer. Wilson (1963) observed that moving cattle were more attractive to tabanids, and Jones and Anthony (1964) noted that tabanids are attracted to slow-moving vehicles. Mazokhin-Porshnyakov and Burakova (1976) showed that a moving trap could be three times as effective as a stationary one. Thorsteinson (1958) found female tabanids were strongly attracted to his heliothermal trap, but Bracken and Thorsteinson (1965) subsequently showed that heat was not a major factor in target attraction.

The use of carbon dioxide as an attractant can greatly increase trap catches (Pechuman, 1972; Knox and Hays, 1972; Anderson et al., 1974). Roberts (1975) used CO₂ in Malaise traps to increase the catch by a factor of 3.5 over unbaited traps. Dry ice may be used both as an attractant and as a method of field storage (Defoliart and Morris, 1967). Knox and Hays (1972) tested 42 chemicals for attractiveness to tabanids, but only CO₂ significantly increased catches overall.

Roberts (1976) compared the efficiency of six types of tabanid traps and concluded that the Stoneville malaise trap with CO₂ was best, followed by a modified Manitoba canopy trap with CO₂. Hansens et al., (1971) showed that a box trap was superior to a Manitoba canopy trap for the collection of the salt marsh greenhead, Tabanus nigrovittatus. Axtell et al. (1975) stated that the box trap was superior for collecting I. nigrovittatus and a related species, I. quinquevittatus, but that the

Manitoba canopy trap was superior in attracting large numbers of a greater variety of species.

VI. SEASONAL ABUNDANCE STUDIES

Seasonal abundance of Tabanidae has been an interesting subject of study due to the large number of species and their sequential appearance in many areas. Pechuman (1954) reported the only solid seasonal abundance data in the state to date, but some data may be gathered from Snow et al. (1957) and Smith, Pickard, and Breeland's 1964-5 study at Land Between the Lakes.

Most seasonal abundance studies are done by making periodic collections from traps or host animals. Some of the earliest notes on seasonal abundance were given by Brimley (1908) from Raleigh, North Carolina. Stone (1930) gave some of the first graphic data on seasonal tabanid activity. Burnett and Hays (1977) presented some excellent seasonal data on Alabama Tabanidae and gave some observations on diurnal activity. Their most prevalent species were Tabanus fulvulus and T. pallidescens, and peak tabanid abundance and species diversity occurred in mid-late June. Wilson (1963) showed that peak populations of Louisiana tabanids occurred from mid-June to mid-July, with a minor peak in mid-September in some areas. Other Southeast U. S. studies include Jones and Anthony (1964), Hoffman (1963), Sheppard (1972), and Lawrence et al. (1976). Several good New York studies include Pechuman (1969) and Matthysse et al. (1974).

CHAPTER III

MATERIALS AND METHODS

I. ADULTS

Seasonal abundance and species diversity data were based on adult female tabanids captured primarily with modified Manitoba canopy traps. The traps were set up before the beginning of the fly season in selected areas across Tennessee. Collections were made at weekly intervals until the end of the season. Adults were recovered from the traps, relaxed, and identified in the lab with the aid of a 10-40X Nikon binocular microscope and Pechuman's Horse Flies and Deer Flies of Virginia (1973). Troublesome specimens and representative specimens of all species were sent to Dr. L. L. Pechuman, Cornell University, for positive identification. Trap operation dates were from March to September during 1977 and from April to October during 1978.

The Manitoba canopy trap design was based on that used by Pechuman (1972) in New York with some modifications. The finished trap (Figure 5) stood approximately 2 m tall, with the base of the canopy measuring 1.54 m across on a side. The canopy was constructed of 4 mil plastic and was approximately 1.23 m tall. The upper half of the canopy was clear plastic; the bottom half was black plastic. The two pieces were sealed by making a 7.5 centimeter overlap on the black plastic, taping both sides of the seam with duct tape, and carefully ironing the seam through a layer of newspaper to obtain a heat seal.



Figure 5. Modified Manitoba Trap at Ball Play (Monroe County).

Some difficulties were encountered near the end of the first season as the clear plastic deteriorated with prolonged exposure to sunlight. This problem was solved the second season by rebuilding all traps with clear ultra-violet-resistant greenhouse plastic. The black plastic did not deteriorate either year. Special greenhouse tape was used the second season but also deteriorated in sunlight and had to be replaced with duct tape.

The top of the canopy was attached to a 26 cm x 26 cm plywood platform. This platform was mounted with a metal wall bracket atop a 5 cm x 5 cm x 2.1 m wooden center pole. All wooden parts were painted with dark green exterior paint. The plywood had a 10 cm hole cut out in the center to allow the flies to fly upward by positive phototaxis into a removable clear plastic collecting head. The lid of this container was equipped with a one-way, mesh-metal, screen cone which prevented their escape. Each collecting head contained a piece of DDVP-impregnated plastic, which killed the flies for up to two months. Since collections were occasionally water-damaged during very wet weeks the first season, the collecting heads were covered with clear plastic bags the second season.

Inflatable plastic beach balls were suspended below the canopy as visually attractive decoys and were coated with glossy, black spray paint. The balls used the first season were comparatively heavy and about 40 cm in diameter. Lighter beach balls about 33 cm in diameter were used the second season and were mobile in even a light breeze. Each trap had a single ball which hung by a chord from the platform and cleared the ground by about 30 cm. The entire ball was thus visible below the canopy.

The canopy was originally designed to allow a 60 cm ground clearance when erected with four guy ropes. The canopy was raised in all but the trap at Ames Plantation to approximately 77 cm in mid-June of the first season, and the 77 cm height was used in all traps through the second season.

Regular trap collections were supplemented occasionally during both seasons with a portable Manitoba trap baited with dry ice. Sticky panel traps (Figure 6) similar to those used by Dale and Axtell (1976) were used in the study areas at Grasslands and Rafter the second season. These were coated with slow-drying Tack Trap[®] (Animal Repellents, Inc., P. O. Box 999, Griffin, Ga. 30224), checked weekly, and were cleaned and recoated with small trowels as needed. Specimens obtained from these were identified on-the-spot when possible, but were often in poor condition. Some were brought back to the lab and cleaned with xylene before identification. A 2-way Malaise trap (Figure 7) similar to that used by Drees (1977) was constructed the second season. It was easily portable and could be used with or without CO₂ as bait. It employed the same type of decoy as was used in the Manitoba traps, and stood approximately 2 m tall by 2.5 m long. Tabanids encountering the trap curtain flew upward into the "eaves" of the trap, where they could be easily collected by hand. Other collecting methods included netting from cattle, horses, people and vegetation, vehicle collections, and several light trap collections. Chrysops were periodically sampled by slowly walking through good habitat areas (creek bottoms and pond edges) and netting the females that attacked the collector overhead. The author noted approximate



Figure 6. Sticky Panel Trap.



Figure 7. Modified Two-way Malaise Trap.

maximum numbers of some deer flies over a period of 15 minutes of overhead netting when and where a species was most common, and these numbers and locations follow the species name in the species discussions.

II. LARVAE

Limited larval studies were carried on during the late winter and early spring of both seasons. Samples of soil approximately 30 cm x 30 cm x 10 cm deep were taken from pond and creek edges, low-lying pasture, and similar habitats, in 1977. Most of these samples were taken on the Grasslands Farm, Cumberland County, and brought back to Knoxville in individually-numbered plastic bags. They were usually placed in an outdoor storage shed and washed the next day with an apparatus and procedure similar to that used by Edwards et al. (1974) (Figure 8). Tabanid larvae thus exposed were picked up from the screen. Remaining heavy organic material was placed in a Burlese funnel to drive out any additional larvae into small jars, where they were recovered later. Most tabanid larvae were taken to the lab, killed in hot water, and placed in vials with insect preservative for future identification. Detailed collecting information was recorded for all specimens.

In 1978 only "unusual" habitats were searched in an attempt to locate the unknown larvae of Hybomitra difficilis, a prominent cattle pest in upland areas. Terrestrial habitats on wooded hillsides were searched to a depth of 5-10 cm with a small hand-held rake. An extensive aquatic survey of area creeks was made with a 16-mesh screen sieve supported on two poles. The screen could be positioned downstream by one person while

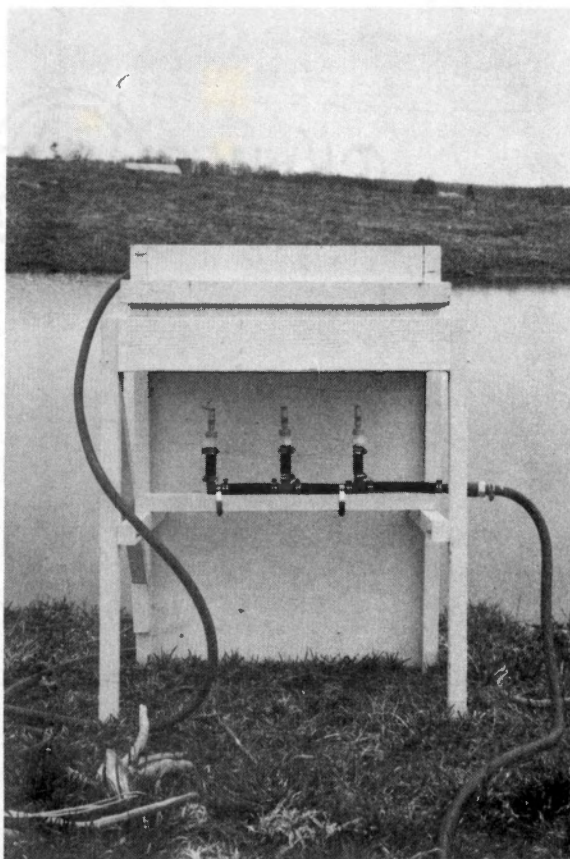


Figure 8. Washing Rack for Extraction of Tabanid Larvae from Soil.

another person moved upstream, dislodging rocks and vegetation. Stream invertebrates were washed onto the screen by the current.

III. STUDY AREAS

Traps were operated in six Tennessee counties: Blount, Cumberland, Fayette, Knox, Madison, and Monroe (Figure 9). Descriptions of these study areas are given below.

Grasslands Farm (Cumberland County)

Grasslands Farm, part of The University of Tennessee Plateau Experiment Station, is located on the Cumberland Plateau, an upland area with an average elevation of approximately 615 m. Extending north to south through the state, the Plateau is characterized by steep rolling hills and receives about 137 cm of precipitation per year. The upland forests are dominated by oaks (Quercus spp., especially Q. alba L.), pines (Pinus spp., especially P. virginiana Miller and P. echinata Miller), hickories (Carya spp.) and other hardwoods. Ravines, coves, and gorges are vegetated on some sites by oak forests and on other sites with more moisture by mixed mesophytic forests dominated by beech (Fagus grandifolia Ehrhart), sugar maple (Acer saccharum Marshall), basswoods (Tilia spp.), yellow-poplar (Liriodendron tulipifera L.) and others. Very damp areas have considerable blackgum (Nyssa sylvatica Marshall), red maple (Acer rubrum L.) and alder (Alnus spp.). Dogwood (Cornus florida L.) is a common understory tree throughout the state. Steep sandstone gorge slopes are often covered by a shrub layer dominated by mountain laurel (Kalmia latifolia L.), and rhododendron (Rhododendron maximum L.).

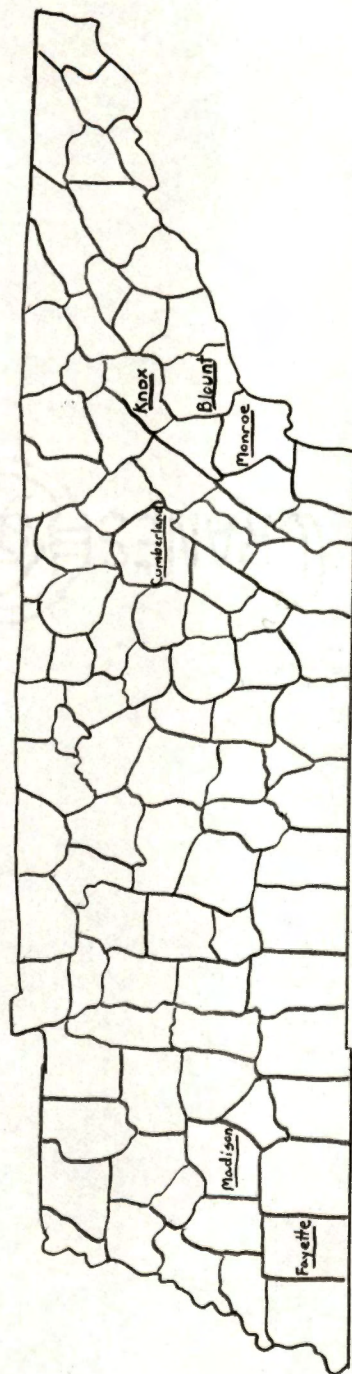


Figure 9. Map of Tennessee Showing Study Areas.

Grasslands Farm itself consists of approximately 600 hectares, half of which is in pasture, and is used primarily for beef cattle studies. Four Manitoba traps (Figure 10) were ultimately placed in the open near ponds. Several streams and numerous farm ponds are located on the property. During the early part of the 1977 fly season, traps 2 and 3 were placed in woods near a field edge. On 16 June 1977 they were moved slightly to nearby pond edges and the canopy height was raised.

Traps 1 and 4 were not moved but were raised at the same time. Trap operation dates during 1977 were from 18 March to 16 September (traps 1 and 3) or 29 September (traps 2 and 4). During 1978 all traps were operated from 11 April until 10 October. All Manitoba traps were at least 800 m apart. Eleven sticky panel traps were monitored here from early April until late September.

Ames Plantation (Fayette County) and Jackson (Madison County)

These two West Tennessee areas are in the Mississippian Plateau of the Western Mesophytic Forest Region. Vegetation is predominantly oak (Quercus spp.), hickory (Carya spp.), and some pine (Pinus spp.), with a dogwood (Cornus florida) understory. The herbaceous layer is less diverse with less cover and the shrub layer is less developed than in East Tennessee. At Ames Plantation, a University of Tennessee research farm of about 7,500 hectares, the topography is quite flat, with much of the land under cotton, corn and soybean cultivation. Several slow, muddy rivers are in the area and there are numerous farm ponds and periodic streams. Situated near the Tennessee-Mississippi border, Ames

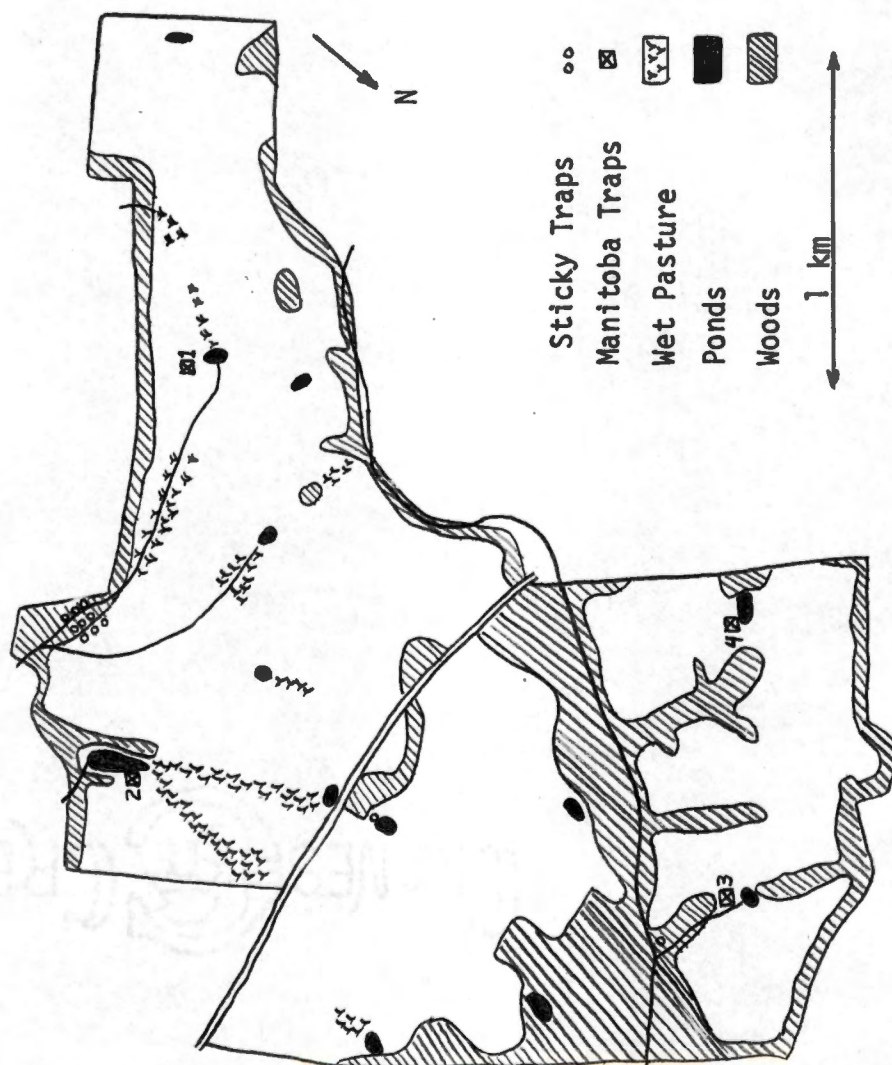


Figure 10. Map of Grasslands Farm (Cumberland County) Showing Trap Locations.

Plantation is at the transition area of the Plateau and Coastal Plains vegetative types, with more of the Coastal Plain oak-pine influence. One trap was operated in an open shaded area near a farm pond in 1977 and was moved to an open but still partially shaded area in 1978. The 1978 location was not adjacent to a pond, but was within 100 m of a periodic stream. Trap operation dates were from 8 May to 23 September 1977 and from 20 April to 17 October 1978.

One trap was operated about seven miles north of Jackson (Madison County) from 13 April to 12 October 1978. This area is similar to Ames Plantation except with slightly more rolling terrain. The trap was placed in a small field area near a barn with woods and a pond nearby.

Ball Play (Monroe County)

Ball Play is an agrarian community situated in the Tellico River Valley at the base of the Tellico Mountains. The terrain is rolling, with considerable pastureland and cropland in the valley areas, and numerous farm ponds and feeder creeks may be found. Elevation is approximately 260 m.

Yellow-poplar (Liriodendron tulipifera), white oak (Quercus alba), hickories (Carya spp.), several pines (Pinus spp.) and numerous other tree taxa vegetate this mixed forest region. A trap was placed in a small open area near the Tellico River on 13 April 1977, but was moved to a nearby cornfield edge in mid-June. This location was about 60 m from the river but was much more visible, and the canopy height was raised slightly at this time. From 22 August to 20 September 1977, the

trap was in poor condition due to deterioration of the clear plastic canopy. In 1978 the trap was again moved slightly to the edge of a small feeder creek about 30 m from the river, where it was operated from 13 April to 12 October. None of these sites were over 100 m apart.

Rafter (Monroe County)

Rafter, an area in the Tellico Mountains of the Blue Ridge Mountain Chain, has an elevation of approximately 460 m. It was the second Monroe County study site and was approximately 10 km from Ball Play. Rafter is typified by densely forested mountainsides with ubiquitous small creeks, springs, and drainages. The small valley areas are used for subsistence farming and pastureland. Vegetation consists of yellow-poplar (Liriodendron tulipifera), hemlock (Tsuga canadensis (L.)), beech (Fagus grandifolia), oaks (Quercus alba and Q. ruba), black locust (Robinia pseudo-acacia L.) and numerous other overstory trees, with the understory dominated by dogwood (Cornus florida) and thickets of Rhodendron maximum, mountain laurel (Kalmia latifolia) and dog hobble (Leucothoe spp.).

A single trap (Rafter 1) was operated during the 1977 season in a long, narrow five hectare field containing several cows. Originally erected near a woods edge, the trap was moved beside a small feeder creek in early June due to poor trap collections. Several of these creeks flow through the pasture area into a small trout stream at one end of the field. Several springs containing watercress (Nasturtium officinale R. Brown) and accompanying marshy areas with sweetflag (Acorus calamus L.) and cattail (Typha latifolia L.) are also found. During 1977 the trap was operated from 7 April to 20 September.

During the 1978 season it was decided to investigate the area further. One trap (Rafter 1) was operated on the same site from 13 April to 12 October 1978, when all area traps were dismantled. On 7 June another Manitoba trap (Rafter 3) was placed on a steep wooded hillside 30 m west of Rafter 1 and 15 m from the woods edge. Three sticky panel traps were erected about 50 m south of Rafter 1 and were monitored from early May until early September. They were not visible from Rafter 1, being separated from it by a rise. An additional Manitoba trap (Rafter 2) was placed in a different Rafter location. A larger valley with approximately 20 ha of cleared land is located almost 600 m southwest of the original study site but is separated from it by a steep wooded ridge. This ridge reaches approximately 25-30 m above the valley floor. The trap was placed in the open near a barn and a small, wooded trout stream on 27 April 1978.

Johnson Bible College (Knox County)

This Tennessee Valley location has an altitude of about 275 m and is a rich oak forest area with valley areas in cultivation. Numerous farm ponds are situated in close proximity in the rolling terrain, and the Manitoba trap was placed at the edge of one of these ponds. Some of the bottomland areas have small areas of mixed mesophytic forest.

Nearby pastureland is used for grazing cattle and horses. Operating dates were from 5 May to 12 October 1978.

Tremont (Blount County)

A Manitoba trap was erected in the Tremont area of the Great Smoky Mountains National Park on the grounds of Maryville College

Environmental Education Center. It stood in a small, open, grassy area between two sewage settling ponds and about 20 m from a trout stream. The vegetation and topography of this area are quite similar to that at Rafter (Monroe County). The trap was erected on 8 June and taken down on 16 August 1977.

A number of other Blount County collections were made in 1978 in nearby areas (Cades Cove and Townsend) and are reported here for Blount County.

CHAPTER IV

RESULTS AND DISCUSSION

I. SUMMARY

The modified Manitoba canopy trap proved to be an excellent tool for the capture of female tabanids, both in terms of species diversity and total numbers. Since male tabanids are not blood seekers, they were rarely captured. If one assumes that the trap is equally attractive to host-seeking females of the same species throughout that species' flight season, it can provide very good seasonal abundance data for a given species in a given area. It is probably quite useful in comparing that species' abundance in different areas.

Tabanid collections from Manitoba traps coincided well with observations of individual species on host animals with respect to their relative abundance. It appears, however, that the modified Manitoba canopy trap may have inherent bias in its attractiveness to different species (Mullens and Gerhardt, unpublished data). This presents some problems in representing the relative prevalence of various species as a percentage of the total catch for that location and year.

In this thesis, the relative abundance of species primarily reflects Manitoba trap collections, supplemented by other methods when possible. Some notes are provided when the abundance of a species in the Manitoba trap collections does not agree with its abundance as noted by host

observation and malaise trap collections (e. g., Tabanus calens).

Generally speaking, Chrysops spp. were poorly represented in the Manitoba traps.

Since many species of Chrysops are attracted to humans, most data on their seasonal abundance are based on overhead netting. A better representation of the Chrysops fauna is thus given in the data from Cumberland County and Monroe County (Rafter), where most overhead netting was done. Overhead collections were made often, but no attempt was made to quantitatively sample the Chrysops via regular collections for uniform time periods in each area through the season. Because more netting was done at some times than others, discussions of total numbers of each species taken may be somewhat misleading for comparative population discussions. Approximate maximum numbers/15 minute period of overhead collecting are given for some species.

The number of tabanid species present in Tennessee (based on Goodwin's 1966 list and supplemented by records generously loaned by Dr. L. L. Pechuman and five new state records reported here) is 100 species in 15 genera. In the course of this study, 71 species and 2 forms presently classified as subspecies in 10 genera were taken. A list of these, with notations on those species taken from cattle, is as follows (+ indicates feeding on cattle; * indicates state record):

Atylotus Osten Sacken
 *ohioensis (Hine)
 species near thoracicus (Hine)

Chlorotabanus Lutz
 +crepuscularis (Bequaert)

Chrysops Meigen

- brimleyi Hine
- +callidus Osten Sacken
- *calvus Pechuman and Teskey
- carbonarius Walker
- celatus Pechuman
- cincticornis Walker
- cuclux Whitney
- +cursim Whitney
- flavidus Wiedemann
- fulvistigma Hine
- +geminatus Wiedemann
- +impunctus Krober
- macquarti Philip
- moechus Osten Sacken
- montanus Osten Sacken
- niger Macquart
- pikei Whitney
- pudicus Osten Sacken
- reicherti Fairchild
- +separatus Hine
- univittatus Macquart
- *upsilon Philip
- +vittatus vittatus Wiedemann

Hamatabanus Philip

- +carolinensis (Macquart)

Hybomitra Enderlein

- +cincta (Fabricius)
- +difficilis (Wiedemann)
- +lasiophthalma (Macquart)
- +sodalis (Williston)
- +trispila (Wiedemann)
- *typhus (Whitney)

Leucotabanus Lutz

- +annulatus (Say)

Stonemyia Brennan

- isabellina (Wiedemann)

Tabanus Linnaeus

- aar Philip
- +abdominalis Fabricius
- +americanus Forster
- +aranti Hays
- +atratus atratus Fabricius
- +calens Linnaeus
- cymatophorus Osten Sacken
- exilipalpis Stone
- fairchildi Stone

Tabanus Linnaeus (continued)

+fulvulus Wiedemann
 +lineola Fabricius
 +longus Osten Sacken
 marginalis Fabricius
 +melanocerus Wiedemann
 +moderator Stone
 +molestus molestus Say
 +molestus mixis Philip
 mularis Stone
 +nigrescens Palisot de Beauvois
 +nigripes Wiedemann
 +pallidescens Philip
 +petiolatus Hine
 +proximus Walker
 +pumilus Macquart
 +quinquevittatus Wiedemann
 +reinwardtii Wiedemann
 +sackeni Fairchild
 sagax Osten Sacken
 +similis Macquart
 +sparus milleri Whitney
 stygius Say
 +sublongus Stone
 +subsimilis subsimilis Bellardi
 +sulcifrons Macquart
 +superjumentarius Whitney
 +trimaculatus Palisot de Beauvois
 +turbidus Wiedemann

Whitneyomyia Bequaert

*beatifica atricorpus Philip

Statewide, the most abundant horse flies were Tabanus quinquevittatus Wiedemann, Hybomitra lasiophthalma Macquart, T. sparus milleri Whitney, T. pallidescens Philip and T. fulvulus Wiedemann. The most abundant deer flies were Chrysops callidus Osten Sacken, C. niger Macquart, C. vittatus vittatus Wiedemann, C. macquarti Philip, and C. geminatus Wiedemann. The composition of the tabanid fauna varies greatly among the study areas, however, and they are best examined individually.

In most areas, from three to six species of Tabanidae made up over 75% of the trap catches, with numerous additional species present

in smaller numbers. Maximum tabanid flight activity and species diversity occurred in late June and early July. For purposes of this discussion, months were arbitrarily divided into three 10-day sections--"early," "middle," and "late." Early-season peaks due to H. lasiophthalma and H. difficilis (late-May) were evident in hilly areas, and some late-season peak activity was noted for such species as T. sulcifrons and T. sackeni with some second brood activity for C. callidus, T. lineola, and T. subsimilis. Most species had well-defined periods of peak activity and flight periods of six to ten weeks, but a few were almost aseasonal, as was T. subsimilis subsimilis (except for a late season peak in Cumberland County in 1978).

In 1977 the total number of tabanids taken was 5,723. In 1978 an additional 26,822 were taken, for a two-season total of 32,545 specimens. The huge increase in 1978 is partially due to 3,995 individuals captured with sticky panel traps. The additional Manitoba traps at Johnson Bible College (Knox Co.), Jackson (Madison County), and Rafter 2 (Monroe County) added some specimens. Early-season species such as Hybomitra lasiophthalma were better represented in 1978 collections due to improved trap location and slightly higher trap height, and some very late-season specimens may have been lost due to trap deterioration during the first season. A lighter, more mobile decoy ball was used in the traps (except West Tennessee) in 1978 and may have enhanced trap attractiveness. Even when all these factors are considered, it seems likely that tabanids were simply more abundant the second season.

The seasonal abundance of the various species was quite similar for both years. It is interesting to note, however, that a number of species reached peak population numbers from one to three weeks later in 1978 than in 1977. Since the larvae of most Tabanidae are found in mud and moist soil conditions, a probable explanation for the delayed emergence could be considerably lower soil temperatures in the spring of 1978 (Table 1). Soil temperatures were an average of 5.9°F cooler in May of 1978, when many species were completing development.

TABLE 1. $\bar{x}$ Soil Temperature (F° at 4" depth) at University of Tennessee Agricultural Experiment Stations

	March		April		May		June	
	1977	1978	1977	1978	1977	1978	1977	1978
Ames Plantation (Fayette County)	54.9	48.1	65.6	66.1	77.7	71.9	83.9	84.1
Jackson (Madison County)	51.4	45.6	63.2	62.8	76.3	68.5	81.9	80.5
Crossville (Cumberland County)	51.9	46.4	60.9	60.2	70.6	66.6	78.0	77.0
Knoxville (Knox County)	47.4	43.6	59.7	57.8	69.6	63.5	76.3	76.4

Source: National Oceanic and Space Administration, 1978. Climatological data. Tennessee, Vol. 83, Numbers 3-6. Environmental Data and Information Service, National Climatic Center, Asheville, N. C.

In the following discussions figures used in describing the relative abundance of a species are mostly from 1978 data because better

collections were made of early- and late-season specimens. Discussions of "pest species" have some degree of subjectivity by nature. In this report pest species among Tabanus and Hybomitra are those that caused visible discomfort to livestock due to numbers of females attempting to feed. Fewer of the large species were required to constitute "pest levels." Pest species among the Chrysops are those that were present in large numbers and were of annoyance to man (or sometimes livestock). Some basic discussion of tabanid species is given in the area faunal discussions. For more detailed discussions of individual species, the reader is directed to that section. Seasonal abundance of the Tabanus sulcifrons complex, which was present in large numbers in most areas, is discussed under that species. All trap data are available in the Appendix.

II. AREA TABANID FAUNAL DESCRIPTIONS

Grasslands Farm (Cumberland County)

A total of 44 species in eight genera were taken here with four Manitoba traps and 11 sticky panel traps. The five major species, which comprised 91% of trap catches in 1978, are given in Figure 11. A list of species collected and their approximate seasonal abundance is given in Figure 12.

Deer flies were not observed frequently on cattle here, but several were a nuisance for humans at times. The major deer fly species were Chrysops brimleyi and C. niger (early season), C. callidus and C. macquarti (early-mid season) and C. vittatus vittatus (mid-late season).

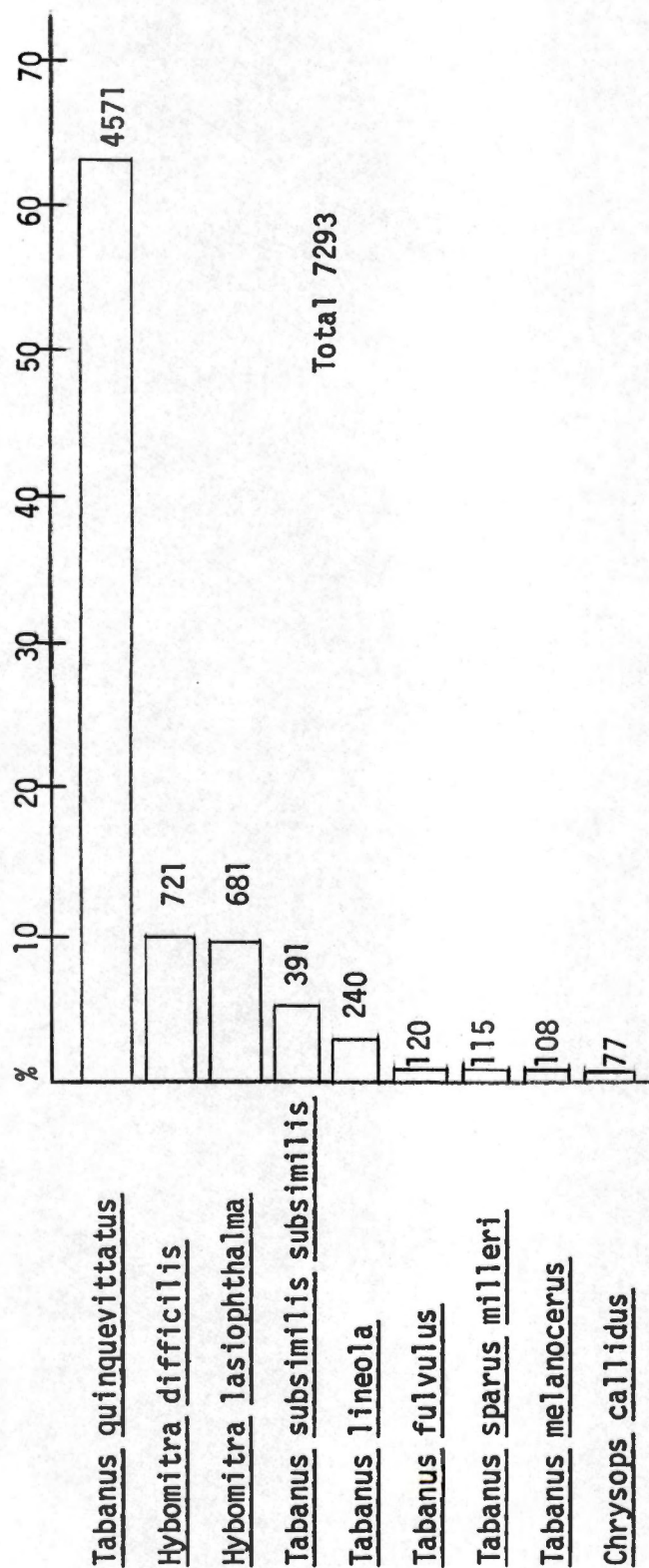


Figure 11. 1978 Trap Composition, Grasslands Farm, Cumberland Co.

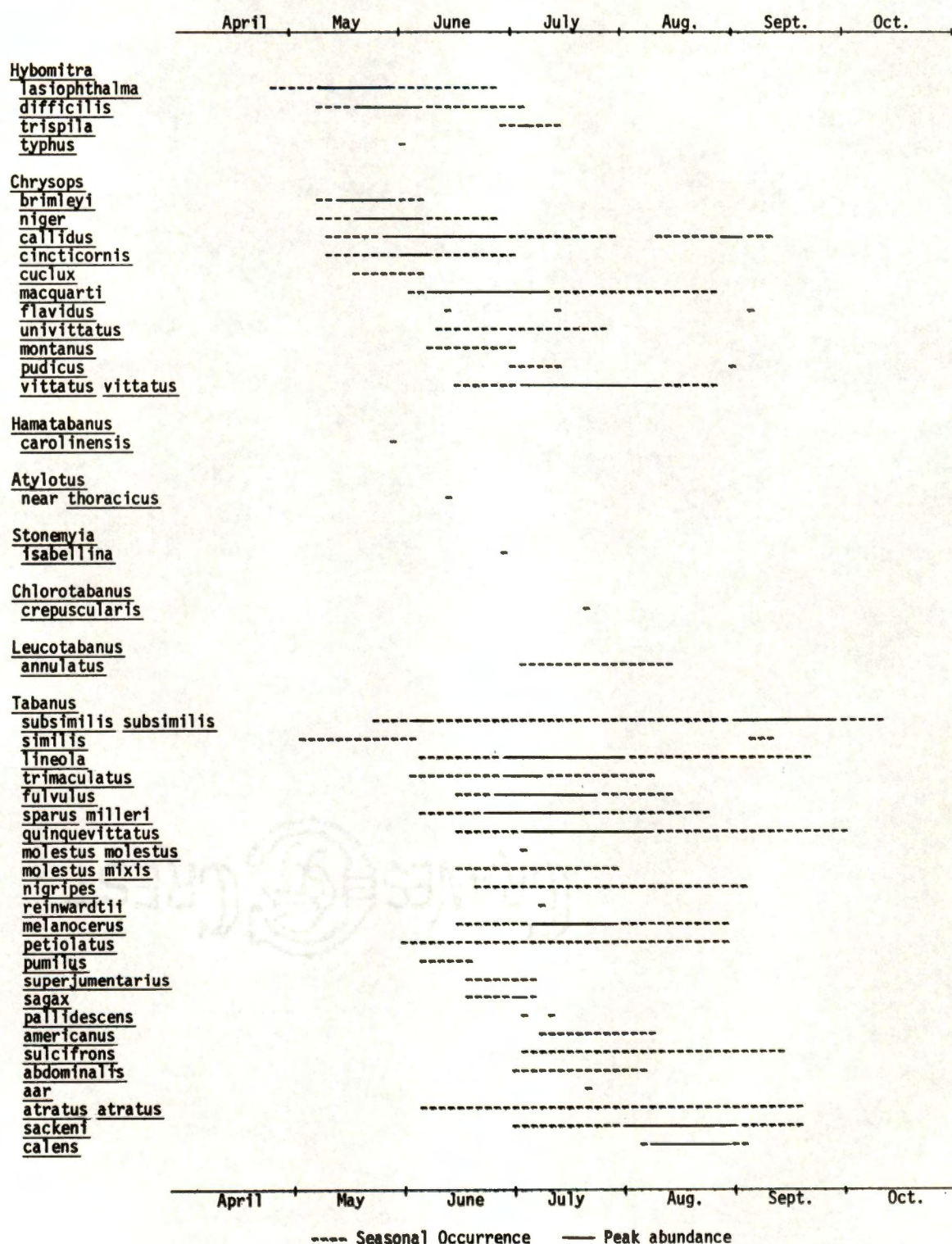


Figure 12. Species Collected and Approximate Seasonal Abundance of Tabanidae at Grasslands Farm, Cumberland County.

C. callidus apparently had a partial second brood in 1978, as did Tabanus subsimilis subsimilis and T. lineola, both horse fly pests of cattle.

This is one study location where the trap data may be particularly misleading. Although Tabanus quinquevittatus made up the bulk of the trap collections, it was a problem only in certain low pasture areas. Of four traps in operation, one trap (#2) was in such an area and took 88% (4009 specimens) of the total T. quinquevittatus catch in 1978. The two Hybomitra species, lasiophthalma and particularly difficilis, flew together in early season and were by far the most annoying tabanid cattle pests. A large late-season cattle pest, Tabanus calens, was observed frequently on the cattle but was very poorly represented in the traps. Seasonal abundance data for some tabanids are presented in Figure 13. On the week preceding 7 July 1977, cattle knocked down trap #3, which captured many T. lineola through the season. This helps to account for the sudden depression in trap catches.

Ames Plantation (Fayette County)

A total of 27 species in four genera were taken at Ames during the study. There were radical changes in species composition between the two years which were probably due to the change in trap location. Since direct observations or other collection methods are unavailable, it is difficult to say which data present the truer picture, although the 1977 data was more uniform. Trap composition is presented in Figure 14.

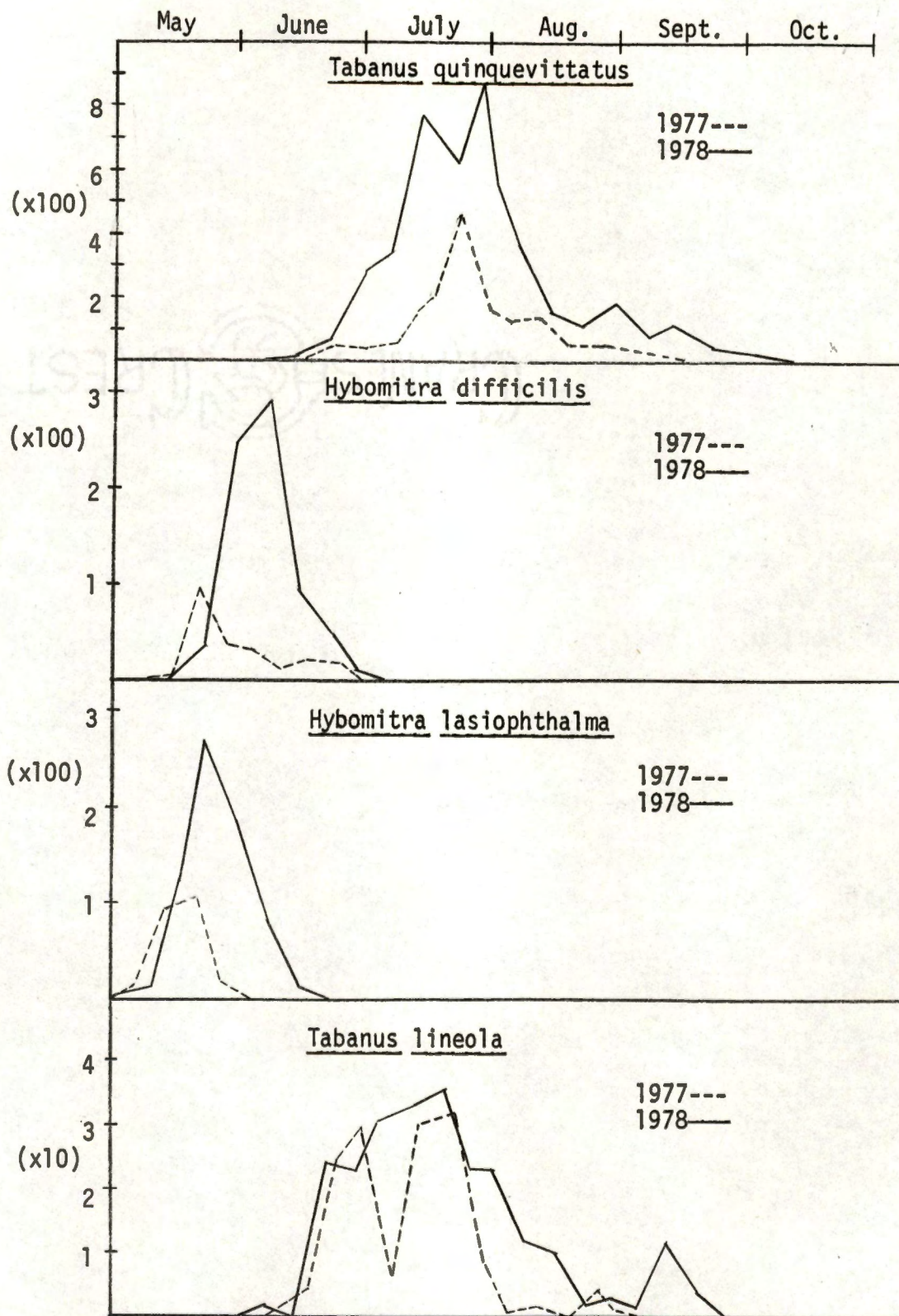


Figure 13. Seasonal Abundance of Some Cumberland Co. Tabanidae

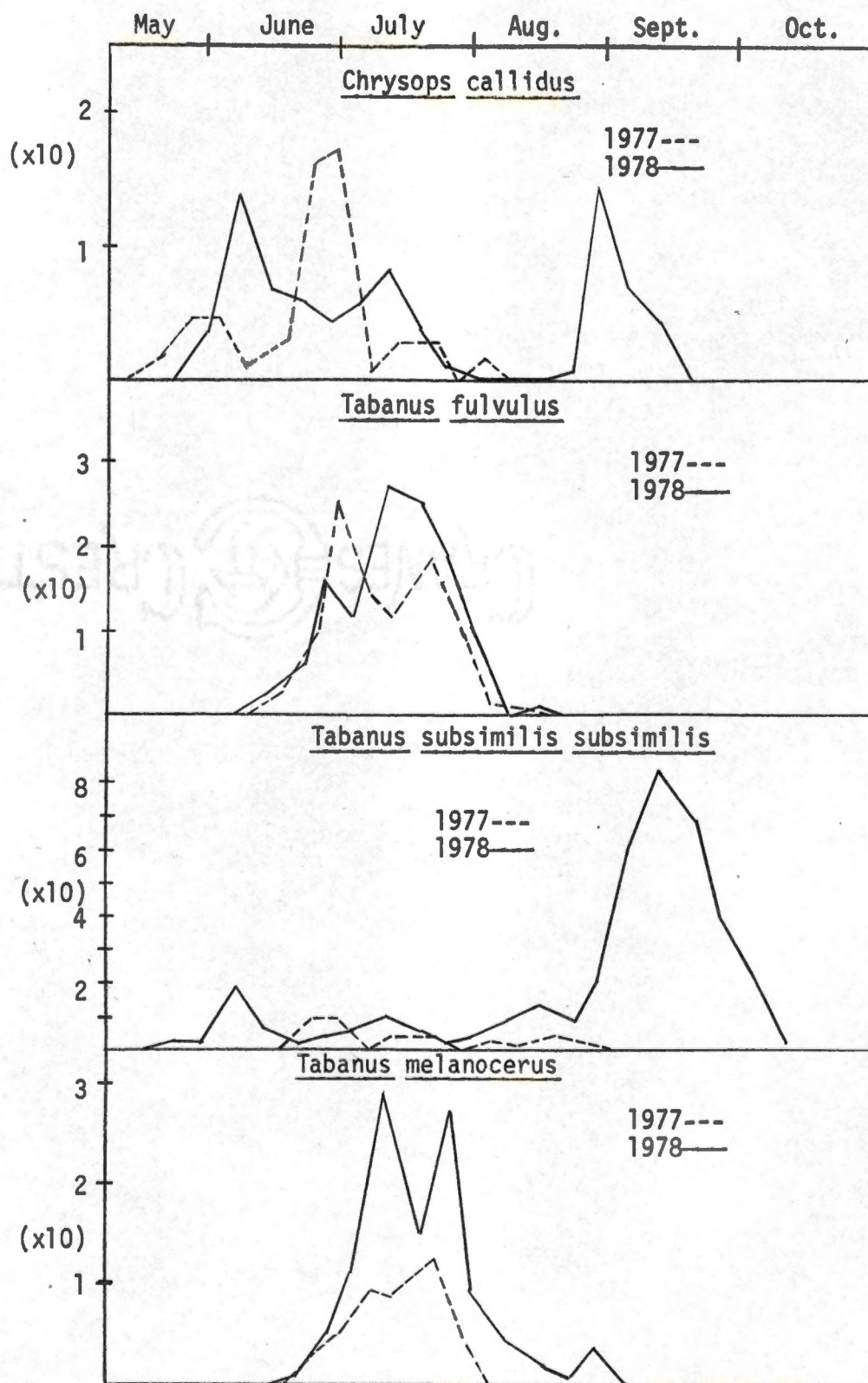


Figure 13. (Continued).

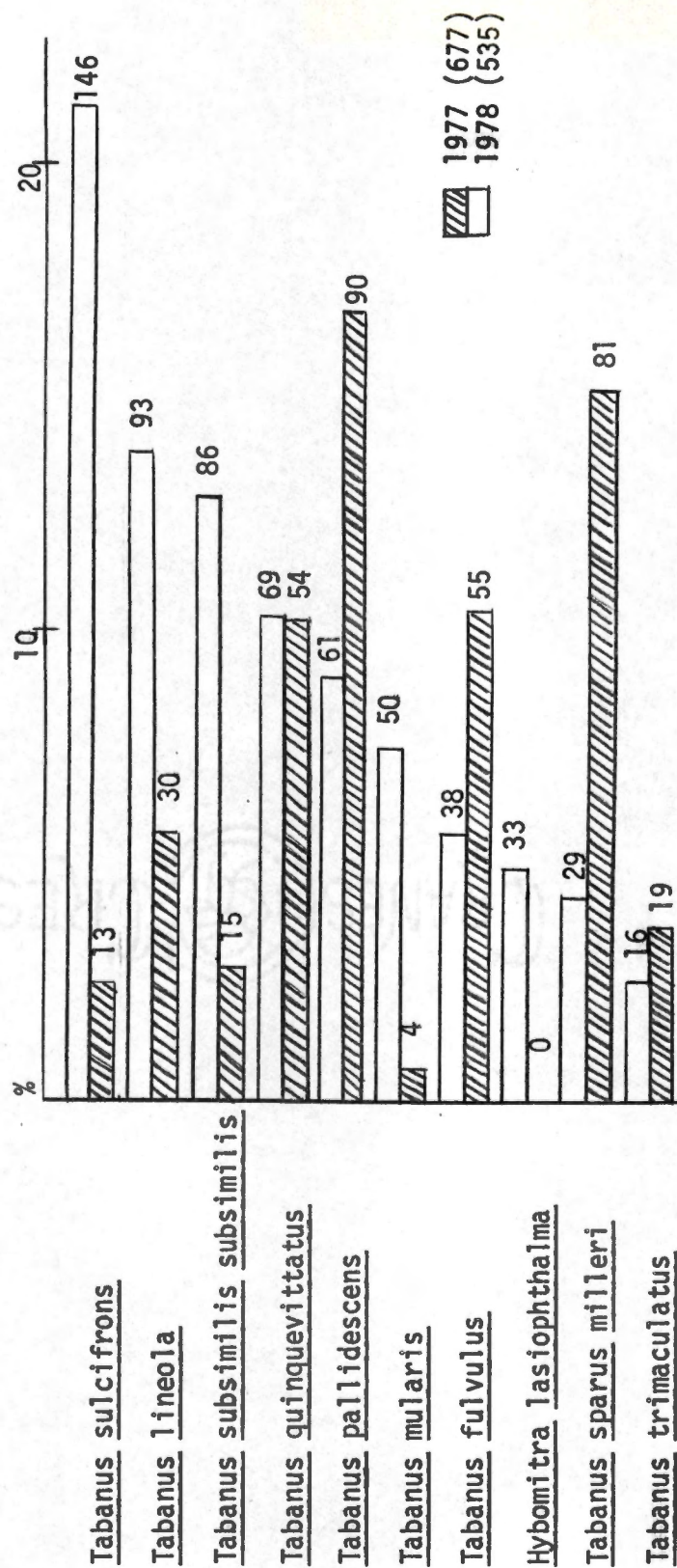


Figure 14. Trap Composition, Ames Plantation, Fayette Co.

Considerable differences in tabanid faunal composition between West Tennessee and East Tennessee were observed. Tabanus mularis, T. cymatophorus, and Chrysops reicherti are among those species that are present in West Tennessee and lacking or very uncommon in East Tennessee. The East Tennessee tabanid fauna is more diverse, probably reflecting the more diverse habitat available. Among the numerous species present in East Tennessee, those most obviously lacking in West Tennessee include Hybomitra difficilis, H. cincta, H. sodalis, and Tabanus longus. One might expect a somewhat earlier emergence and longer flight period in the warmer West Tennessee regions. Actually, most West Tennessee tabanid species appeared to have comparable seasonal abundance times, with a few, such as T. sackeni and T. sulcifrons, flying later than in East Tennessee.

During the period 23 June to 13 July 1978, only one trap collection was made (13 July). Since this period is critical to an examination of the seasonal abundance of some species, the following graphs (Figure 15) are marked accordingly for 1978, and the point represented is a three week accumulation rather than a regular one week collection. The week preceding 18 July 1978 was quite wet, but this does not fully explain the total lack of tabanids in the trap.

Jackson (Madison County)

This trap was operated only during the 1978 season, and was quite interesting in several respects. Two major species at Ames Plantation (which is south of Jackson but still in West Tennessee), Tabanus pallidescens and T. fulvulus, were less common here. Also, T. petiolatus

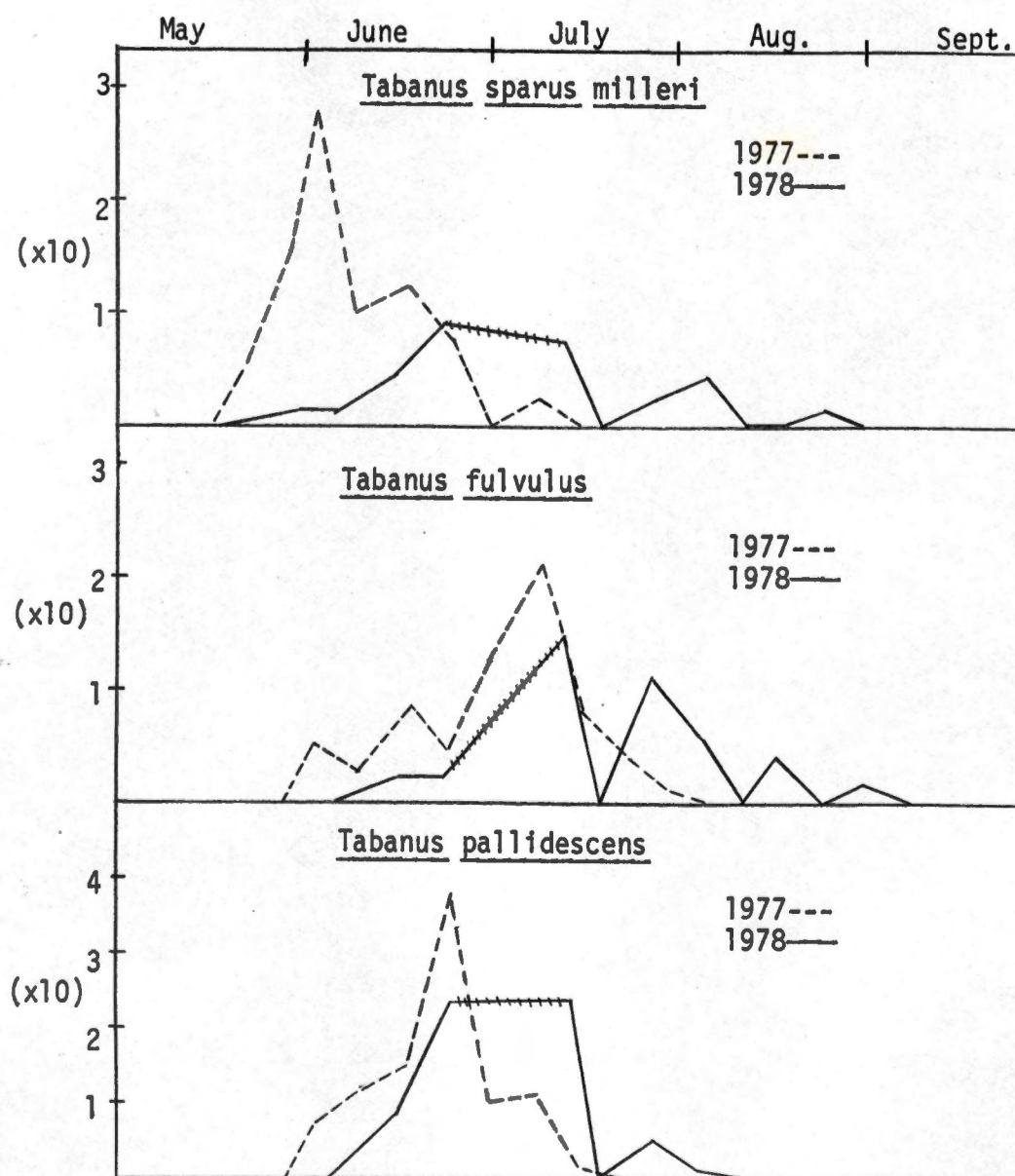


Figure 15. Seasonal Abundance of Some Fayette Co. Tabanidae

was taken in relatively small numbers elsewhere but was a major species at Jackson. A total of 34 species in four genera were taken, and species captured only at Jackson include Chrysops upsilon (state record), C. fulvistigma, and C. reicherti. Most specimens of T. cymatophorus and T. proximus were captured here. Trap composition is presented in Figure 16 and some seasonal abundance data in Figure 17.

Johnson Bible College (Knox County)

Because this trap was not moved to this area until 20 July 1977, no usable seasonable abundance data were obtained for that year. Trap composition is given in Figure 18; seasonal abundance data are presented in Figure 19.

Here, as in Cumberland County, Tabanus quinquevittatus was present in large numbers. Moist pasture drainage areas were also prevalent here, and the trap was fairly close to these areas (as was trap #2 in Cumberland County). Chrysops callidus and C. niger were extremely common deer flies around ponds and were a considerable nuisance to humans. C. callidus was taken in the highest numbers of any Chrysops in the traps, and here it was the third most prevalent species in the collections. A total of 24 species in four genera were collected here, including the state record for Whitneyomyia beatifica atricorpus.

Tremont (Blount County)

The trap collections for Tremont were not particularly good and were regularly made only from 15 June to 16 August 1977. A total of 194 specimens (17 species in two genera) were taken in this trap, and

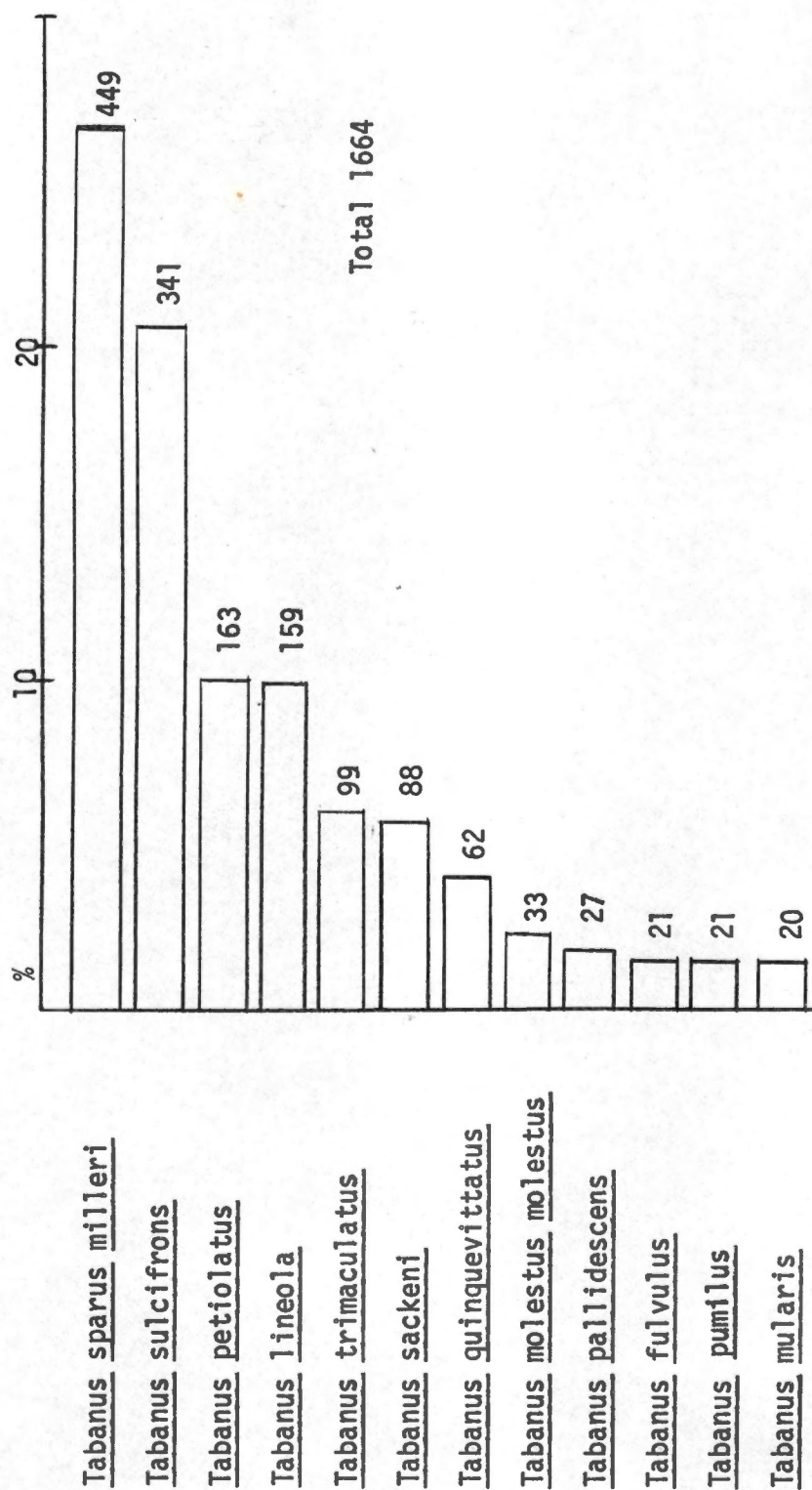


Figure 16. 1978 Trap Composition, Jackson, Madison Co.

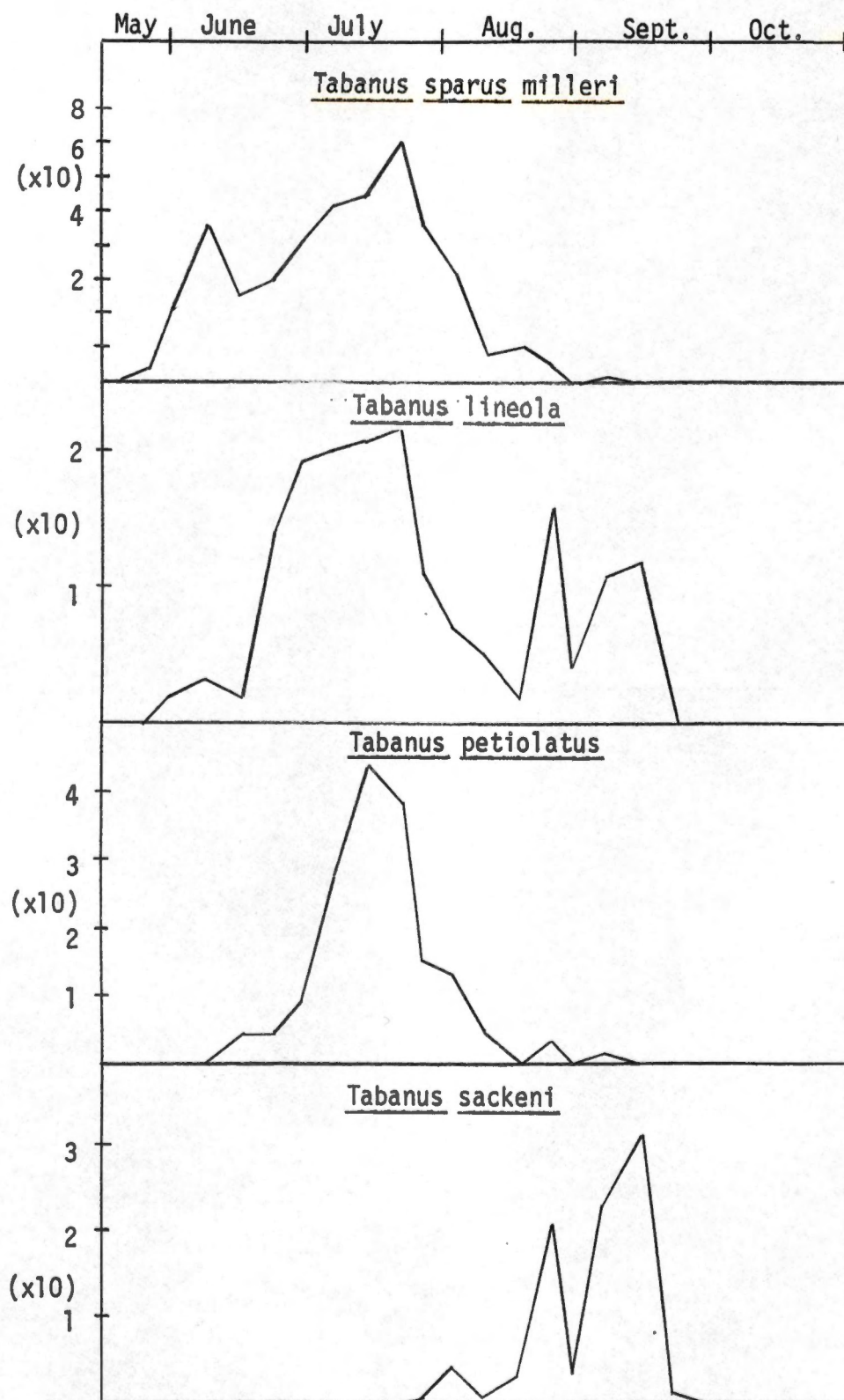


Figure 17. Seasonal Abundance of Some Madison Co. Tabanidae

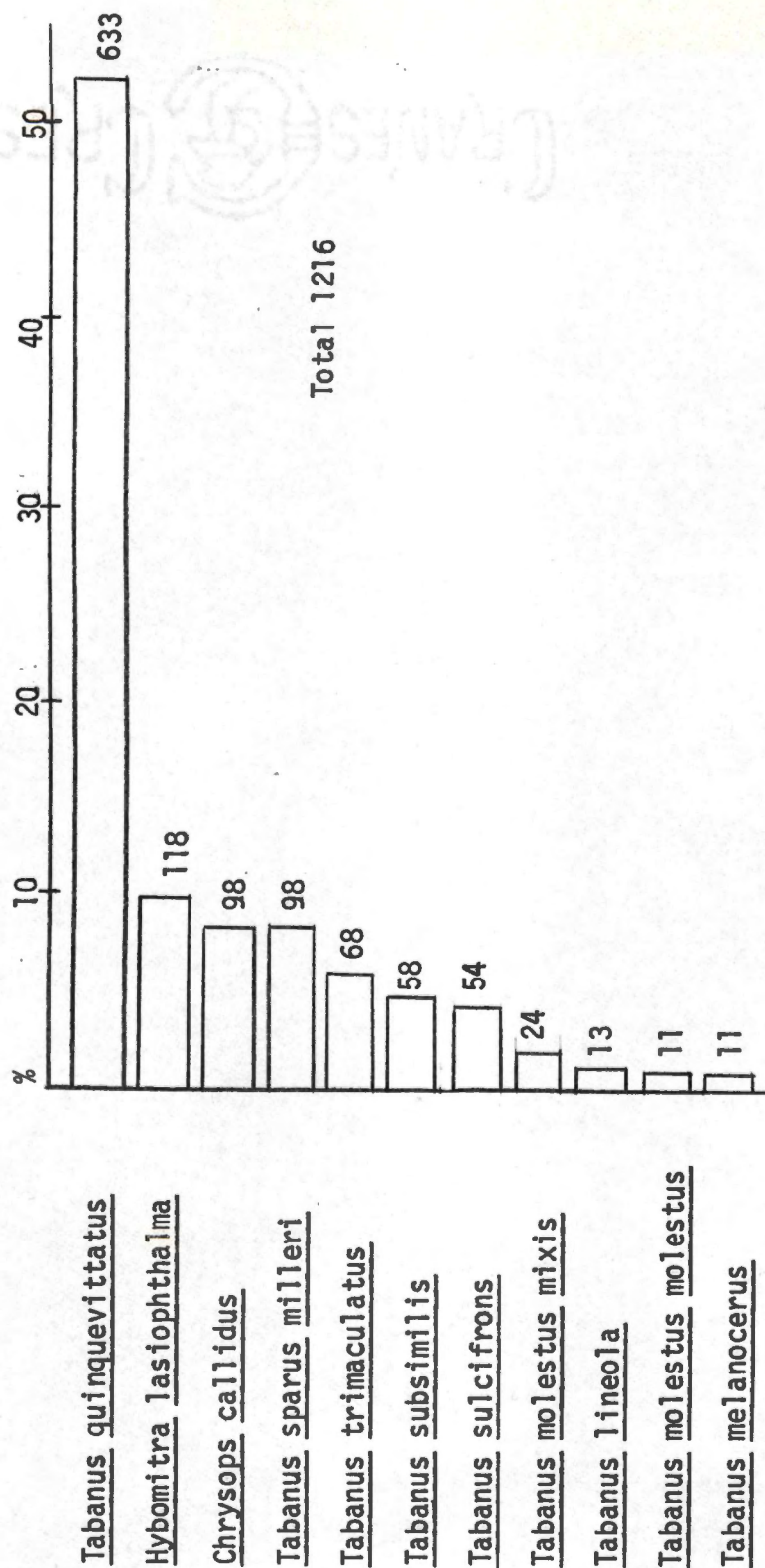


Figure 18. 1978 Trap Composition, Johnson Bible College, Knox Co.

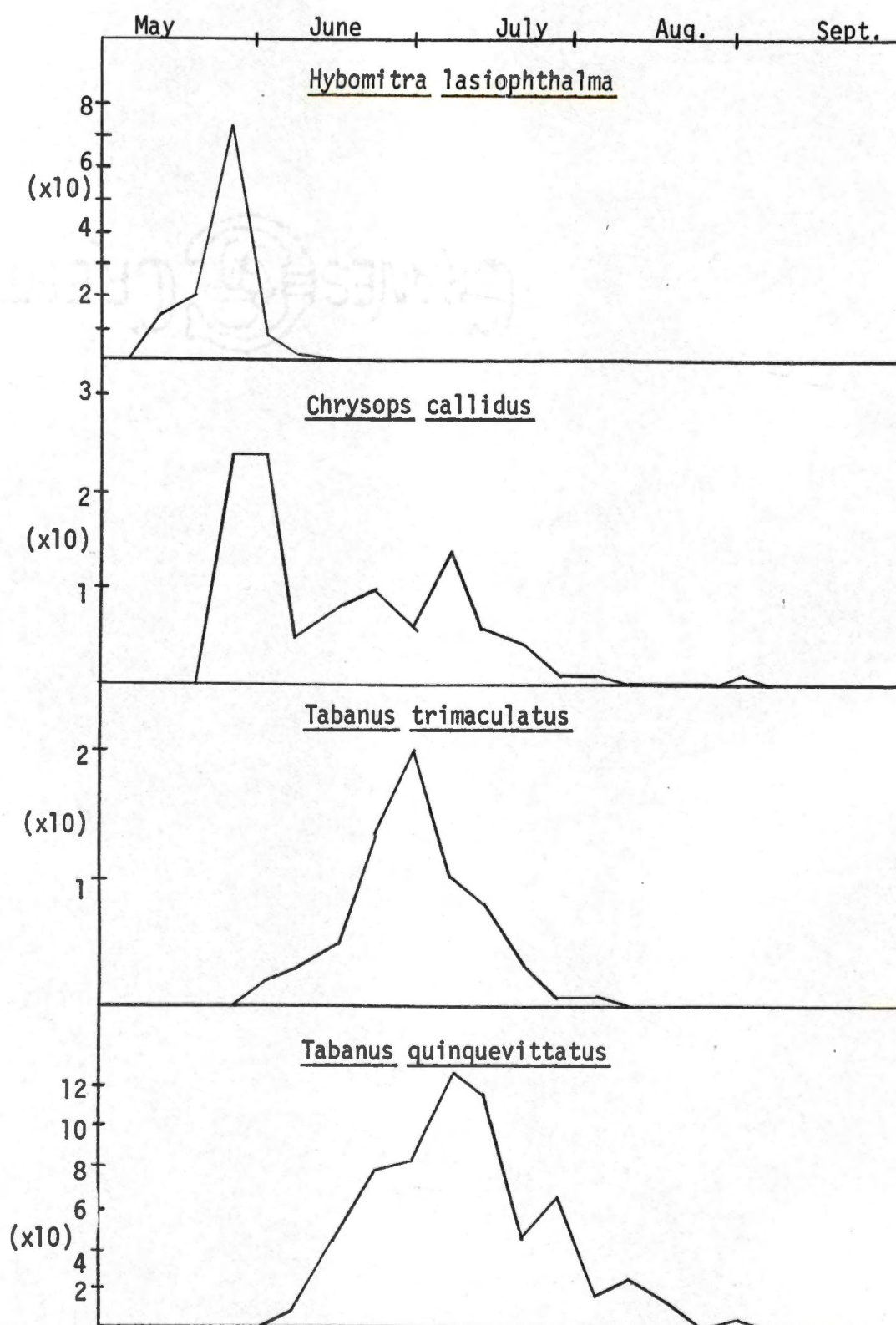


Figure 19. Seasonal Abundance of Some Knox Co. Tabanidae

this figure is surely not representative of the total tabanid population in the area. Major species in the collections were Tabanus sublongus, T. sackeni, T. molestus mixis, and T. superjumentarius. The reader is referred to the Appendix for numerical data.

The seasonal abundance of T. sublongus is given in Figure 20.

Ball Play (Monroe County)

From a total of 350 specimens in 27 species taken here in 1977, the tabanid catch increased dramatically to 6,860 specimens in 42 species in 1978. This difference must be largely attributed to trap location. Two trap locations were utilized in 1977, but neither of these was over 100 m from the 1978 location. The lighter decoy ball and slightly elevated early season trap height may have contributed to the 20x increase, but it seems highly unlikely that this was the main reason, particularly since the same modifications were done on other traps with far less impact on the total catch.

Many species were well represented in trap collections in 1978 that were sparse the previous season, especially early-season species. Hybomitra lasiophthalma, for instance, comprised almost 22% (1505 specimens) of the total 1978 catch, as opposed to <1.0% (three specimens) in 1977. Because of the obvious inconsistencies in the 1977 data, trap composition is based on 1978 data (Figure 21). The seasonal abundance of some species is presented in Figure 22.

It is especially interesting to compare Ball Play with the Rafter area, which is only 10 km away. Less overhead netting was done at Ball Play, so the Chrysops population was sampled less adequately.

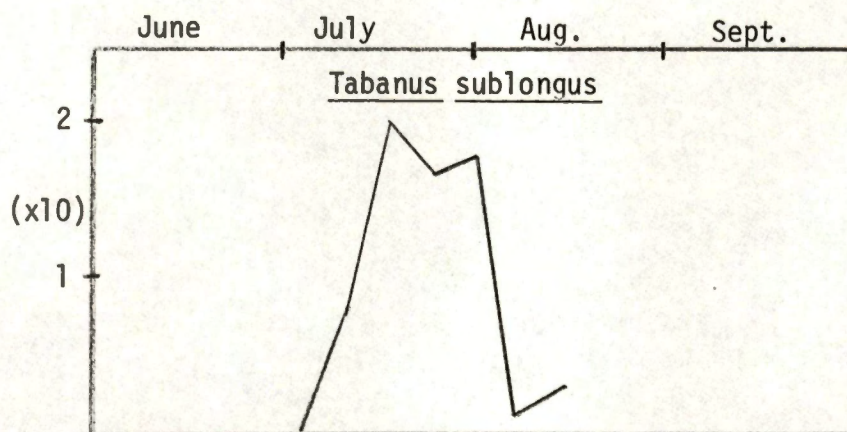


Figure 20. 1977 Seasonal Abundance of Tabanus sublongus at Tremont (Blount County, Tennessee).

CRANESEST CREST

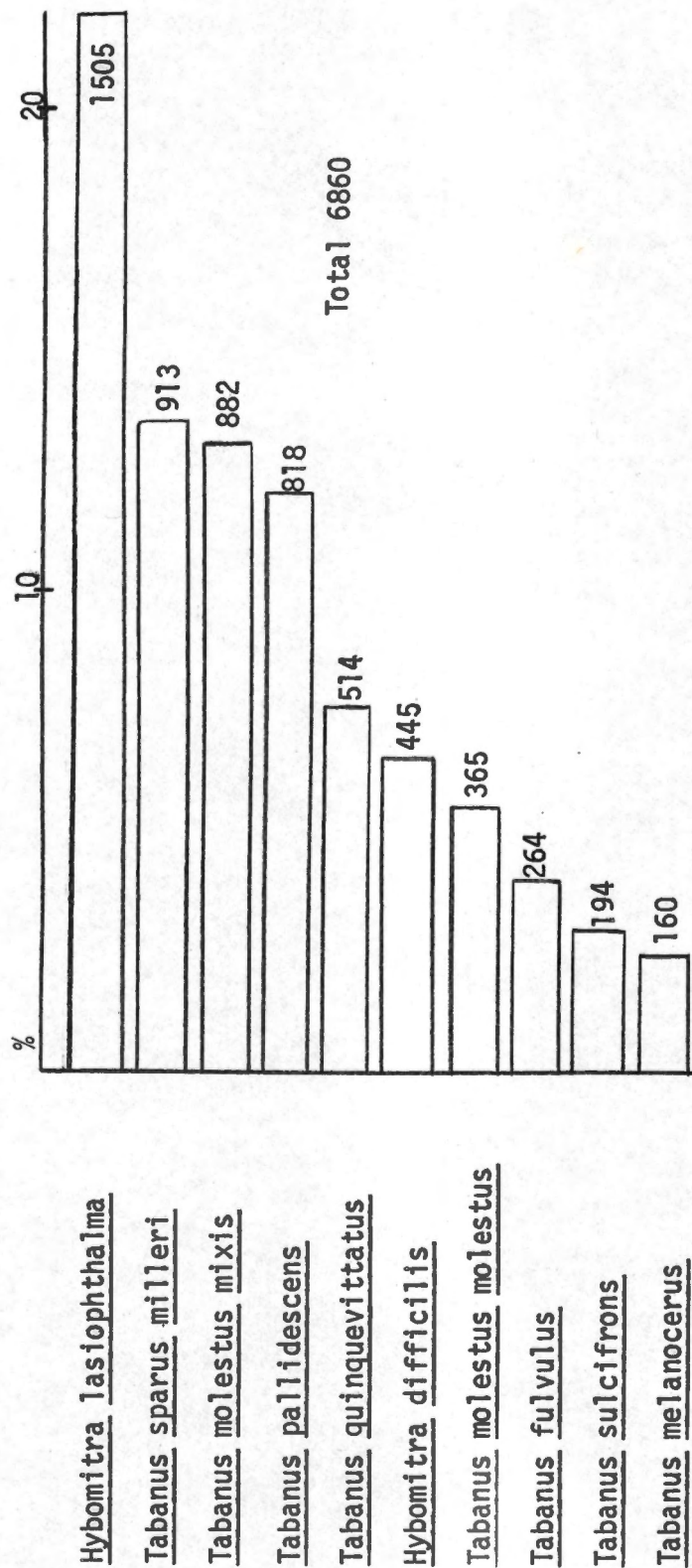


Figure 21. 1978 Trap Composition at Ball Play, Monroe Co.

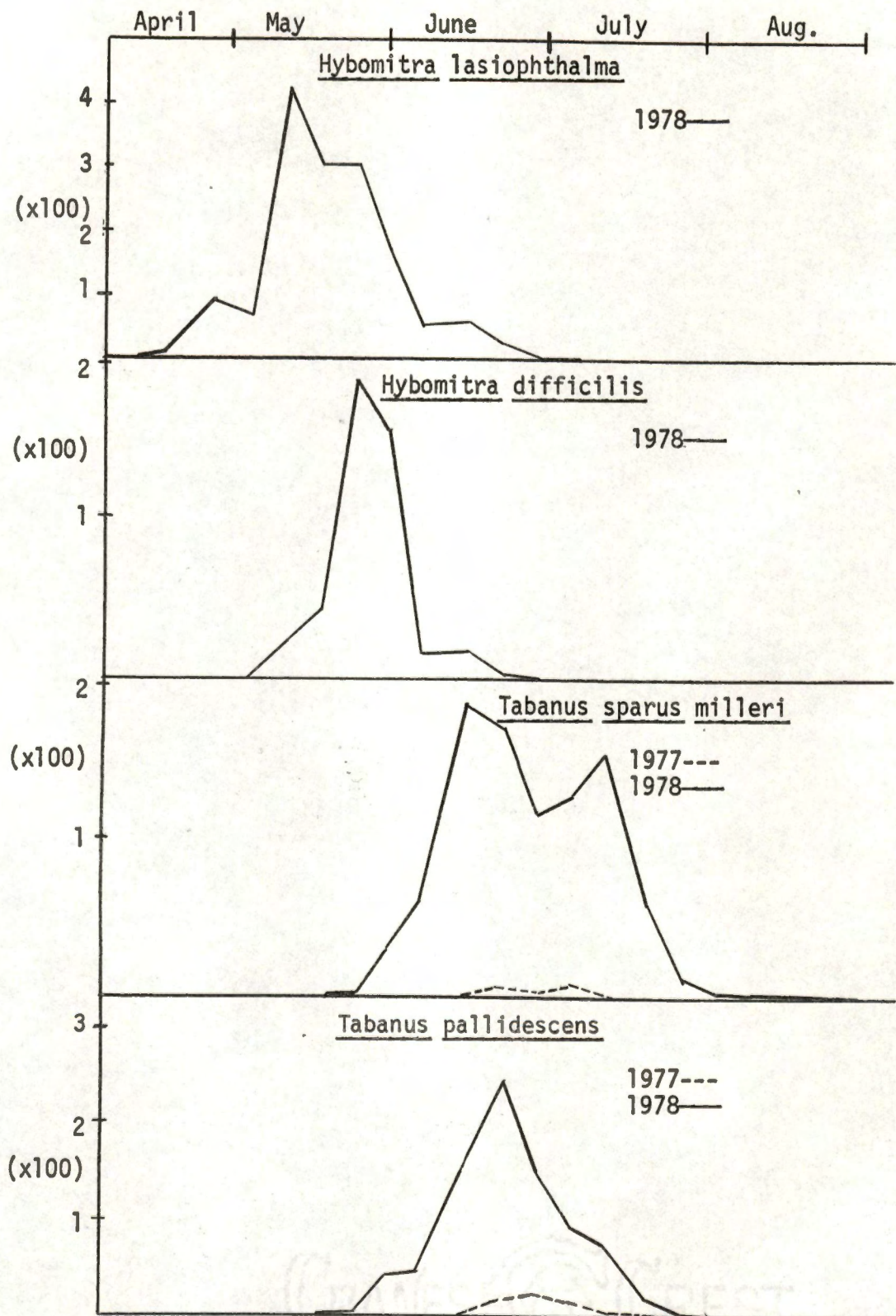


Figure 22. Seasonal Abundance of Some Ball Play, Monroe Co. Tabanidae

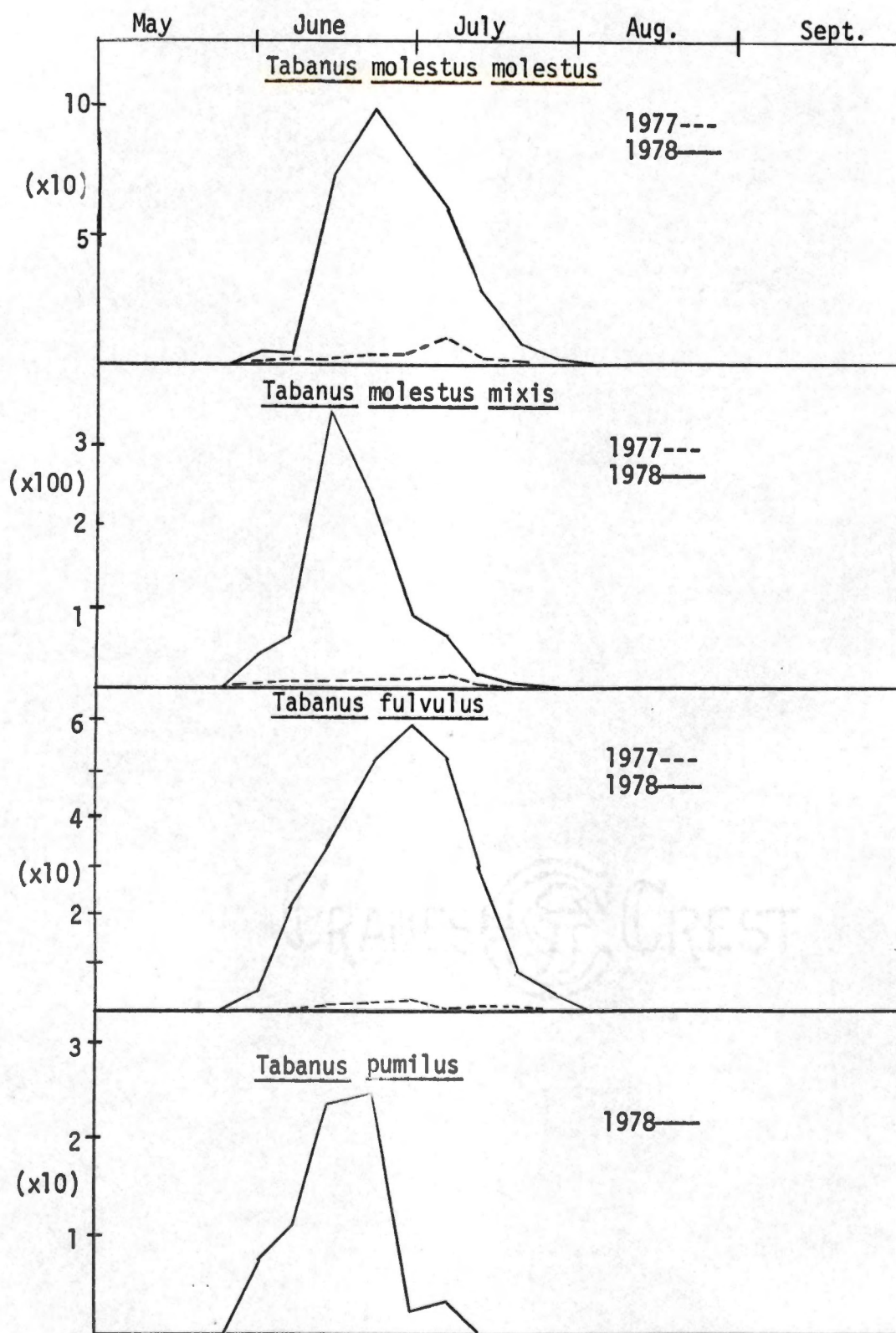


Figure 22. (Continued)

Species taken at Ball Play that were not taken at Rafter include Tabanus exilipalpis (significant range extension, see species discussion), Hamatabanus carolinensis, Atylotus ohioensis (state record), C. separatus (see species discussion), and C. pikei. Species that were much more common at Ball Play include T. molestus, T. m. mixis, T. subsimilis, T. fairchildi, T. trimaculatus, C. moechus, and C. callidus. In 1978 the trap at Ball Play took more tabanids than any other trap.

Rafter (Monroe County)

The Rafter area is characterized by diverse topography and vegetation, and tabanid species diversity was greater here than in any other study area. A total of 54 species in five genera were taken during the two year study. A list of these species and their approximate seasonal abundance is given in Figure 23. When compared with Ball Play, marked faunal differences are evident. Seasonal abundance for species common to both areas was quite similar. While less Chrysops sampling was done at Ball Play, some of the more common Rafter species surely would have been collected if comparable numbers were present. Chrysops brimleyi, niger, geminatus, and impunctus were all present at pest levels here during their peak abundance times. Cattle in the area were severely bothered by many species of horse flies. Species taken at Rafter that were not found at Ball Play include Hybomitra sodalis, H. cincta, Chlorotabanus crepuscularis, Tabanus marginalis, T. longus, Chrysops cuclux, C. cursim, C. calvus, C. celatus, C. geminatus, C. impunctus, and others. Species that were more common at Rafter included H. difficilis, T. sublongus, and T. superjumentarius.



Figure 23. Species Collected and Approximate Seasonal Abundance of Tabanidae at Rafter, Monroe County.

The trap designated Rafter 1 was operated during the 1977 and 1978 seasons in a small (5 ha) mountain valley pasture area. In 1978 two additional traps were erected, one (Rafter 3) in the woods near Rafter 1 and another (Rafter 2) in a larger (20 ha) mountain valley field-pasture area across a ridge from Rafter 1. The trap in the woods caught few specimens (56 in 10 species). Almost half of these (25 specimens) were T. sulcifrons (late season form). Others included T. pallidescens (12 specimens), T. fulvulus (6 specimens), and H. sodalis (5 specimens). The traps Rafter 1 and Rafter 2 showed the same basic species composition, but several interesting differences were noted.

As shown in Figure 24, Rafter 1 was notably lacking T. quinquevittatus (one specimen was taken in 1977) and had a lower proportion of H. lasiophthalma and T. pumilus. Rafter 2 caught fewer H. sodalis, C. univittatus, and T. superjumentarius, in spite of taking many more of the other tabanids during the season. Relatively fewer T. sulcifrons were captured at Rafter 2. This may be partially due to the fact that Rafter 2 was without a decoy ball for two weeks when the late season form of T. sulcifrons was at its peak. More detailed seasonal abundance data follow (Figure 25) and all numerical data are in the Appendix. The seasonal abundance of T. sulcifrons here is of special interest and is found under the discussion of that species.

III. SPECIES DISCUSSIONS

The following is a list of species collected and some information on each.

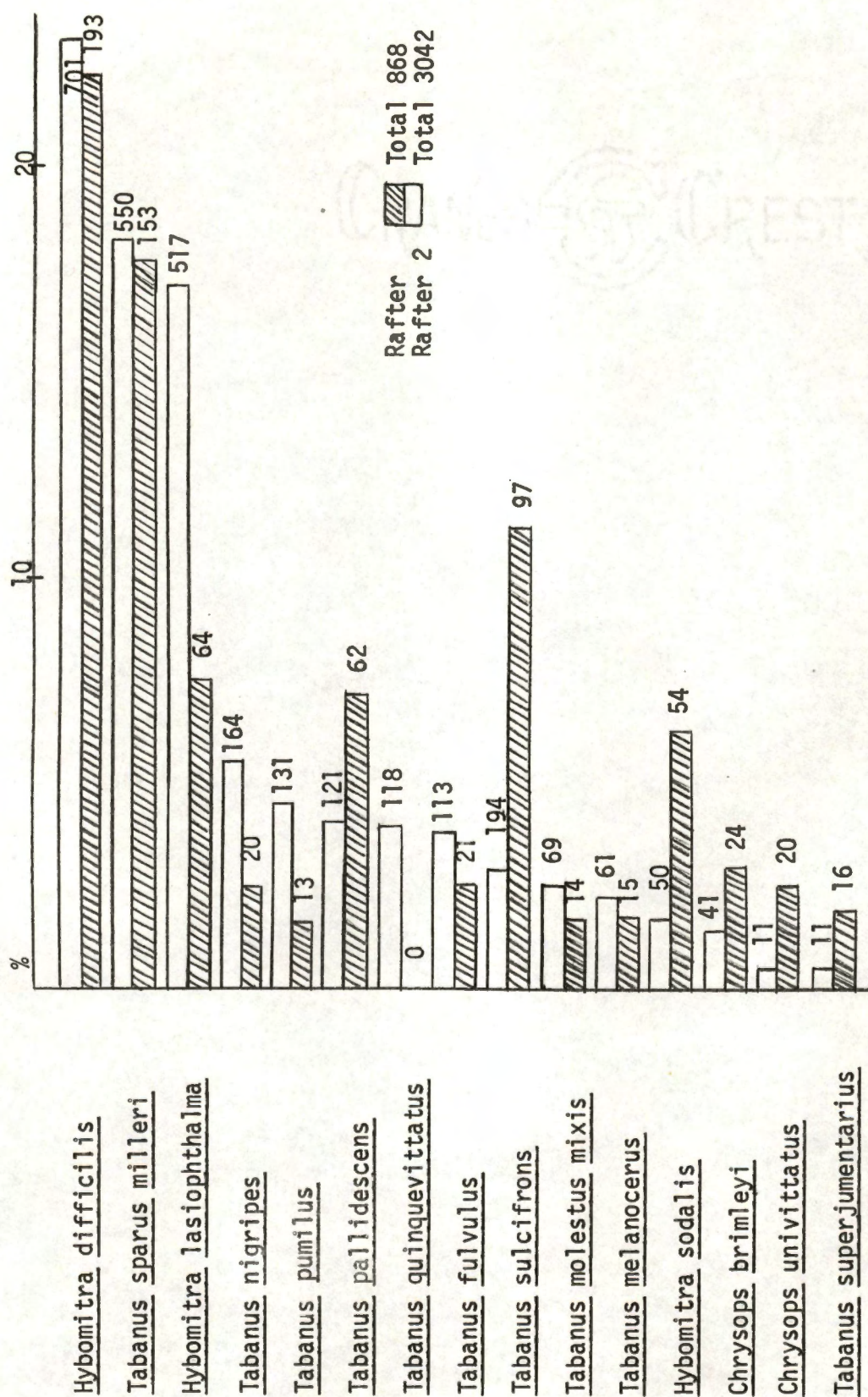


Figure 24. 1978 Trap Composition at Rafter, Monroe Co.

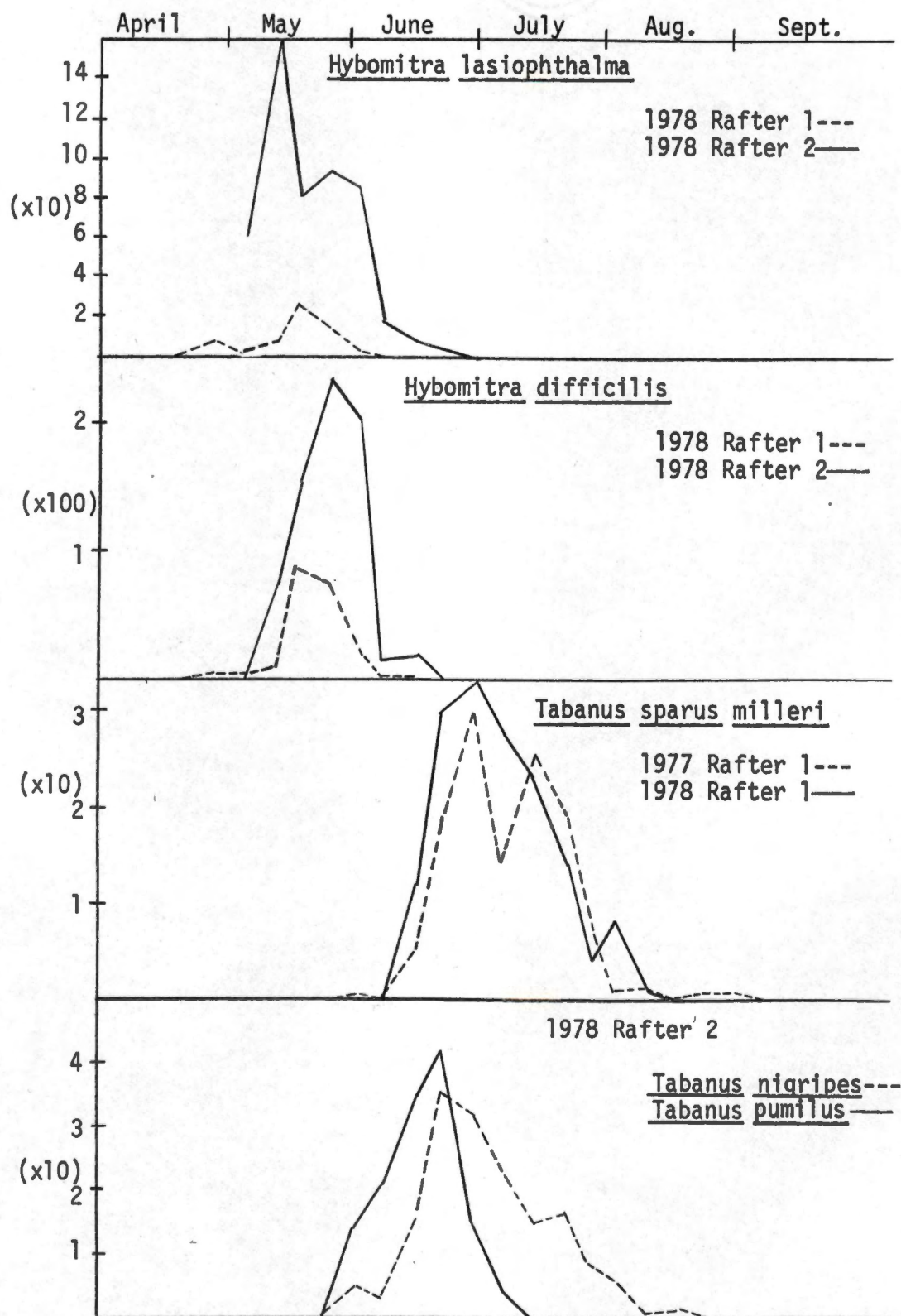


Figure 25. Seasonal Abundance of Some Rafter, Monroe Co. Tabanidae

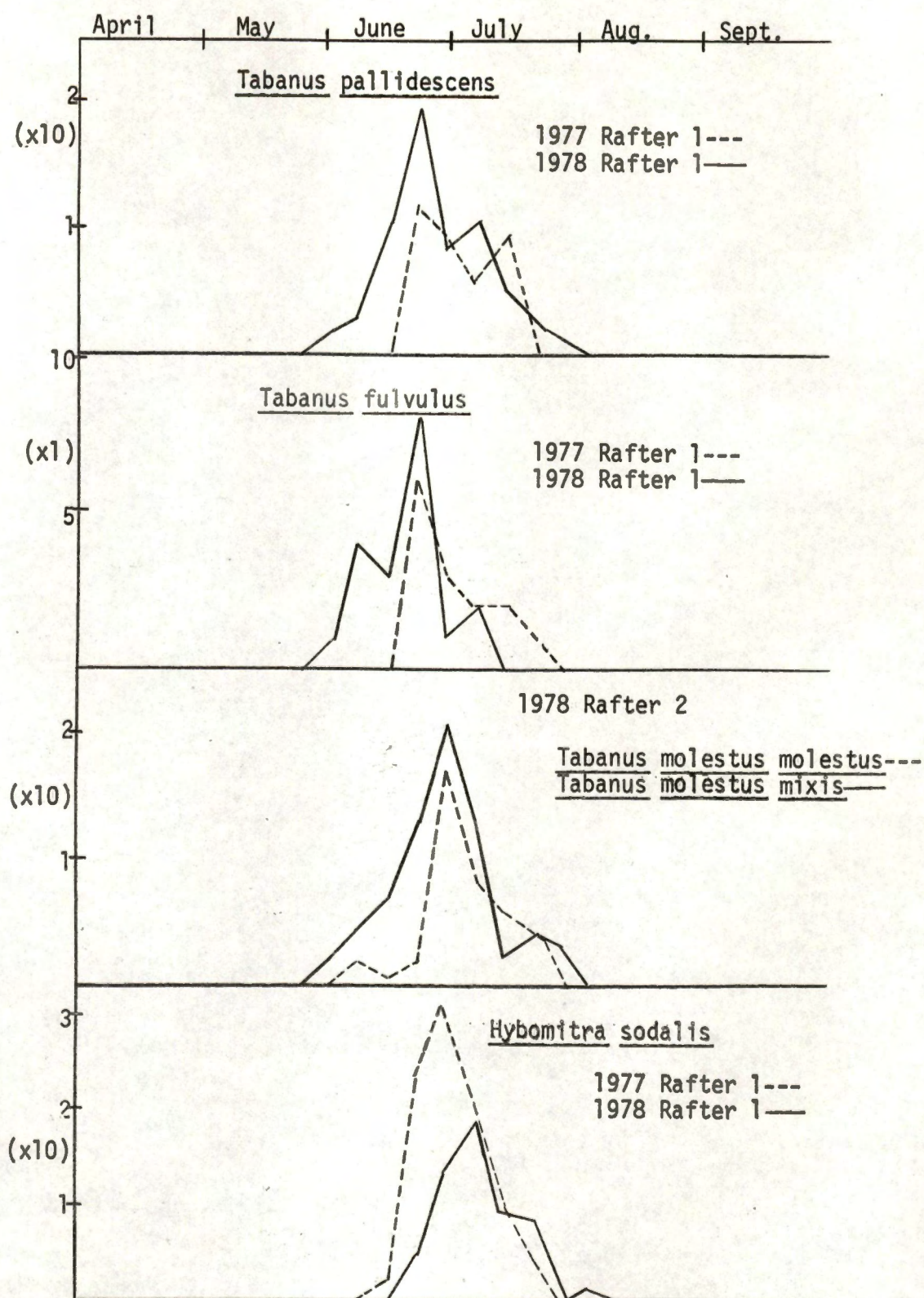


Figure 25. (Continued)

Stonemyia isabellina (Wiedemann)

Pechuman (1972) states that this species may be collected on flowers and is not known to feed on blood. A single female was captured on a sticky trap adjacent to a pond in Cumberland County on 27 June 1978.

Atylotus ohioensis (Hine)

One rather poor female specimen was collected in the Manitoba trap at Ball Play (Monroe County) on 22 June 1978. It is a state record for the species.

Atylotus species "near" thoracicus (Hine)

A single female specimen was collected in a two-way malaise trap in Cumberland County on 12 June 1978. The trap was situated in a pasture near a woods edge and was close to a pond and shaded marshy area.

Chlorotabanus crepuscularis (Bequaert)

This beautiful, yellow-green species was not commonly observed in any of the study areas, due to low population numbers and to its crepuscular activity patterns. None were captured in the traps. One specimen was collected in Knox County at dusk at a light on 20 June 1977 by C. D. Pless. Eight specimens were collected at dusk and dawn at Rafter (Monroe County) while they were attacking a cow on 28 June and 12 July 1978. A single specimen was seen attacking cattle in Cumberland County on the morning of 18 July 1978. While the specimen could not be captured, the distinctiveness of this species leaves no doubt as to identification.

CRANES CREST

Hamatabanus carolinensis (Macquart)

This species does not appear to be very common in the state. One specimen was collected in a Manitoba trap in Cumberland County on 26 May 1977. Another was captured attacking a man at Walker Springs (Knox County) on 13 June 1977. Two specimens were captured in a Manitoba trap at Ball Play (Monroe County) and one was captured feeding on a cow at the same location. All Monroe County specimens were collected between 2 June and 23 June 1978.

Leucotabanus annulatus (Say)

Apparently L. annulatus is widely distributed in Tennessee. Collection dates range from 29 June (Monroe County, Rafter) to 17 August (Madison County). Its crepuscular habits probably contributed to its being captured in low numbers in traps during its flight season. This species was collected in the study areas in Monroe (Ball Play and Rafter), Cumberland, Madison, Fayette, Blount (Tremont), and Knox (Cherokee Woodlot) counties. One specimen was observed attacking man.

Some interesting feeding behavior was noted for this species at Rafter (Monroe County) on the evening of 12 July 1978. While the author was observing crepuscular feeding of Tabanidae on cattle, large numbers of L. annulatus females were noted. From approximately 20 minutes before dark until 45 minutes afterward, they fed voraciously on the ventral midline. So dense were their numbers that a single swing of the net across a cow's umbilicus yielded a dozen specimens. One hour after dark, all activity had ceased.

Whitneyomyia beatifica atricorpus Philip

A single female specimen of this species was taken in a Manitoba trap at Johnson Bible College (Knox County) on 7 June 1978. It is the first state record for the genus and is the northernmost extension of the species range.

Chrysops brimleyi Hine

C. brimleyi is one of the earliest species on the wing, and collection dates range from 27 April (Madison County) to 10 June (Blount County, Cades Cove and Madison County). It was present in considerable numbers in Cumberland and Monroe (Rafter) Counties in mid-May and attacked man readily. Maximum number/15 minutes was 8 (Monroe County, Rafter).

Chrysops callidus Osten Sacken

The noisy attack of C. callidus is a common occurrence from mid-May through June in East Tennessee. Among the Chrysops, C. callidus was the most common in Manitoba trap collections. The species was collected in all study areas across the state and collection dates ranged from 7 May (Knox County) to 14 September (Madison County). It was only occasionally collected at Rafter (Monroe County) but was an annoying pest of man in Cumberland and Knox Counties.

This is one species that apparently may have a partial second brood, as was noted in Cumberland County in late August and early September of 1978 (Figure 13, p. 43). Oviposition was observed several times. The shining black, single-tiered egg masses (Figure 3, p. 4) are approximately 12 x 4 mm in size and are common on emergent vegetation

at the edges of ponds. C. callidus was observed feeding on both cattle and horses, and one was taken from the neck of a dog. Line graphs dealing with its abundance in Manitoba trap collections are found in the 1978 area discussions of Grasslands Farm (Cumberland County) (Figure 13, p. 43) and Johnson Bible College (Knox County) (Figure 19, p. 51). Maximum number/15 minutes was 12 (Knox County).

Chrysops calvus Pechuman and Teskey

This species was captured only in Monroe County (Rafter) and closely resembles C. niger, which flies at the same time. Collection dates ranged from 18 May to 2 June, with most flying in late May. It is a more northern species but its range extends southward along the Appalachians. This is the first state record for C. calvus. Maximum number/15 minutes was 5 (Monroe County, Rafter).

Chrysops carbonarius Walker

C. carbonarius was captured only in the East Tennessee mountains of Monroe (Rafter and Ball Play) and Blount (Cades Cove) Counties. Five specimens were taken in Cades Cove on 10 June 1978 and two were taken at Rafter on 15 and 22 June 1978 and one at Ball Play on 23 June 1978. Maximum number/15 minutes was 2 (Blount County, Cades Cove).

Chrysops celatus Pechuman

C. celatus was never commonly collected and was taken only in Cumberland and Monroe (Rafter) Counties. Cumberland County specimens were collected from 13 June to 30 June, while the single Rafter specimen was taken on 15 June 1978.

Chrysops cincticornis Walker

This species seems to be fairly widespread in Tennessee but was never found in large numbers. Collection dates range from 10 May (Knox County) to 27 June (Cumberland County). It was also taken from Madison and Monroe (Rafter) Counties. It seemed most common in Cumberland County in early June, and was observed ovipositing on emergent vegetation at a pond edge. The dark brown egg mass is in several tiers and approximately 4 x 4 mm in size. Maximum number/15 minutes was 4 (Cumberland County).

Chrysops cuclux Whitney

This species was captured only in the higher elevations in Tennessee. In Cumberland County it was collected from 19 May to 6 June; at Rafter (Monroe County) from 4 May to 2 June, and at Cades Cove (Blount County) on 6 May 1977. It was never abundant, but most were taken in late May. Maximum number/15 minutes was 2 (Cumberland County).

Chrysops cursim Whitney

Rafter (Monroe County) is the only location where this species was found, but it was regularly collected there. Collection dates ranged from 15 June to 27 July, with most flying in early July. C. cursim was observed attacking cattle. Maximum number/15 minutes was 2 (Monroe County, Rafter).

Chrysops flavidus Wiedemann

This species was not often collected in East Tennessee, but seemed more common in Madison County.

A male of C. flavidus was taken at a light by C. D. Hylton on 8 July 1978 in Maryville (Blount County). Two females were captured

in Knox County. One of these was from I. C. King Park (overhead netting) on 20 June 1977, while the other was netted from a horse on 25 May 1978 at Johnson Bible College. At Grasslands (Cumberland County), single specimens were collected on 13 June, 11 July and 5 September 1978. Six specimens were taken in a low-lying area in Madison County on 9 June 1978 by two collectors in a 45 minute period of overhead netting.

Chrysops fulvistigma Hine

A single specimen of this species was taken in a Manitoba trap in Madison County on 13 July 1978.

Chrysops geminatus Wiedemann

C. geminatus is an extremely common species in the East Tennessee mountains in late June and early July and readily attacked both humans and cattle. Under heavy attack at Rafter (Monroe County) the ears of cattle became blood-caked, with up to six or eight females feeding on an animal at one time. Collection dates at Rafter ranged from 13 June to 26 July. A male was taken there at a light on 13 July 1978. This species was also collected on Lumber Ridge and Gregory's Ridge (both Blount County) on 2 June 1977 and 3 July 1978, respectively. In Knox County, it was taken at Cherokee Woodlot from 11 June to 25 June.

C. geminatus was sometimes captured on "dry" wooded ridges with no nearby water source, indicating either that the adults disperse well or that the larvae may also be terrestrial. Pechuman (1973) stated the larvae seemed to favor mossy habitats in spring-fed drainages.

Maximum number/15 minutes was 14 (Monroe County, Rafter).

Chrysops impunctus Krober

This form flies with geminatus at Rafter (Monroe County) and the Cherokee Woodlot (Knox County) but is less abundant. It cannot, therefore, be a true subspecies. The "dry" ridges where geminatus was collected did not yield impunctus. Collection dates were from 28 June to 27 July at Rafter and 20 June to 2 July at Cherokee Woodlot. Like C. geminatus, C. impunctus readily attacked humans and cattle.

The larval habitat of impunctus is unknown, and the male was only recently found in a series collected with a light trap in Illinois (Pechuman, personal communication). It is probably a distinct species.

Maximum number/15 minutes was 7 (Monroe County, Rafter).

Chrysops macquarti Philip

This species is widespread and was collected in Monroe (Rafter and Ball Play), Blount (Cades Cove), Knox (Cherokee Woodlot), and Cumberland Counties. Collection dates ranged from 31 May (Ball Play) to 22 August (Cumberland County).

While the species was fairly common in all these areas, the highest populations were found in several wooded areas in Cumberland County. One low area, bisected by a slow stream, had populations heavy enough that two or three were often collected in a sweep over one's head with a net. The relatively silent approach of this small species made it a special nuisance in these areas. Maximum number/15 minutes was 11 (Cumberland County).

A female specimen was reared from one of several larvae collected in submerged sand along a small stream.

Chrysops moechus Osten Sacken

The Monroe County study areas (Ball Play and Rafter) were the only locations in which this species was collected, although it is more widespread in Tennessee. While common at Ball Play, it was rare at Rafter. Single Rafter collections were made on 14 and 21 June. At Ball Play, 15 specimens were taken in the trap from 17 May to 3 August, with a population peak around mid-June. Eight were taken by overhead netting. Maximum number/15 minutes was 2 (Monroe County, Ball Play).

Chrysops montanus Osten Sacken

This was not a commonly collected species in overhead netting (eight specimens) and was found only in Cumberland County. It was more common in 1977, where 11 specimens were taken in the Manitoba traps on 23 June and 30 June. Collection dates range from 6 June to 30 June. Its relatively high numbers in trap collection (when compared to other Chrysops) may indicate a preference for non-human hosts.

Chrysops niger Macquart (Ten, Knox County)

During its flight season, which peaks from mid-May to early June, this small black species can be a considerable annoyance to humans. It is quite widespread and was collected in the East Tennessee counties, Blount, Cumberland, Knox, and Monroe (Rafter) from 9 May to 27 June (Cumberland County).

About a dozen females of C. niger were captured feeding on a horse in Knox County (Johnson Bible College) in late May and early June. Maximum number/15 minutes was 10 (Knox County).

Chrysops pikei Whitney

Specimens of this species were regularly collected in the trap at Ball Play (Monroe County), although never in high numbers, from 6 July to 27 July. Scattered collections from Madison County ranged from 20 July to 10 August, and one was taken there on 14 September 1978. One specimen was captured by W. J. Van Landingham on 20 June 1978 in Blount County.

Chrysops pudicus Osten Sacken

C. pudicus was collected only at Rafter (Monroe County) on 5 July 1977 and Grasslands (Cumberland County) on 13 June 1977, 12 July 1977 and 20 August 1978. It was uncommon in both these areas.

Chrysops reicherti Fairchild

This species seems to be present only in the western part of the state. It was regularly collected in the trap in Madison County from 8 June to 25 August 1978, and 14 specimens were taken there on 9 June by two collectors in a 45 minute period of overhead netting.

Chrysops separatus Hine

A single specimen of this species was captured in the cab of a truck at Ball Play (Monroe County) on 7 April 1978. This species is fairly rare in collections (Pechuman, personal communication) which may be due in part to its unusually early flight period. Another specimen was observed on 13 April 1978 trying to feed on the neck of a bull.

Chrysops univittatus Macquart

Though widespread and fairly common in Tennessee, C. univittatus seldom reached high population levels in any of the study areas. It was collected in Blount, Knox, Cumberland, Monroe (Ball Play and Rafter) and Madison Counties. Most were taken in July, but collection dates ranged from 9 June (Cumberland County) to 6 September (Rafter). Maximum number/15 minutes was 6 (Monroe County, Rafter).

A male was captured in Blount County at a light by C. D. Hylton on 8 July 1978.

Chrysops upsilon Philip

The state record for this species was collected by R. R. Gerhardt on 9 June 1978 in Madison County. Six specimens were subsequently captured in the Manitoba trap in Madison County from 3 August to 14 September 1978.

Chrysops vittatus vittatus Wiedemann

This is one of the most widespread Chrysops species, and proved to be very common in some areas. Extreme collection dates ranged from 9 June (Madison County) to 30 August (Monroe County, Rafter). C. vittatus was also taken from Knox, Blount, and Cumberland Counties. It could be a local pest of man and cattle in all these areas and reached peak numbers in July. Maximum number/15 minutes was 12 (Knox County, Cherokee Woodlot). A male was taken in Blount County at a light on 8 July 1978 by C. D. Hylton.

Hybomitra cincta (Fabricius)

This is a moderately large, black species, with a bright yellow-orange abdominal band that makes it unmistakable. It was found only in

the higher elevations. One was taken in a two-way malaise on Gregory's Bald (Blount County) on 1 July 1978. Records of this species from Tremont (Blount County) range from 26 June to 17 July 1977. At Rafter (Monroe County) H. cincta was a common pest of cattle and was present from 21 June to 27 July, with most flying in late June and early July. It did not seem as common in the trap collections as its prevalence on cattle would indicate.

Hybomitra difficilis (Wiedemann)

Hybomitra difficilis is a widespread pest of cattle and horses in the higher elevations of Tennessee and occasionally attacks man. Populations build rapidly from mid-late May and remain at peak levels for only about three weeks, declining very rapidly in mid-June. Line graphs dealing with the seasonal abundance of H. difficilis may be found in Figures 13, 22, and 25, pp. 43, 56, and 62, respectively.

Catches of this species were low in the Monroe County study areas in 1977, presumably due to poor trap location. In 1978 H. difficilis was the most abundant species in the Rafter area, comprising 22% (193 specimens) of the total catch at Rafter 1 and 23% (701 specimens) at Rafter 2. It was also prevalent at Ball Play, where it made up 6.5% (445 specimens) of the total. The 1978 populations in both these Monroe County areas peaked in late May and early June, and extreme collection dates ranged from 26 April (Rafter) to 22 June (Ball Play). Blount County records for this species ranged from 29 May (Townsend) to 15 June (Tremont).

In Cumberland County H. difficilis was the major tabanid cattle pest during both seasons. It was especially bothersome in late May, when large numbers of H. lasiophthalma were also flying. These two species often forced the cattle to remain in deep woods and bushes or seek refuge in waterholes during the day, seriously disrupting grazing activity. Under very heavy tabanid attack the cattle would sometimes stampede, holding their tails high in a manner similar to "gadding" caused by the heel fly Hypoderma bovis (Degeer). Single sticky panel traps situated at a wooded pasture edge in a cattle loafing area captured up to 425 specimens of H. difficilis in one week. This was six times the average number caught in Manitoba traps during the same time period.

In 1978 H. difficilis comprised approximately 10% (721 specimens) of the total tabanid catch in Cumberland County, as compared to about 9% (217 specimens) during 1977. Peak populations were flying in mid-late May in 1977 and late May-early June in 1978. Extreme collection dates ranged from 12 May to 3 July.

Although H. difficilis is a major pest of cattle and horses and is sometimes present in large numbers in upland areas of the eastern U. S., nothing is known of its basic biology. During the late winter and early spring of 1978, surveys were conducted on the Cumberland Plateau (Cumberland County) with the hope of locating the larvae of this species. It seemed likely that since most specimens are taken from hilly regions, larvae of H. difficilis could be inhabitants of swift water, or possibly terrestrial hillsides. A thorough survey of various lotic situations was made in streams and rivers near Grasslands

Farm with negative results. In light of this survey it seems quite plausible that the larvae of H. difficilis might be terrestrial, possibly in deep organic soil. While some terrestrial searching was done, it was by no means exhaustive, due to the time-consuming nature of the search procedures and the wide variety of potential habitats involved.

At Rafter (Monroe County) a female was captured with mud on the thorax. A sticky panel trap located on a hillside in deep woods caught almost five times as many female specimens as an identical trap in the open less than 100 feet away. Most other tabanid species were caught in comparable or greater numbers on the trap in the open. This may be a clue to ovipositional sites for the females of H. difficilis or may reflect a tendency for them to fly along wooded hillsides. Subsequent studies hopefully will reveal some of the biological secrets of this fascinating species.

Hybomitra lasiophthalma (Macquart)

This species has the earliest seasonal abundance and is widely distributed in Tennessee. It was taken in all study areas. Like H. difficilis it can be a major pest of cattle and horses and builds to peak population levels very rapidly. In West Tennessee it comprised 5% (33 specimens) of the 1978 Ames catch (Fayette County) but only three specimens were taken from Madison County. In Knox County it accounted for almost 10% (118 specimens) of the total; at Rafter (Monroe County), 17.4% (64 specimens); at Rafter 2, 17% (517 specimens); and in Cumberland County about 9% (681 specimens). At Ball Play (Monroe County) this species was the major tabanid in 1978 trap catches, accounting for 22% (1505 specimens) of the total catch.

The 1977 population peaks for H. lasiophthalma in Monroe County were undetectable due to poor trap location. In 1978 Ball Play populations were highest in early and mid-May, while they were highest in mid-May at Rafter. Extreme collection dates were 18 April and 29 June 1978 (Ball Play).

In Cumberland County peak populations occurred in mid-to-late May in 1978 and about two weeks earlier in 1977. H. lasiophthalma was a major cattle pest during its peak abundance. Extreme collection dates ranged from 25 April to 27 June.

Line graphs dealing with the seasonal abundance of H. lasiophthalma are given in Figures 13, 19, 22 and 25, pp. 43, 51, 56, and 62, respectively.

Hybomitra sodalis (Williston)

This species was found only in the mountain areas of Rafter (Monroe County) and Tremont (Blount County). At Rafter it was a pest of cattle during its period of peak activity, which was in late June in 1977 and about one week later in 1978. Only about half as many females were taken in the Rafter 1 trap in 1978 as in 1977, but it still comprised 1.6% (50 specimens) of the total.

Extreme collection dates for Rafter were 14 June and 3 August, and for Tremont (Blount County) were 15 June and 26 June 1977. A line graph dealing with the seasonal abundance of H. sodalis is presented in Figure 25, p. 63. Adults were reared from three larvae collected from leaves and moss in a hillside spring-seepage area near Walland (Blount County).

Hybomitra trispila (Wiedemann)

H. trispila closely resembles H. sodalis and was taken from Rafter (Monroe County) at the same time as sodalis, though in fewer numbers. Collection dates for Rafter ranged from 21 June to 20 July. It was also taken at Ball Play (Monroe County) from 15 June to 5 July. In Cumberland County it was captured from 27 June to 11 July, with a small but apparent peak in early July of 1978.

Though H. trispila was observed feeding on cattle, it was not present in sufficient numbers to be a serious pest.

Hybomitra typhus (Whitney)

The state record for this northern species was taken in Cumberland County on 30 May 1978, and was a very significant westward and southward range extension. It is a dark form of the "true" H. typhus and is not the "northern form" that Dr. H. J. Teskey is currently describing as a new species (Pechuman, personal communication).

Tabanus aar Philip

A single specimen of this species was taken in a Manitoba trap in Cumberland County on 21 July 1977. Pechuman (personal communication) refers to this as the "dark form of aar" and states that it is probably either an undescribed species or an extreme variant.

Tabanus abdominalis Fabricius

This species is part of the difficult T. sulcifrons complex and is discussed later under that heading.

Tabanus americanus Forster

This is the largest horsefly in North America, reaching a length of over 30 mm. It was quite common through most of the season at Rafter (Monroe County) but was never present in large numbers. A similar situation was observed at Ball Play (Monroe County). It was somewhat less common in Cumberland County.

Seasonal abundance data had to be based on observations of cattle, as this species was rarely taken in the Manitoba traps. Extreme dates ranged from ^{31 May} ~~7 June~~ (Rafter) to 8 August (Cumberland County).

Tabanus aranti Hays

This species closely resembles the more commonly collected T. atratus. It was occasionally seen attacking cattle at Rafter (Monroe County), where it was present in low numbers from 21 June to 12 July. It was taken in Manitoba traps at Ball Play (Monroe County) on 21 June 1977, in Knox County on 29 June 1978, and in Madison County on 26 July 1978.

Tabanus atratus atratus Fabricius

This common, large, black species is widespread in Tennessee and has a long flight season. It is a pest of cattle in many areas, but was never observed in great numbers. It was seldom collected in Manitoba traps, and of eight total specimens taken in the traps, three were males. T. atratus was taken from Monroe (Ball Play and Rafter), and Cumberland Counties, and one was netted from a cow in Madison County on 23 August 1977. Extreme collection dates ranged from 6 June to 19 September (Cumberland County).

Several females were observed ovipositing at the edges of farm ponds; one on emergent vegetation (Figure 1, p. 4) and one on an old fence post. Larvae of T. atratus were located in a primary settling pond below a dairy barn in Madison County. The floating mat of fecal debris was about 15 cm thick and four nearly mature larvae of T. atratus were recovered from .4m² of this debris. This density is quite high for such a large invertebrate predator. Larvae of T. subsimilis were also found. Finding of these species agrees with similar observations by Gingrich and Hoffman, 1967.

Tabanus calens Linnaeus

This large species was a very common late-season pest of cattle in Cumberland County. Collection dates there ranged from 1 August to 5 September. It also seemed to be fairly common in late August in Madison and Fayette Counties. Collections in the Manitoba traps were not representative of their total numbers. T. calens was less common in Knox and Monroe (Ball Play and Rafter) Counties. Collection dates ranged from 26 July (Rafter) to 15 September (Fayette County).

Two larvae of this species were found and reared. One was collected in a hillside seepage area of Sevier County by D. A. Ethier. The other was collected by the author on a moist, well-drained hillside in Cumberland County. It was in surface organic soil rich in tipulid larvae. A thorough search of the top several inches of soil over a circumscribed 2m² area failed to produce more tabanid larvae.

Tabanus cymatophorus Osten Sacken

This species was taken only in the western portion of Tennessee. Manitoba trap collections in Madison County and Fayette County ranged from 20 July to 31 August (five specimens total).

Tabanus exilipalpis Stone

Three specimens of this species were taken in a Manitoba trap at Ball Play (Monroe County) from 25 May to 15 June 1978. It was previously known only from the West Tennessee counties, and these collections represent an eastern range^{extension} of about 350 miles (Pechuman, personal communication).

Tabanus fairchildi Stone

This species was taken from Blount (Tremont), Knox and Monroe (Ball Play and Rafter) Counties. Dates of collection ranged from 22 June (Ball Play) to 26 July (Rafter), with a population peak evident in early July at Ball Play in 1978 and in mid-July at Rafter in 1977. Only one specimen was taken in 1978 at Rafter (versus 10 specimens in 1977).

Larvae of T. fairchildi are found in streams and rivers (Teskey, 1969). Though this species has been reported from counties adjacent to Cumberland County, neither adults nor larvae were collected in Cumberland County.

Tabanus fulvulus Wiedemann

This medium-sized, yellowish "greenhead" is a common and widespread species in Tennessee. It was occasionally difficult to distinguish

from T. pallidescens, with which it flies in many areas. It was taken from Knox, Madison, Fayette, Blount (Tremont and Townsend), Cumberland, and Monroe (Ball Play and Rafter) Counties. Collection dates range from ^{27 May Fayette Co.} ~~2 June (Ball Play)~~ to 31 August (Fayette County), with population peaks in late June or early July in most areas.

The largest populations of T. fulvulus were observed at Ball Play (Monroe County) where this species comprised almost 4% (264 specimens) of the 1978 tabanid catch. In conjunction with T. pallidescens, it was a major pest of cattle there, with up to eight specimens attempting to feed simultaneously on one leg of a cow. It was also a major species in West Tennessee and in Cumberland County. In Fayette, Monroe (Ball Play) and Cumberland Counties the 1978 peak populations occurred about two weeks later than in 1977, the latest peak being in Cumberland County in mid-late July 1978. Line graphs dealing with the seasonal abundance of T. fulvulus are given in Figures 13, 15, 22, and 25, pp. 44, 48, 58 and 62, respectively.

Tabanus lineola Fabricius

A melanistic form of T. lineola is quite common and widespread in Tennessee. It can be a cattle pest in some areas and was captured from Cumberland, Blount (Cades Cove), Madison, Fayette, Knox, and Monroe (Rafter and Ball Play) Counties. It was quite common in West Tennessee, comprising 10% (159 specimens) of the tabanid fauna in Madison County and 14.2% (90 specimens) in Fayette County during 1978. In Cumberland County it was also quite common and made up 3.3% (240 specimens) of the total catch in 1978. By contrast, it was rare at Rafter (two specimens

total) and made up less than 1% of the total catch at Ball Play and Knox County. Peak population levels were reached from mid-late June (Ball Play) to July (Cumberland County) and were about one week later in 1978 than 1977 at most locations. There was some evidence of a partial second brood in Cumberland County in Early September of 1978. Extreme collection dated ranged from ²⁰~~27~~ May to 2 October (Fayette County). Line graphs dealing with the seasonal abundance of lineola are given in Figures 13, p. 43, and 17, p. 50.

Tabanus longus Osten Sacken

This species is part of a difficult group comprised mainly of T. longus, T. sublongus, and T. sackeni in Tennessee. Specimens from this group show a great deal of morphological variation, and Pechuman (personal communication) states "Characters which usually hold in other Tabanus species seem quite plastic in the longus group." The larva and male of T. longus are unknown.

Data from 1977 dealing with T. longus may be partially erroneous, as these specimens were separated from those of T. sublongus primarily on the basis of color and shape of abdominal spots, and some specimens were discarded after identification. While these are good separating characters, a combination of characters, including color and shape of abdominal spots, frons width, and maxillary palp length allowed more accurate separation of these two species in 1978.

T. longus was a fairly common species in the East Tennessee mountains at Rafter (Monroe County) and was a minor cattle pest, flying from 2 June to 7 September, with an apparent minor population peak in

mid-August at Rafter. One positively-identified specimen was taken at Tremont (Blount County) on 3 July 1977, and two were taken at Townsend (Blount County) on 31 July 1977 while attacking man.

Tabanus marginalis Fabricius

A series of 20 specimens of this species was taken at Rafter (Monroe County) from 11 May to 2 June 1978. It is a more northerly species, but disjunct populations occur southward along the Appalachian mountain chain (Pechuman, 1973).

Tabanus melanocerus Wiedemann

This species is widespread in Tennessee and was observed feeding on cattle. It was taken in all study areas and dates range from 7 June (Ball Play, Monroe County) to 31 August (Madison County), with peak populations occurring from late June to mid-July. Though not prevalent, it was fairly common, comprising from about 1% (11 specimens, 1978 Knox County) to 4.7% (41 specimens, 1977 Rafter) of the total tabanid catch in all study areas.

Specimens of T. melanocerus were quite difficult to separate from T. petiolatus in East Tennessee, but became much easier to separate in the western counties. The author felt that most specimens from East Tennessee that displayed intermediate characters were T. melanocerus.

A line graph concerning the seasonal abundance of melanocerus is given in Figure ¹³22, p. ⁴⁴56.

Tabanus moderator Stone

Tabanus moderator was taken only from Monroe County (Ball Play and Rafter) and Knox County. Extreme collection dates are ^{31 May Blount Co.} ~~7 June~~ (Ball Play) and 26 July (Rafter), with apparent 1978 population peaks in mid-late June in Monroe County. This species made up about 1% (73 specimens) of the total tabanid catch at Ball Play and about 1% (31 specimens) at Rafter 2.

T. moderator was observed feeding heavily on cattle at Rafter at dusk during its peak abundance in late June.

Tabanus molestus Say

Both T. molestus and a dark form T. molestus mixis Philip were observed feeding on cattle, and are widespread in Tennessee. They were captured at all locations and flew at the same times. Extreme collection dates range from ^{31 May} ~~2 June~~ to 27 July (Ball Play, Monroe County) for molestus and ²⁴ ~~25~~ May (Madison County) to 9 August (Ball Play) for mixis. Peak populations for both generally occurred in late June and early July.

In most areas neither form exceeded 1% of the total tabanid fauna. T. molestus was the predominant form in West Tennessee, while T. m. mixis was the predominant form in all other study areas. In Madison County, T. molestus comprised only 2% (33 specimens) of the tabanid fauna. At Ball Play (Monroe County) this trend was reversed, as the two forms combined to make up 18.2% of the total catch in 1978. T. molestus made up 5.3% (365 specimens), while T. m. mixis made up 12.9% (882 specimens). Oddly, in spite of huge numbers captured in the traps, nearby horses and

cattle were not extremely bothered during the day. Some crepuscular feeding activity was noted for both forms. Line graphs dealing with the seasonal abundance of both forms are given in Figures 22 and 25, pp. 56 and 62, respectively.

The morphological appearance of these two forms differs markedly with almost no intergradation. Pechuman (personal communication) states "Since T. m. molestus and T. m. mixus fly together they can hardly be subspecies; they must either be color forms of one species or 2 species."

Tabanus mularis Stone

This species was captured only in West Tennessee. It was not present in either Fayette or Madison Counties in large numbers, but had a long flight period. Extreme dates of collection ranged from 1 June (Madison County) to 15 September (Fayette County). A population peak was evident in Fayette County in late June of 1978.

Tabanus nigrescens Palisot de Beauvois

This species appears to be widespread in Tennessee, but it was not common in any of the study areas. It was occasionally captured feeding on cattle at Rafter (Monroe County). Manitoba traps seldom caught more than one or two in a season. Other collection areas included Knox, Blount, Monroe (Ball Play), Fayette, and Madison Counties. The earliest record is from Rafter on 28 June, while the latest is from Madison County on 3 August.

Tabanus nigripes Wiedemann

This stout little species is common and widespread in the state and was captured in all study areas except Blount County, where it is

probably present. It has a long flight season, with most flying from mid-June to early July. Records range from 2 June (Rafter, Monroe County) to 5 September (Cumberland County).

In most areas I. nigripes comprised less than 1% of the total catch. It was fairly common in Monroe County, however, and was a cattle pest at Rafter. At Ball Play it made up 1.2% (80 specimens) of the total catch in 1978. At Rafter it comprised 2.3% (20 specimens) of the catch, while across the ridge at Rafter 2 it was one of the more common species, making up 5.4% (164 specimens) of the total. A line graph pertaining to the seasonal abundance of I. nigripes is given in Figure 25, p. 62.

Tabanus pallidescens Philip

This species is one of the most prevalent and widespread in Tennessee and was collected in all study regions. It resembles I. fulvulus but generally outnumbers it, except in Cumberland County, where only two were collected. Its seasonal abundance was similar to that of I. fulvulus and it was a major pest of cattle and horses in Monroe County. In Madison County it comprised less than 2% (27 specimens) of the 1978 total, while in Fayette County it made up 9% (61 specimens) of the 1978 catch. I. pallidescens was common in Monroe County. At Rafter it comprised 7.1% (62 specimens) of the total and 4.1% (124 specimens) at Rafter 2. It was most prevalent at Ball Play, where 818 specimens comprised 12% of the total tabanid catch for 1978.

Collection records cover a period of ^{31 May} ~~2 June~~ (Fayette County; Monroe County, Rafter, ~~Blount County, Tremont~~) to 4 August (Fayette

County) with most peak population levels occurring from mid-June to early July. Line graphs dealing with the seasonal abundance of I. pallidescens are presented in Figures 15, 22 and 25, pp. 48, 56, and 62, respectively.

Tabanus petiolatus Hine

I. petiolatus did not separate easily from I. melanocerus in the eastern part of the state. It is possible that some specimens called I. melanocerus actually may have been extreme variants of I. petiolatus. The morphological differences between the West Tennessee specimens (which separated very easily from I. melanocerus) and the East Tennessee specimens (which display a complete range of characters) are considerable. I. petiolatus was collected from Fayette, Madison, Cumberland, and Monroe (Rafter) Counties. In Cumberland County some specimens were collected which displayed many very definite I. petiolatus characters, but the same could be said of very few Monroe County specimens.

This was a minor species (<1% of the total catch) in all areas except Madison County. Here I. petiolatus comprised over 10% (163 specimens) of the tabanid catch. Extreme collection dates are 15 June to 7 September (Madison County), with peak abundance in early to mid-July. It was occasionally seen feeding on cattle in Cumberland County. A line graph dealing with the seasonal abundance of I. petiolatus is given in Figure 17, p. 50.

Tabanus proximus Walker

This large, dark species was much more commonly collected in West Tennessee, but was occasionally collected in Monroe County (Rafter

and Ball Play). It has a late flight season, but too few were captured in the Manitoba traps to discern a peak flight period. Records range from 5 July (Ball Play) to 14 September (Madison County). Three specimens were captured feeding on cattle in Madison County in late August. The trap in Madison County was most productive for this species, capturing 17 specimens in 1978.

Tabanus pumilus Macquart

This tiny Tabanus was taken from Monroe County (Ball Play and Rafter), Knox County, Cumberland County, and Madison County. Closely resembling T. sparus milleri, it was always much less common. In Knox and Cumberland Counties it was rarely collected. It comprised slightly over 1% (21 specimens) of the tabanids collected from Madison County with a population peak in early June but was more abundant in Monroe County. At Ball Play it made up about 1% (70 specimens) of the catch. An interesting situation occurred at Rafter. While only 13 specimens were taken in the small valley at Rafter 1, 131 specimens were taken across the ridge at Rafter 2, where a definite population peak occurred in mid-June. Dates range from 25 May to 11 July.

T. pumilus was observed in small numbers attacking cattle. Though Pechuman (1973) states it readily attacks man, none were collected by overhead netting. Seasonal abundance graphs for this species are presented in Figures 22 and 25, pp. 58 and 62, respectively.

Tabanus quinquevittatus Wiedemann

This species is widespread in Tennessee and was captured in all study areas. In some areas it was rarely collected, while in others it

was the major species in trap collections. T. quinquevittatus was rarest at Rafter 1 (Monroe County) and Blount County (Tremont), where only two specimens were taken. At Rafter 2, however, this species comprised 3.9% (118 specimens) of the total tabanid catch. It was quite common in Fayette County (10% of total, 69 specimens) and Monroe County, Ball Play (7.5% of total, 514 specimens). In Knox County it made up over 52% (633 specimens) of the total catch. It has a very long flight season and was collected from 28 May (Knox County) to 28 September (Monroe County, Ball Play).

In Cumberland County, where four traps were operated, it was by far the most prevalent species, comprising 51.7% (1254 specimens) of the catch in 1977 and 62.7% (4571 specimens) in 1978. Interestingly, one trap (trap #2) captured the bulk of the specimens, taking 69% of the total in 1977 and 88% in 1978. Tashiro and Schwardt (1949) reported moist pasture sod as a favored breeding habitat of T. quinquevittatus. Trap #2 was situated adjacent to large areas of moist pasture (Figure 10, p. 29). It also could be seen easily from a considerable distance. In observations of the cattle, relatively low numbers of T. quinquevittatus were observed attacking cattle except in these low pasture regions, where as many as 10 to 12 specimens could be observed on a single animal at one time. For this reason, though it was taken in larger numbers, it was a less significant cattle pest than H. lasiophthalma and H. difficilis in Cumberland County.

A larva of this species was removed from moist pasture sod in Cumberland County.

Line graphs concerning the seasonal abundance of T. quinquevittatus may be found in Figures 13 and 20, pp. 48 and 52, respectively.

Tabanus reinwardtii Wiedemann

A total of seven specimens were taken in the course of this study from Cumberland County, Knox County, and Monroe County (Rafter and Ball Play), and collection dates ranged from 15 June (Ball Play) to 26 July (Rafter).

Though common in larval collections, T. reinwardtii is rarely collected as an adult (Pechuman, 1973). The habits of the adult males were documented in Wyoming (Lavigne et al., 1968) but the behavior of the females remains obscure. In the course of this study, two females were captured resting on the interior of an open cattle shed, and one was taken from the ventral midline of a cow, where it landed twice.

Tabanus sackeni Fairchild

T. sackeni is widespread in Tennessee, but was a minor factor with regard to tabanid totals in most areas, comprising less than 1% of the population. It was captured from Blount, Monroe (Rafter and Ball Play), Madison, Fayette and Cumberland Counties. It has a fairly late flight season, extreme collection dates ranging from 20 June (Blount County, Tremont) to 28 September (Ball Play). Peak flight periods are from mid-July to late August.

T. sackeni was fairly common in Cumberland County, with 91 specimens collected in 1977 and 53 specimens in 1978. In Madison County it comprised 4% (56 specimens) of the tabanid catch. At Ball Play (Monroe County) the species was less than 1% (33 specimens) of the catch.

This species was observed attacking cattle and one was taken while attacking a man. One male was captured in a light trap at Rafter on 13 July 1978. A line graph dealing with the seasonal abundance of T. sackeni is presented in Figure 17, page 50.

Tabanus sagax Osten Sacken

Collection dates for this uncommonly collected species range from 20 June to 11 July (Cumberland County). Ten specimens were taken from Cumberland County; five from Ball Play (Monroe County), and one from Rafter (Monroe County). A small peak of activity was evident in Cumberland County in early July.

Tabanus similis Macquart

The females of this species were quite difficult to separate from those of T. subsimilis. A total of 14 specimens were taken during this study from Cumberland County. The species seems to have two generations in Cumberland County. Collection dates range from 3 May to 30 June, with a second group of collections on 5 and 12 September. One specimen was netted from a cow on 2 June 1977. One specimen was taken with a net from Monroe County (Ball Play) on 7 June 1978.

Tabanus sparus milleri Whitney

This tiny species is a common and widespread pest of man and cattle in Tennessee, attacking man much like a Chrysops. It was taken from every study area except Tremont (Blount County) and is probably present there also, as it was captured in large numbers at both Cades

Cove and Townsend. Collection dates ranged from 20 May (Fayette County) to 7 September (Madison County). Most were captured from early June to mid July.

Large numbers of this species were taken in the traps, with Ball Play (Monroe County) yielding the most (913 specimens). T. sparus milleri was the most prevalent tabanid species taken in Madison County, comprising 28% (449 specimens) of the tabanid catch. It was the second most common species in Monroe County (Ball Play and Rafter) and ranked third in Knox County. Of hundreds of fresh specimens seen and dozens more relaxed, all had a single eyeband (T. sparus sparus has none). For this reason all specimens of T. sparus were assumed to be milleri.

Line graphs concerning the seasonal abundance of this species may be found in Figures 15, 17, 22 and 25, pp. 48, 50, 56 and 62, respectively.

Tabanus stygius Say

Two specimens of this species were taken in the Manitoba traps in Madison County on 6 July 1978 and on 17 June 1977 in Fayette County.

Tabanus sublongus Stone

T. sublongus may be difficult to separate from T. longus but seems both more common and more widespread. Though it was never present in large numbers, it was fairly common at Rafter, Monroe County (51 specimens) and Tremont, Blount County (65 specimens) in mid-July. It was captured from Monroe (Ball Play and Rafter), Blount (Tremont), Knox, Fayette, and Madison Counties. Dates range from 29 June to 30 August.

T. sublongus was seen attacking cattle. A line graph dealing with the seasonal abundance of sublongus may be found in Figure 20, p. 53.

Tabanus subsimilis subsimilis Bellardi

This species is fairly common in Tennessee and was taken from every study area. It has a very long, almost aseasonal flight period in most areas, with collection dates ranging from 11 May (Monroe County, Ball Play) to 10 October (Cumberland County). Most areas showed a slight population peak from late-May to mid-June.

T. subsimilis was present in large numbers in early September in Cumberland County in 1978. This second brood was much larger than the first and was not detected in 1977, probably due to the poor condition of the traps. In late season it was a significant pest of cattle. Late collections from other locations add support to the suggestion that this species regularly has two broods. Schwardt (1931) reported two broods for subsimilis in Arkansas.

A specimen of T. subsimilis was reared from a larva collected with several T. atratus larvae in fecal debris in a lagoon below a dairy barn.

A line graph pertaining to the seasonal abundance of subsimilis is presented in Figure 13, p. 44.

Tabanus sulcifrons complex

This complex has presented considerable taxonomic difficulty for many years. The presently recognized species that appear to be involved in this group include T. abdominalis Fabricius, T. sulcifrons Macquart, and possibly T. gladiator Stone and T. nefarius Hine (J. F. Burger, personal communication). Stone (1938) wrote:

For many years Tabanus sulcifrons, T. exul, and T. variegatus have been considered to be distinct species or, in the case of exul at least, synonymous with abdominalis Fabricius. As pointed out under the latter species, abdominalis is quite distinct and should not be confused. This leaves a somewhat variable species, divided by Osten Sacken into three. One, which he described and named Tabanus tectus, he later found to be a synonym of T. sulcifrons Macquart, after studying the type of the latter. In this the abdominal triangles are large and broad and the large facets in the eye of the male are reduced in number, occupying only the upper portion of the eye. Another, described by Osten Sacken and named T. exul, has small abdominal triangles and a more extensive area of large facets in the male eye. The third, T. variegatus F., has the discal portion of the wing distinctly whitish. The writer has studied a large number of this species, involving both sexes of all three forms, and cannot see that any of the above-mentioned characters are sufficient even to differentiate varieties or races. They do not sort out geographically, and intergrade so completely in any given area that there appears to be no excuse for separating them.

Of the species that may be involved in the complex, two were encountered in this study, T. abdominalis Fabricius and T. sulcifrons Macquart. The species that the author has called abdominalis was taken from Cumberland, Monroe (Ball Play and Rafter), Fayette, and Blount (Townsend) Counties. It is characterized by an extremely narrow frons, lack of abdominal triangles, and more evident thoracic stripes. Some of these specimens have a hint of abdominal triangles. The peak flight period is from early to mid-July, with records ranging from 21 June (Rafter) to 8 August (Cumberland County), and the peaks usually corresponded with those of the early form of T. sulcifrons.

T. sulcifrons is a major pest species of cattle in many areas of Tennessee. Though a relatively minor species in Cumberland County, considerable numbers were taken in Monroe County (Ball Play and Rafter), and it comprised 17% (107 specimens) of the total catch in Fayette

County and over 20% (318 specimens) in Madison County in 1978. In late season at Rafter as many as 13 individuals were seen feeding on a cow at one time. Dates ranged from 14 June to 17 October.

A female of I. sulcifrons was observed with its abdomen in the soil of a tobacco field in Greene County, apparently ovipositing. Several other females were taken in the same field by C. D. Hylton with pitfall traps containing an ethylene glycol-water mixture.

The seasonal abundance of I. sulcifrons proved to be extremely interesting. Two fairly distinctive morphological forms were found in most study areas. These forms were temporally isolated in Monroe County (Ball Play and Rafter) and have distinctive population peaks in most other areas, notably Madison County and Fayette County. In other study areas too few specimens were captured to be sure of distinct seasonal peaks. It is obvious that there are early and late-season emergences of the species called I. sulcifrons in many areas of Tennessee (Figure 26).

Dr. J. F. Burger of the Department of Entomology, University of New Hampshire, has been working with the sulcifrons complex. In personal communication he stated that he is testing about 25 characters on the group and has noted distinct differences in these two forms, notably in the female genitalia. Unfortunately, while the two populations differ noticeably in appearance, the author has noted that variation is quite common in respect to an individual's specific morphological characters. This is especially true in West Tennessee, where the populations have

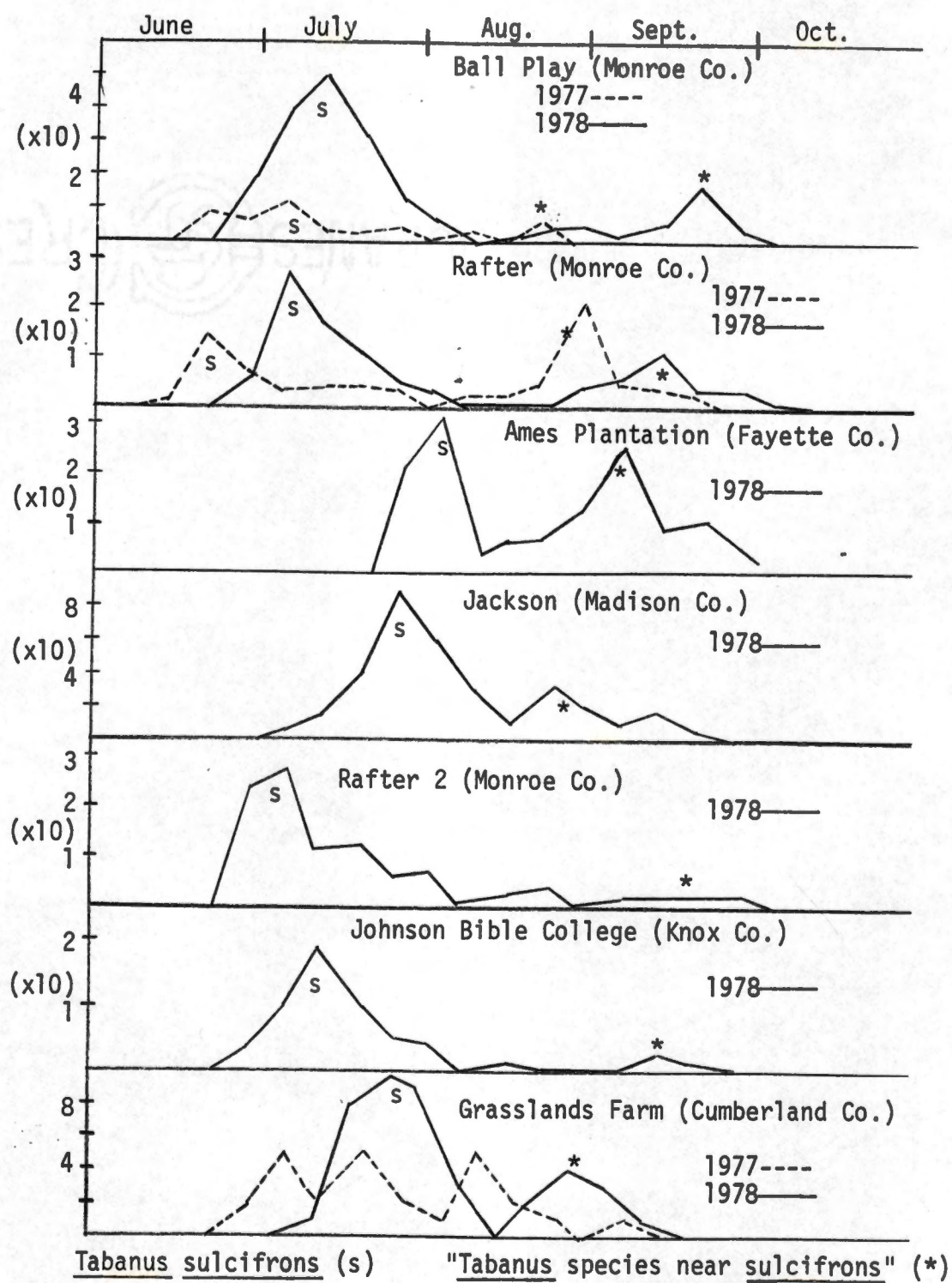


Figure 26. Seasonal Abundance of *Tabanus sulcifrons* in Tennessee.

considerable temporal overlap. At Rafter (Monroe County), however, where the early and late season forms are well segregated temporally, some general descriptions can be made that hold to some extent there and in other areas of Tennessee.

Ten randomly selected specimens of each of the early and late forms of T. sulcifrons were measured in terms of gross body length and length of the labrum from the base of the frontoclypeus to the tip (an approximation of mandible length). In these specimens the early season form tended to be significantly larger in size than the late form (22.20 ± 1.17 mm versus 19.35 ± 1.47 mm, $p < .01$). The labrum was nonetheless shorter than in the last season form 2.73 ± 0.13 mm versus 2.97 ± 0.14 mm, $p < .01$).

General coloration of the thorax is more brown in the early form, while the late form has a lighter, more grayish thorax. The abdominal triangles of the early form are yellowish, while those of the late form are more silver. In addition, the background coloration of the abdomen tends to be a darker shade of burnt orange in the late form, and the wings of the late form lack the yellowish cast present in the early form. Burger (personal communication) also notes that the basal and median frontal callosities are distinctly joined by a denuded ridge in the early form, while being separated in the late form.

Fabricius may have applied the name T. variegatus to the late form of T. sulcifrons, but it is preoccupied and unavailable. It now appears as though the late form, which Pechuman calls the "Carolina form," is formally unnamed and specifically distinct from the earlier

and more widespread form which Macquart described as I. sulcifrons (Burger, personal communication). For this reason the late form is referred to in Figure 26, p. 97 as "Tabanus sp. near sulfifrons."

Actually, however, the forms or species related to sulfifrons are not necessarily limited to two (Pechuman, personal communication) and more work remains to be done on this fascinating but confusing group.

Tabanus superjumentarius Whitney

I. superjumentarius was sometimes plentiful enough at Rafter (Monroe County) to make it a minor pest of cattle. The species seemed prevalent in mid-late June, and extreme collection dates range from 7 June (Rafter and Knox County) to 27 July (Rafter). It was collected from Cumberland, Knox, Blount (Tremont) and Monroe (Ball Play and Rafter) Counties.

Tabanus trimaculatus Palisot de Beauvois

This tabanid resembles I. superjumentarius, but is generally more common and widespread, though less common than superjumentarius in the East Tennessee mountains. I. trimaculatus was most common in Knox County, where it comprised 5.4% (66 specimens) of the catch, and Madison County, where it made up 6% (99 specimens) of the catch. It was also fairly common in Cumberland and Fayette Counties, and was captured in smaller numbers in Monroe County (Rafter and Ball Play) and Blount County (Townsend). In Cumberland County, the 1977 populations seemed to peak in late June, while they were about one week later in 1978. A similar situation occurred in Fayette County, where the early

June peak of 1977 was delayed about one week in 1978. Line graphs dealing with the seasonal abundance of trimaculatus are given in Figure 13, p. 44, and Figure 19, p. 52.

I. trimaculatus was an occasional pest of cattle. A larva of this species was found in the roots of aquatic vegetation growing along a slow pasture stream in Polk County.

Tabanus turbidus Wiedemann

This moderately large species was not very common in the traps but may have been poorly represented due to its crepuscular and nocturnal habits. At Rafter, for instance, few were caught, although dozens were noted feeding on cattle slightly before dark. I. turbidus was collected in Monroe County (Rafter and Ball Play), Blount County (Townsend), and in Madison County. It was most common at Ball Play, where it comprised slightly over 1% (71 specimens) of the catch. Collection dates ranged from 31 May (Townsend) to 27 July (Ball Play). Peak activity appeared to be in early July. Both sexes were readily attracted to lights, and a good series was taken in a light trap in Blount County (Townsend) by J. H. Hope from 31 May to 11 July 1977.

IV. RESULTS OF LARVAL SAMPLING

During the winter and early spring of 1977, hundreds of tabanid larvae were collected, killed in hot water, and preserved with detailed collecting information. The author intended to identify these larvae and thereby gather ecological information on the habitats of various

species. As the study developed, however, it became obvious that the adult portion was a full-fledged effort in itself, leaving little time for the proper identification of the larvae. It would have been easier to maintain the live larvae and rear the adults, and this was done with a few specimens, particularly those gathered in late winter and early spring of 1978.

Species reared from larvae included Tabanus calens, T. subsimilis subsimilis, Chrysops macquarti, and Hybomitra sodalis. One pupa of T. lineola was reared. Larvae of T. quinquevittatus, T. atratus, and T. trimaculatus were identified. Additionally, oviposition was observed for T. atratus atratus, C. callidus, and C. cincticornis. Notes on all the above species may be found in the species discussions.

A great deal of time and effort was spent attempting to locate the larvae of Hybomitra difficilis. Though the adults are present in large numbers and are a major pest of cattle and horses in several areas of Tennessee, the larvae were never found. For a more detailed discussion, the reader is referred to the section on that species.

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APPENDIX



Table 2. 1977 Seasonal Abundance (Cumulation of 4 Traps)- Grasslands Farm, Plateau Exp. Sta.
Cumberland Co. Tennessee

	Apr.				May				June				July				Aug.				Sept.			
	28	5	12	19	26	2	9	16	23	30	7	12	21	28	4	11	18	25	1	8	15	22		
<u>Hybomitra</u>																								
<u>lasiopterna</u>		10	88	101	16	5																		
<u>difficilis</u>			3	92	34	33	11	22	22	1														
<u>trispila</u>										2	1													
<u>Hamatabanus</u>																								
<u>carolinensis</u>					1																			
<u>Chrysops</u>																								
<u>callidus</u>				2	4	4	1	3	16	17	1	3	3	-	2									
<u>niger</u>		1	1																					
<u>montanus</u>										7	4													
<u>pudicus</u>										2	-	1												
<u>vittatus vittatus</u>										1														
<u>univittatus</u>											1	1	-	1										
<u>Leucotabanus</u>																								
<u>annulatus</u>											1	-	5	1										
<u>Tabanus</u>																								
<u>subsimilis subsimilis</u>										9	9	-	5	4	-	2	1	3	2	1				
<u>similis</u>										2	1													
<u>lineola</u>										1	4	24	30	6	30	32	8	1	2	-	4	1		
<u>trimaculatus</u>										2	3	9	10	5	4									
<u>sparus milleri</u>										2	1	24	16	9	10	21	3	2						
<u>fulvulus</u>											3	10	25	14	13	19	11	2	1					
<u>molestus mixus</u>											2	-	-	2	1	-	1							
<u>nigripes</u>											2	6	3	11	9	-	3	3						
<u>melanocerus</u>											2	5	9	8	12	4								
<u>petiolatus</u>											1	3	2	2	9	-	1							
<u>quinquevittatus</u>										45	36	43	178	445	179	127	135	28	25	9	5	3		
<u>sulcifrons</u>											2	5	2	5	2	1	5	2	1	-	1			
<u>abdominalis</u>												3	7	7	1									
<u>sagax</u>											1	-	1											
<u>sackeni</u>											1	2	4	37	29	9	4	5						
<u>superjumentarius</u>												1	1											
<u>reinwardtii</u>												1												
<u>aar</u>														1										
<u>atratus atratus</u>														1	-	-	1	-	-	1				

Table 3. 1978 Seasonal Abundance (Cumulation of 4 Traps)- Grasslands Farm, Plateau Exp. Sta.,
Cumberland Co., Tennessee

	Apr.				May				June				July				Aug.				Sept.				Oct.
	28	2	9	16	23	30	6	13	20	27	3	11	18	25	1	8	15	22	29	5	12	19	26	3	10
<u>Hybomitra</u>																									
<u>lasiopterna</u>		5	13	124	269	182	75	11	2																
<u>difficilis</u>				1	36	241	294	92	49	7	1														
<u>typhus</u>						1																			
<u>trispila</u>											1	6	1												
<u>Chrysops</u>																									
<u>niger</u>				1	-	1																			
<u>brimleyi</u>					1	1																			
<u>callidus</u>				3	13	7	6	4	6	8	3	1	-	-	-	-	1	14	7	4					
<u>cincticornis</u>				1	-	-	1																		
<u>cuclux</u>						1																			
<u>macquarti</u>						1																			
<u>pudicus</u>																									
<u>flavidus</u>													1						1						
<u>univittatus</u>												2	-	2											
<u>Leucotabanus</u>																									
<u>annulatus</u>												1	-	1	-	1	2								
<u>Tabanus</u>																									
<u>subsimilis subsimilis</u>		2	2	19	6	2	4	5	10	5	2	3	9	13	9	21	60	84	69	40	24	2			
<u>similis</u>				1	3																				
<u>lineola</u>				2	-	24	23	31	33	36	23	23	12	10	2	3	1	3							
<u>trimaculatus</u>						1	3	8	6	2	3	2	1												
<u>sparus milleri</u>						1	4	15	26	29	12	16	5	1	-	2									
<u>fulvulus</u>						3	6	16	12	27	25	19	11	-	1										
<u>molestus mixis</u>						3	4	5	5	2	2	2													
<u>molestus molestus</u>																									
<u>quinquevittatus</u>						1	75	257	333	781	615	884	568	363	148	110	190	84	103	42	11	6			
<u>nigripes</u>						4	4	1	5	4	7	4	1	2	2	1									
<u>melanocerus</u>						1	6	11	29	15	27	9	4	2	1	3									
<u>petiolatus</u>									1	3	3	3	-	1	-	2									
<u>pumilis</u>						4	1			1															
<u>sagax</u>							1	1	-	6															
<u>superjumentarius</u>							1	-	1																
<u>pallidescens</u>																									
<u>sulcifrons</u>											1	8	10	9	3	-	2	4	3	1					
<u>abdominalis</u>											2	1	5	7	4	1									
<u>sackeni</u>												1	1	4	17	9	-	4	11	2	2	2			
<u>calens</u>																	1	1	-	-	1				
<u>atratus atratus</u>																	1	-	1	-	2				

Table 6. 1977 Seasonal Abundance- Rafter 1, Monroe Co., Tennessee

	Apr.				May				June				July				Aug.				Sept.				
	14	21	26		3	10	17	24	31	7	14	21	28	5	13	19	26	2	9	16	22	30	6	12	20
<u>Hybomitra</u>																									
<u>lasiopteralma</u>			1		1	-	-	-	-	-	1														
<u>difficilis</u>			5		3	4	4		-	-															
<u>sodalis</u>											2	23	31		21	10	5								
<u>cincta</u>											1	3													
<u>trispila</u>											2	3		1											
<u>Chrysops</u>																									
<u>univittatus</u>											3	-	3	1	4	1									
<u>geminatus</u>											2	1	-	3											
<u>impunctus</u>												1	-	1											
<u>callidus</u>												1													
<u>vittatus vittatus</u>														1											
<u>cursim</u>														2	1	1									
<u>Leucotabanus</u>																									
<u>annulatus</u>														1	1	-	1								
<u>Tabanus</u>																									
<u>sparus milleri</u>											5	19	30	14	26	19	7	1	2	-	1	2			
<u>pumilis</u>											2	4	1	2	2										
<u>nigripes</u>											2	1	6	2	14	10	6	3	-	-	3	2			
<u>superjumentarius</u>											1	2	4	4	1										
<u>melanocerus</u>											3	2	4	2	10	11	3	1	2	1	2				
<u>petiolatus</u>														1	2										
<u>molestus mixis</u>											1	4	-	1											
<u>molestus molestus</u>																									
<u>longus(?)</u>											1														
<u>pallidescens</u>											1	2	1	1	1	7	-	-	1	1	2	2			
<u>fulvus</u>											12	9	6	9											
<u>sulcifrons</u>											6	3	2	2	1										
<u>abdominalis</u>											1	14	9	3	5	3	-	2	2	5	21	5	3	2	
<u>fairchildi</u>											1	2	1	1											
<u>nigrescens</u>												1	1	5	1	2									
<u>quinquevittatus</u>												1	-	-	1										
<u>sublongus</u>												1	-	-	1	-	2								
<u>turbidus</u>													2	5	3										
<u>sackeni</u>														1											
<u>lineola</u>														1	3	1	-	-	-	-	-	3			
<u>proximus</u>																									
<u>americanus</u>																									
<u>reinwardtii</u>																									
<u>subsiniilis subsiniilis</u>																									
<u>moderator</u>											2	-	-	-	-	1							1	1	

Table 7. 1978 Seasonal Abundance- Rafter 1, Monroe Co., Tennessee

[illegible]

Table 10. 1977 Seasonal Abundance- Ames Plantation, Fayette Co., Tennessee

	May			June				July					Aug.				Sept.			
	15	20	27	2	9	17	24	1	8	15	22	29	5	11	19	26	2	8	16	23
<u>Chrysops</u>																				
<u>callidus</u>							1		1					1						
<u>Leucotabanus</u>																				
<u>annulatus</u>								2	1	1	2	-	-	1						
<u>Tabanus</u>																				
<u>trimaculatus</u>	1	-	2	5	3	5	1	1	1											
<u>subsimilis subsimilis</u>	2	2	1	6	2	-	1	1												
<u>sparus milleri</u>		5	16	27	10	12	7	-	2	-	2									
<u>lineola</u>			1	3	-	2	7	5	4	1	5	1								
<u>mularis</u>				2	-	1	-	-	-	1										
<u>quinquevittatus</u>				1	1	-	1	-	14	2	15	9	2	6	-	3	-	-	1	
<u>fulvulus</u>				5	2	8	5	12	21	7	4	1								
<u>pallidescens</u>				4	11	15	38	10	11	1										
<u>melanocerus</u>					1	1	1	1	3	1	-	-	-	1						
<u>petiolatus</u>									4	3	-	1	-	1						
<u>molestus molestus</u>						1	1	1	1											
<u>sulcifrons</u>								1	1	2	2	1	1	1	1	-	1	1	-	1
<u>abdominalis</u>								1	1	1										
<u>proximus</u>								1	-	3	-	1								
<u>nigrescens</u>								1												
<u>sackeni</u>										2	2	1	1	3	8	4	-	1		
<u>atratus atratus</u>													1							
<u>sublongus</u>															1	-	1	-	1	
<u>calens</u>																2	-	1		

Table 11. 1978 Seasonal Abundance- Ames Plantation, Fayette Co., Tennessee

	Apr.		May		June			July			Aug.				Sept.			Oct.	
	20	28--	16--	29	5	15	23--	13	18	26	4	11	16	23	31	8	15	22--	2--17
<u>Hybomitra</u>																			
<u>trispila</u>								1											
<u>lasiopterna</u>																			
<u>Chrysops</u>																			
<u>callidus</u>								1	-	-	1	2	1						
<u>Tabanus</u>																			
<u>trimaculatus</u>					1	1	5	7	1	-	-	1							
<u>subsimilis subsimilis</u>				3	-	3	26	26	8	-	-	5	4	-	1	2	2	1	2
<u>sparus milleri</u>				1	1	4	9	8	-	2	3	-	-	1					
<u>lineola</u>						14	24	24	-	10	8	-	3	3	3	1	2	-	1
<u>mularis</u>					2	6	16	9	-	-	12	2	1	1	1	-	1		
<u>quinquevittatus</u>					1	8	5	2	-	20	24	9	6	4					
<u>fulvulus</u>						2	2	13	-	11	6	-	3	-	1				
<u>pallidescens</u>						9	23	23	-	5	1								
<u>molestus molestus</u>							1	3											
<u>molestus mixis</u>							1												
<u>nigripes</u>					1	-	-	-	-	2									
<u>melanocerus</u>							3	-	4	7	-	-	1						
<u>petiolatus</u>							2	-	2	2									
<u>aranti</u>									1										
<u>sulcifrons</u>									22	30	4	6	7	13	25	9	12	3	5
<u>abdominalis</u>									1	3									
<u>sackeni</u>										1	1	2	2	3	1	1	1		
<u>cymatophorus</u>										1									
<u>sublongus</u>											1	1	-	2					
<u>proximus</u>													1						
<u>calens</u>																2	3	1	2

VITA

Bradley Alan Mullens was born in Audubon, Iowa on 5 April 1954. He attended elementary school in Denver, Colorado and moved to Knoxville, Tennessee in 1965. After graduation from Bearden High School in 1972, he enrolled at The University of Tennessee. Summers during college were spent as a crew leader for the Youth Conservation Corps in the Great Smoky Mountains National Park. In June of 1976 he received a B. S. in agriculture with a major in animal science. He entered the Department of Agricultural Biology at The University of Tennessee in the fall of 1976 where he served as a graduate research assistant. In March 1979 he received the M. S. degree with a major in Entomology.

Brad Mullens is a member of the Tennessee Entomological Society, the Entomological Society of America, the American Society of Animal Scientists, and the honor societies Gamma Sigma Delta and Phi Kappa Phi.