

THE TABANIDAE OF OKLAHOMA

By

Orville Carl Schomberg

Bachelor of Science

Colorado Agricultural and Mechanical College

Fort Collins, Colorado

1949

Submitted to the Faculty of the Graduate School
of the Oklahoma Agricultural and Mechanical College
in Partial Fulfillment of the
Requirements for the Degree of

MASTER OF SCIENCE

May 1952

a-57

JUL 31 1952

ii

THE TABANIDAE OF OKLAHOMA

Thesis Approved:

D. C. Howell

Thesis Adviser

Chas. A. Butt

D. G. W. Zutoch

Dean of the Graduate School

294787

PREFACE

Investigation into the biology of tabanids was begun in the spring of 1949 by the Division of Insects Affecting Man and Animals cooperating with the Department of Entomology, Oklahoma A. and M. College, in an effort to learn more of the biology of this economically important group of insects in Oklahoma. The material of this thesis outlines approximately two and one-half years cooperative work by the author while being employed by the Division of Insects Affecting Man and Animals, Kerrville, Texas.

I wish to express my appreciation for the assistance given to me by the following: Dr. Alan Stone of the United States National Museum at Washington, D. C.; Dr. C. B. Philip, Rocky Mountain Laboratory, Hamilton, Montana, and L. L. Pechuman, Lockport, New York, for identification of many difficult specimens; to the entomological staff for their suggestions; Dr. D. E. Howell for advice and guidance; and the Entomology Department, Cornell University, Ithaca, New York, for the loan of several unpublished Doctorate theses pertaining to the bionomics of New York Tabanidae; photograph of larva and habitat taken by G. A. Bieherdorf, Entomology Department, Oklahoma A. and M. College.

TABLE OF CONTENTS

ECONOMIC IMPORTANCE - - - - -	1
GENERAL BIONOMICS - - - - -	4
COLLECTING METHODS- - - - -	11
REARING METHODS- - - - -	13
OVIPOSITION OF CAGED FEMALES- - - - -	15
BIONOMICS OF REARED AND COLLECTED SPECIES- - - - -	16
LARVAL KEY- - - - -	45
LIST OF OKLAHOMA SPECIES - - - - -	49
SUMMARY- - - - -	60
LITERATURE CITED- - - - -	61

ECONOMIC IMPORTANCE

Blood sucking flies of the family Tabanidae are serious pests of domestic animals in nearly every part of the United States. Many of the insects affecting animals have been studied to such an extent that more of the pertinent information pertaining to biology and control has been acquired than with tabanids. Both the biology and control measures of this family are so poorly known that this group might be considered the outstanding challenge facing entomologists working on insect parasites of domestic animals.

The prime importance of horseflies lies in the amount of blood taken by engorging females and the consequent worrying produced in the grazing animals. Philip (13)* estimates that 50 Hybomitra lasiophthalma (Macquart) feeding at ten minute intervals will take a minimum of 300 c.c. of blood in one day. Webb and Wells (21) working with Tabanus phaenops Osten Sacken in Nevada states that this fly will consume an average of 100 c.c. of blood in one day. Schwardt (17) considers these estimates too low and states that the amount of blood trickling from the feeding puncture was not taken into consideration and the amount of the blood would probably be larger. This fact is borne out by Tashiro (20) who found that a heavy infestation of Hybomitra lasiophthalma (Macquart) may consume 387 c.c. of blood per day.

* Numbers in parentheses refers to Literature Cited, page 61.

During the periods when horseflies attack domestic animals while grazing, they become extremely restless and continuously interrupt their feeding to fight off the flies. If extremely large populations are present, they may become passive and stop fighting the attacking flies. This passivity under heavy infestations has been noted by Tashiro (20) in New York and Phillip (13) in Minnesota. During the summer of 1951, the author observed a herd of 25 cattle in Louisiana in which the animals averaged approximately 100 flies, yet very little effort was made to dislodge any of the biting flies.

Phillip (13) considers tabanids as the worst pest of livestock in Minnesota and quotes Howard as stating that in 1916 in certain areas of the state the milk supply was reduced as much as 60 percent in two weeks following a heavy outbreak. In some areas, dairying was discontinued during periods of heavy horsefly infestations. Many dairymen and parish agents in the Louisiana milk shed area are of the opinion that milk production will be reduced from 50 to 75 percent when a large number of horseflies prevent the cattle from grazing and resting sufficiently. This type of situation is usually of short duration as the various species found in Louisiana emerge at staggered intervals during the fly season. However, a survey conducted throughout the 31 parishes in Louisiana in the summer of 1951 emphasized the fact that a satisfactory tabanid control was the foremost problem of all the cattlemen interviewed.

Howell et. al. (6) working with tabanids in Oklahoma clearly demonstrated the ability of this group to mechanically transmit anaplasmosis in cattle. They found that seven species of tabanids are capable of transmitting anaplasmosis and see little reason why most of the species of the Tabanus group may not serve as mechanical transmitters.

Farley et. al. (4) records this febrile disease of cattle as occurring in 29 of the 48 states and probably may continue to spread to additional states. Dr. Batt (1) in discussing anaplasmosis in Florida cattle with the writer stated that in the last few years many outbreaks occurred throughout the cattle raising area of the state. Farley et. al. (4) states a probable \$1,000,000 annual loss in Oklahoma cattle production. It should be mentioned that tabanids are not the only route of transmission of this disease, but may be spread by any mechanical transfer of blood, such as occurs in bleeding, dehorning, or castration.

The preceding economic importance of horseflies concerns chiefly those flies of the Tabanus group. Related flies such as the genus Chrysops are also important, that in many areas their large numbers worry livestock and occasionally become pestiferous to man and are capable of transmitting an infectious disease, Bacterium tularense, to man from infected rodents, particularly rabbits.

GENERAL BIONOMICS

The egg masses of tabanids vary considerably in shape, coloration, number of eggs and place of oviposition. Chrysops usually place a flat, single tiered, oval mass consisting of 150 to 300 eggs upon the stems of aquatic or semi-aquatic plants. Philip (13) describes the egg mass of Hybomitra lasiophthalma (Macquart) as being a regularly arranged, downward-sloping basic layer on which are superimposed two smaller layers also sloping in a similar direction. These pitch black, wrinkled masses are invariably glued to a blade or stem of grass. Tabanus atratus Fabricius is not as selective in oviposition sites as many other species, as the ovoid, tiered, grey colored masses are commonly found firmly cemented to such objects as leaves, green twigs, sticks and projecting debris about some moist situation. The author has collected masses of this species glued to a cement wall above running water at a disposal filter bed and on one occasion found a Tabanus atratus Fabricius egg mass on the underside of a clothesline rope beneath a porch roof. The emerging larvae fell approximately five feet on to a cement platform and perished after several hours. Four hundred and twenty larvae emerged from this single egg mass. Tabanus abactor Philip, a common and important species in Texas, Oklahoma, and Kansas, has oviposited under laboratory conditions in which 50 to 150 eggs are placed in several loose piles with nearly one-third of the eggs individually scattered near the smaller masses.

Larvae of Tabanus equalis Hine have been collected in this study, but to date no egg masses have been collected. Schnorrenberg (16) in working with this species obtained egg masses under laboratory conditions and describes them as resembling a miniature honey comb, the eggs being laid in one layer and perpendicular to the object upon which they are attached.

The duration of the incubation period varies within species and specific groups. Schwardt (17) describes the incubation period of Chrysops callida Osten Sacken in the summer time to be seven days while those of Chrysops flavida Wiedemann require only four days. He further states that egg masses of Tabanus atratus Fabricius and Tabanus quinquevittatus Wiedemann hatch quite consistently after a period of five days. Tabanus lineola Fabricius had a short incubation period of four days while Tabanus sulcifrons Macquart required nine days. Schnorrenberg (16) obtained egg masses from caged Tabanus abactor Philip, but fails to mention the incubation period. The average incubation period for Tabanus abactor Philip under laboratory conditions was six days. The description of the masses he obtained, however, was the same as those observed during the course of this study. An interesting note on the incubation of tabanid eggs was made by Schnorrenberg (16). He states that from four masses of Tabanus equalis Hine eggs, one was broken up and used for measurements after the fifth day of development. This manipulation caused the larvae to emerge immediately while the remaining three masses required eight days.

Apparently egg masses of the majority of known species emerge almost simultaneously. Philip (13) describes the emergence of Hybomitra lasiophthalma (Macquart) as being nearly simultaneous as observed in numerous Chrysops egg masses. This has been observed with Tabanus atratus Fabricius, Tabanus quinquevittatus Wiedemann, Tabanus abactor Philip, and Chrysops sp. under laboratory conditions. Several hours prior to emergence, the eggs can be studied under a low power binocular where the opaque larvae with their prominent dark mouth parts can be seen to move about within the chorion. The larvae then cause a longitudinal slit along one side of the chorion and wriggle forth.

Upon emerging in nature, the larvae fall to the ground or water and develop if conditions are favorable. In many instances, the larval habitat is often referred to as aquatic or semi-aquatic. In the light of present studies, it seems more probable that only a few species may be called aquatic such as Tabanus fairchildi Stone as described by Schwardt (17). The largest percentage of tabanid larvae develop between a semi-aquatic to terrestrial condition. Several species are capable of developing under completely terrestrial situations as the information on Tabanus sulcifrons Macquart, Tabanus abactor Philip, Tabanus equalis Hine, and Tabanus quinquevittatus Wiedemann will later show.

Once in the proper larval habitat, the larvae crawl about feeding on various types of annelids, snails, crustaceans, insect larvae, and

even their own species, as many of the tabanid larvae are extremely cannibalistic. In one instance, several field collected larvae were placed in a vial for transportation to the laboratory where it was discovered that the largest of the larvae had fed upon two of the smaller larvae, the interim not being over two hours. During development, the larvae undergo from four to nine molts, depending upon the species and environmental conditions. Of the several species collected in this study, nearly all the larvae were found at or near the surface of the ground and rarely over two inches deep. This appears to be true of most species as reported in the literature. At least four species of larvae, Tabanus lineola Fabricius, Tabanus atratus Fabricius, Tabanus sulcifrons Macquart, and Tabanus equalis Hine, have been collected during winter months and no apparent differences on depth in the soil were noted.

The time spent in the larval stage varies with the species. Schwardt (17) records two generations a year for Tabanus lineola Fabricius under Arkansas conditions. He further reports that Tabanus atratus Fabricius may have either a one or two year life cycle. This is also apparently true for Tabanus sulcifrons Macquart where the length of the life cycle depends upon the favorableness of the environment. Jones (8) in Florida reared Tabanus rufofrater Walker from the eggs and had one larva that was 573 days old and had failed to pupate. Most of the species, however, require one year to complete the life cycle.

After the larvae have completed their development, they may either move to a drier place to pupate or remain in the place where they developed. Philip (13) states that in nature, the pupa forces its way to the surface with the aid of the spinose fringes and projections on the abdomen. It seems likely that aquatic species such as Tabanus fairchildi Stone would move to drier strata to pupate as their development is entirely in water. Several pupae of Tabanus lineola Fabricius and Tabanus atratus Fabricius have been collected where larvae of the same species were collected earlier. In one instance at least, pupae of Tabanus sulcifrons Macquart were collected in the same habitat as the larvae, and due to the general type of situation these larvae usually develop under, it appears likely that they may pupate in the larval habitat. In view of this same approach, two pupae of Leucotabanus annulatus (Say) were collected from a decayed oak log where larvae were developing. While in the pupal stage, they may be found in different positions and depths in the soil. Schwardt (17) observed numbers of Tabanus atratus Fabricius pupal cases in a vertical position with the anterior end exposed. Several pupae of Tabanus sulcifrons Macquart have been collected while in a vertical position and adjacent to the surface of the soil.

The duration of the pupal period again varies with species and individuals within species. Temperature and moisture very likely are the predominant regulating factors in determining this phase of the life cycle. Schwardt (17) gives 9.5 days for the average pupal period of Tabanus quinquevittatus Wiedemann while Tashiro (20) found the

average pupal period of Tabanus sulcifrons Macquart to be 20 days. In Oklahoma, Tabanus sulcifrons Macquart pupated on an average of 15 days, Tabanus lineola Fabricius in 10 days, Tabanus atratus Fabricius in 12 days, Tabanus reinwardtii Wiedemann in 8.5 days, Leucotabanus annulatus (Say) in 12 days, and one male Tabanus ahauctor Philip in 10 days.

The adults, upon emerging from the pupal case, usually remain in a teneral and quiescent condition for several minutes while voiding amber colored droplets of meconium. Philip (13) states that Hybomitra lasiophthalma (Macquart) so remains from half to three-quarters of an hour, but will fly away sooner if disturbed. Very little information is at hand on the activities of the adult flies until the female visits the host to obtain a blood meal. It is generally thought that several days after emergence, the males congregate in a mating flight, after which copulation between the sexes takes place. These "mating or swarming" flights have been observed by Sanborn (15) with Tabanus sulcifrons Macquart and Snyder (18) with Tabanus americanus Forster, but the ensuing mating was not observed. Hine (5) records one of the few instances in the mating of tabanids with Tabanus sulcifrons Macquart. He states that several pairs were observed in copulation about 8 a.m. with the male clinging to some object and the female hanging motionless in the air.

Generally, few males are observed in nature. However, it is thought that males feed upon nectar, sap, or other types of plant exudates. The majority of the female tabanids seek one or more blood meals from some typical host as a cow, horse, pig, deer, rabbit, etc.

Some species, however, have never been collected feeding upon any host. Parman (12) collected many larvae and adults of Tabanus dorsifer Walker, yet never observed a single instance of a female engorging. Tashiro (20) has demonstrated that Hybomitra lasiophthalma (Macquart), Tabanus quinquevittatus Wiedemann, and Tabanus sulcifrons Macquart, respectively, consume an average of .121 - .090 - .370 c.c. of blood at a single feeding. Tabanus abactor Philip in Oklahoma will take approximately .186 c.c. of blood at a single feeding. Little information is at hand on the number of times a female will engorge during the life span of the adult. Eddy (3) by marking engorging flies in the field found some of the females returning for a second meal. One captive, Tabanus abactor Philip, was placed upon the back of a cow. On the first day, it readily engorged, the second day also engorged, while on the third day, the fly was approximately two-thirds engorged. Due to an accident, it was destroyed, so no further records were obtained.

Very little information was obtained on parasite and predators of this group. Schnorrenberg (16) was unable to locate any tabanid parasites, but mentions a solitary wasp, Monedula carolina Drury and a wheel bug, Arilus cristatus Linnaeus, as being predacious upon adult tabanids. The only record of parasites from Oklahoma was made in the fall of 1949. An old Tabanus atratus Fabricius egg mass was collected from a willow twig and examined. A number of small hymenopterous parasites were projecting from eggs presenting an appearance which

indicated they failed to emerge. The specific name, however, is not known. While investigating horsefly outbreaks in East Texas and Louisiana, a Sphecid wasp, Bembix carolina Fabricius, commonly called a "horse guard" was observed hovering about livestock. The animals paid little if any attention to their hovering flight and attacks as the wasp would catch tabanids that had alighted upon the host to feed. The predators had difficulty in capturing larger tabanids as Tabanus atratus Fabricius, but very easily attacked Tabanus lineola Fabricius or Tabanus molestus Say and flew off with their prey.

Parman (12) completed an extensive study of a Hymenopterous parasite on Tabanus dorsifer Walker along the Nueces river where he mentions a small boy collecting nine pints of egg masses in one day of which 97 percent of the masses were parasitized. He further mentions this parasite being reared from egg masses of this tabanid in numerous Texas counties. During September 1951, the author visited Mr. Parman in an effort to collect adults, larvae, egg masses, and parasites of Tabanus dorsifer Walker to become familiar with this type of parasitism. Nearly one day of intensive searching was spent in favorable locations where Parman had previously worked. The efforts were almost fruitless as only one old egg mass was collected, and it was impossible to tell if it had been parasitized from the weathered condition of the dried egg cluster.

COLLECTING METHODS

The methods of collecting and rearing were modifications of those used by Schwardt (17). Three large circular sieves, 18 inches in diameter and five inches in depth, were used to wash soil wherever water was available in the field. The sieves were constructed of galvanized metal and bronze screen wire, 20-16 and 4 mesh per square inch respectively, with reinforced bottoms to prevent sagging of the screen when partially filled with wet soil. The sides of the sieves were slightly less than vertical so that they could be placed one inside the other, the coarser mesh being at the top and the finest mesh at the bottom. Soil samples were then placed in the top sieve and washed until the majority of the soil had fallen below. Any larvae present were removed and the process repeated on the second and third sieve. The method employed was less time consuming than utilizing a 16 mesh screen only as the single screen would become plugged with debris and hamper the washing process. By utilizing a sequence of meshes, the majority of the large debris was removed when the 4 mesh sieve was examined and set aside. This method was particularly useful in collecting smaller larvae, especially those of the genus Chrysops.

When water was not available to wash soil samples, the soil was turned with a shovel or other suitable instrument and the examination completed by hand. It is believed that the latter method is not as accurate as the washing method, but with a little experience, the

larvae may be easily recognized as many specimens collected in this manner were from 3 mm. in length to the larger and more developed larvae.

REARING METHODS

Because of the cannibalistic habit of the majority of the species, the larvae had to be maintained in individual containers. For this purpose, a one-half pint jelly glass with a close fitting cover was utilized. A fine grade of moistened white sand was employed as a rearing media. The sand used in the jars was from one-half to one inch deep, usually depending upon the size of the larva. Food was then offered the larva and on the following day the jar was flooded with water and gently agitated. In this manner, any debris, food remnants, and excreta can be decanted. When white sand is utilized, any exuvia will be quickly recognized and facilitated in recording information on the molting process.

Earthworms are very satisfactory as food, yet are difficult to obtain readily during certain seasons. An excellent source of food material which is easily collected in large numbers is an annelid worm, Eisenia foetida, which may be found throughout the year in filter beds of sanitary disposal plants. Housefly or stable fly larvae are also an excellent source of food, particularly for the smaller tabanid larvae. An available source of this type of larval food can be had by rearing a small colony of the flies in the laboratory.

If larvae were collected from soil some distance from standing water, as in the case of Tabanus abactor Philip, Tabanus equalis Hine,

and Tabanus sulcifrons Macquart, soil from the habitat was employed as a rearing medium, utilizing the same types of food the larvae developed normally in this type of media. It has one disadvantage, however, in that it is nearly impossible to find any exuvium when the larva molts.

The media employed for Leucotabanus annulatus (Say) which were found developing solely in decaying logs were pulverized portions of the log. Extremely low mortality was experienced in this manner, but it is not certain if the same might not be true if another rearing media were utilized.

OVIPOSITION OF CAGED FEMALES

Sixteen mesh screen wire cylinders, six inches in diameter and ten inches tall, were covered with cheese cloth and placed over a flower pot nearly filled with sand. Two types of plants were utilized to provide oviposition sites in an effort to simulate natural environmental conditions. Small wheat plants with only a few leaves were transplanted to the soil of the cage for all of the species except in the case of Tabanus abactor Philip where a short twig bearing one or two leaves was placed in the soil in a vertical position. The leaves and twigs were never used for oviposition sites by Tabanus abactor Philip as the very loose piles of eggs were scattered upon the sand in the cage. Tabanus quinquevittatus Wiedemann and Chrysops callida Osten Sacken oviposited seven egg masses upon a plant surface and in these instances the small masses were placed at the tip of a wheat blade. A small X-shaped incision was made at the side of the screen cylinder into which a small vial filled with honey water and plugged with absorbent cotton was placed to provide moisture for the caged females. Of the number of females caged, only two were observed feeding upon the honey water. Information pertaining to the results of these experiments are presented in Table I.

TABLE I

	No. of caged females	Oviposition sites	No. of egg masses	Average incubation period in days
<u>Tabanus abactor</u>	70	On sand only	19	6
<u>Tabanus quinquevittatus</u>	10	Tip of blade of wheat	2	4
<u>Tabanus sulcifrons</u>	12		0	
<u>Chrysops callida</u>	2	Tip of blade of wheat	5	6

BIONOMICS OF REARED AND COLLECTED SPECIES

The following data under the bionomics of reared and collected species will consist of only the species and related information that was obtained in the course of the study. With the exception of several species, all the following tabanids were from Oklahoma, while the few species observed in Texas will be so designated. This information on the Texas species has been included because it is interesting adenda to the tabanids of Oklahoma as those species are also present in this State and it is likely the bionomics will be very similar. The arrangement of species in this section as well as the species list from Oklahoma presented later will follow that used by Philip (14). The brief pertinent information on the adult characteristics has been taken from Stone (19) or Brennan (2).

Esenbeckia incisuralis (Say)*

Female:

Color. Fuscous and yellow, the former usually dominant.

Size. Length, 14 m.m. to 16 m.m.

Pertinent characteristics: Dorsum of thorax and scutellum fuscous, yellow pubescent. Dorsum of abdomen fuscous, yellow and pubescent. Wings subhyaline; stump vein usually present at furcation.

Male: Similar.

* Synonymy is presented in the list of Oklahoma species, page

Several individuals of this species were observed hovering around the underline of a cow. They somewhat resembled the hovering flight of a bumble bee while visiting flowers. None of the flies were observed biting or even landing upon the cow. One of these specimens was taken on June 14, 1950.

Silvius quadrivittatus (Say)

Female:

Color. Gray or yellow-gray; abdominal dorsum with four rows of spots; wings spotted.

Size. Length, 7 m.m. to 10 m.m.

Pertinent Characteristics: Dorsum of thorax and scutellum yellow-gray pollinose, the former with alternate light and dark stripes. Dorsum of abdomen yellow-gray or gray pollinose with four rows of black vittate spots. Legs yellow.

Male: Nearly similar to female.

This species has been observed to feed upon the ears and scrotal region of a horse that was led through some trees adjoining a farm pond. They were not as tenacious as most of the Chrysops present at the time. One engorged female was returned to the laboratory and placed in an oviposition cage, but died two days later without ovipositing.

Chrysops callida Osten Sacken

Female:

Color. Black, with middorsal yellow triangles on the abdomen and large pale yellow spots on the sides near the base.

Size. Length, 7 m.m. to 9 m.m.

Pertinent Characteristics: Dorsum of thorax and scutellum green-gray pollinose, the former with the usual three stripes. The yellow of the abdominal dorsum with a large quadrate black spot under scutellum and remaining segments with yellow mid-dorsal triangles on segments III, IV, and V. Legs yellow and black.

Male: Similar to the female.

Numerous larvae of this species were easily collected in April and May in saturated soil bordering farm ponds and Lake Carl Blackwell. The larvae, a typical yellowish color, were found from near the surface to four and five inches in depth in the soil. Those larvae returned to the laboratory did not feed and only the full grown forms pupated and emerged as adults. Four males and six females emerged in the laboratory with 8 and 7.5 days average pupal periods, respectively. Several typical Chrysops egg masses were found on leaves of aquatic vegetation where larvae were found and adults netted while sweeping the shore line vegetation. The collected masses were returned to the laboratory, but the emerged larvae could not be kept alive. Females were also collected while feeding upon the ears and face of a tethered horse.

Chrysops flavida Wiedemann

Female:

Color. Yellow, with brown abdominal pattern.

Size. Length, 7 m.m. to 10 m.m.

Pertinent Characteristics: Thoracic dorsum, pleurae and venter yellow or gray-yellow pollinose. Dorsum of abdomen yellow, the second segment with more or less inverted V-shaped brown figure at the posterior margin.

Male: Similar to female; more densely pilose.

Larvae of this species not only resemble those of Chrysops callida Osten Sacken, but were collected from similar habitats. The larvae were usually found from two to four inches deep in extremely wet soil bordering fern ponds. No egg masses of the species were collected. Of the larvae returned to the laboratory, eight males emerged with an average pupal period of eight days, while seven females emerged with the pupal period being six days. None of the larvae were induced to feed and only the developed ones pupated and emerged as adults. Several females have been collected in the field while feeding upon the ears of a tethered horse.

Chrysops montana Osten Sacken

Female:

Color. Yellow, with black abdominal pattern.

Size. Length, 7.5 m.m. to 10 m.m.

Pertinent Characteristics: Dorsum of thorax and scutellum dark brown or plumbeous and former with usual grayish pollinose stripes. Dorsum of abdomen yellow; second abdominal segment with median inverted V-shaped black figure.

Male: Differs from female by a greater display of fuscous.

One female of this species was collected from the cab of a pickup on June 19, 1950. This is apparently the first record of this being taken in Oklahoma and probably represents the western most record as Brennan (2) and Philip (14) record the species range from Florida north to Quebec and west to Ohio. The collection point in this instance was from a tree covered bank along a small creek.

Chrysops pikei Whitney

Female:

Color. Yellow and black, abdomen vittate.

Size. Length, 6.5 m.m. to 8 m.m.

Pertinent Characteristics: Dorsum of thorax gray-yellow pruinose with fuscous stripes, scutellum yellow. Abdominal dorsum yellow with four longitudinal black stripes.

Male: Similar to female.

In numbers of field collected specimens, Chrysops pikei was the most common deer fly. It was collected from the ears of a horse and on numerous occasions taken from the cab of a pickup. Extensive screening for larvae of this species in areas where the adults were common did not produce a single individual. There is little reason to suspect the habitat is much different from the other Chrysops larval habitats as Schwardt (17) collected several larvae and numerous egg masses in Northwestern Arkansas.

Chrysops sackeni Hine

Female:

Color. Black and yellow, the former dominant in the abdominal pattern.

Size. Length, 7.5 m.m. to 10.5 m.m.

Pertinent Characteristics: Dorsum of thorax and scutellum fuscous, the former with broad, gray pollinose stripes. Abdominal dorsum yellow with a dominant black pattern. Heavily inverted V-shaped spot on second segment which often follows along posterior margin. Venter of abdomen yellow with median black spots on segment I-IV.

Male: Black figures on dorsum of abdominal segments I and II broader. Venter similar. Legs darker.

A number of typical yellowish larvae were collected from saturated soil along a stagnant stream and were assumed to be those of Chrysops cellida Osten Sacken. Seven adults of this species emerged representing the single collecting point where larvae were found. Of the seven adults, five were females with an average of 7 days in the pupal stage and two males which pupated in 6 days. No adults of this species were over collected in the field.

Leucotabanus annulatus (Say)

Female:

Color. Generally pale, femora reddish; abdomen banded.

Size. Length, 10 m.m. to 12 m.m.

Pertinent Characteristics: Below vertex a small ocellar tubercle; antenna nearly uniformly orange brown; abdomen above reddish brown with narrow posterior fringe of white on each segment.

Male: Large and small facets of eye sharply differentiated. Body densely clothed with white hair.

Larvae of this small tabanid were easily collected in decaying oak logs in southeastern Texas, yet only two females were collected in the area and one in Oklahoma. All sizes of the white, sluggish larvae were found throughout decayed logs from beneath the bark to the center, one log being approximately 1/4 inches in diameter. While examining a log, two pupae were found in a decayed portion about one inch beneath the bark. None of the larvae were observed while feeding on any of the various forms such as snails, coleopterous larvae, annelids, dipterous larva and termites that were usually present.

A quantity of the decayed log was broken up and returned to the laboratory with the larvae where they were placed in individual one-half pint jelly glasses containing one and one-half inches of the decayed wood. Stable fly larvae were offered as food which they readily fed upon and developed into pupae. A total of nine males and twelve females were reared in this manner with an average pupal period of 12 days. The larvae, although very sluggish, developed quite rapidly. One larva, 4 m.m. in length when collected, developed into an adult male in 62 days. It is quite possible that this species may have two generations a year, at least in their southern range. Schwardt (17) states that Leucotabanus annulatus (Say) is crepuscular which might explain a paucity of adults after extensive collecting throughout one season in the East Texas area. The single specimen observed in Oklahoma flew into the cab of a pickup on the morning of July 12, 1950, and was collected.

Hybomitra lasionthalma (Macquart)

Female:

Color. Abdomen with orange laterally; infuscation at furcation and cross veings.

Size. Length, 12 m.m. to 15 m.m.

Pertinent Characteristics: Eye densely pilose, deep purple in life, with four narrow, pale blue-green bands. Well defined, reddish, ocellar tubucle. Median callus short, black, separated from basal callus. Abdomen above orange brown, with a black median stripe as wide as scutellum on first tergite, narrow on tergites II to IV and widening beyond fourth.

Male: Eye facets nearly uniform in size. Frontal triangle gray.

Schnorrenberg (16) records this species as appearing in Payne County during the last two weeks of April and first week of May and also mentions it being a serious stock pest in the eastern part of the State. Large numbers have been observed in the eastern part of the State during April and May. This fly prefers to feed on the udder and nose of cows as numbers of the flies would hover about the underline of a cow closely resembling a swarm of bees. Cattle when returned to barns for evening milking would have the udders streaked with blood that had trickled from the feeding punctures. Because of this habit, the cattlemen of eastern Oklahoma refer to it as the "coat fly".

Only four larvae have been collected in the field. One was found in loose soil beneath a pecan tree far removed from any standing water. The other three were collected from beneath a button bush (Cephalanthus occidentalis) along with a number of Tabanus sulcifrons Macquart larvae on March 19, 1951. The habitat in this case was

slightly moist, grass-covered soil. All of the larvae were in the prepupal stage and within one week pupated with two males emerging on April 2 and 4, 1951 after pupation periods of 10 and 14 days.

Tabanus abactor Philip

Female:

Color. Brown, with three rows of pale triangles on abdomen. Basal portion of third antennal segment orange.

Size. Length, 12 m.m. to 15 m.m.

Pertinent Characteristics: Eye bare, purple, with two green bands. Mesonotum dull brown with indications of pale lines in usual pattern. Wing hyaline with faint spot at furcation. Dorsum of abdomen dull orange brown, with a median row of pale-grayish triangles which usually reach the edge of the tergites. Venter grayish brown, with a broad, median, darker stripe.

Male: Area of large and small facets sharply differentiated.

This is one of the species of tabanids that has a rather limited range. To date it has been collected in Kansas, Oklahoma, Texas, and Arkansas. Schmorrenberg (16)¹ states it is the most postiferous horsefly in this part of Oklahoma, as well as the most abundant.

Eight larvae of this species have been collected, five in Oklahoma and three in Texas. It is interesting to note the extreme paucity of larvae with the adults so numerous during the summer months. The five larvae from Oklahoma were collected from extremely dry, grass-

¹ This species is referred to as Tabanus rubescens Bellardi. Stone (19) suggests the superficial resemblance of Tabanus rubescens Bellardi to Tabanus abactor Philip which in conjunction with reference to distribution, prevalence, and description by Schmorrenberg suggests the species was not determined correctly.

covered soil directly beneath a small chittanwood tree (Humelia lanuginosa) where no standing water would ever be present except temporarily under flood conditions. Only one of the larvae lived to pupate on July 1, 1950, and emerged as a male after 10 days in the pupal stage. The entirely white larvae are very sluggish and develop slowly compared to many other tabanids. Soil from the habitat was utilized as a rearing media and both stable fly larvae and earthworms are readily accepted as food, the stable fly larvae being used when the larvae are quite small. A number of larvae are presently being reared from eggs obtained during the month of August 1951. It appears as if the larvae will be able to pupate in 10 months which might suggest the average life cycle can be completed in one year.

Seventy fully engorged females were individually placed in an oviposition cage from which 19 partial to complete egg masses were obtained. The gray, loose masses contained a minimum of 40 to a maximum of 175 eggs, with the average being 93 eggs per mass. In many instances, the eggs were widely scattered upon the sand of the cage. With the exception of four masses which molded, the remaining masses emerged after an incubation period of five to seven days.

Schnorrenberg (16) records this species as being collected from May 18 to October 7 and reaching its seasonal abundance during the month of July.

Because of its importance in the states where it is present, a number of fully engorged females were weighed to obtain information on the amount of blood consumed at a single engorgement. As the females

void droplets of a clear fluid immediately after feeding, it was necessary to utilize a method whereby the total engorged weight of the fly could be recorded. A large number of previously weighed vials were taken to the field where flies were collected from a tethered horse. Normal and engorged flies were returned to the laboratory in this manner for accurate weighing. This information is outlined in the following table.

Blood Consumption of Tabanus abactor Philip

Wt. of unfed flies ¹ in milligrams			Wt. of fed flies ² in milligrams			Avg. wt. of blood in milligrams	Equivalent in c.c.
Min.	Max.	Mean	Min.	Max.	Mean		
21.5	86.7	68.2	186.9	294.6	246.2	178.0	0.186

¹ Average of 24 flies.

² Average of 32 flies.

A comparison of blood consumed by small, medium and large tabanids might be shown by using Tabanus quinquevittatus Wiedemann, Tabanus abactor Philip, and Tabanus sulcifrons Macquart, respectively. With the exception of Tabanus abactor Philip, the information was taken from Tashiro (20).

Comparison of Blood Meal of Three Tabanids

	Avg. wt of normal Fly in milligrams	Avg. wt of engorged Fly in milligrams	Blood consumed
<u>Tabanus</u>			
<u>quinquevittatus</u>			
Wiedemann	48.2	134.0	0.090 c.c.
<u>Tabanus abactor</u>			
Philip	68.2	246.2	0.186 c.c.
<u>Tabanus sulcifrons</u>			
Macquart	229.7	584.5	0.370 c.c.

Tabanus atratus Fabricius

Female:

Color. Black, wing with dark brown to black.

Size. Length, 20 m.m. to 28 m.m.

Pertinent Characteristics: Large. Eye bare. Antennae black, third segment rather slender with a prominent, slender, dorsal process, which projects forward somewhat. Thorax, abdomen and legs black. Cell R₅ decidedly narrowed at margin.

Male: Area of large facets of eye extensive.

This is probably one of the widest known of the horseflies, although most workers never report the adults to become very abundant while the larval stages are rather numerous and easily collected nearly any season of the year. Schwardt (17) states that in common with most Tabanidae, Tabanus atratus Fabricius deposits its eggs in masses which are so constant in structural plan as to make specific determination of the egg mass readily possible. He reports the

incubation of the egg masses under laboratory conditions to have hatched in a constant period of five days. Egg masses of this species have been readily collected from twigs, limbs, leaves, debris, etc., around standing water or sluggish brooks and streams. The females, however, do not always select a favorable site as one mass was collected from a clothes line rope over a cement porch, while several masses were collected from cement walls of a filter bed where the emerging larvae would very likely be washed with the effluent into the drainage stream.

The white larvae, strikingly marked with black, were the commonest larvae collected in the field; invariably found in saturated soil at the margins of streams, farm ponds, lakes and drainages from dairy barns. The instances of cannibalism in this species were observed most frequently with this species as two larvae could not be placed, even temporarily, in a vial or jar without the resulting death, usually of the smallest individual. This phenomena might in part explain the paucity of adults as the majority of the larvae from a particular habitat would fail to live long enough to develop into adults.

Larvae reared in the laboratory readily fed upon earthworms and other annelids that were collected from filter beds. Pupation was usually beneath the surface of the media. A total of 20 adults have emerged in the laboratory.

	Pupal Period in Days
10	13.5
10	11

Adults have never been observed in large numbers in the field. Two seasons of extensive collecting in eastern Oklahoma by D. E. Howell produced very few adults in large number of tabanids collected. Schwardt (17) states that the low pitched ominous buzz of this fly seems to annoy cattle as much as its bite. The author observed the same phenomena to be true while leading a horse through tabanid infested areas. The horse made little effort to dislodge such species as Tabanus slector Philip, Tabanus lineola Fabricius, and Tabanus quinquevittatus Wiedemann, while one Tabanus atratus Fabricius would cause the animal to become very disturbed and hard to manage.

Tabanus equalis Nine

Female:

Color. Grayish brown, with a median row of grey spots the length of the abdomen: a rather distinct spot at furcation.

Size. Length, 17 m.m. to 22 m.m.

Pertinent Characteristics: Eye bare, dark purple, with two green bands. First and second antennal segments dark reddish with black hair; third with a distinct dorsal angle, usually the cross veins and furcation faintly margined with brown. Venter nearly uniformly reddish, with pale pollen.

Male: Essentially similar.

This species, being rather common in the eastern part of the State, superficially resembles Tabanus sulcifrons Macquart. However, the former is usually abundant in the earlier part of the season,

preceding the normal emergence of Tabanus sulcifrons Macquart.

Schnorrenberg (16) considers Tabanus equalis Hine as a major species in Payne County having been collected from May 15 to July 19, reaching its peak emergence about the end of June.

No egg masses of this species were collected in the field or obtained under laboratory conditions. Schnorrenberg (16) describes the egg mass as resembling one side of a miniature honey comb, the eggs laid in one layer, perpendicular to the object to which they were attached. He obtained 13 egg masses under laboratory conditions with an average incubation period of eight days, but does not mention the number of eggs per mass.

Approximately 20 larvae have been collected in the field with one male emerging on June 15, 1950 after a pupal period of 14 days. The larvae are noticeably cylindrical and possess a dull yellow coloration not found in any other collected species. The mandibles, a contrasting dark brown, are usually retracted as this species is the most sluggish of any larvae ever examined.

The habitat of five collecting points was identical in that it was shaded by elm trees and the soil was sparsely covered with vegetation. In no instance would any standing water ever be present as the habitats were usually sloping to such an extent as to permit excellent drainage. The larvae were wide spread in the soil and collected from one to five inches deep. Soil from the habitat was

employed as a rearing media with earthworms as a food. The larvae develop slowly and apparently are not very aggressive as two larvae were placed in the same container for three weeks in the absence of any food without any harm to either of the larva. Only one record of the size of a mature larva was obtained, this being 24 m.m. in length and 6 m.m. in diameter.

During the past two seasons, Tabanus equalis Hine was not abundant in Payne County, but apparently is more numerous in the eastern part of the state. Few flies were collected from livestock while the majority of the field collected specimens were taken from the cab of a pickup which had attracted the females apparently by its motion.

Tabanus lineola Fabricius

Female:

Color. Yellowish brown to blackish, with three rows of yellowish-gray spots on abdomen.

Size. Length, 10 m.m. to 15 m.m.

Pertinent Characteristics: Eye bare, purple with a broad, diagonal, green stripe from inner angle to near outer margin, and a V-shaped mark above, the apex near end of lower band. Mesonotum gray, with erect black hair and recumbent pale-yellowish hair. Wing hyaline including costal cell. Abdomen above with a median, parallel-sided, yellowish or whitish stripe.

Male: Essentially same as female.

The recognized common name of this widespread species is the "striped horsefly". Schnorrenberg (16) records this fly as being taken from April 23 to September 29 and reaching the peak of its emergence at the end of August. Schwardt (17) states the adults have been taken from May 4 to October 9 and are present in large numbers throughout the season, except for a brief period between generations which occurs in the later part of July.

Adults were commonly observed throughout the season and in one instance when large numbers were prevalent, several herds of cattle were observed in August 1950 in eastern Oklahoma where 50 to 75 Tabanus lineola Fabricius were present on the majority of animals.

Larvae are easily collected during any season of the year in moist soil somewhat removed from permanent water. The larvae, found within the top two inches of the soil, in several instances averaged 10-12 per square yard. Spring seeps and drainage ditches are the favored habitat regardless of the presence of overhanging trees which is usually associated with many other species. Little additional information on the biology of this species has been added to that provided by Schwardt (17) who worked in a similar area. Fifty-six adults have been reared from field collected larvae. Of this number, 30 were males with an average pupal period of 10 days and 26 were females with an average pupal period of 9.5 days.

Tabanus mularis Stone

Female:

Color. Mesonotum grayish green, abdomen blackish. Costal cell orange brown.

Size. Length, 10 m.m. to 12 m.m.

Pertinent Characteristics: Eye bare, green with a single, diagonal, purple band. Mesonotum olive green, unstriped. Wing hyaline with the costal cell orange brown. Abdomen black, with a light-yellowish-gray median stripe and an indication of faint sublateral stripes. Venter olive green.

Male: Area of large and small facets sharply differentiated, the former extensive; in dried specimens the large facets yellow, the small facets black.

The only information pertaining to this species is the observations of some females in the field. The adults are occasionally collected feeding on the underline of cows and horses; the females somewhat resembling Tabanus quinquevittatus Wiedemann and only with close observation is this species recognized.

Tabanus nigrescens subsp. atripennis Stone

Female:

Color. Black, wing deeply smoky.

Size. Length, 24 m.m. to 26 m.m.

Pertinent Characteristics: Wing deeply smoky, only slightly paler posteriorly, if at all. Thorax and abdomen covered with short, black pile.

Male: Similar to female.

One female was collected on June 15, 1950, while alighting upon the back of a cow. This is the only instance of seeing this species in the field.

Two white larvae, 30 m.m. in length and possessing a distinct brown stigmatal spine were collected from saturated soil bordering a farm pond near Claremore, Oklahoma, on December 7, 1949. One of the specimens emerged as a female on June 14, 1950, after a pupal period of 13 days.

Tabanus nigripes Wiedemann

Female:

Color. Brownish black. Wing hyaline. Fore tibia with a few white hairs at base.

Size. Length, 11 m.m. to 13 m.m.

Pertinent Characteristics: Eye bare, uniformly dark. Antenna dark orange brown to entirely black. Mesonotum reddish brown to nearly black. Wing hyaline, with brown veins and yellow stigma.

Male: Head large with areas of large and small facets sharply and strongly differentiated. Whole body dark brown with black hair. Venter of abdomen with narrow posterior bands.

Two larvae were collected in the fall of 1949 from saturated, shaded soil at a spring seep. One male emerged on June 12, 1950, after eleven days pupation. A number of larvae were also collected from saturated, sandy soil at a spring seep in eastern Texas. Seven females and three males emerged with an average pupal period of nine days. Schwardt (17) states the species is of little economic importance in Arkansas, but does not mention any host. No females have

been observed engorging on livestock in Oklahoma. McGregor (10) observed the females feeding on cattle on two instances in East Texas.

Tabanus pumilus Macquart

Female:

Color. Blackish, a row of narrow, pale median triangles on abdomen.

Size. Length, 9 m.m. to 11 m.m.

Pertinent Characteristics: Eye bare, deep purple, with two rather broad green-blue heads. Antenna orange, the annulate portion sometimes darker. Palpus creamy white. Mesonotum brownish black, with gray longitudinal stripes in usual pattern. Wing hyaline; vein R_2 sometimes with short stump. Abdomen brownish black, with cream colored markings consisting of very narrow posterior margin to tergites, a faint median row of triangles and sublateral rows of round spots completely surrounded by the dark brown color. Venter gray tinged with reddish.

Male: Essentially same as female.

Schnorrenberg (16) records this species as being collected from May 29 to June 26 and never abundant. Tabanus pumilus Macquart is about as abundant as Tabanus mularis Macquart and has similar feeding habits. It prefers the underline of cows and horses and particularly the scrotum of horses. This is the smallest species of "horseflies" found in Oklahoma

Tabanus quinquevittatus Wiedemann

Female:

Color. Yellowish, with a median, parallel sides stripe on abdomen bordered by blackish. Costal cell yellow.

Size. Length, 11 m.m. to 13 m.m.

Pertinent Characteristics: Eye bare, green, with one diagonal purple band. Antenna slender, orange brown, the annulate portion dark brown to black. Mesonotum dark brown, with yellow pollen, erect black hair and recumbent yellow hair; no indication of stripes. Wing hyaline, the costal cell rather intensely yellow. Abdomen above variable but always with a median stripe of pale-yellow pollen and hair the entire length.

Male: Essentially similar with hair longer and abdomen with less black.

Schwardt (17) states that in Arkansas this is the most abundant horsefly and that over a seven year period, it composed 47 percent of all the flies collected. Here again is another instance of a horsefly being extremely common yet after conducting an extensive search, one larva was collected in the field. Logothetis (9) in New York found this species to be the most abundant as adults and succeeded in recovering numbers of the larvae from pasture land, hay fields and even in a cabbage field. Adults were repeatedly collected by sweeping clover and timothy fields during the night. The collecting of larvae of this species from similar habitats by Washiro (20) further substantiated Logothetis finding.

With this information at hand, considerable time was spent in investigating similar types of habitats. One larva was collected near the surface of the soil in a grass covered slight depression where standing water could remain temporarily after a heavy rain. This single specimen, collected on April 4, 1951, emerged as a male on June 22, 1951, after a pupal period of eight days.

Adults are usually quite numerous from May through to September and possess feeding habits similar to Tabanus mularis Stone and Tabanus lineola Fabricius in that they prefer to feed upon the legs and underline of cattle and horses. The brilliant green eyes and size make field recognition of this "green head" quite easy.

Tabanus reinwardtii Wiedemann

Female:

Color. Blackish with 3 rows of gray spots on abdomen. Furcation and cross veins margined with brown.

Size. Length, 15 m.m. to 19 m.m.

Pertinent Characteristics: Eye bare or with very sparse, short pile, purple, with two bluish-green diagonal bands. Mesoscutum nearly black, with lines of reddish pollen and gray pile in usual pattern. Wing hyaline, the cross veins and furcation distinctly marginal with brown; cell R_5 somewhat narrowed apically. Legs reddish brown to black. Abdomen above black, tinged with reddish, with three rows of gray spots; median triangles rather narrow; sublateral spots larger, oblique, touching hind margin on second and sometimes third segment.

Male: Eye densely pilose. Hair of genae black, of pleura and sternum white, dense.

Adults of this rather rare species have never been taken in Oklahoma. Schwarzit (17) in Arkansas failed to collect adults, but found larvae at the borders of springs or spring-fed ponds where the water was continuously cold. Numbers of larvae were collected from the root mass of grasses growing in a shaded spring seep. They were quick in movement and difficult to detect while collecting. Ten adults comprising seven males with an average pupal period of eight days and three females with an average pupal period of nine days emerged from field collected larvae.

Tabanus sulcifrons Macquart

Female:

Color. Orange brown, with a median row of white or yellowish triangles on abdomen. Fore tibia bicolorod.

Size. Length, 18 m.m. to 23 m.m.

Pertinent Characteristics: Eye blue, with two diagonal green bands. First two antennal segments dark orange brown, with black hair; basal portion of third orange, the annulate portion black. Mesonotum dark reddish brown, with yellowish-gray lines in the usual pattern. Wings subhyaline tinged with orange, or sometimes grayish discally, the costal cell orange and cross veins and furcation marginal with brown; cell R_5 narrowed apically, but only rarely closed at margin. Abdomen above orange brown, somewhat darkened apically; a median row of white or yellowish triangles on tergites I-V or VI.

Male: Second palpal segment nearly black. Coloration essentially as in female.

Tabanus sulcifrons Macquart is widely distributed in the United States, and over much of its range it is recognized as one of the most injurious horse flies. Schwardt (17) in Arkansas, Tashiro (20) in New York, and Schnorrenberg (16) in Oklahoma record it as being one of the five most important horseflies in their respective areas. In the course of this study it would at least be among the four more important and abundant species.

Schwardt (17) found three egg masses fastened to a small branch of an elm tree and collected larvae in numbers only once at the border of a small swamp. However, he was of the opinion that the species apparently did not require much moisture during the larval

stage and may be intolerant of excessive moisture. Tashiro (20) collected several larvae at the edge of a small pond in wet soil, but believed this was not a typical habitat. Five larvae were collected by MacCreary (11) in Delaware from one and one-half square yards of soil in the town of Newark where no standing water was ever present except for a few hours following a heavy rain.

Published records of larvae collected in the United States are meager, therefore, an extensive series of soil samples was taken in the Stillwater area in 1949, 1950, and 1951. The data in Oklahoma are believed to be applicable wherever this species is abundant.

Although thousands of samples of soil were taken from wet areas, sulcifrons larvae were collected in such areas only once. A single larva -- the one positive sample -- was taken from permanently wet moss-covered soil adjacent to a shaded spring seep.

A total of 225 sulcifrons larvae were found in 37 different locations, all in well-drained areas. The moisture conditions ranged from damp to extremely dry. It appeared that the only moisture received in these habitats was the result of rainfall. Permanent standing water never was present in those locations.

The larvae were widely scattered throughout each of the habitats. The maximum number found per square yard was four, but in favorable sites the average population was two or three per square yard. The larvae were distributed from just below the surface to a maximum

depth of two inches, most of them being from 0.5 inch to 1.5 inches below the surface. There was no evidence that they penetrated deeper into the soil to escape desiccation or freezing.

Estivation occurred in short dorso-ventrally flattened tunnels in the dry soil. During periods between rainfalls the finding of such tunnels was a definite aid in determining the presence of larvae. Plate I A illustrates a nearly mature larvae during estivation.

Most of the larvae were taken from shaded dry-wash gullies where American elm, chittamwood and burr oak trees were usually present. Except in three locations, American elm was always present. Plate I B shows a typical dry-wash gully where larvae were usually collected. A series of 12 larvae, ranging in size from very small to full grown, were collected in about four square yards of slightly moist grass-covered soil under a small burton bush. Two Hybomitra lasiophthalma Macquart larvae were taken in the same place, furnishing the only instance of another species being collected in the same location with Tabanus sulcifrons Macquart.

Several larvae, ranging from 8 to 32 m.m. in length, were collected from slightly moist grass-covered soil along a slight drainage depression traversing an open sod pasture. There were no trees or bushes within several hundred feet. Other examinations of treeless pasture land were negative, therefore this one finding seems atypical.



(A)



(B)

In one favorable site, approximately 10 square yards of soil were examined and 26 larvae, ranging in length from 4 to 32 m.m. were found. Thus, one collection consisted of larvae ranging in size from very small to nearly grown.

Collections were made throughout the year, and although grown larvae were abundant in May and June, they were found every month. Most field-collected larvae, when brought to the laboratory, completed their growth and emerged within a year; however, some required more than one year to complete their development. This observation, together with field findings, suggests that sulcifrons may have either a one or a two year life cycle.

Apparently sulcifrons larvae will feed whenever soil temperatures become warm enough for activity. A number of fully engorged larvae were collected in the last week of February 1951. Nearly all of the larvae collected early in March showed evidence of having fed recently and were quite active.

Three pupae of sulcifrons were found in the same location in which larvae were simultaneously collected. One pupa was lying in a horizontal position very near the soil surface. The other two were in a vertical position with the anterior end of the pupa nearly exposed. One of these emerged as a male on July 2, 1950, the earliest seasonal emergence of this species in the laboratory.

Fifty-four adults emerged in the laboratory from field collected larvae. Of this number, 29 were females with an average pupal period of 15 days with the remaining 25 males having an average pupal period of 14.5 days. The length of pupation which is about 15 days is somewhat shorter than the average of 18 days reported by Tashiro (20) in New York.

Adults usually make their appearance about the first of July, reaching their maximum abundance during the month of August with populations declining in September. The large amount of blood consumed by this horsefly has been clearly demonstrated by Tashiro (20) who found the average blood meal to be 0.370 c.c. With an average of 40 flies feeding per hour, a mean volume of 118 c.c. of blood would be consumed from a single animal in one day. The total loss may conceivably be larger due to blood oozing from the many feeding punctures. This species was also implicated by Howell et. al. (6) as a possible vector of anaplasmosis which information would assist in ranking Tabanus sulcifrons Macquart as one of the more important tabanid pests throughout a large portion of the United States.

Tabanus trimaculatus Palisot de Beauvois

Female:

Color. Thorax largely white; abdomen above dark brown or black. Prominent white, median triangular tergites III-V.

Size. Length, 15 m.m. to 18 m.m.

Pertinent Characteristics: Eye bare, purple, with two rather narrow green bands. Mesoscutum brown, with 5 distinct light-gray lines in usual pattern; presutal lobe reddish gray; scutellum with grayish pollen discally. Wing nearly hyaline except for deep-yellow costal cell and infuscated spots at cross veins and furcation; Cell R_5 somewhat narrowed apically. Prominent white, median triangles on each of tergites III-V, sometimes tergite II bearing a pair of small, pale, oblique spots on each side of middle. Venter gray with a broad, dark-brown, median stripe.

Male: Essentially same as in female.

This strikingly marked fly is probably the easiest to recognize in the field of any of the tabanids in Oklahoma with the exception of Chlorotabanus crepuscularis (Dequaert). The adults usually are not very numerous and were occasionally observed throughout the summer months. Here again this species bears a striking similarity to Tabanus atratus Fabricius in that the larvae are normally easy to collect, but few adults observed. The larvae prefer saturated soil bordering spring seeps, ponds and sluggish streams, and on many instances were found in soil that was quite matted with tree and plant roots. Difficulty was had, however, in rearing the larvae, as many of them for no apparent reason would refuse to feed and consequently died. Also many of the pupae would develop normally and prior to expected emergence would turn very dark and upon examination be found in a slightly decomposed condition. A total of eight females emerged with an average pupal period of 8.5 days and two males which both pupated in 9 days.

Tabanus venustus Osten Sacken

Female:

Color. Dark, wing variegated; abdomen with a median row of white triangles.

Size. Length, 16 m.m. to 18 m.m.

Pertinent Characteristics: Eye bare, purple, with two narrow green bands. Second palpal segment brown, with short black and yellowish hair. Mesoscutum with gray pollen and pile and longitudinal stripes of brown pollen. Wing nearly hyaline with dark brownish infuscations. Cell R₅ somewhat narrowed at margin. Abdomen above dark brown to black, first tergite with a small, median, white spot; tergites II-VI with median white triangles.

Male: Facets of upper two-thirds of eye scarcely larger than those of lower third. Palpus, thorax, and legs nearly black. Venter dark brown.

Adults have been collected occasionally feeding on the underparts of animals. Schwardt (17) states this species has been rarely taken as an adult and collected three larvae from the banks of a spring fed pond. Schnorrenberg (16) obtained one egg mass in the laboratory for which the incubation period was three days.

The white, slender larvae possess a brownish stigmatal spine that is not very prominent and only seen under close observation. Larvae were collected once in large numbers in the mud bordering a small, sluggish drainage ditch from a dairy barn. No apparent difficulty was experienced in rearing the larvae and 30 adults emerged in the laboratory. Of this number, 14 were males with an average pupal period of seven days and 16 females with an average pupal period of eight days.

Larval Key

As the basic problem of this study was primarily of a biological nature, no emphasis was placed upon taxonomy of the larval stages. This phase of tabanid biology is the least understood and probably the most difficult part of the tabanid taxonomy as it has come under the writer's observation that many larvae vary in the pertinent descriptive characters within their range as well as localized areas. An example of this might be offered in that several larvae were collected in East Texas and thought to be a species previously not collected. One specimen emerged as Tabanus atratus Fabricius male. Of the hundreds of Tabanus atratus Fabricius larvae collected during the course of this study, it was difficult to believe that unfamiliarity with the species could have been responsible for the obvious misidentification.

The following key taken from Johansson (7) is being given as it serves a useful purpose in identification of some of the more common forms and as the key was compiled largely from northeastern tabanids, it should be used with caution in determining Oklahoma material.

1. Anterior colored ring of prothorax widened on sides of body, covering more than half of lateral areas 2
- Anterior colored ring not wider on sides of body..... 7
2. Abdominal segments 1 to 7 with a dorsal median pubescent projection posteriorly from anterior ring..... 3
- Abdominal segments lacking such projection..... 4

3. Pubescent areas dark brown to black; no terminal exsertile spine; dorso-lateral color projections of mesothorax broadening posteriorly; dorsal median pubescent projections of abdominal segments 1 to 7 very distinct and over half the length of segment..... Tabanus atretus Fabricius
- Pubescent areas paler; terminal exsertile spine distinct; dorso-lateral color projections of mesonotum not enlarged posteriorly; dorsal median pubescent projections of abdominal segments 1 to 7 indistinct and never half the length of segment..... Tabanus stygius Say
4. Anterior abdominal annuli broad, a transverse non-pubescent area dorsally in each one; a distinct posterior annulus on most of the abdominal segments, especially the seventh... 5
- Anterior abdominal annuli narrow and without a transverse area on dorsal side; posterior annuli very narrow and irregular..... Tabanus vivax Osten Sacken
5. Thoracic stripes on second and third segments subequal; no dorso-lateral isolated spot cephalad above the rather small declining lateral row of spots on anal segment; anal segment usually tapering, the siphon elongate, dark when extended...
..... Tabanus trimaculatus Palisot de Beauvois
- Thoracic stripes on second segment distinctly longer than those on third; dorso-lateral spot on anal segment above lateral row of spots; anal segment rounded, siphon when extended rather short, about the length of posterior ring.. 6
6. Length of mature larvae alive 27-30 mm., preserved 36-40 mm.
..... Tabanus reinwardtii Wiedemann
- Length of mature larva preserved, over 40 mm.....
..... Tabanus nigrescens Palisot de Beauvois
7. Posterior ring of anal segment absent or vestigial..... 8
- Posterior ring of anal segment present, narrow to broad.. 13
8. A lateral pubescent spot above anus; annuli of meso- and metathorax and abdominal segments scarcely visible..... 9
- No lateral pubescent spot above anus; annuli of abdominal segments slender but distinct..... 12

9. Larva with a series of dorso-lateral short dark dashes which may or may not be connected by faint shading; translucent brown or green in life..... 11
- Larva chiefly whitish, maculations if present not prominent except for accumulation of dirt on pseudopods..... 10
10. Anal siphon very short; body completely covered with striae; thoracic segments with faint narrow rings anteriorly.....
..... Hybomitra trispila (Wiedemann)
- Anal siphon moderately elongate; body smooth and shining on dorsum and venter, striate laterally; no dark annuli; tracheal trunks black and conspicuous.....
..... Tabanus nivosus Osten Sacken
11. Dashes confined to abdominal region; no pubescent bands on anterior margin of meso- and metathoracic segments.....
..... Hybomitra lasiopterna (Macquart)
- Dashes extending onto thorax also; pubescent bands connecting across or running around thoracic segments anteriorly; mature larva 25 mm. long; thoracic bands pale, not evident on abdomen..... Hybomitra illota (Osten Sacken)
12. Mature larva 17-19 mm. in length alive, 20-22 mm. preserved
..... Hybomitra minuscula (Hine)
- Mature larva green when living in sphagnum, 22-25 mm. in length alive, 26-28 mm. preserved.....
..... Hybomitra trepida (McDunnough)
13. Elongate dorso-lateral posterior pubescent projections from anterior ring of mesothorax very distinct.....
..... Tabanus lineola Fabricius
- Elongate dorso-lateral posterior pubescent projections from anterior ring of mesothorax present but so indistinct that visible only under good magnification, can be regarded as absent..... 14
14. Mature larva large; more than 30 mm. in length fully relaxed; nearly all white or cream except for mouthparts, tracheal trunk and posterior ring of anal segment..... 15
- Mature larva small; less than 25 mm. in length fully relaxed..... 16

15. Anal segment with a distinct arc of brown pubescence joining pubescent anal ring with lateral region of posterior ring; posterior ring brown to gray; 30-35 mm. in length preserved..... Tabanus sulcifrons Macquart

Anal segment with no projection from pubescent anal ring or posterior ring; posterior ring light brown; 45-50 mm. in length preserved..... Tabanus giganteus Degeer

16. Anal segment with a distinct anterior ring of pubescence including anus, with two posterior lateral projections from it..... Tabanus quinquevittatus Wiedemann

Anal segment without a distinct anterior ring..... 17

17. Anal segment with a slender longitudinal pubescent spots dorsally and laterally..... Atylotus bicolor Wiedemann

Anal segment without dorso-lateral spots, sometimes with a small round lateral spot... Hybomitra septentrionalis (Loew)

List of Oklahoma Species

The taxonomic arrangement and synonymy of the following list has been taken from Philip (14). Nine genera and 69 species have been collected or reared in Oklahoma.

TABANIDAE Osten Sacken. 1875-76.

Subfamily PANGONINAE Loew, 1860.

Tribe PANGONINI Enderlein, 1922.

Genus ESENBECKIA Rondani, 1863.

1. Esenbeckia incisuralis (Say), 1823.

14-15 June.

Pangonia incisuralis Say, 1823.

Tribe CHRYSOPINI Enderlein, 1922.

Genus SILVIUS Meigen, 1820.

1. Silvius notatus (Bigot), 1892.

30 August.

Silvius laticallus Brennan, 1935.

2. Silvius pollinosus Williston, 1880.

8 June-5 October.

3. Silvius quadrivittatus (Say), 1823.

9 June-27 August.

Chrysops quadrivittatus Say, 1823.

4. Silvius quadrivittatus subsp. texanus Pechuman, 1938.

22 September.

Genus CHRYSOPS Meigen, 1800.

- 1.
- Chrysops aestuans
- van der Wulp, 1867.

7-19 July.

Chrysops moerens Walker, 1848.

- 2.
- Chrysops brunnea
- Hine, 1903.

12-28 June.

- 3.
- Chrysops callida
- Osten Sacken, 1875.

26 May-13 August.

Chrysops callidula Philip, 1941.

- 4.
- Chrysops celeris
- Osten Sacken, 1875.

29 April.

? Chrysops cincticornis Walker, 1848.? Chrysops uter Marchand, 1917.

- 5.
- Chrysops flavida
- Wiedemann, 1821.

1 June-21 September.

Chrysops canifrons WalkerChrysops guiterasi Brunetti, 1923.? Chrysops pallidus Bellardi, 1859.

- 6.
- Chrysops fulvaster
- Osten Sacken, 1877.

7-19 July.

Chrysops coloradensis Bigot, 1892.Heterochrysops fulvaster Krober, 1926.

7. Chrysops geminata Wiedemann, 1828.
9-19 June.
Chrysops fallax Osten Sacken, 1875.
8. Chrysops inda Osten Sacken, 1875.
3-28 July.
Chrysops pilumnus Krober, 1926.
9. Chrysops moecha Osten Sacken, 1875.
6-26 June.
Chrysops maechus Segal, 1936.
10. Chrysops montana Osten Sacken, 1875.
19 June.
Chrysops furcatus Hine, 1904.
11. Chrysops nigra Macquart, 1838.
23 May-6 June.
Chrysops carbonarius var. B Walker.
12. Chrysops obsoleta Wiedemann, 1821.
6 June-23 July.
? Chrysops trinotata Macquart, 1838.
Chrysops morosus Osten Sacken, 1875.
Chrysops lugens Hine, 1903.
Chrysops lugens var. morosus Daecke, 1907
13. Chrysops pikei Whitney, 1904.
16 June.

14. Chrysops pudica Osten Sacken, 1875.
16 June.
15. Chrysops separata Hine, 1907.
20 April-22 June.
16. Chrysops sequax Williston, 1887.
9 June-28 August.
17. Chrysops univittata Macquart, 1855.
26 June.
? Chrysops fascipennis Macquart, 1834.
18. Chrysops vittata Wiedemann, 1821.
6 June-7 August.
Chrysops areolatus Walker, 1848.
Chrysops lineatus Jaennicke, 1867.
19. Chrysops wiedemanni Krober, 1926.
5 June-6 August.
Chrysops obsoletus of authors, not Wiedemann, 1821.
Chrysops fraternus Krober, 1926.
20. Chrysops sackeni Hine, 1903.
25 April.

Subfamily TABANINAE Loew, 1860.

Tribe CHLOROTABANINI Philip, 1941.

Genus CHLOROTABANUS Lutz, 1909.

1. Chlorotabanus crepuscularis (Bequaert), 1926.

10 June-5 July.

Tabanus sulphureus Palisot de Beauvois 1813-1820.

Tabanus flavus Macquart, 1834.

Tabanus mexicanus of authors, not Linnaeus.

Tribe TABANINI Enderlein, 1922.

Genus ATYLOTUS Osten Sacken, 1876.

1. Atylotus bicolor Wiedemann, 1821.

22 July.

Tabanus pulvescens Walker, 1848.

Tabanus ruficeps Macquart, 1855.

Genus ANACIMAS Enderlein, 1923.

1. Anacimas dodgei (Whitney), 1879.

14 April-13 May.

Tabanus dodgei Hine, 1904.

Genus LEUCOTABANUS Lutz, 1913.

1. Leucotabanus annulatus (Say), 1823.

8-12 July.

Tabanus annulatus Say, 1823.

Genus HYBOMITRA Enderlein, 1922.

1. Hybomitra difficilis (Wiedemann), 1828.

8 April-20 May.

Hybomitra carolinensis of authors.

Tabanus difficilis Wiedemann, 1828.

2. Hybomitra lasiophthalma (Macquart), 1938.

16 April-23 July.

Tabanus lasiophthalmus Osten Sacken, 1876.Tabanus punctipennis Macquart, 1847.Tabanus notabilis Walker, 1848.Tylostypia lasiophthalmus Enderlein, 1925.Theriopectes lasiophthalma Osten Sacken, 1878.Theriopectes (Sic) lasiophthalmus Krober, 1930.3. Hybomitra patulus (Walker), 1848.

15-29 April.

Hybomitra oklahomensis (Stone), 1933.Tabanus oklahomensis Stone, 1938.Genus TABANUS Linnaeus, 1758.1. Tabanus abactor Philip, 1936.

10 June-29 September.

Tabanus gracilis Sanborn, Stiles and Moe, 1932.2. Tabanus abdominalis Fabricius, 1805.

2 July-8 September.

3. Tabanus americanus Forster, 1771.

9 June-14 August.

Tabanus plumbeus Drury, 1773.Tabanus ruficornis Fabricius, 1775.Tabanus limbatus Palisot de Beauvois, 1807.

Stigmatophthalmus americanus Enderlein, 1925.

Tabanus americanus Mosier and Snyder, 1918.

4. Tabanus atratus Fabricius, 1775.

10 June-8 October.

Tabanus americanus Drury, 1773.

Tabanus niger Palisot de Beauvois, 1897.

Tabanus validus Wiedemann, 1828.

Straba atrata Enderlein, 1935.

Stigmatophthalmus atratus Enderlein, 1925.

5. Tabanus cymatophorus Osten Sacken, 1876.

6-26 August.

6. Tabanus equalis Hine, 1923.

25 May-28 July.

Tabanus uniformis Hine, 1917.

Tabanus aequalis Jones and Bradley, 1924.

7. Tabanus fairchildi Stone, 1938.

3 June-23 August.

Tabanus vivax of authors.

8. Tabanus fulvulus Wiedemann, 1828..

16 June-24 August.

Tabanus fulvofrater Walker, 1848.

? Tabanus mutatus Walker, 1850.

9. Tabanus fulvulus subsp. pallidescens Philip, 1936.

9 July-29 August.

10. Tabanus fuscicostatus Hine, 1906.

1 June-24 September.

11. Tabanus gigantous Degeer, 1776.

9 July-21 September.

Tabanus lineatus Fabricius, 1781.

? Tabanus pallidus Palisot de Beauvois, 1809.

Tabanus bicolor Macquart, 1847.

Tabanus caesiofasciatus Macquart, 1855.

12. Tabanus lineola Fabricius, 1794.

17 April-16 August.

Tabanus vicarius Walker, 1848.

? Tabanus comixtus Walker, 1860.

Tabanus compactus Aldrich, 1905.

Tabanus quinquevittatus Hine, 1906.

Tabanus quinquemaculatus Hine, 1904.

13. Tabanus lineola subsp. scutellaris Walker, 1850.

17 April-25 September.

Tabanus lineola of authors (partim).

14. Tabanus longus Osten Sacken, 1876.

9 July-20 August.

15. Tabanus melanocerus Wiedemann, 1828.

6 June-7 July.

16. Tabanus molestus Say., 1823.
3 June-13 July.
Atylotus tenossensis Bigot, 1892.
17. Tabanus mularis Stone, 1935.
21 June-9 July.
18. Tabanus nigrescens subsp. atripennis Stone., 1935.
14 June.
19. Tabanus nigripes Wiedemann, 1821.
12 June-9 July.
Tabanus coffeatus Macquart, 1847.
20. Tabanus orbicallus Philip, 1936.
21. Tabanus proximus Walker, 1848.
17 July-21 September.
Tabanus benedictus Whitney, 1904.
22. Tabanus pusillus Macquart, 1838.
10 June-30 July.
23. Tabanus punctifer Osten Sacken, 1876.
11 June-24 August.
24. Tabanus quinquevittatus Wiedemann, 1821.
23 June-19 August.
Tabanus costalis Wiedemann, 1828.
Tabanus vicarius Walker, 1848.
Tabanus baltimorensis Macquart, 1855.
Tabanus floridanus Szilady, 1926.

25. Tabanus reinwardtii Wiedemann, 1828.
15 June-8 July.
Tabanus erythrotelus Walker, 1850.
26. Tabanus sackeni Fairchild, 1934.
22 July-19 September.
Tabanus longus Osten Sacken, 1878.
27. Tabanus sagax Osten Sacken, 1876.
3 August-21 September.
Atylotus baal Townsend, 1895.
Tabanus dawsoni Philip, 1931.
28. Tabanus sparus subsp. milleri Whitney, 1914.
Tabanus milleri Bequaert, 1933.
29. Tabanus stygius Say, 1823.
12 June-19 July.
30. Tabanus sublongus Stone, 1938.
27 August.
31. Tabanus sulcifrons Macquart, 1855.
20 June-24 October.
Tabanus variegatus Fabricius, 1805.
Tabanus tectus Osten Sacken, 1876.
Tabanus exul Osten Sacken, 1878.
32. Tabanus trimaculatus Palisot de Beauvois, 1807.
27 May-25 August.
Tabanus aestivum Bosc (ms) by Macquart, 1838.
Tabanus quinquelineatus Macquart, 1834.

33. Tabanus venustus Osten Sacken, 1876.

2 June-17 August.

34. Tabanus vittiger subsp. nippontucki Philip, 1942.

35. Tabanus vittiger subsp. schwardti Philip, 1942.

36. Tabanus wiedemanni Osten Sacken, 1876.

17 June-19 July.

? Tabanus palpatus Palisot de Beauvois 1813-20.

Tabanus ater Wiedemann, 1828.

37. Tabanus zythicolor Philip, 1936.

15 July.

SUMMARY

The family Tabanidae which composes the horseflies and deerflies constitute a very important group of external parasites to domestic animals in the United States. In securing a blood meal, horseflies consume quantities of blood and also cause much blood to trickle from the feeding punctures. These feeding flies cause animals to become restless and consequently to graze poorly. Because of this type of feeding habit, diseases such as anaplasmosis and tuleremia are mechanically transmitted to new hosts by the horseflies.

Various phases of tabanid biology have been investigated in the course of this study with particular reference to the larval habitats. The larval habitat of Tabanus sulcifrons Macquart is presented in detail. Information on the larval habitat of Tabanus abactor Philip and Tabanus equalis Hine is reported for the first time. Additional data on larval habitats of many Oklahoma species are also presented.

Information to the rearing of immature stages of tabanids has been described and several new types of larval food has been demonstrated to be quite useful and time saving.

A species list of the tabanids found in Oklahoma to the present has been given with the pertinent synonymy of all the species. Nine genera and 69 species are known to occur in Oklahoma and of this number, several species have been collected or reared for the first time. The genus Tabanus forms the most important and largest genus of this group.

LITERATURE CITED

- (1) Batt, T. R.
Personal communication.
- (2) Brennan, James Marks.
The Pangoniinae of Nearctic America (Tabanidae, Diptera).
Univ. of Kans., Science Bul. 36(2):249-401. April, 1935.
- (3) Eddy, G. W.
Personal communication.
- (4) Farley, Herman, Lon E. Foote, C. C. Pearson, and Ira Olin Kliever.
Anaplasmosis in Oklahoma cattle. Okla. Agric. Exp. Sta.
Bul. No. B-323. September, 1948.
- (5) Hine, J. S.
Tabanidae of Ohio. Papers Ohio State Acad. Science,
(5):1-57, 1903.
- (6) Howell, D. E., C. E. Sanborn, L. E. Rozeboom, G. W. Stiles, and
L. H. Moe.
The transmission of anaplasmosis by horseflies (Tabanidae).
Okla. Agric. Exp. Sta. Tech. Bul. No. T-11, October, 1941.
- (7) Johannsen, O. A.
Aquatic Diptera., Part II. Cornell Univ. Agric. Exp. Sta.
Memoir 177, June, 1935.
- (8) Jones, Calvin.
Fourth Quarterly Report, Division of Insects Affecting Man
and Animals, B.E.P.O., Kerrville, Tex., 1951.
- (9) Logothelis, Clearchos.
Biology of some Tabanidae of New York State. PhD. Thesis.
Cornell University, September, 1947.
- (10) McGregor, W. S.
Personal communication.
- (11) MacCreary, Donald.
Report on the Tabanidae of Delaware. Univ. of Del. Agric.
Exp. Sta. Bul No. 226, May 1940.
- (12) Parman, D. C.
Experimental dissemination of the Tabanid egg parasite
Phamurus emersoni Girault and biological notes on the species.
U.S.D.A. Cir. No. 181, January 1928.

- (13) Philip, C. B.
The Tabanidae (horseflies) of Minnesota. Univ. of
Minn. Agric. Exp. Sta. Tech. Bul. 80, June 1931.
- (14) Philip, C. B.
A catalog of blood-sucking fly family Tabanidae (horseflies
and deerflies) of the Nearctic. Am. Midland Nat. 37(2):
257-324. March 1947.
- (15) Sanborn, C. E., G. W. Stiles, and Lewis Moe.
Preliminary experiments in the transmission of anaplasmosis
by horseflies. Okla. Agric. Exp. Sta. Bul. No. 204, May 1932.
- (16) Schnorrenberg, Harold.
Taxonomy, distribution, and biological studies of Oklahoma
Tabanidae. M. thesis. O.A.M.C., 1932.
- (17) Schwardt, H. H.
Horseflies of Arkansas. Univ. of Ark. Agric. Exp. Sta.
Bul. No. 332, June 1936.
- (18) Snyder, T. E.
Swarming of Tabanus americanus. Proc. Ent. Soc. Wash. 19:
141, 1917.
- (19) Stone, Alan.
The horseflies of the subfamily Tabanidae of the Neartic
Region. U.S.D.A. Misc. Pub. No. 305, June 1938.
- (20) Tashiro, Hauro.
The biology and attempted control of Tabanidae in New York.
PhD. thesis. Cornell Univ., Ithaca, N. Y., 1950.
- (21) Webb, J. L. and R. W. Wells.
Horse-flies: Biologies and relation to western agriculture.
U.S.D.A. Bul. No. 1218, July 1924.

VITA

Orville Carl Schomberg
candidate for the degree of
Master of Science

Thesis: TABANIDAE OF OKLAHOMA

Major: Entomology

Minor: Zoology

Biographical and Other Items:

Born: September 2, 1922, at McLean, Nebraska.

Undergraduate Study: Colorado Agricultural and Mechanical
College, 1946-1949.

Graduate Study: Oklahoma Agricultural and Mechanical College,
1950-1952.

Experience: U.S.A.A.F., 1942-1945; Employed by Bureau of
Entomology and Plant Quarantine, Division of Insects
Affecting Man and Animals, 1949-present.

Member of Phi Sigma and The American Association of Economic Entomologists.

Date of Final Examination: May 15, 1952

THESIS TITLE: The Tabanidae of Oklahoma

AUTHOR: Orville Carl Schomberg

THESIS ADVISER: D. E. Howell

The content and form have been checked and approved by the author and thesis adviser. Changes or corrections in the thesis are not made by the Graduate School office or by any committee. The copies are sent to the bindery just as they are approved by the author and faculty adviser.

TYPIST: Mrs. Dorothy Sitton