COMPARATIVE ANATOMY AND SEASONAL MODIFICATIONS OF MALE REPRODUCTIVE GLANDS IN THE NORTH AMERICAN BATS: *MYOTIS VELIFER*, *ANTROZOUS PALLIDUS* AND *TADARIDA BRASILIENSIS MEXICANA*.

By

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COMPARATIVE ANATOMY AND SEASONAL MODIFICATIONS OF MALE REPRODUCTIVE GLANDS IN THE NORTH AMERICAN BATS: MYOTIS VELIFER, ANTROZOUS PALLIDUS AND TADARIDA BRASILIENSIS MEXICANA.

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PREFACE

Many observations and studies have been made on the phenomena of reproduction in bats. Of these, perhaps the least completely studied are the seasonal changes in the male reproductive glands, which constitute the subject of this report.

Acknowledgment of appreciation is extended to Dr. Bryan P. Glass, who directed the investigation, and to Drs. G. A. Moore, F. M. Baumgartner and W. S. Newcomer for their assistance and counsel.

Sincere appreciation is expressed to my colleagues, Robert M. Sutton and Clarence J. McCoy, Jr., and to Dr. Bernardo Villa-R., University of Mexico, and Dr. D. G. Constantine, United States Public Health Service for assistance in providing specimens needed for this investigation.

Acknowledgment is made of help in the form of a Research Assistantship through the Research Foundation supported by a research grant, No. E819(C3) from the National Institutes of Health, Public Health Service.

The gracious assistance of my wife in the typing of this paper is gratefully acknowledged.

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INTRODUCTION

The purpose of the present study was to determine the gross morphology of the male glandular genitalia of three species of bats, and to chart the cyclic changes that occur in each of the glands through the course of the year.

The three forms involved in this study were Myotis velifer (Allen), Antrozous pallidus (Le Conte) and Tadarida brasiliensis mexicana (Saussure). The first two species are members of the family Vestertilionidae and the latter, a migratory species, is a member of the family Molossidae.

The complete reproductive cycle has been studied in males of the pallid bat, Antrozous pallidus, in California, the freetailed bat, Tadarida brasiliensis cynocephala (Le Conte), in Florida and two species of Myotis, M. lucifugus (Le Conte) and M. grisescens (Howell), in Missouri. There have been no definite comparisons made between these cycles or of the seasonal modifications of the testes and accessory glands. The complete male reproductive cycles of Myotis velifer and Tadarida brasiliensis mexicana have not been studied.

This paper presents a review of the literature on the subject and makes some comparisons between two different species of the family Vespertilionidae and between representatives of the Vespertilionidae and Molossidae.

REVIEW OF THE LITERATURE

A detailed description of the internal anatomy of several European Vespertilionids has been given by Robin (1881) and Courrier (1927). The gross anatomy of the species studied by Robin and Courrier differ only slightly from the North American species used in the present study.

Miller (1939), describing the male reproductive glands of Myotis grisescens and M. lucifugus, indicated the following: The testes lie between the skin and the thigh muscles just lateral to the anus. The epididymis consists of two portions, the cap or head which rests on the anterior end of the testis and the elongate caudal or tail portion, which extends posterior to the testis into the interfemoral membrane. When the testis is descended the ductus deferens arises from the medial side of the caudal epididymis and passes anteriorly along the medial side of the testis into the abdominal cavity. There may or may not be a pigmented cremaster sheath covering portions of the testis and epididymis.

The accessory of glands of vespertilionids as described by Courrier (1927), consist of the prostate, one or two pairs of Cowper's glands and two pairs of seminal vesicles designated as the principal and accessory seminal vesicles, respectively. Each ductus deferens passes into a principal seminal vesicle which lies anterior and slightly dorsolateral to the urinary bladder. The accessory lobe of the seminal vesicle is smaller than the principal lobe and adjoins along its lower lateral border. The prostate consists of a large glandular mass that partially or completely surrounds the urethra. The Cowper's glands lie at the

base of the penis and posterior to the bladder. The penis is free and pendulous. It is covered by a fine skin, which is usually pigmented, and is devoid of hair except at its extreme base (Jones, 1916). The testes, when descended, are held in a scrotum situated at the base of the penis. The scrotum is usually pigmented and may be pre- or postanal in position. The regression of the testis is periodic in most forms. During the breeding season the descended glands reach remarkable dimensions.

Most authors agree that the testes of the bats emerging from hibernation in the winter months are small and do not exhibit any spermatogenic activity. At this time the males scatter and live comparatively segregated lives. The testes remain inactive until summer. In early summer the testes begin to enlarge and reach maximum size in September. Pearson (1952), studying Corynorhinus, referred to the interstitial tissue of the testis as being remarkably hypertrophied in the young males throughout the year, and in adult males only in the summer. Specimens in mid-summer showed the seminiferous tubules to be filled with cells of immature stages, including a few spermatids but no spermatocytes. Evans (1930) found mature spermatocytes in the testis of Eptesicus fuscus (Beauvois) only in late summer or fall.

In captive male Antrozous, enlargement of the gonads becomes noticeable toward the latter part of August (Orr, 1954).

Miller (1939) stated that spermatogenesis in bats of the genus Myotis occurred during the summer months, at which time the remainder of the reproductive system was quiescent. The interstitial cells attain their maximum size in the summer, undergo retrogression in the fall and remain small until the following spring. Wimsatt (1945) found in a species of Myotis in the eastern United States, that during the winter

the seminiferous tubules undergo involution and become quiescent.

Generally when the testis regresses in the summer, the epididymis becomes distended with spermatozoa. Miller (1939) observed that the epididymides of Myotis lucifugus and M. grisescens contain a great mass of spermatozoa throughout the fall, winter and early spring. Pearson (1952) described the epididymis of Corynorhinus rafinesquei (Lesson) as large and conspicuous in the interfemoral membrane from November to March and filled with spermatozoa. A male Eptesicus fuscus was collected on December 31 by Evans (1930); the epididymis after sectioning was found to be composed of widely dilated tubules packed with spermatozoa. In another specimen collected in midsummer, sectioning revealed the epididymis to be empty except for a small amount of secretion from the lining cells.

Orr (1954) in his study of Antrozous pallidus found the same seasonal changes described by Evans in Eptesicus fuscus and added this observation concerning the cremaster sack: "Weekly examination of four captive bats from October to the end of April showed a steady decrease in the size of the cremaster sack. This decrease in the fall is associated with a decrease in the size of the testis, but not of the epididymis." The epididymis was filled with motile spermatozoa until the end of hibernation and the beginning of spring, at which time the spermatozoa disappeared and the epididymis regressed.

The accessory glands follow the same sexual cycle as the epididymides. Miller (1939) observed in Myotis lucifugus and M. grisescens that when the testis is quiescent in the winter the accessory glands are at a maximum size and function. Pearson (1952) in his study of Corynorhinus, noted that "the accessories remain small through the spring and summer,

begin to enlarge in August and achieve their maximum in November near the breeding season. Despite the regression of the testis the accessories of adults remain conspicuously large throughout the winter until early spring, then they regress".

PROCEDURES AND METHODS

Approximately 150 male bats were examined during the course of this study. Measurements of the reproductive glands were made from the majority of these specimens and a microscopic examination was made of sections from selected individuals. A number of specimens had been collected from one to three years previously by Dr. Glass and his associates. Other collections were made periodically during the years 1957 and 1958 by the writer and fellow graduate students. The specimens were obtained from various caves located throughout the State of Oklahoma, mostly in the western portion.

Bats were collected in summer with mist nets (Glass, 1956) strung across the openings of caves, with sturdy sweep nets for scraping the bats off of the cave walls, and by hand. In winter, hibernating bats could usually be picked off the low ceilings and walls by hand. Because the freetailed bat of Oklahoma migrates out of the State in the fall, the November, February and March collections were obtained from Mexico and Carlsbad, New Mexico. According to Dr. D. G. Constantine of Carlsbad, (personal communication to Dr. Glass), the freetailed bat in New Mexico has the same breeding season as it has in Oklahoma. The November specimens of T. b. mexicana were secured from the vicinity of Mexico City and therefore may not be exactly comparable to specimens from Oklahoma and New Mexico.

Specimens were killed within 48 hours after being received in the laboratory. The pelvic region, including the reproductive organs, was dissected out and placed in either ten per cent formalin or in Bouin's

picro-formal solution for a period of at least 24 hours. After fixation they were washed in water or 35 per cent solution of isopropanol respectively. The testes, epididymides and seminal vesicles were removed from the other tissues.

The separate glands were measured to the nearest tenth of a millimeter with calipers and millimeter ruler. The length of the testis was measured from a point just below the epididymal cap to the posterior tip of the testis. The width was taken at right angles to the length and at the widest point. The length of the epididymis was measured from a point just below the posterior end of the testis to the posterior end of the cauda epididymis. The width was taken at the widest point and at right angles to the length. The values for the seminal vesicles were made from the principal seminal vesicle. The length was taken at the longest axis and the width was taken at the widest point at right angles to the length. These two measurements were multiplied together to give a single value whose magnitude was correlated with the state of functional activity of the gland. These values, taken at monthly intervals, were plotted along the ordinate of a graph with the months of the year forming the abscissa.

Following measurement, the glands were dehydrated and cleared by the alcohol-xylene method, infiltrated with paraffin and embedded. Sections for the study of functional activity were cut at 10 microns. Sections were stained with Harris' Haematoxylin and counterstained with triosin.

Observations and photomicrographs were made with a Spencer compound microscope utilizing both 10x and 44x objectives and a 10x ocular.

OBSERVATIONS

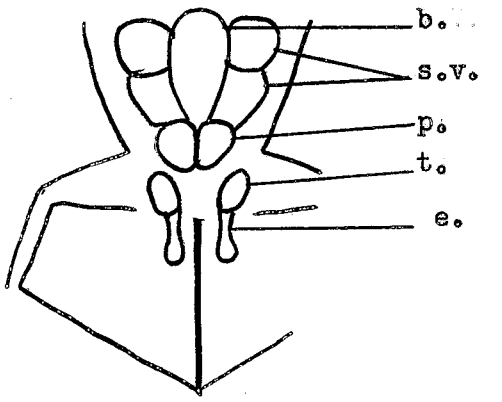
Testes

Gross anatomy--The testes of adult M. velifer and A. pallidus were located just outside the abdominal wall posterior to the pelvis in all specimens examined. In adult T. b. mexicana, the testes remained within the abdomen, one on each side of the urinary bladder and anterior to the seminal vesicles. Apparently they never descend outside the body wall (figure 1).

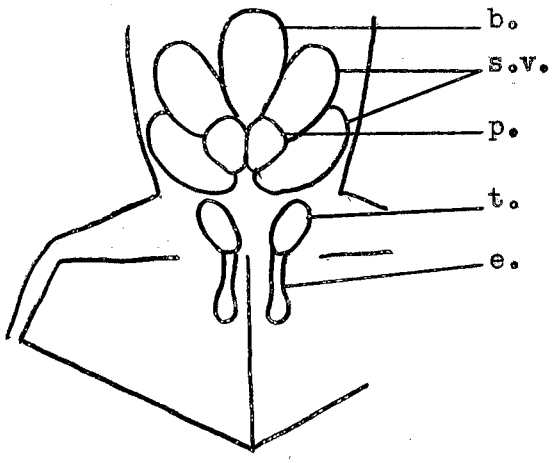
In January the testes of M. velifer were at a minimum size, averaging 4.4 mm. in length and 2.6 mm. in width. No conspicuous change in size occurred until May when enlargement began and continued to a maximum size in September, averaging 7.3 mm. in length and 4.5 mm. in width. An abrupt decrease in size occurred the following month (figure 2).

The testes of A. pallidus were decreasing in size in March and reached a minimum in June, averaging 4.7 mm. in length and 2.8 mm. in width. Enlargement began in July and reached the greatest dimensions in September, averaging 5.3 mm. in length and 4.5 mm. in width. The testes decreased abruptly in size the following month and then diminished slowly to near the minimum size in March (figure 3).

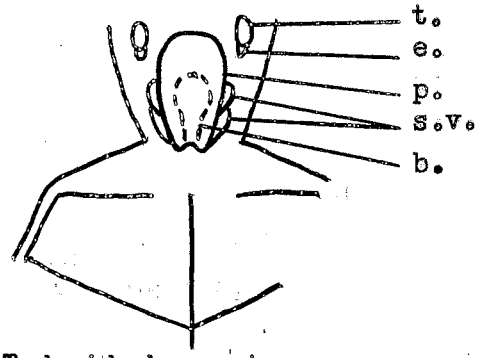
In February the testes of T. b. mexicana were at a maximum size with an average measurement of 5.2 mm. in length and 3.2 mm. in width. Regression began in March and reached a minimum size in August, averaging 3.0 mm. in length and 1.6 mm. in width. A noticeable increase in size



Myotis velifer



Antrozous pallidus



Tadarida b. mexicana

Figure 1. Ventral view of the testes and accessory glands near peak of enlargement. b., urinary bladder (empty in all examples); p., prostate; s.v., seminal vesicles; t., testes; e., epididymis.

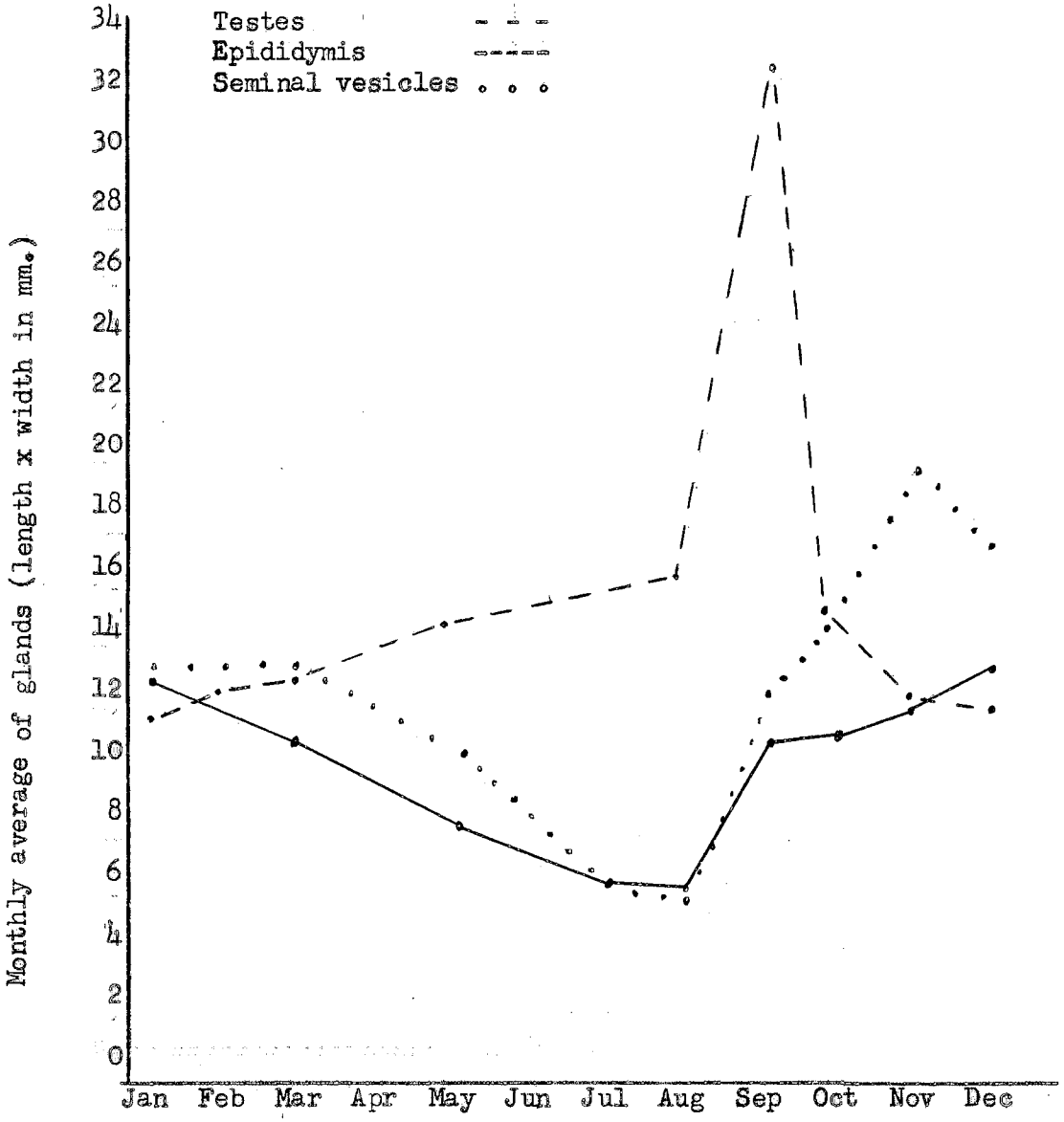


Figure 2. Comparison of the cyclic changes in size of the testes, epididymis and seminal vesicles of M. velifer.

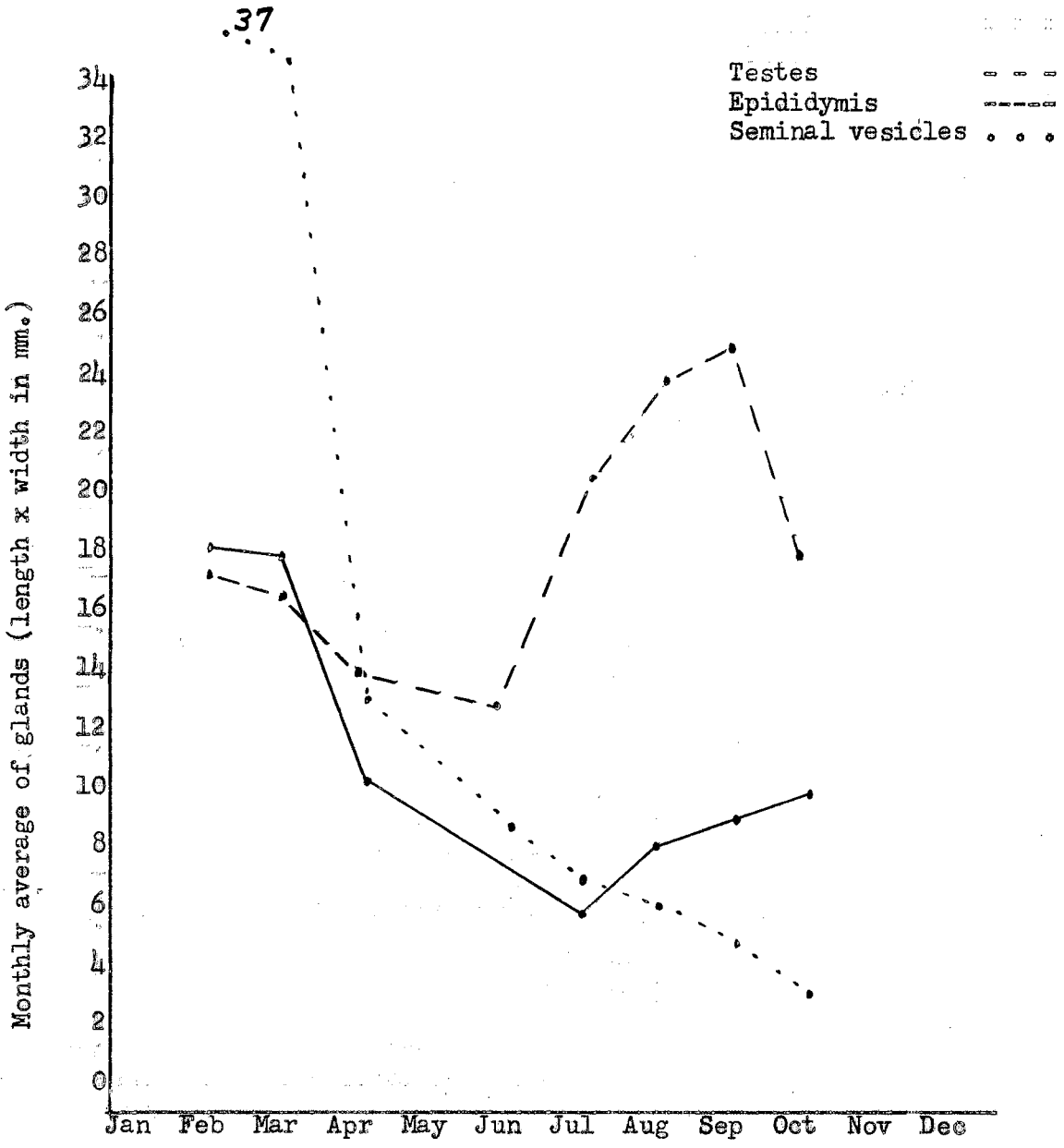


Figure 3. Comparison of the cyclic changes in size of the testes, epididymis and seminal vesicles of A. pallidus.

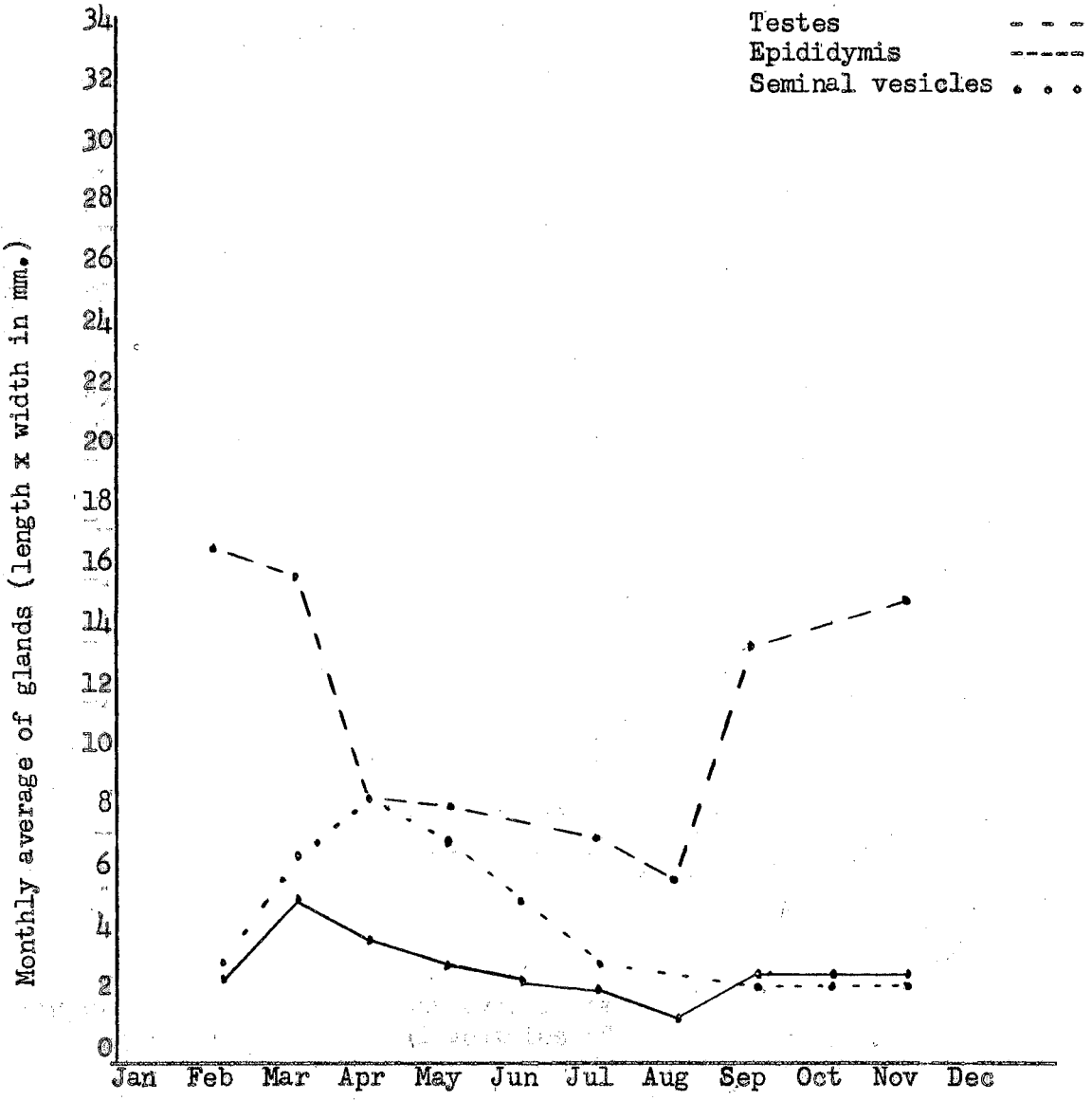


Figure 4. Comparison of the cyclic changes in size of the testes, epididymis and seminal vesicles of T. b. mexicana.

of the testes occurred the following month and enlargement continued through the winter (figure 4).

Functional status--From late November to May the testes of M. velifer were regressed and inactive. The seminiferous tubules were small and interstitial tissue filled a large portion of the glands (figure 5). In May the seminiferous tubules increased in size but no spermatogenetic activity was observed. By August the tubules were very large, spermatogenesis had reached a peak of activity and the interstitial tissue had apparently decreased in amount (figure 6). Spermatozoa were present in the lumen of the tubules during August and September. In October the spermatogenetic activity had ceased, only a few spermatozoa were left in the seminiferous tubules and the relative amount of interstitial tissue was increasing (figure 7).

In March the testes of A. pallidus were inactive, the seminiferous tubules were small and there was much interstitial tissue present (figure 8). This inactive status prevailed until July when a few cells began spermatogenesis and an apparent decrease in the amount of interstitial tissue occurred (figure 9). Spermatogenetic activity reached a peak in August and September but spermatozoa were not noticeable in the lumens until October (figure 10). Spermatogenesis ceased in October and the seminiferous tubules began to regress. As the tubules decreased in size the relative amount of interstitial tissue increased.

The testes of T. b. mexicana were at a peak of spermatogenetic activity in February. The seminiferous tubules were large and very little interstitial tissue was seen. In March the lumens of the tubules were filled with spermatozoa (figure 11). Spermatogenesis ceased in May, the tubules began to regress and the interstitial tissue had apparently

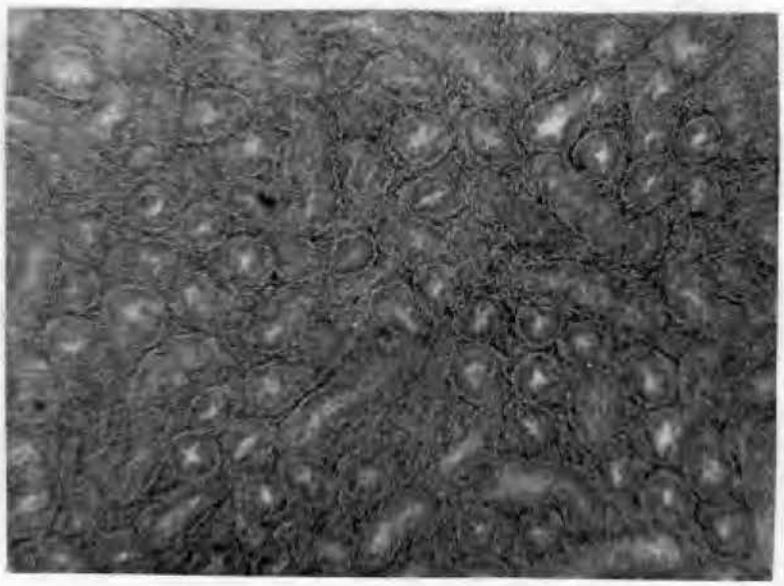


Figure 5. Testis of M. velifer in May. Note small size of tubules and relatively large amount of interstitial tissue. 100x

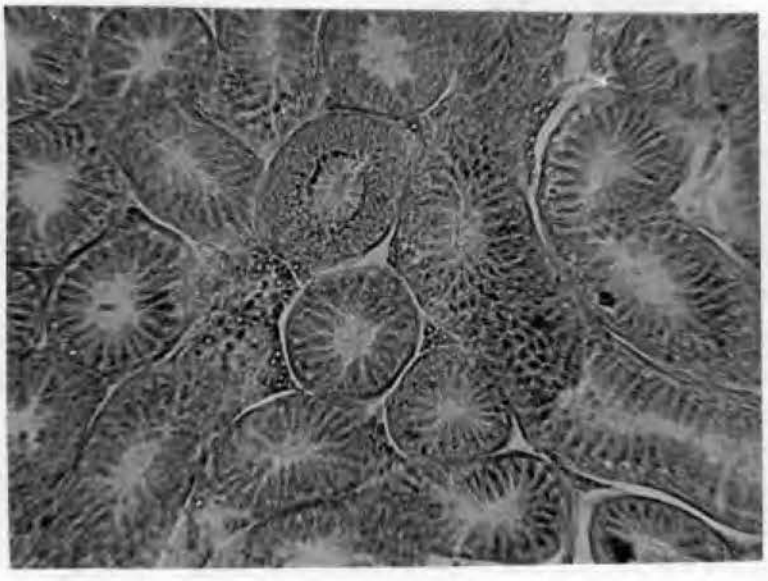


Figure 6. Testis of M. velifer in August. Note spermatozoa in the lumens and almost complete absence of interstitial tissue. 100x

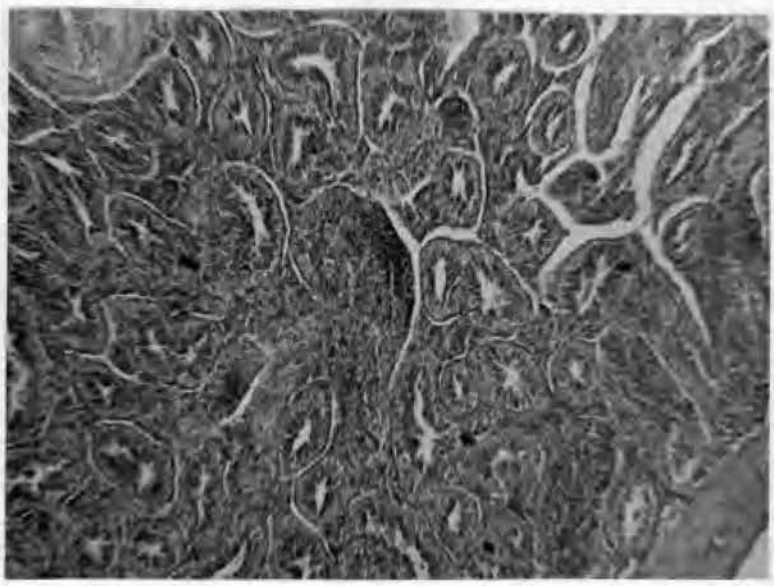


Figure 7. Testis of M. velifer in October. Note small size of tubules and relatively large amount of interstitial tissue. 100x

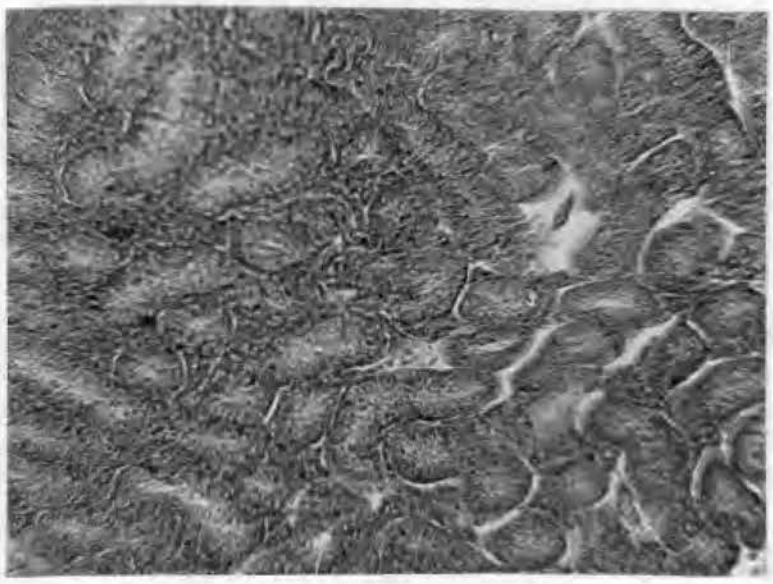


Figure 8. Testis of A. pallidus in March. Note small size of tubules and large amount of interstitial tissue. 100x

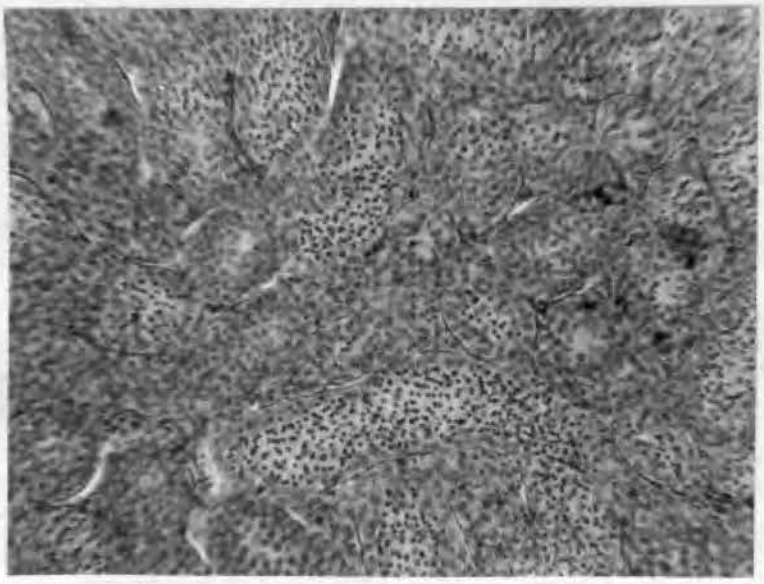


Figure 9. Testis of A. pallidus in July. Note large size of tubules and scarcity of interstitial tissue. 100x

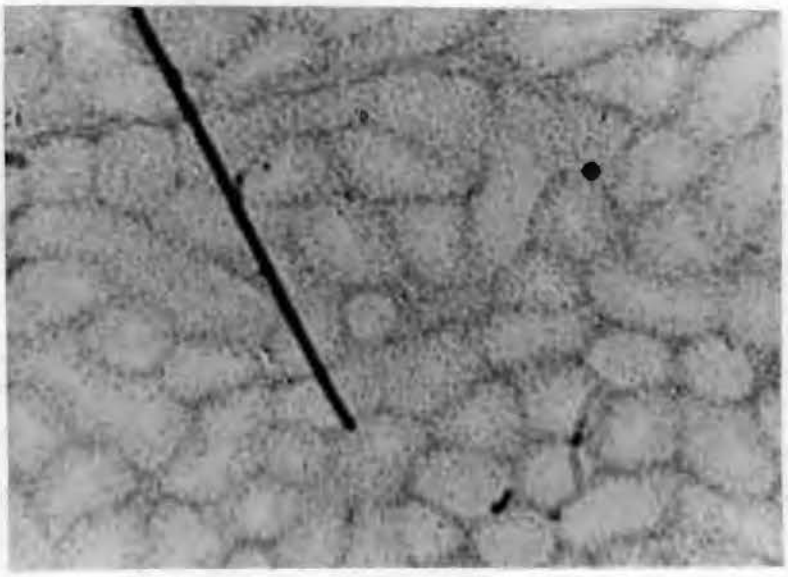


Figure 10. Testis of A. pallidus in October. Note size of tubules and scarcity of interstitial tissue. 100x

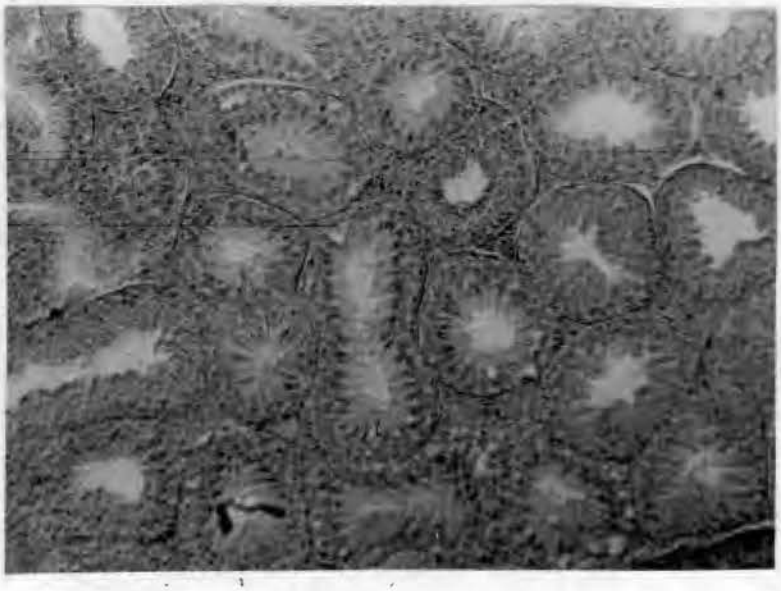


Figure 11. Testis of T. b. mexicana in March. Note the size of tubules and spermatozoa in the lumens. 100x

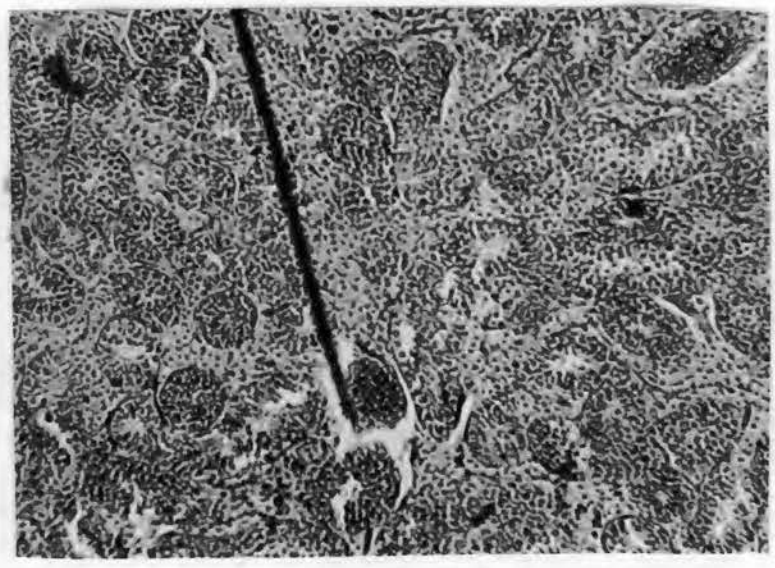


Figure 12. Testis of T. b. mexicana in May. Note small size of tubules and relatively large amount of interstitial tissue. 100x

increased (figure 12). The quiescent state of the testes continued until September, then the tubules began to enlarge and the relative amount of interstitial tissue decreased. In October spermatogenesis was evident and the tubules were very large (figure 13).

Epididymides

Gross anatomy--The seasonal changes of the epididymides involved primarily the caudal portion with very little change occurring in the cap portion. The caudae epididymides of M. velifer began to decrease in size in March and reached a minimum size in July and August, averaging 3.0 mm. in length and 1.5 mm. in width. In September the epididymides showed a large increase in size and continued to a maximum size in December, when they averaged 5.0 mm. in length and 2.8 mm. in width. A slight decrease occurred in January but the onset of full regression did not take place until March.

In February the epididymides of A. pallidus were at a maximum size, averaging 5.5 mm. in length and 3.4 mm. in width. The epididymides remained large through March and in April a sharp decrease in size occurred. A gradual decrease continued until July when a minimum size, averaging 2.8 mm. in length and 2.0 mm. in width was reached. Enlargement of the epididymides began in August and continued at a fairly constant rate until a maximum size was restored in January and February.

The epididymides of T. b. mexicana were largest in size in March, averaging 2.5 mm. in length and 2.0 mm. in width. From April to August, a steady decrease in size occurred reaching a minimum size averaging 1.0 mm. in length and 0.5 mm. in width. A slight enlargement of the epididymides was noted in September and a size averaging 2.0 mm. in length and 1.2 mm. in width, which remained the same until February when another

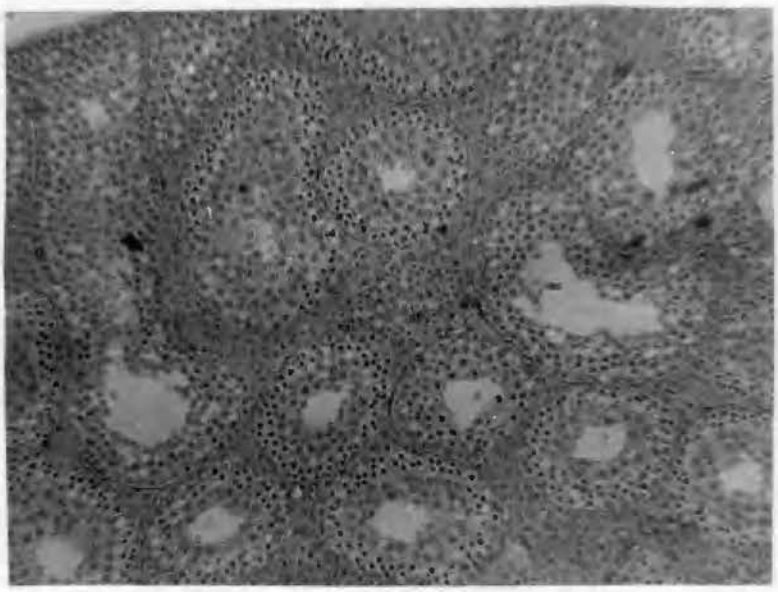


Figure 13. Testis of T. b. mexicana in October. Note large size of tubules and scarcity of interstitial tissue. 100x

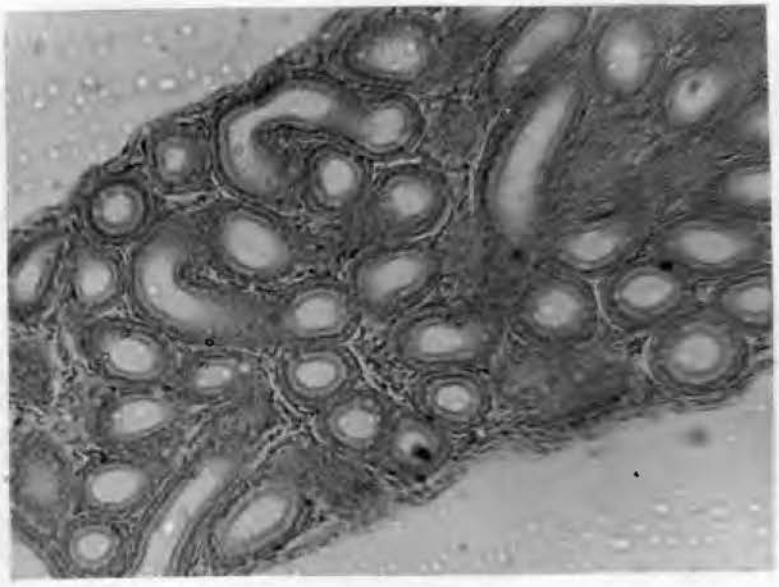


Figure 14. Epididymis of M. velifer in May. Note small size of tubules and lack of spermatozoa. 100x

slight increase was noted. The above observations are presented graphically in figures 2, 3, 4.

Functional status--In April the epididymides of M. velifer had begun to regress. From May to July the epididymides were completely regressed (figure 14). In August the epididymides were small but filled with spermatozoa. From September to January the tubules of the epididymides were packed with spermatozoa (figure 15). A slight decrease in the number of spermatozoa was noted in January and greater decreases occurred in February and March.

The epididymides of A. pallidus in February were filled with spermatozoa (figure 16). In March a slight decrease in the number of spermatozoa was observed and regression was completed in April with few spermatozoa remaining in the epididymides (figure 17). This state of regression continued until September when a few spermatozoa were seen in the tubules of the epididymides. In October large numbers of spermatozoa filled the tubules.

The epididymides of T. b. mexicana were almost filled with spermatozoa in February and in March they were packed (figure 18). In April and May the number of spermatozoa in the epididymides decreased rapidly. From July through November the epididymides were regressed and void of spermatozoa (figure 19).

Seminal Vesicles

Gross anatomy--The seminal vesicles of M. velifer began to decrease in size in March and continued to decrease steadily until a minimum size, averaging 2.5 mm. in length and 2.0 mm. in width, was reached in August. In September and October a steady increase in the size of the seminal

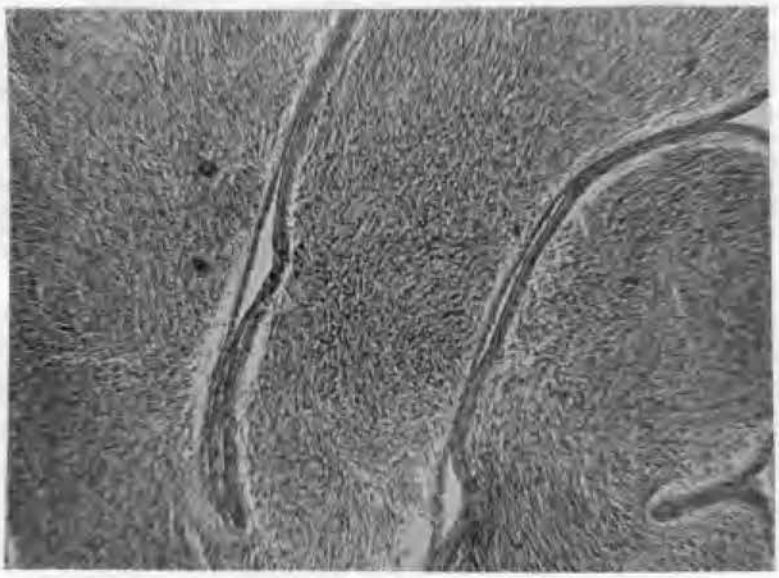


Figure 15. Epididymis of M. velifer in September. Note extremely large size of tubules packed with spermatozoa. 100x

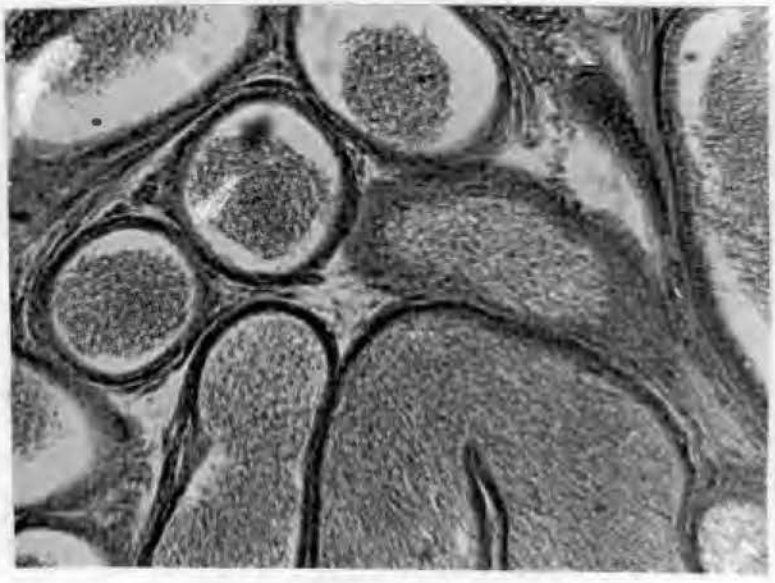


Figure 16. Epididymis of A. pallidus in February. Note large size of tubules filled with spermatozoa. 100x

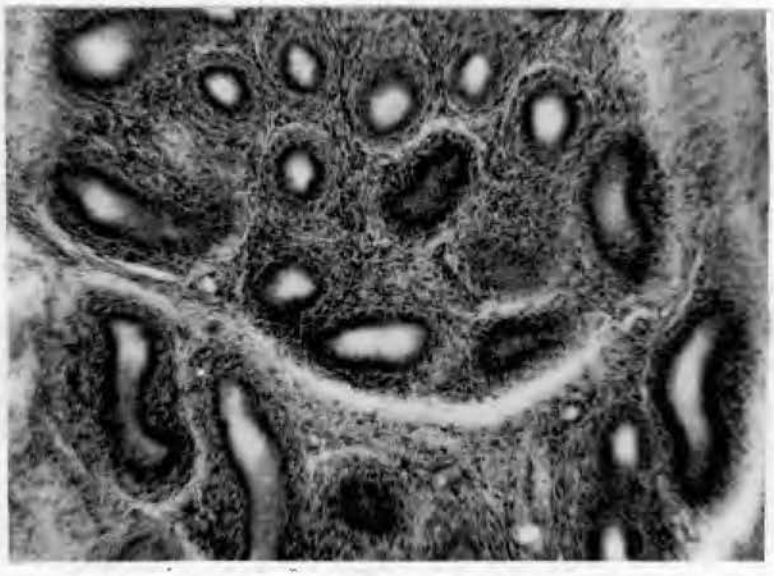


Figure 17. Epididymis of A. pallidus in April. Note small size of tubules and lack of spermatozoa. 100x

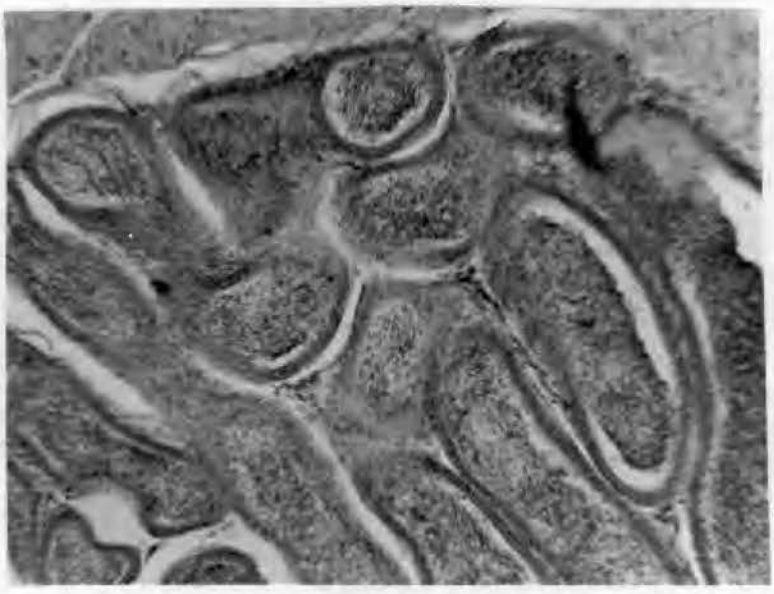


Figure 18. Epididymis of T. b. mexicana in March. Note large size of tubules filled with spermatozoa. 100x

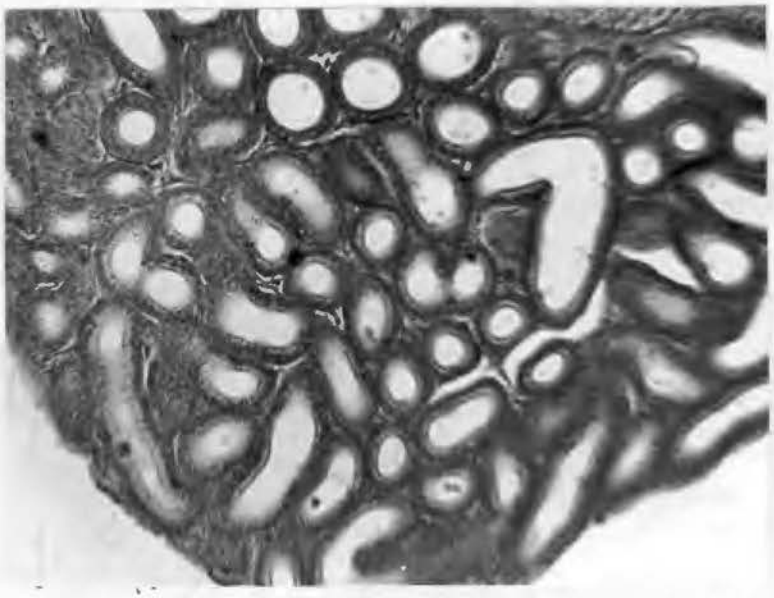


Figure 19. Epididymis of T. b. mexicana in July. Note small size of epididymis and tubules. 100x

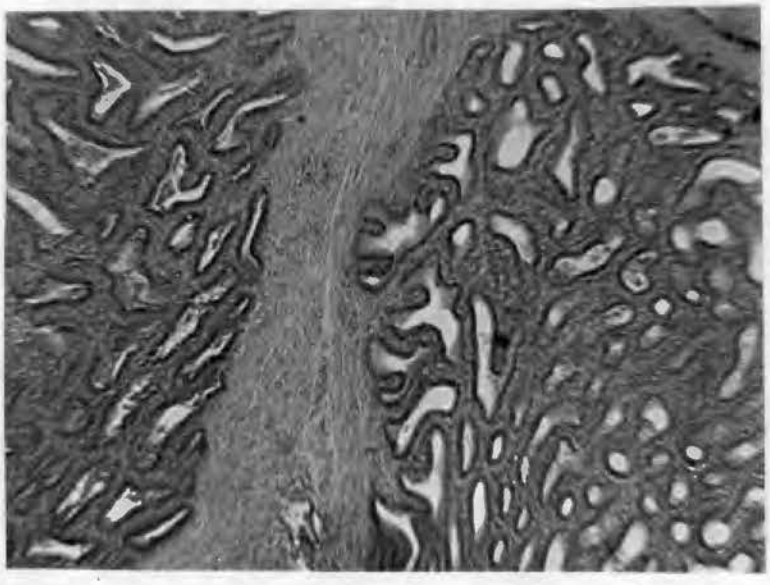


Figure 20. Seminal vesicle of M. velifer in May. Note small size of cavities and lack of fluid. 100x

vesicles was observed with a maximum size, averaging 5.5 mm. in length and 3.7 mm. in width, being reached in November. A sharp decrease in size of the seminal vesicles occurred during December and an average size of 4.2 mm. in length and 3.1 mm. in width was reached in January and maintained until March.

The seminal vesicles of A. pallidus were at a maximum size in February, averaging 8.6 mm. in length and 4.3 mm. in width. Between March and April a great decrease in the size of the seminal vesicles was noted with a gradual decrease continuing until October and a minimum size was reached, averaging 4.2 mm. in length and 2.3 mm. in width.

In February, the seminal vesicles of T. b. mexicana were enlarging. A maximum size averaging 3.2 mm. in length and 2.5 mm. in width, was reached in April. From May to August a gradual decrease in size of the seminal vesicles occurred. From August through November a minimum size, averaging 2.0 mm. in length and 1.0 mm. in width, was observed. The above observations are presented graphically in figures 2, 3, 4.

Functional status--Regression of the seminal vesicles of M. velifer began in March and was completed by late May (figure 20). An inactive status with very little fluid remaining in the cavities continued until August. In September the seminal vesicles were filled with fluid and remained full and active until March (figure 21).

In A. pallidus, the seminal vesicles were filled with fluid in February and March (figure 22) with a slight reduction in the amount of fluid occurring in March. By April the seminal vesicles contained only small amounts of the fluid and were regressed (figure 23). Regression of the seminal vesicles persisted through October.

The seminal vesicles of T. b. mexicana began filling with fluid in late February and were completely filled and in an active state in April

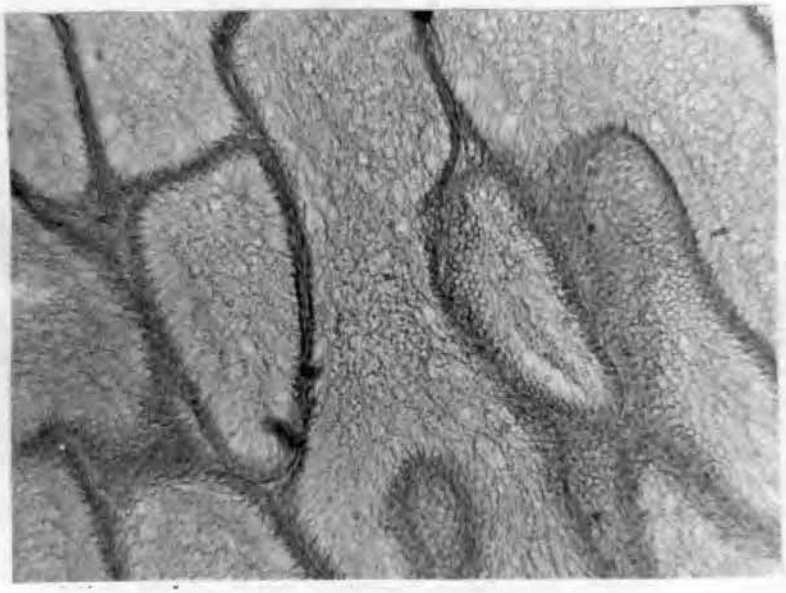


Figure 21. Seminal vesicle of M. velifer in September. Note large size of lumens filled with fluid. 100x

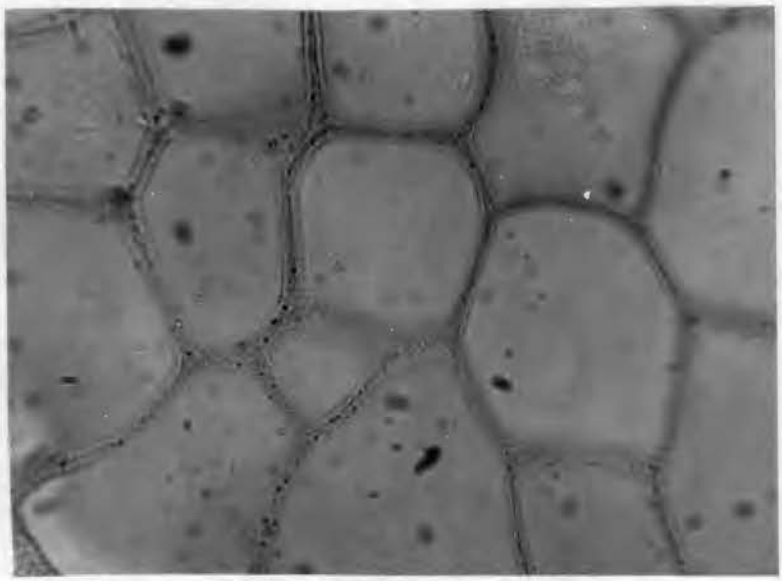


Figure 22. Seminal vesicle of A. pallidus in March. Note large size of lumens filled with fluid. 100x

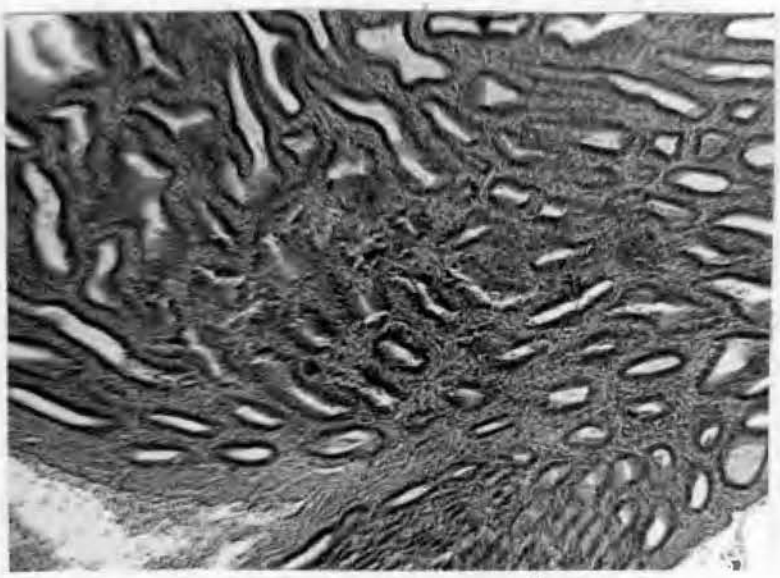


Figure 23. Seminal vesicle of A. pallidus in May. Note small size of lumens and lack of fluid. 100x

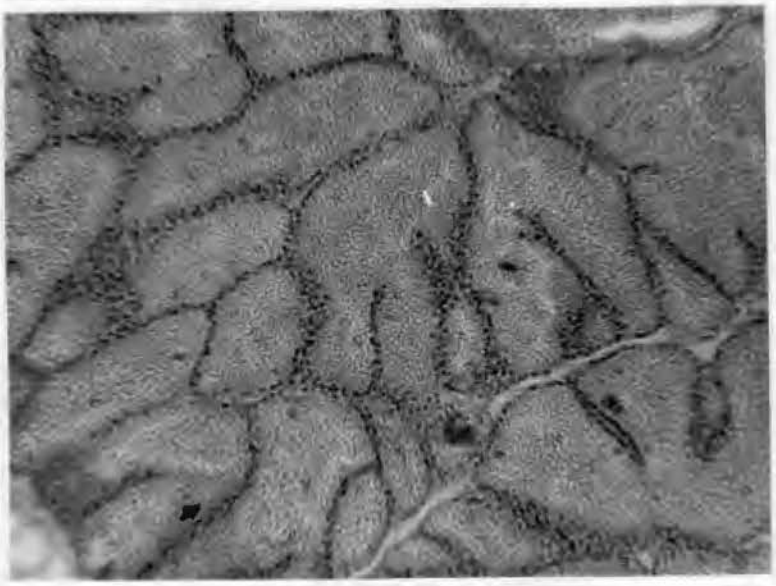


Figure 24. Seminal vesicle of T. b. mexicana in April. Note large size of lumens filled with fluid. 100x

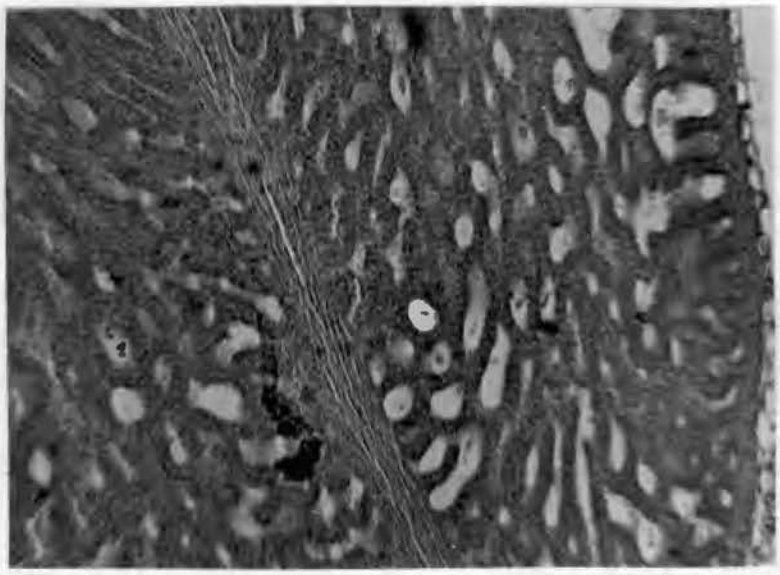


Figure 25. Seminal vesicle of T. b. mexicana in July. Note small size of cavities and lack of fluid. 100x

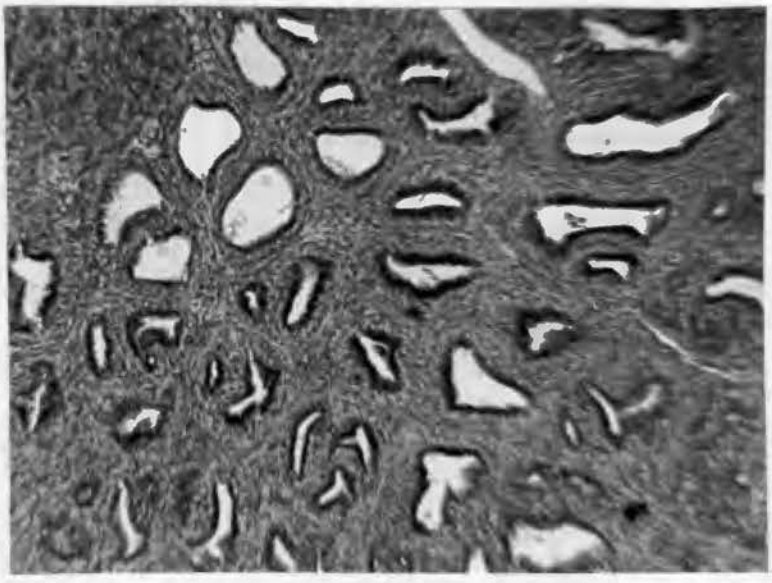


Figure 26. Prostate of T. b. mexicana in July. Note lack of fluid in cavities. 100x

(figure 24). In May the vesicles were regressing and contained smaller amounts of fluid. The seminal vesicles were regressed and void of fluid in July (figure 25) and remained quiescent throughout the summer and fall.

Prostate

The prostate in M. velifer was small and showed no conspicuous changes in size (figure 1) during the year.

In A. pallidus the prostate remained small and no noticeable changes in size occurred during the year.

The prostate in T. b. mexicana was small and inactive between June and January (figure 26). In February enlargement began and in March and April a remarkable size was reached (figure 1). The cavities were filled with fluid (figure 27). Regression of the prostate began in May and was completed in June.

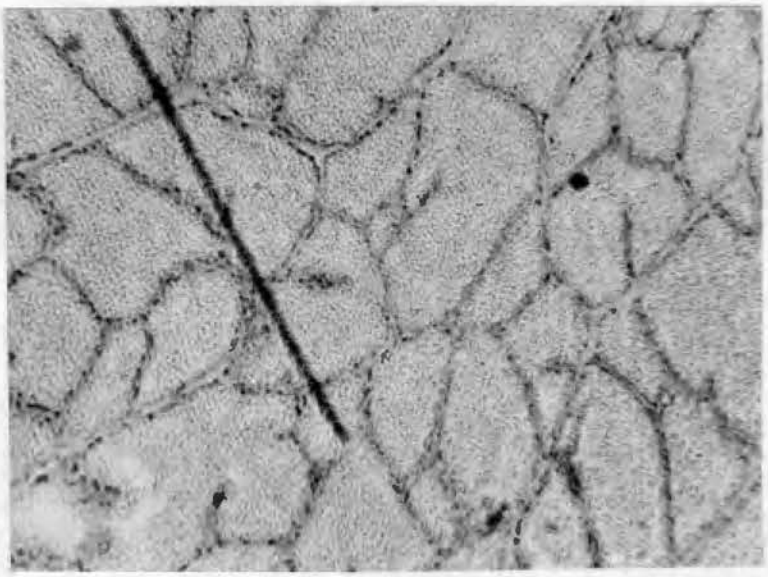


Figure 27. Prostate of T. b. mexicana in April. Note large size of lumens and copious amounts of prostate fluid. 100x

COMPARISONS

Intrafamily

Gross anatomy--In M. velifer and A. pallidus, species of the family Vespertilionidae, the seasonal changes in the testes, epididymides and seminal vesicles were very similar. The main difference was in the times that the various glands reached a peak in activity and size (figures 28, 29, 30). The testes of M. velifer and A. pallidus were descended outside the body cavity in all adult specimens examined (figure 1). Enlargement of the testes of M. velifer began in May and in A. pallidus the testes began enlargement in July, two months later. In both species the testes reached a maximum size in September. Regression of the testes of M. velifer to a minimum size occurred in January, the testes of A. pallidus did not reach a minimum size until June.

The extension of the caudae epididymides of both species into the interfemoral membrane was conspicuous in the fall and winter (figure 1). In June and July, the epididymides were at a minimum size. Enlargement of the epididymides of both species began in August. Maximum size was attained in December for M. velifer, while for A. pallidus it occurred two months later in February.

The seminal vesicles showed the greatest difference in the time when they were at a maximum size (figure 30). In M. velifer, the maximum size of the seminal vesicles occurred in November. Regression of the seminal vesicles began in March and a minimum size was reached in August. The

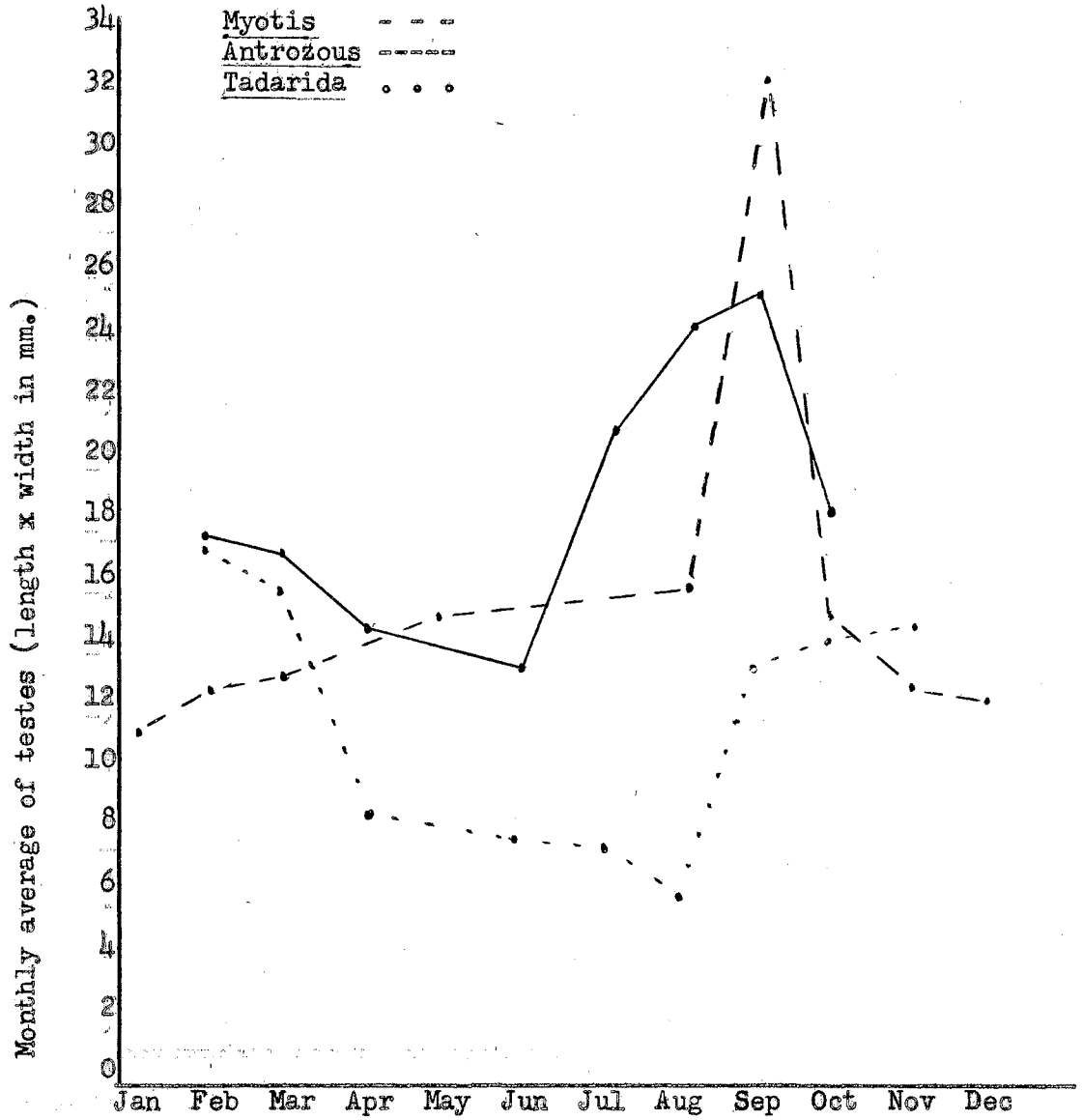


Figure 28. Comparison of the cyclic changes in size of the testes of Myotis, Antrozous and Tadarida.

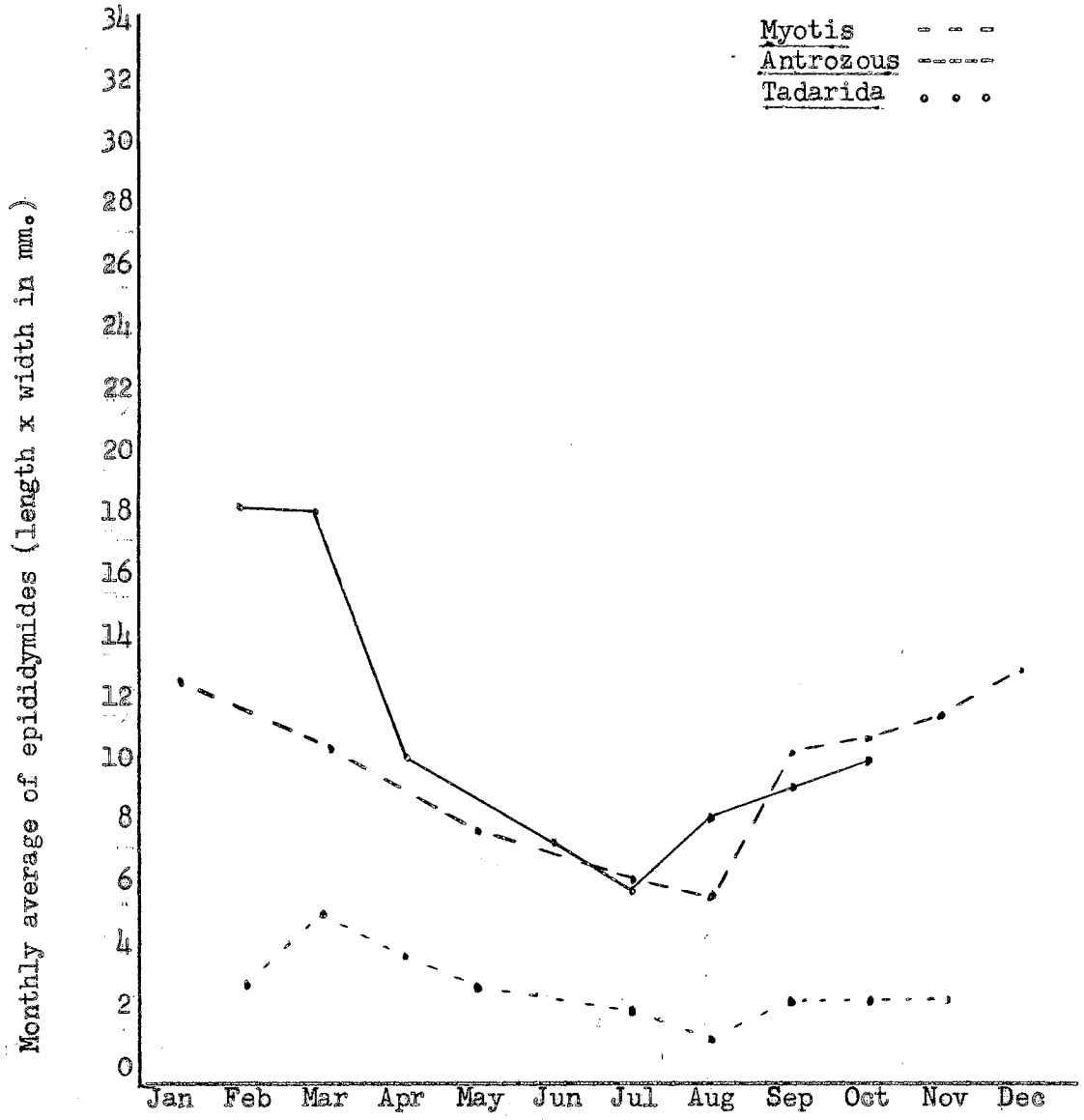


Figure 29. Comparison of the cyclic changes in size of the epididymides of Myotis, Antrozous and Tadarida.

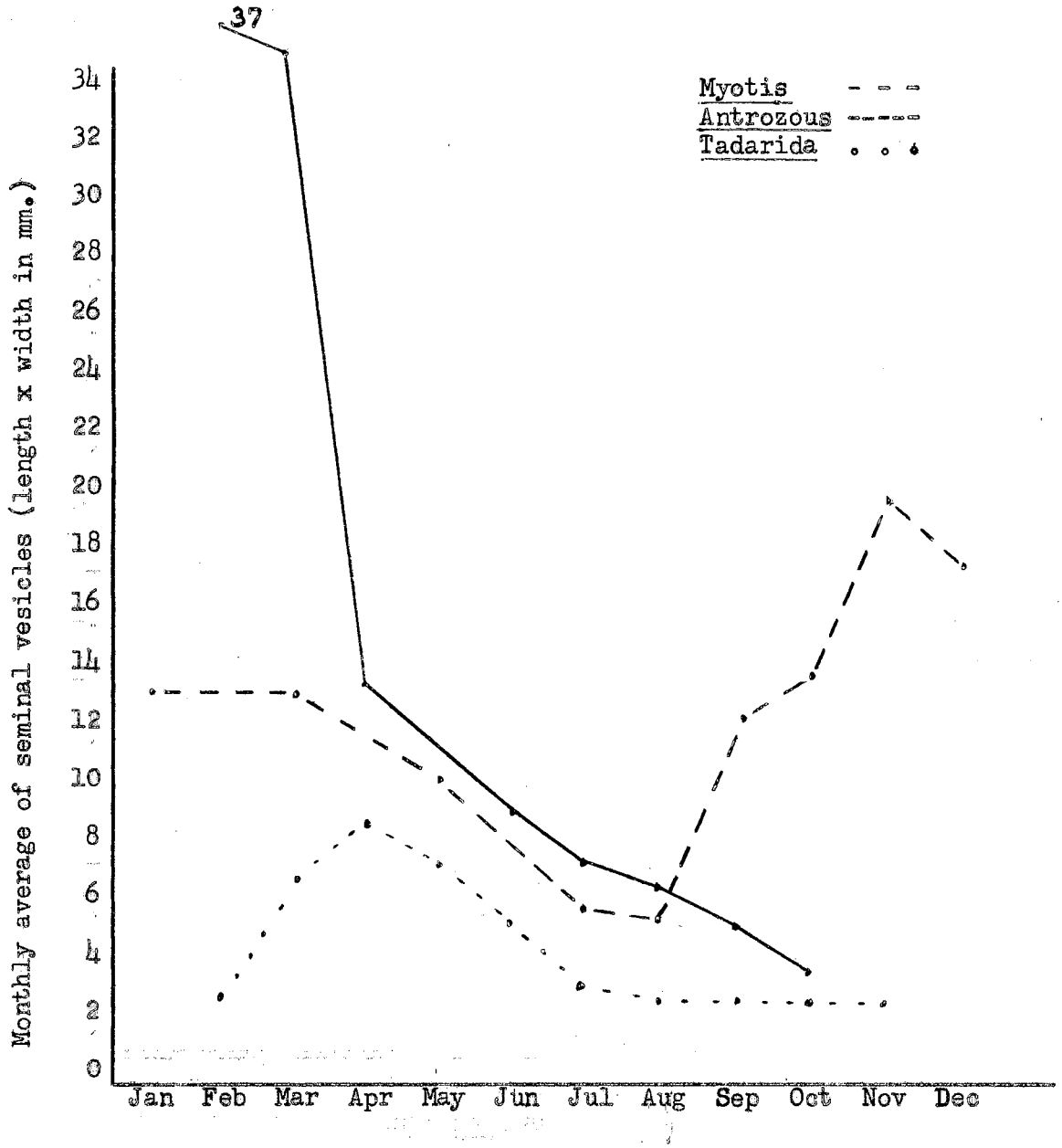


Figure 30. Comparison of the cyclic changes in size of the seminal vesicles of Myotis, Antrozous and Tadarida.

seminal vesicles of A. pallidus were at a maximum size in February, three months later than those of M. velifer. A decrease in size of the seminal vesicles followed and a minimum size was reached in October.

Functional status--The testes of M. velifer were in an inactive status between November and May (figure 5). By August the testes were very active (figure 6). Activity ceased in October. In A. pallidus, the testes were regressed and inactive between October and June. Spermatogenetic activity began in late June and reached a peak in August (figure 10).

In M. velifer the epididymides were regressed from April to July. Spermatozoa were observed in the epididymides from August to March (figure 15). Between September and February full functional status was maintained. The epididymides of A. pallidus were in regression from April to September. In September a few spermatozoa were seen in the tubules with increasing amounts (figure 16) occurring until March when a decrease in the amount of spermatozoa was noted.

The seminal vesicles of M. velifer were quiescent between March and September. In September the cavities were filled with fluid and remained full and active until March (figure 21). The seminal vesicles of A. pallidus were filled with fluid and active in February and March (figure 22). Regression of the seminal vesicles occurred in April and an inactive status persisted through October.

Interfamily

Gross anatomy--Comparisons on an interfamily level were made between M. velifer, of the family Vespertilionidae and T. b. mexicana, of the family Molossidae. An extreme difference in the time the various reproductive glands were at a peak of activity and size was noted

(figures 28, 29, 30).

The testes of T. b. mexicana did not descend outside the body cavity as did the testes of M. velifer (figure 1). Enlargement of the testes of M. velifer began in May and the maximum size was reached in September. Regression of the testes to a minimum size was reached by January. The testes of T. b. mexicana were enlarging and at a maximum size in January and February, the same time regression occurred in the testes of M. velifer. Regression began in March and a minimum size was reached in August.

The same extreme variation was observed between the epididymal cycles of M. velifer and T. b. mexicana. In M. velifer the caudae epididymides were enlarged and extended posteriorly into the interfemoral membrane from September to March. Regression occurred between March and August. The caudae epididymides of T. b. mexicana did not at any season show any great enlargement and remained within the abdominal cavity with the testes. A slight enlargement of the epididymides was observed between February and March when a maximum size was reached. Regression of the epididymides occurred between April and September.

The cycles of the seminal vesicles of M. velifer and T. b. mexicana differed considerably. The seminal vesicles of M. velifer began enlargement in September, reached a peak in November and decreased slightly in the following months. Regression occurred from March to September. In T. b. mexicana the seminal vesicles showed only a slight increase as compared to seminal vesicles of M. velifer. This slight increase occurred from February to April. In May, regression of the seminal vesicles began and continued through November.

The prostate gland in T. b. mexicana followed the same cycle as the

seminal vesicles. It showed extreme enlargement, as did the seminal vesicles of M. velifer and A. pallidus (figure 1). The prostate gland in M. velifer and A. pallidus remained small throughout the year and showed no conspicuous increase in size (figure 1).

Functional status--The periods of activity of the testes and accessory glands in T. b. mexicana were almost opposite to those in M. velifer. The testes of M. velifer were active in spermatogenesis in July and by August the seminiferous tubules contained spermatozoa (figure 6). Regression occurred from November to May (figure 5). On the contrary, in T. b. mexicana spermatogenetic activity was at a peak in February and spermatozoa were seen in the seminiferous tubules in March (figure 11). In May the testes began to regress and were inactive until September.

The epididymides of M. velifer were filled with spermatozoa from August to January (figure 15). A decrease in the amount of spermatozoa began in January and from May to July the epididymides were regressed. In T. b. mexicana the epididymides were filled with spermatozoa during February and March (figure 18) and by April a decrease in the number of spermatozoa was noted. From July through November the epididymides were completely regressed and void of spermatozoa.

From September to March the seminal vesicles of M. velifer were very large and active (figure 21). Regression began in late March and was completed by June and continued until September. The seminal vesicles of T. b. mexicana enlarged only slightly and were filled with fluid and active from late February through April (figure 24). In May, regression began and only a small amount of fluid remained in the cavities. A quiescent status prevailed from July through November.

The prostate gland of T. b. mexicana followed the same cycle as the

seminal vesicles. The extreme enlargement of the prostate in this species was unique (figure 1). It has not been reported for any other genus of North American bat. This enlargement probably accounts for the failure of the seminal vesicles to increase to large dimensions.

The period of sexual activity of the reproductive glands of M. velifer and A. pallidus (family Vespertilionidae) extends from fall to early spring, which corresponds to the period of hibernation. The period of sexual activity of the reproductive glands of T. b. mexicana (family Molossidae) is limited to the early spring months. This species migrates from Oklahoma South, spending the winter months either in south Texas or Mexico (Glass, in press, and Villa, 1956) and there is no long period of hibernation.

It seems probable that the cyclic sexual differences between the vespertilionid species and the molossid species are correlated with or a result of these profound differences in physiology and behavior.

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VITA

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Master of Science

Thesis: COMPARATIVE ANATOMY AND SEASONAL MODIFICATIONS OF MALE REPRODUCTIVE GLANDS IN THE NORTH AMERICAN BATS: MYOTIS VELIFER, ANTROZOUS PALLIDUS AND TADARIDA BRASILIENSIS MEXICANA.

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