# IDENTIFICATION AND DISTRIBUTION OF THE *PEROMYSCUS LEUCOPUS* SPECIES GROUP IN EAST TEXAS

by
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## ABSTRACT

The utility of external and cranial measurements to distinguish between specimens of *Peromyscus leucopus* and *P. gossypinus* from East Texas was assessed. The extent of age, sexual, and individual variation was statistically evaluated in each species. No significant secondary sexual dimorphism was evident, but age variation was significant in both species. Difficulty in identifying certain individuals was circumvented when age was taken into account. Univariate and multivariate statistical analyses were used to determine the identity of specimens previously regarded as hybrids between *gossypinus* and *leucopus* by McCarley (1954). Results indicate these specimens are not intermediate in cranial morphology and, consequently, it is doubtful that they represent "natural hybrids." The distribution of *leucopus* and *gossypinus* in East Texas is redefined based on correct identification of specimens.

# ACKNOWLEDGEMENTS

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Most of all, I thank my wife, Cindy, who assisted in all phases of this project and whose constant encouragement drove this project toward completion.

DEDICATION

To Cindy

# TABLE OF CONTENTS

# LIST OF TABLES

## LIST OF FIGURES

# INTRODUCTION

The *Peromyscus leucopus* species group includes two species, the white-footed mouse, *Peromyscus leucopus*, and the cotton mouse, *Peromyscus gossypinus* (Osgood, 1909). *Peromyscus leucopus* is a wide ranging species occuring throughout the eastern wooded portion of the United States. *Peromyscus gossypinus,* on the other hand, is limited in distribution to the wooded portion of the Gulf coastal plains. These two species are sympatric throughout a considerable portion of the Mississippi Valley region and the northern portion of the Gulf coastal plains (McCarley, 1963).

Dice (1937, 1940), in laboratory experiments, demonstrated that these two species were interfertile and produced fertile hybrids. Howell (1921) and McCarley (1954B) reported presumed "natural hybrids" from Alabama, Texas and Louisiana. These are the only instances of hybridization reported for these two species.

Apparently there are some habitat differences between the two species which seperate them in areas of sympatry. McCarley (1954A, 1963) reported that *P. leucopus* is restricted to the upland forested habitat, whereas *P. gossypinus* occurs predominantly in the lowland forested habitat. This ecological isolating mechanism generally seperates the two species. However, during periods of maximum population densities, *P. gossypinus* may also occur in the upland forested habitat.

McCarley (1964) suggested that this ecological isolation alone is not adequate to maintain species distinctiness. He proposed that there is a significant species discrimination mechanism that further separates the species.

A portion of the sympatric range for these two species occurs in the timbered regions of East Texas. McCarley (1954B) reported two presumed "natural hybrids" in this region. One (TNHC 2990) was collected in the vicinity of Malakoff, Henderson, County; the other (TNHC 2989) was collected in Nacogdoches County, Texas.

The objectives of this study are threefold. First, an evaluation will be made of cranial and external characters to determine those features most useful in discriminating between these two species. Second, statistical methods will be established for use in identification of possible natural hybrids. Finally, specimens will be examined to determine if hybridization as reported by Howell (1921) and McCarley (1954) is evident in East Texas populations of these two species.

## METHODS

A total of 425 P. gossypinus and 73 P. leucopus skulls and skins were examined from the Texas Cooperative Wildlife Collection (TCWC) at Texas A&M University. In addition, 26 P. leucopus were examined from the Texas Natural History

Collection (TNHC) at the University of Texas at Austin including the two presumed natural hybrids (TNHC 2989, 2990) reported by McCarley (1954B).

The identity of each specimen had been determined previously by visual comparison of pelage and overall size. Characters most often employed to distinguish the two species include the smaller size, shorter body, lighter weight, and brighter color of _P. leucopus_ as compared to _P. gossypinus_ (Osgood, 1909, Hall and Kelson, 1959, Davis, 1974). According to Osgood (1909:137), the only certain character for distinguishing between the two species in all conditions of pelage is size, for although _gossypinus_ is almost always darker in unworn pelage, specimens occur which are similar to _leucopus_ in certain stages of worn pelage. The skull and teeth of _gossypinus_ are of the same general character as _leucopus_ but decidedly larger (Osgood, 1909). Specimens identified by visual comparison were employed to test the hypothesis that correct identification is possible using mensural comparison.

A series of 14 measurements were recorded for each specimen. Four external measurements (total length, tail length, hind foot length and ear length) were recorded directly from specimen labels. In addition, 10 cranial measurements were taken with vernier dial calipers (to the nearest 0.1 mm). Cranial measurements were taken as follows, with letters denoting end points of the measurements (Fig 1): greatest length of skull (A-B), the greatest distance from the anterior most projection of the nasals to the posterior most projection of the occipital; length of rostrum (C-A), the diagonal distance from the notch formed by the lacrimanl projection to the anterior most point of fusion of the nasals; length of nasals (D-A), greatest length of the nasal bones taken along the median suture; interorbital constriction (E-F), the least distances taken across the top of the skull between orbits; zygomatic bredth (G-H), the greatest distance across the zygomatic arches at right angles to the long axis of the skull; length of maxillary toothrow (I-J), the distance taken at the alveolar surface from the anterior face of M1 to the posterior face of M3; length of diastema (I-K), the distance taken at the alveolar surface from the posterior face of the incisor to the anterior face of M1; length of the palatine foramen (L-M), the length from the anterior to the posterior most projection of the foramen; mastoid breadth (N-O), the greatest distance measured at the mastoid process; and skull depth (P-Q), the greatest distance from the doral most portion of the cranium to the tympanic bullae.

All specimens were aged based on the height of the molar teeth and the relative obliteration of the molar cusp pattern. Six distinct age classes were defined as follows:

1. Third molar erupted, but below the height of first and second upper molars.

2. Third upper molar at the full height in the tooth-row; little to no wear on any cheek teeth.

3. Some wear on upper M3; little to no wear on M1 or M2.

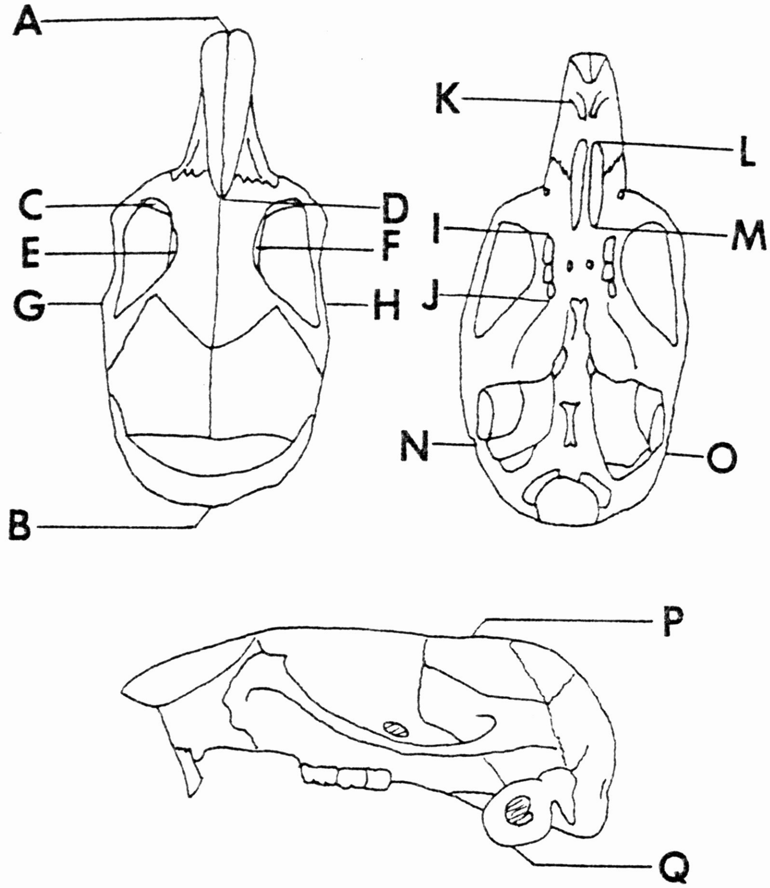
4. Some wear on all upper cheek teeth; M3 "dished out" due to wear.

5. Moderate wear on all upper cheek teeth; most cusps obliterated on M3 and M2.

6. Heavy wear on all upper cheek teeth; all cusps obliterated by wear.

A series of statistical analyses were performed on the AMDAHL 470/V6 computer at Texas A&M University using the Statistical Analysis System (SAS). The procedure means routine was used to calculate standard statistics (means, range, standard deviation, and coefficient of variation) for each character for each species with sexes separated. A t-test was used to evaluate whether significant differences ($P \leq .05$) existed between males and females for each species. The general linear model routine of SAS was used to evaluate age variation as well as the interaction between age and sexual variation. Duncan's multiple range test was used to determine where significant differences existed among age classes as well as between taxa. A stepwise discriminant function analysis was performed using

Fig. 1. Dorsal, ventral, and lateral views of the skull of *Peromyscus gossypinus* showing points used to establish cranial measurements. Names and description of measurements are given in the text.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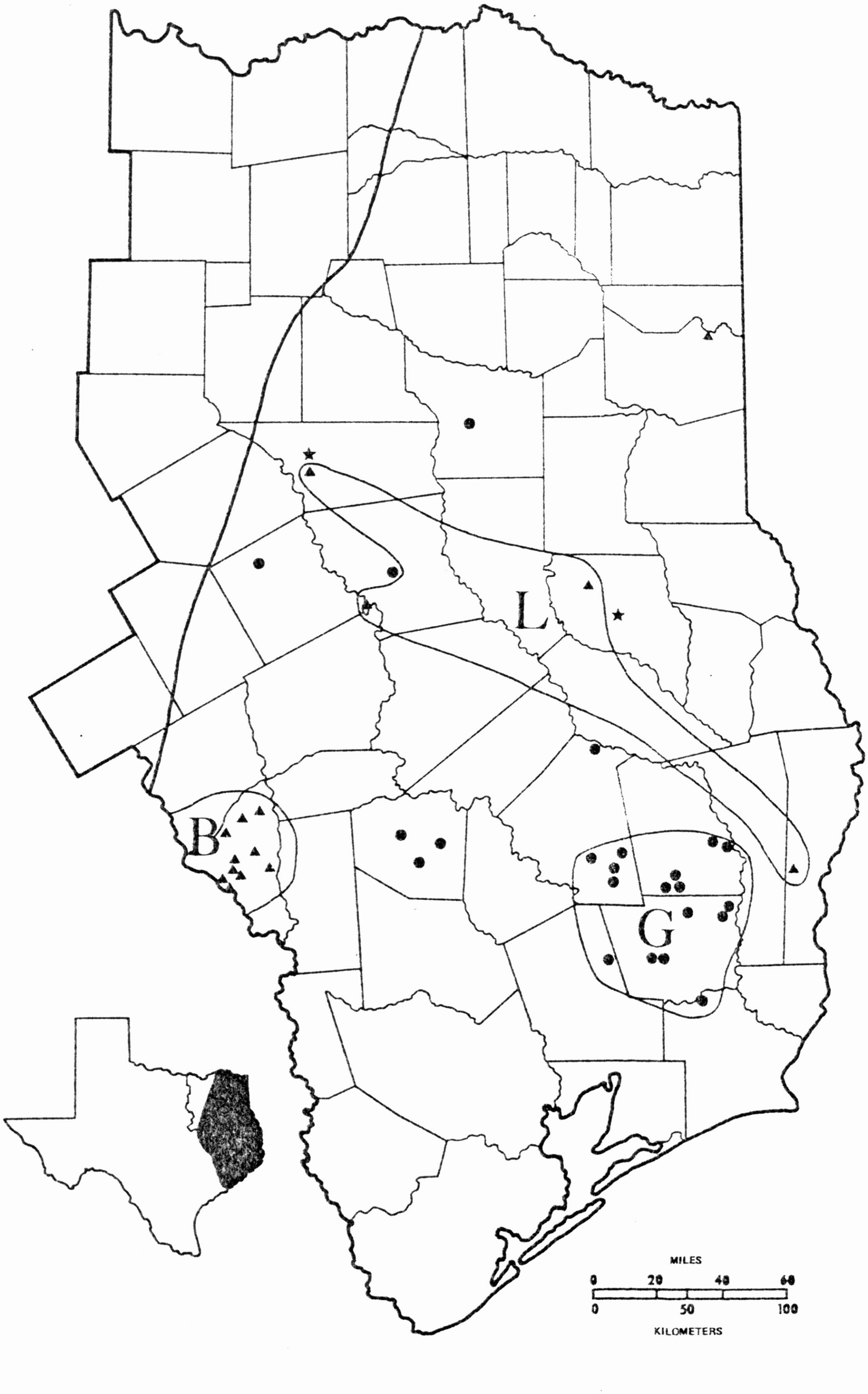
the BMD07 program of the BMD Biomedical Computer Programs.

Locations of specimens used in statistical analyses are shown in Figure 2. The *P. leucopus* sample was divided into two groups, *P. leucopus* - B (Brazos Co.) and *P. leucopus* - L (northcentral counties). The majority of the *P. gossypinus* sample is from the Big Thicket National Preserve, and is treated as a single sample.

Fig. 2. East Texas localities of *Peromyscus leucopus* (▲), *P. gossypinus* (●), and unknowns (★) included in this study showing groups *P. leucopus* - B (Brazos Co.), *P. leucopus* -L (northcentral counties) and *P. gossypinus* - G.


L
B
G
MILES
0 20 40 60
0 50 100
KILOMETERS

# RESULTS

## NONGEOGRAPHIC VARIATION

The large sample of P. gossypinus (N=425) from Big Thicket National Preserve was used to assess age, sexual, and individual variation in this species. Although the sample of P. leucopus was much smaller (N=76), the patterns of variation observed in this species were almost identical to those obtained for P. gossypinus. Consequently, only results for gossypinus are presented herein.

Secondary Sexual Variation. - Results indicated no significant variation ( $P \leq .05$) between sexes in age classes IV, V and VI in the four external and 10 cranial measurements. In age classes I and II, only one cranial characteristic (rostral length and greatest length of the skull, respectively) showed significant ($P \leq .05$) variation. Individuals in age class III showed significant sexual dimorphism in tail length and length of the maxillary toothrow. Because so few measurements differed significantly between sexes, males and females were combined for purposes of subsequent analysis.

Age Variation. - Table 1 presents the results of the analyses for variation among age categories using Duncan's multiple range test. Age classes V and VI did not exhibit significant variation due to age ($P \leq .05$) in eight of 10 characters. However, these two age classes were significantly different from the other four classes in all measurements; consequently, age classes V and VI were combined to form the adult sample group. Clearly, the remaining four age classes are morphometrically distinct. In almost all measurements (10 of 14) the classes formed seperate units. These results indicate the importance, when making species comparisons, of using only those individuals of corresponding age categories.

Individual Variation. - Coefficients of variation for the various measurements of each age class ranged from 1.8 (mastoid breadth, age class I) to 10.7 (length of tail in age class I). A greater amount of variation was encountered in the four external measurements as compared to the 10 cranial measurements. These results led to the exclusion of the four external measurements in subsequent analysis.

Table 1. - Variation with age in 4 external and 10 cranial measurements of <u>Peromyscus gossypinus</u>. Age classes as described in text were tested at the .05 significance level via Duncan's multiple range test.

| Age | N | Mean (Range) ± 2SE | CV | Results Duncan |
|---|---|---|---|---|
| | | **Total Body Length** | | |
| VI | 47 | 191.4 (170.0-214.0) ± 2.97 | 5.3 | |
| V | 70 | 186.6 (161.0-206.0) ± 2.50 | 5.6 | |
| IV | 104 | 173.0 (153.0-200.0) ± 1.77 | 5.2 | |
| III | 111 | 162.5 (140.0-184.0) ± 1.68 | 5.4 | |
| II | 41 | 150.3 (131.0-168.0) ± 2.71 | 5.6 | |
| I | 8 | 129.6 (116.0-142.0) ± 5.48 | 6.0 | |
| | | **Tail Length** | | |
| VI | 47 | 82.4 ( 69.0- 98.0) ± 1.68 | 7.0 | |
| V | 70 | 80.9 ( 67.0- 94.0) ± 1.32 | 6.8 | |
| IV | 104 | 73.4 ( 57.0- 91.0) ± 1.15 | 8.0 | |
| III | 111 | 68.8 ( 50.0- 82.0) ± 1.00 | 7.7 | |
| II | 41 | 63.0 ( 50.0- 77.0) ± 1.81 | 9.2 | |
| I | 8 | 57.1 ( 47.0- 69.0) ± 4.32 | 10.7 | |
| | | **Hind Foot Length** | | |
| V | 70 | 24.5 ( 22.0- 28.0) ± 0.23 | 3.9 | |
| VI | 47 | 24.2 ( 19.0- 26.0) ± 0.36 | 5.1 | |
| IV | 104 | 23.8 ( 19.0- 26.0) ± 0.21 | 4.5 | |
| III | 111 | 23.6 ( 17.0- 25.0) ± 0.24 | 5.3 | |
| II | 41 | 23.1 ( 21.0- 25.0) ± 0.29 | 4.0 | |
| I | 8 | 21.8 ( 20.0- 23.0) ± 0.91 | 5.9 | |
| | | **Ear Length** | | |
| VI | 47 | 18.9 ( 13.0- 21.0) ± 0.45 | 8.2 | |
| V | 69 | 18.8 ( 16.0- 22.0) ± 0.29 | 6.4 | |
| IV | 104 | 18.8 ( 15.0- 22.0) ± 0.27 | 7.5 | |
| III | 111 | 18.5 ( 15.0- 22.0) ± 0.26 | 7.4 | |
| II | 41 | 18.0 ( 14.0- 20.0) ± 0.42 | 7.5 | |
| I | 8 | 16.8 ( 16.0- 18.0) ± 0.73 | 6.2 | |

Table 1. - Continued.

| Age | N | Mean (Range) ± 2SE | CV | Results Duncan |
|---|---|---|---|---|
| | | Greatest length of skull | | |
| VI | 52 | 32.3 ( 28.9- 31.5) ± 0.17 | 2.1 | |
| V | 79 | 29.8 ( 27.1- 31.0) ± 0.21 | 3.2 | |
| IV | 109 | 28.6 ( 27.1- 31.0) ± 0.15 | 2.8 | |
| III | 129 | 27.7 ( 25.4- 30.2) ± 0.16 | 3.3 | |
| II | 41 | 26.1 ( 21.2- 28.2) ± 0.33 | 4.1 | |
| I | 10 | 24.4 ( 23.7- 25.8) ± 0.44 | 2.8 | |
| | | Rostral Length | | |
| VI | 51 | 11.6 ( 10.5- 12.5) ± 0.12 | 3.7 | |
| V | 79 | 11.5 ( 10.2- 12.7) ± 0.11 | 4.4 | |
| IV | 109 | 10.9 ( 10.1- 12.4) ± 0.07 | 3.6 | |
| III | 129 | 10.5 ( 9.4- 12.5) ± 0.09 | 5.5 | |
| II | 44 | 9.7 ( 8.0- 10.7) ± 0.15 | 5.1 | |
| I | 10 | 8.6 ( 8.1- 9.2) ± 0.25 | 4.5 | |
| | | Nasal length | | |
| VI | 51 | 11.4 ( 10.1- 12.5) ± 0.04 | 3.8 | |
| V | 79 | 11.2 ( 10.1- 12.9) ± 0.13 | 5.0 | |
| IV | 109 | 10.7 ( 9.7- 12.8) ± 0.10 | 5.0 | |
| III | 129 | 10.3 ( 8.8- 12.0) ± 0.10 | 5.5 | |
| II | 44 | 9.5 ( 8.5- 10.6) ± 0.15 | 5.4 | |
| I | 10 | 8.6 ( 7.8- 9.1) ± 0.25 | 4.6 | |
| | | Maxillary toothrow length | | |
| V | 80 | 4.0 ( 3.6 - 4.4) ± 0.03 | 3.4 | |
| IV | 112 | 4.0 ( 3.5 - 4.6) ± 0.03 | 3.6 | |
| VI | 52 | 4.0 ( 3.5 - 4.3) ± 0.04 | 3.8 | |
| III | 135 | 4.0 ( 3.5 - 4.3) ± 0.21 | 3.4 | |
| II | 45 | 4.0 ( 3.2 - 4.2) ± 0.05 | 4.4 | |
| I | 10 | 3.8 ( 3.2 - 4.1) ± 0.15 | 6.4 | |
| | | Palatine slit length | | |
| VI | 52 | 5.8 ( 5.1 - 6.8) ± 0.08 | 5.3 | |
| V | 80 | 5.7 ( 5.0 - 6.9) ± 0.08 | 6.3 | |
| IV | 112 | 5.4 ( 4.7 - 6.2) ± 0.05 | 5.0 | |
| III | 134 | 5.3 ( 4.4 - 6.7) ± 0.06 | 6.1 | |
| II | 45 | 4.9 ( 4.0 - 5.8) ± 0.10 | 7.1 | |
| I | 10 | 4.4 ( 4.1 - 5.0) ± 0.16 | 5.9 | |

Table 1. - Continued

| Age | N | Mean (Range) ± 2SE | CV | Results Duncan |
|---|---|---|---|---|
| | | **Diastema Length** | | |
| VI | 52 | 8.1 ( 7.2 - 9.0) ± 0.10 | 4.4 | |
| V | 80 | 7.9 ( 7.0 - 8.8) ± 0.07 | 4.1 | |
| IV | 112 | 7.5 ( 6.9 - 8.6) ± 0.06 | 4.3 | |
| III | 135 | 7.2 ( 5.0 - 8.1) ± 0.06 | 5.0 | |
| II | 45 | 6.7 ( 5.4 - 7.5) ± 0.11 | 5.7 | |
| I | 10 | 6.1 ( 5.8 - 6.5) ± 0.14 | 3.7 | |
| | | **Interorbital constriction** | | |
| VI | 52 | 4.4 ( 4.0 - 4.8) ± 0.06 | 4.3 | |
| V | 80 | 4.3 ( 3.8 - 4.7) ± 0.04 | 4.0 | |
| IV | 111 | 4.2 ( 3.9 - 4.7) ± 0.03 | 3.7 | |
| III | 135 | 4.2 ( 3.9 - 4.8) ± 0.03 | 4.3 | |
| II | 45 | 4.1 ( 3.5 - 4.5) ± 0.06 | 5.4 | |
| I | 10 | 3.9 ( 3.7 - 4.3) ± 0.10 | 4.2 | |
| | | **Zygomatic breadth** | | |
| VI | 50 | 15.1 ( 14.4- 16.0) ± 0.10 | 2.4 | |
| V | 76 | 15.0 ( 14.0- 16.0) ± 0.11 | 3.1 | |
| IV | 108 | 14.4 ( 11.6- 15.7) ± 0.10 | 3.4 | |
| III | 129 | 14.1 ( 13.1- 15.4) ± 0.08 | 3.2 | |
| II | 39 | 13.5 ( 12.8- 14.5) ± 0.11 | 2.6 | |
| I | 9 | 12.6 ( 12.1- 13.2) ± 0.24 | 2.8 | |
| | | **Mastoid breadth** | | |
| V | 80 | 11.2 ( 10.4- 11.9) ± 0.06 | 2.5 | |
| VI | 52 | 11.2 ( 10.5- 11.8) ± 0.08 | 2.7 | |
| IV | 112 | 10.9 ( 10.1- 11.6) ± 0.05 | 2.5 | |
| III | 132 | 10.8 ( 10.1- 11.6) ± 0.05 | 2.6 | |
| II | 42 | 10.5 ( 8.7- 11.2) ± 0.12 | 3.7 | |
| I | 10 | 10.3 ( 10.0- 10.6) ± 0.11 | 1.8 | |
| | | **Skull depth** | | |
| VI | 52 | 10.4 ( 9.9- 10.9) ± 0.06 | 2.1 | |
| V | 80 | 10.4 ( 9.7- 11.1) ± 0.06 | 2.5 | |
| IV | 111 | 10.1 ( 9.5- 11.0) ± 0.05 | 2.7 | |
| III | 132 | 9.9 ( 9.3- 10.8) ± 0.05 | 2.6 | |
| II | 43 | 9.7 ( 8.6- 10.3) ± 0.09 | 3.2 | |
| I | 10 | 9.5 ( 9.2- 10.0) ± 0.14 | 2.4 | |

## SPECIES COMPARISONS

Univariate Analysis. - Tables 2 and 3 present the results of the univariate analysis of the 10 cranial characters in the three defined groups (P. leucopus - B, P. leucopus - L, and P. gossypinus) for age categories IV and V-VI using Duncan's multiple range test. Results indicate a complete separation of P. gossypinus from P. leucopus in both age categories in every cranial measurement. Age category IV individuals show a separation of the two P. leucopus samples in six of 10 craniel measurements. In age category V-VI, there was seperation of the two P. leucopus samples in five of 10 cranial measurements. Examination of the reported hybrid (TNHC #2990) indicated it was an age class IV individual. In comparisons with cranial measurements for age class IV P. gossypinus and P. leucopus (Table 2), the hybrid fell exclusivly within the range of P. gossypinus in four of 10 cranial measurements. For the remaining six cranial measurements, the hybrid fell within the range of both P. gossypinus and P. leucopus. The second reported natural hybrid (TNHC 2989), an age V-VI individual, was compared with specimens of comparable age of P. leucopus and P. gossypinus (Table 3). Results show the cranial measurements of the hybrid to fall exclusively within those of P. leucopus in five of 10 characters. In the remaining five characters, the cranial measurements of the hybrid fell within the range of both P. leucopus and P. gossypinus.

TABLE 2. Variation in cranial measurement (in mm) of age class 4 or *Peromyscus leucopus* - B (Brazos Co.), *P. leucopus* -L (northcentral counties), and *P. gossypinus* with comparison to TNHC #2990.

| Category | N | Mean (Range) ± 2SE | | | CV | Result Duncan | THNC 2990 |
|---|---|---|---|---|---|---|---|
| | | | Greatest length of skull | | | | |
| *P. gossypinus* | 109 | 28.6 | (27.1-31.0) | ±0.15 | 2.8 | \| | |
| *P. leucopus*-L | 5 | 25.8 | (24.9-27.6) | ±0.92 | 4.0 | \| | 27.2 |
| *P. leucopus*-B | 19 | 24.8 | (21.4-26.7) | ±0.61 | 5.3 | \| | |
| | | | Length of rostrum | | | | |
| *P. gossypinus* | 109 | 10.9 | (10.1-12.4) | ±0.07 | 3.5 | \| | 10.7 |
| *P. leucopus*-L | 5 | 9.6 | ( 9.0-10.4) | ±0.49 | 5.6 | \| | |
| *P. leucopus*-B | 19 | 9.2 | ( 7.8-10.2) | ±0.27 | 6.4 | \| | |
| | | | Length of nasal | | | | |
| *P. gossypinus* | 109 | 10.7 | ( 9.7-12.8) | ±0.10 | 5.0 | \| | |
| *P. leucopus*-L | 5 | 9.7 | ( 8.5-10.9) | ±0.77 | 8.9 | \| | 10.2 |
| *P. leucopus*-B | 19 | 9.2 | ( 8.2-10.4) | ±0.26 | 6.1 | \| | |
| | | | Length of maxillary toothrow | | | | |
| *P. gossypinus* | 112 | 4.0 | ( 3.5- 4.6) | ±0.03 | 3.6 | \| | 4.0 |
| *P. leucopus*-L | 5 | 3.8 | ( 3.7- 3.8) | ±0.06 | 1.9 | \| | |
| *P. leucopus*-B | 19 | 3.5 | ( 3.2- 3.9) | ±0.10 | 5.9 | \| | |
| | | | Length of palatine slit | | | | |
| *P. gossypinus* | 112 | 5.4 | ( 4.7- 6.2) | ±0.05 | 5.0 | \| | 5.0 |
| *P. leucopus*-L | 5 | 4.5 | ( 4.2- 5.3) | ±0.39 | 9.6 | \| | |
| *P. leucopus*-B | 19 | 4.5 | ( 3.6- 4.9) | ±0.17 | 8.9 | \| | |
| | | | Length of diastema | | | | |
| *P. gossypinus* | 112 | 7.5 | ( 6.9- 8.6) | ±0.06 | 4.3 | \| | 7.3 |
| *P. leucopus*-L | 5 | 6.7 | ( 6.2- 7.1) | ±0.35 | 5.9 | \| | |
| *P. leucopus*-B | 19 | 6.2 | ( 5.1- 6.9) | ±0.21 | 7.5 | \| | |

TABLE 2. Continued

| Category | N | Mean | (Range) | ± 2SE | CV | Result Duncan | THNC 2990 |
|---|---|---|---|---|---|---|---|
| | | | **Interorbital constriction** | | | | |
| *P. gossypinus* | 111 | 4.2 | ( 3.9- 4.7) | ±0.03 | 3.7 | | |
| *P. leucopus*-L | 5 | 3.9 | ( 3.8- 4.1) | ±0.14 | 3.8 | | 4.0 |
| *P. leucopus*-B | 19 | 3.8 | ( 3.0- 4.1) | ±0.11 | 6.3 | | |
| | | | **Zygomatic breadth** | | | | |
| *P. gossypinus* | 108 | 14.4 | (11.6-15.7) | ±0.10 | 3.4 | | |
| *P. leucopus*-L | 5 | 13.3 | (12.9-14.5) | ±0.62 | 5.2 | | 13.7 |
| *P. leucopus*-B | 19 | 12.7 | (11.0-13.7) | ±0.29 | 5.0 | | |
| | | | **Mastoid breadth** | | | | |
| *P. gossypinus* | 112 | 10.9 | (10.0-11.6) | ±0.05 | 2.5 | | 10.7 |
| *P. leucopus*-L | 4 | 10.2 | (10.0-10.5) | ±0.21 | 2.1 | | |
| *P. leucopus*-B | 19 | 9.9 | ( 8.7-10.5) | ±0.17 | 3.8 | | |
| | | | **Skull depth** | | | | |
| *P. gossypinus* | 111 | 10.1 | ( 9.5-11.0) | ±0.05 | 2.7 | | 9.8 |
| *P. leucopus*-L | 5 | 9.2 | ( 9.1- 9.4) | ±0.12 | 1.5 | | |
| *P. leucopus*-B | 19 | 9.2 | ( 8.7- 9.4) | ±0.07 | 1.6 | | |

TABLE 3. - Variation in cranial measurements (in mm) of age classes 5 and 6 of Peromyscus leucopus - B (Brazos Co.), P. leucopus - L (northcentral counties), and P. gossypinus with a comparison to TNHC #2989.

| Category | N | Mean | (Range) | ± 2SE | CV | Result Duncan | THNC 2989 |
|---|---|---|---|---|---|---|---|
| | | | **Greatest length of skull** | | | | |
| P. gossypinus | 131 | 29.9 | (27.0-32.3) | ±0.15 | 2.8 | | |
| P. leucopus-L | 15 | 25.9 | (24.7-27.5) | ±0.36 | 2.7 | | 26.9 |
| P. leucopus-B | 28 | 25.9 | (24.2-27.3) | ±0.30 | 3.0 | | |
| | | | **Length of rostrum** | | | | |
| P. gossypinus | 130 | 11.5 | (10.2-12.7) | ±0.08 | 4.2 | | |
| P. leucopus-L | 15 | 9.4 | ( 8.6-10.2) | ±0.21 | 4.4 | | 10.2 |
| P. leucopus-B | 28 | 9.7 | ( 9.0-10.5) | ±0.15 | 4.0 | | |
| | | | **Length of nasal** | | | | |
| P. gossypinus | 130 | 11.3 | (10.1-12.9) | ±0.10 | 4.8 | | |
| P. leucopus-L | 15 | 9.7 | ( 8.9-10.8) | ±0.25 | 5.1 | | 9.9 |
| P. leucopus-B | 28 | 9.7 | ( 8.7-11.0) | ±0.21 | 5.8 | | |
| | | | **Length of maxillary toothrow** | | | | |
| P. gossypinus | 132 | 4.0 | ( 3.5- 4.4) | ±0.02 | 3.6 | | |
| P. leucopus-L | 15 | 3.6 | ( 3.5- 3.9) | ±0.06 | 3.3 | | 3.6 |
| P. leucopus-B | 28 | 3.5 | ( 3.3- 3.8) | ±0.06 | 4.4 | | |
| | | | **Length of palatine slit** | | | | |
| P. gossypinus | 132 | 5.7 | ( 5.0- 6.9) | ±0.06 | 6.0 | | |
| P. leucopus-L | 15 | 5.0 | ( 4.1- 5.9) | ±0.29 | 11.4 | | 4.6 |
| P. leucopus-B | 28 | 4.4 | ( 3.9- 5.4) | ±0.12 | 7.3 | | |
| | | | **Length of diastema** | | | | |
| P. gossypinus | 132 | 8.0 | ( 7.0- 9.0) | ±0.06 | 4.3 | | |
| P. leucopus-L | 15 | 6.9 | ( 6.0- 7.5) | ±0.18 | 5.0 | | 7.2 |
| P. leucopus-B | 28 | 6.7 | ( 6.1- 7.8) | ±0.14 | 5.5 | | |

TABLE 3. - Continued

| Category | N | Mean | (Range) | ± 2SE | CV | Result Duncan | THNC 2989 |
|---|---|---|---|---|---|---|---|
| | | | Interorbital constriction | | | | |
| *P. gossypinus* | 132 | 4.3 | ( 3.8- 4.8) | ±0.03 | 4.2 | \| | |
| *P. leucopus*-L | 15 | 3.9 | ( 3.6- 4.2) | ±0.07 | 3.6 | \| | 4.0 |
| *P. leucopus*-B | 28 | 4.0 | ( 3.8- 4.3) | ±0.06 | 3.7 | \| | |
| | | | Zygomatic breadth | | | | |
| *P. gossypinus* | 126 | 15.0 | (14.0-16.0) | ±0.08 | 2.8 | \| | |
| *P. leucopus*-L | 15 | 13.3 | (12.9-14.0) | ±0.20 | 2.9 | \| | |
| *P. leucopus*-B | 25 | 13.3 | (12.8-14.0) | ±0.14 | 2.6 | \| | 13.2 |
| | | | Mastoid breadth | | | | |
| *P. gossypinus* | 132 | 11.2 | (10.4-11.9) | ±0.05 | 2.6 | \| | |
| *P. leucopus*-L | 15 | 10.0 | ( 9.6-10.4) | ±0.11 | 2.2 | \| | |
| *P. leucopus*-B | 28 | 10.0 | ( 9.5-10.5) | ±0.09 | 2.5 | \| | 10.3 |
| | | | Skull depth | | | | |
| *P. gossypinus* | 132 | 10.4 | ( 9.7-11.1) | ±0.04 | 2.3 | \| | |
| *P. leucopus*-L | 15 | 9.5 | ( 9.1-10.0) | ±0.12 | 2.4 | \| | |
| *P. leucopus*-B | 28 | 9.4 | ( 8.8-10.0) | ±0.13 | 3.6 | \| | 9.3 |

__Multivariate Analysis__. - Because selection acts upon all charaters in concert, multivariate techniques capable of examining all characters simultaneously were used. A step-wise discriminate function was employed. The matrix classifications, derived from this analysis, for age IV (table 4) and V-VI (table 5) indicate the classification of known and unknown individuals. Age class IV unknowns include the reported natural hybrid (TNHC 2990) and 2 individuals similar in cranial measurments (TNHC 2655,2779). The matrix for age IV classifies all unknowns as __P. gossypinus__. The age V-VI matrix classifies the reported natural hybrid (TNHC 2989) as __P. leucopus__ - B. In both matrices, all known __P. gossypinus__ are correctly classified, and the majority of the known individuals in __P. leucopus__ - B and __P. leucopus__ - L are correctly classified.

Table 6 ranks the 10 cranial measurements in order of decreasing importance as discriminators between species. The associated U-statistic indicates the probability of misidentification and decreases as more cranial measurements are considered.

Further results of the step-wise discriminate function analysis plot all individuals of the associated age class based on all cranial characters, with those of greater importance (Table 6) given the most emphasis (Fig. 3 and Fig. 4). In both age classes, there is a complete seperation of __P. gossypinus__ from __P. leucopus__ and an apparent seperation

TABLE 4. Matrix classification of *Peromyscus leucopus* - B (Brazos Co.), *P. leucopus* - L (northcentral counties), *P. gossypinus,* and unknowns in age class IV.

| Group | *P. gossypinus* | *P. Leucopus*-L | *P. leucopus*-B |
|---|---|---|---|
| *P. gossypinus* | 105 | 0 | 0 |
| *P. leucopus*-L | 0 | 3 | 0 |
| *P. leucopus*-B | 0 | 3 | 16 |
| Unknown | 3 | 0 | 0 |

Table 5. Matrix classification of *Peromyscus leucopus* - B (Brazos Co.), *P. leucopus* -L (northcentral counties), *P. gossypinus*, and unknowns in age classes V and VI

| Group | *P. gossypinus* | *P. Leucopus*-L | *P. leucopus*-B |
|---|---|---|---|
| *P. gossypinus* | 124 | 0 | 0 |
| *P. leucopus*-L | 0 | 12 | 3 |
| *P. leucopus*-B | 0 | 1 | 24 |
| Unknown | 0 | 0 | 1 |

TABLE 6. Summary of F values and U-statistics generated from a step-wise discriminate function anaysis.

| Character | F Value | U-Statistic |
|---|---|---|
| Greatest length of skull | 356.41 | 0.1842 |
| Length of palatine slit | 17.95 | 0.1505 |
| Length of maxillary toothrow | 15.31 | 0.1262 |
| Mastoid breadth | 14.15 | 0.1070 |
| Length of rostrum | 7.31 | 0.0979 |
| Skull depth | 5.88 | 0.0910 |
| Interorbital constriction | 5.26 | 0.0853 |
| Zygomatic breadth | 0.58 | 0.0846 |
| Length of diastema | 0.39 | 0.0842 |
| Length of nasal | 0.07 | 0.0841 |

of the two *P. leucopus* samples. Figure 3 confirms the matrix classification in that all three unknowns fall within the range of *P. gossypinus*. Figure 4 positions the unknown well within the range of *P. leucopus*.

## DISTRIBUTION

All known localities of recorded specimens of both species in East Texas are shown in Figure 5. *P. leucopus* occupies most timbered regions of East Texas, although it is most abundant in the oak-hickory belt and the upland pine forests of northcentral East Texas (Schmidly, 1979). It does not occur in the lowland pine-hardwood forest of southeastern East Texas.

*Peromyscus gossypinus* is the most abundant cricetine rodent in the woodlands of East Texas. It occurs in great abundance in the flood plains of the pine-oak forest in southeastern East Texas and is only sparsely distributed in the oak-hickory belt (Schmidly, 1979).

*Peromyscus leucopus* is apparently one of the least abundant rodents in the pine forests of East Texas. Large samples of *P. gossypinus* indicate that the lack of *P. leucopus* is not due to insufficient field work (St. Romain, 1975).

## DISCUSSION

Laboratory hybrids between *P. goosypinus* and *P. leucopus* are known to be intermediate in morphology between parent

Fig. 3. Step-wise discriminate plot of Age IV *Peromyscus leucopus* - B (▲), *P. leucopus* - L (■), *P. gossypinus* (●), and unknowns (★).

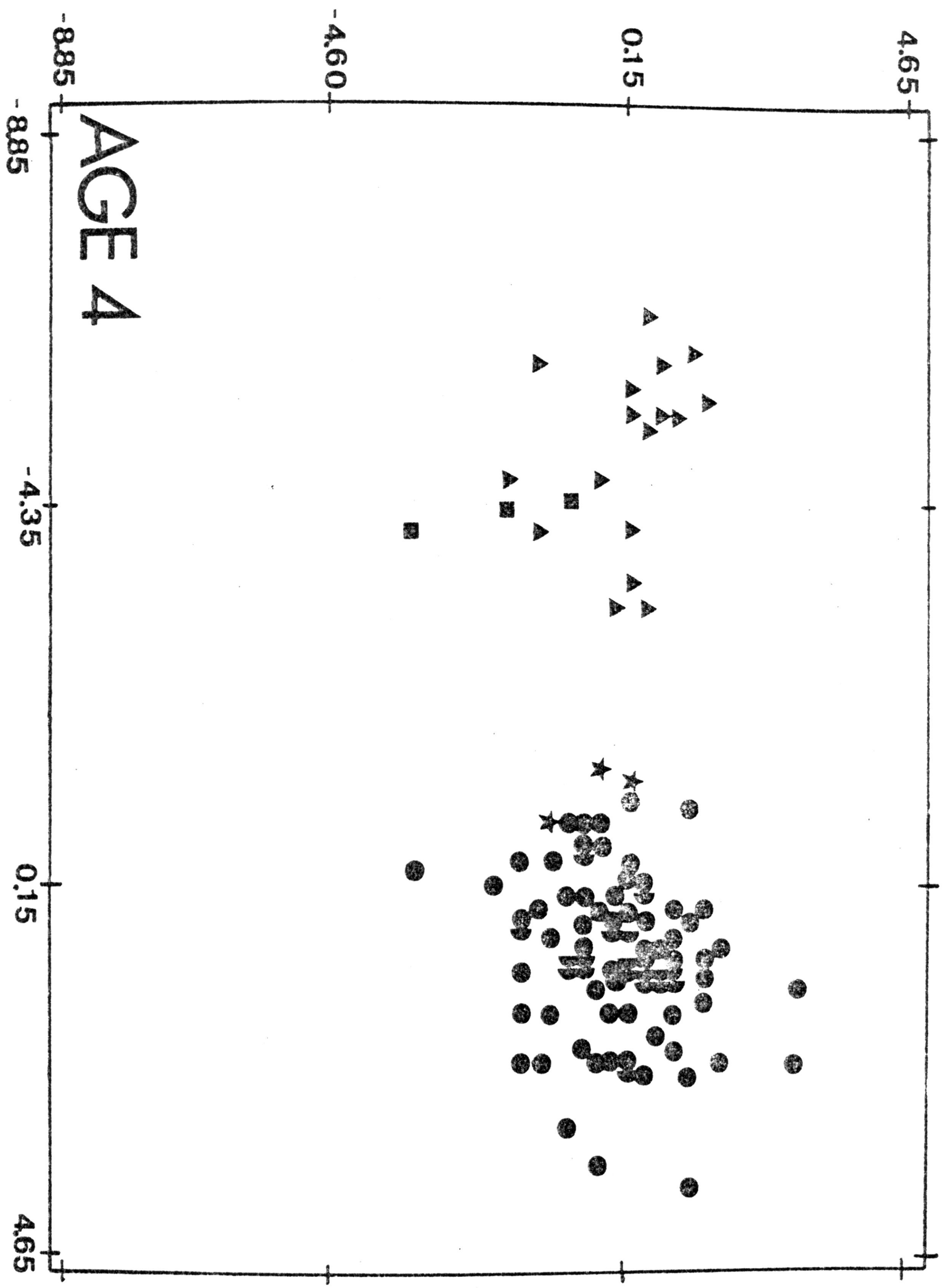
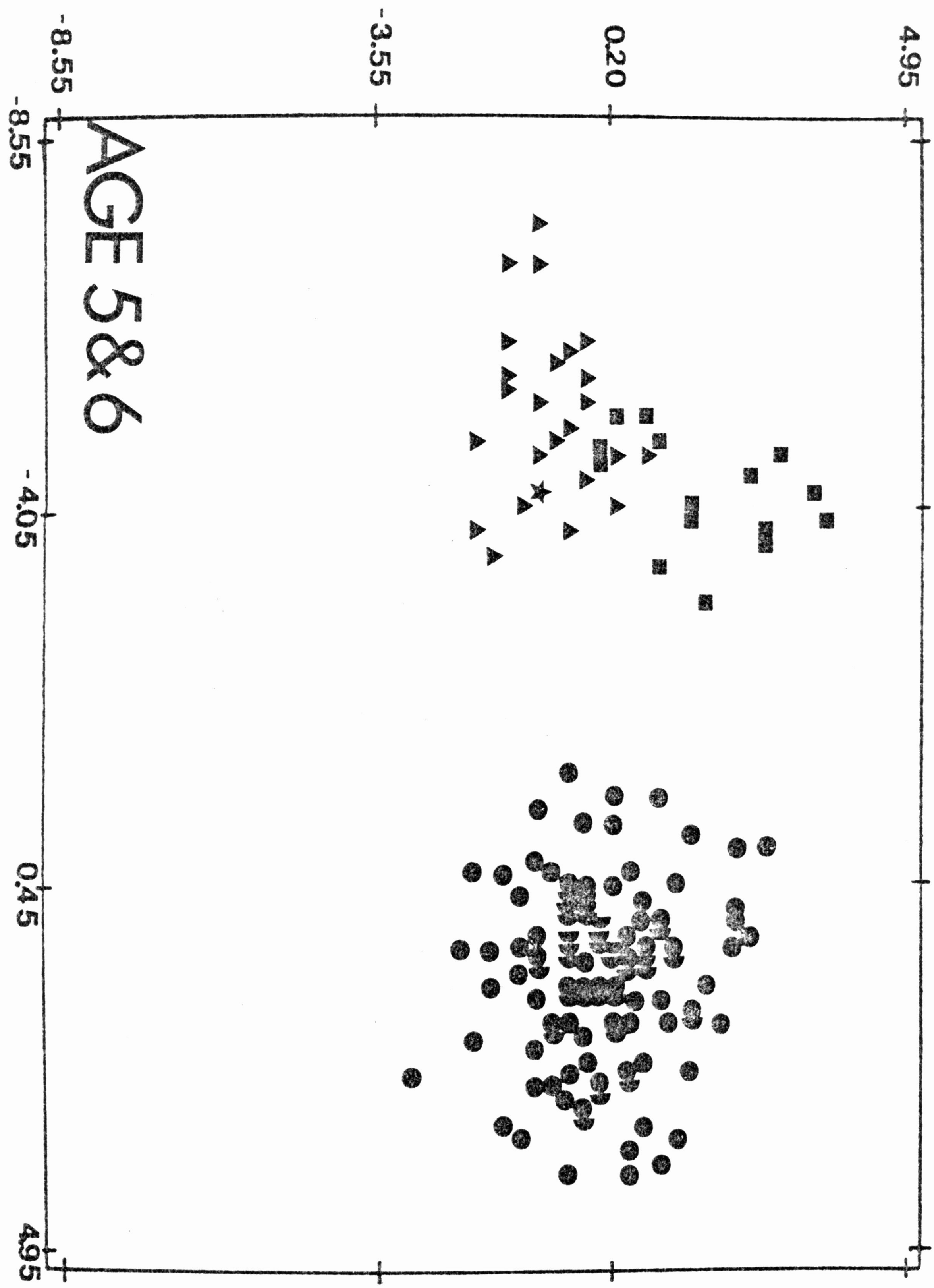

AGE 4
4.65
0.15
-4.60
-8.85
-8.85
-4.35
0.15
4.65

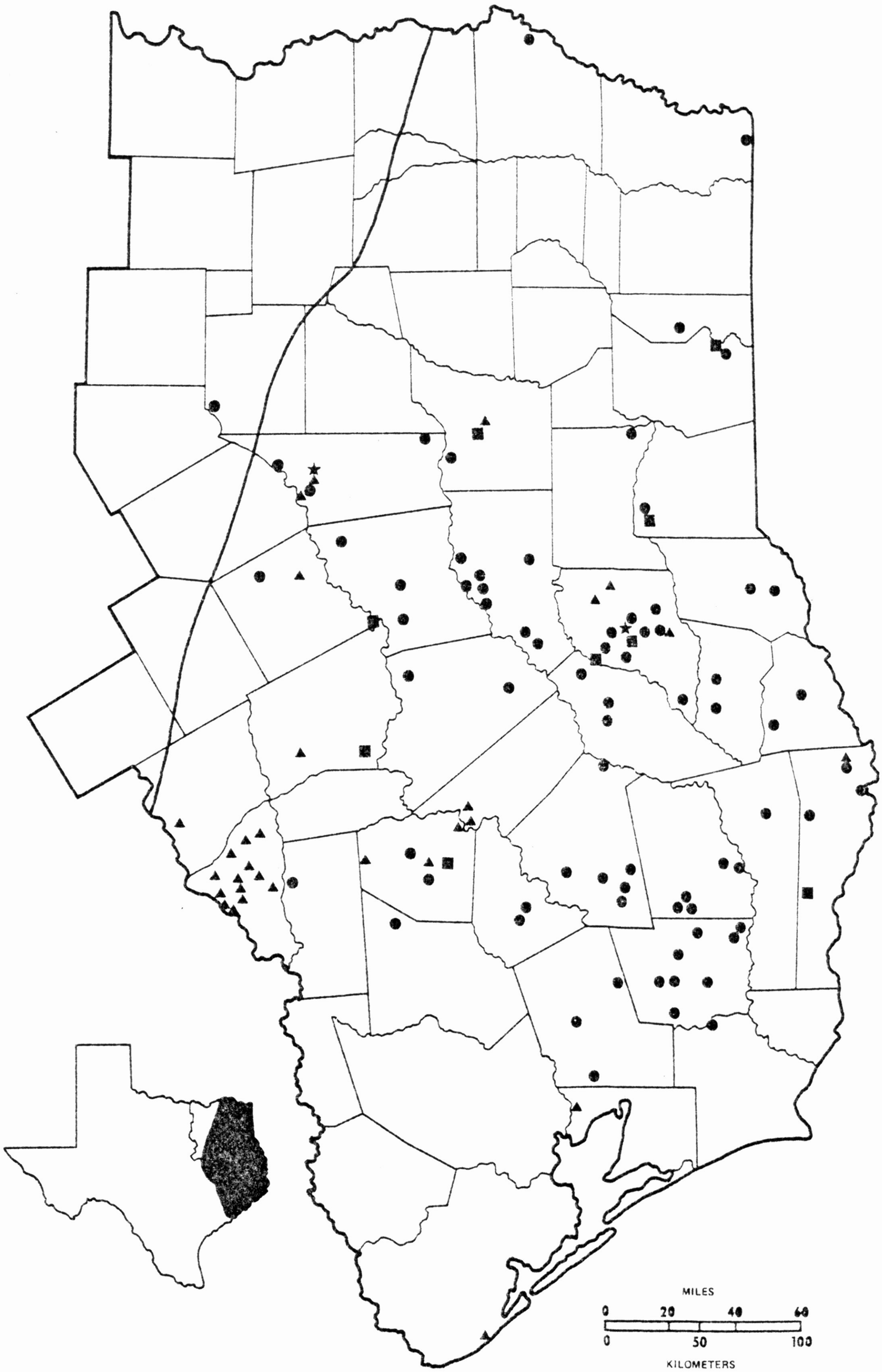
Fig. 4. Step-wise discriminate plot of age V-VI *Peromyscus leucopus*-B (▲), *P. leucopus*-L (■), *P. gossypinus* (●), and unknown (★).


AGE 5&6
4.95
0.20
-3.55
-8.55
-8.55
-4.05
0.45
4.95

species (Dice, 1940). This was the sole criterion used by McCarley (1954B) to distinguish hybrids from the parental stock. This study incorporates a multivariate analysis to examine all cranial characters simultaneously. The validity of such a test in identification of natural hybrids is discussed by Rohwer (1972). He suggests, however, that the incidence of hybridization may be underestimated by such techniques. Results from this study show that both reported hybrids (TNHC 2989,2990) from East Texas are not intermediate in morphology and consequently can not be considered natural hybrids.

Davis (1939) described Peromyscus leucopus brevicaudus as a new subspecies from eastern Texas, in the vicinity of Brazos county. Other authors have challenged the validity of this grouping (Herman, 1952; McCarley, 1959; St. Romain, 1975). Results from this study indicate slight geographic vairation between the Brazos county sample and the north-central counties sample; however, the sample size is insufficient to draw any definitive conclusion. Further research in this area with larger and more extensive samples should decide this point.

Fig. 5. East Texas distribution of _Peromyscus leucopus_ (▲), _P._ gossypinus (●), and reported _hybrids_ (★). _Box_ (■) indicates localities at which both species were taken.


MILES
0 20 40 60
0 50 100
KILOMETERS

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