



EASTERN COTTONTAIL (IMMATURE)

A DETERMINATION OF THE SPECIES AND SUBSPECIES
OF THE RABBITS OF THE GENUS SYLVILAGUS
AND THEIR DISTRIBUTION IN
VIRGINIA

BY

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INTRODUCTION

Historical Sketch

The rabbits of North America, for a long time, were neglected by the workers in the field of mammalogy even though, or perhaps, because of their abundance, early taxonomists had meager material on which to work. Linnaeus (1776*) described the genus Lepus under which all of our rabbits and hares were originally classified until the name was found to be preoccupied in 1898. In 1772 Forster makes vague mention of Lepus sylvaticus (now Sylvilagus floridanus mallurus), while in 1784 Schoph gave an excellent description of this rabbit. Bachman's papers in the Journal of Natural Science in 1837 might be considered classics and are important in the history of the American Leporidae. As a result of these papers, he is given credit for describing L. Sylvaticus. In 1857 Baird makes the first subgenus division in the best and most accurate treatment to date. In 1877 J. A. Allen published on the North American Leporidae, recognizing from the scanty amount of material available, only 18 species and "varieties". In 1890 Allen described Lepus sylvaticus floridanus. In 1894 Bangs described S. transitionalis and in the same year we find the first description of S. f. mearnsii by Allen. The works mentioned contain descriptions of all species and subspecies indigenous to Virginia except

* References cited in this introduction are given complete notation in the bibliography under the dates mentioned.

Sylvilagus floridanus hitchensi which was described by Mearns in 1911 from specimens taken from Fisherman's and Smith's Islands off the coast of Virginia. In 1909 E. W. Nelson, Chief Field Naturalist of the Biological Survey** published a monograph in the North American Fauna Series entitled, The Rabbits of North America. Nelson examined more than 5500 specimens in the preparation of this paper and recognized 97 species and subspecies. This work contains a description of all species and races recognized by him at that time. Since that time, a few gaps have been filled in by descriptions of new races and some ranges have been retracted or extended slightly. However, in recent years, much of the emphasis has been placed on management aspects of the animal.

** Now United States and Wildlife Service.

Problem

Inasmuch as the accurate geographic distribution of the several varieties or races of the genus *Sylvilagus* in Virginia is unknown, an attempt will be made to show the range of the five species and subspecies native to Virginia. The solution of a problem of this nature was particularly applicable to Virginia because it was one of the few remaining states where the natural ranges of this genus have not been disturbed by man through restocking measures. Furthermore, there is at present considerable agitation for restocking or otherwise changing the original range status of the races so that a study of this kind would be scientifically inaccurate in the near future.

In addition to the ranges, a description of each race along with measurements, weights, sex ratio, and other notes made during the preparation of this paper will be given.

Procedure

The largest task in a problem of this kind is collecting, preparing and assembling an adequate number of specimens to serve as a basis for determining ranges.

The greater proportion of the specimens on which this paper is based were secured either by the author or through the cooperation of county game wardens. In the latter case, permits to collect rabbits were issued to the game wardens by the Commission of Game and Inland Fisheries.

The wardens contacted the hunters or trappers in their communities in order to secure the rabbit specimens. The specimens were collected during the months of January, February and March. Collectors were instructed to cool the animal thoroughly before shipping by placing it in the outside air overnight. When instructions were followed, the specimens reached the laboratory in good condition. A nominal fee was paid for specimens secured in this manner. Most of the specimens secured by the writer were collected at night with the aid of an automobile searchlight or a jacklight. This method is an efficient one but has the disadvantage that most specimens so taken are shot in the head resulting in the destruction of parts of the skull that often make identification impracticable. Other specimens were either borrowed from or examined at the United States National Museum (both the Biological Surveys and the Smithsonian collections were studied).

Specimens secured in the flesh were prepared as study skins after being sexed, weighed and measured. Upon completion of the study, a representative selection of the prepared specimens was deposited in the collections of the Virginia Cooperative Wildlife Unit, the Carnegie Museum, and the author's personal collection; while the bulk of the specimens was deposited with the Biological Surveys Collection at the United States National Museum.

Synopsis of LEPORIDAE of Virginia

Genus SYLVILAGUS (Gray) (Lat. woods † Gr. Rabbit)

Sylvilagus floridanus mallurus (Thomas) Eastern Cottontail

(floridanus = Lat. of Florida, mallurus † Gr. wooly)

Sylvilagus floridanus mearnsii (Allen) Mearn's Cottontail

(Lat. in honor of Dr. Edgar A. Mearns)

Sylvilagus floridanus hitchensi Mearns Hitchens Cottontail

(Lat. in honor of Captain George D. Hitchens)

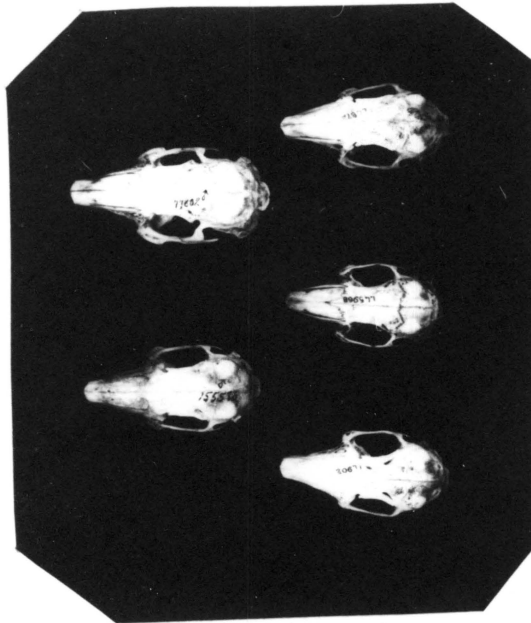
Sylvilagus transitionalis (Bangs) New England Cottontail

(Lat. of Transition Zone)

Sylvilagus palustris palustris (Bachman) Marsh Rabbit

(Lat. of the marsh)

Marsh
rabbit



Mearns
cottontail

New England
cottontail

Hitchens
cottontail

Eastern
cottontail

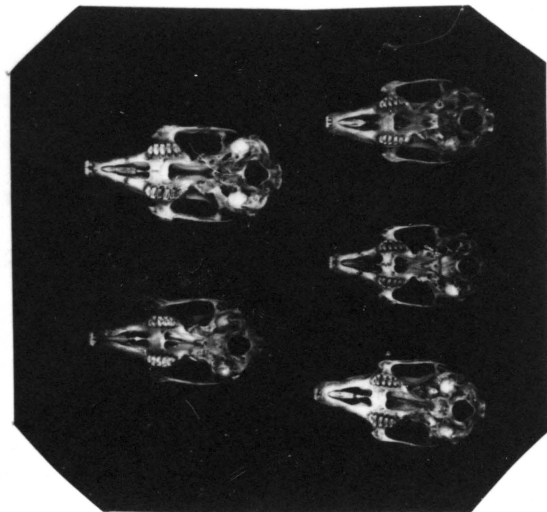
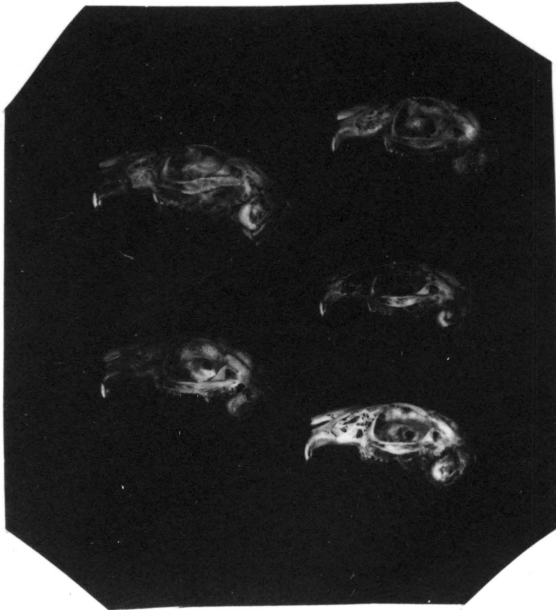


Fig. 1. COMPARISON OF SKULLS OF RABBITS OF VIRGINIA

SYLVILAGUS FLORIDANUS MALLURUS (THOMAS) EASTERN COTTONTAIL

Synonyms: Lepus sylvaticus Bachman (Bachman 1837) Name pre-occupied by Lepus borealis sylvaticus Millson (Thomas 1898) Neither type nor type locality given. Name applied to the "common gray rabbit" of eastern United States.

Type specimen Lepus nuttali mallurus Thomas (Thomas 1898) from Raleigh, N. C. No. 97.2.1.30, adult female, British Museum; collected by H. H. and C. S. Erimley.

General geographic distribution. - "Mainly east of the Alleghany Mountains from Long Island and the lower Hudson Valley south... to about Lake Julian, Polk Co., Florida. The vertical range from near sea level ... up to about 6000 feet on Roan Mt. (N.C.-Tenn.); Zonal range from Lower Austral up through Transition Zone. Mainly upper Austral." (Nelson 1909) (See figure 4).

Distribution in Virginia. - The eastern cottontail is the most important race of rabbits in Virginia, as it is distributed over the major portion of the state. It ranges from the coast in the east, westward practically through the mountains (see fig. 6). The western boundary has been delimited approximately as follows: Beginning at the western corner of Giles County and running south through the eastern part of Bland County; continuing in a southwestern direction through central Wythe County and following the southeastern boundary of Smyth County through Washington County where it meets the southern boundary of Virginia at the junction of the Tennessee - North Carolina boundary.

As one would expect, in a merging area of two races so nearly alike, as the eastern cottontail and Mearn's cottontail, considerable overlapping and hybridization would occur. Thus the ranges of this race is not definitely limited by this boundary as there appears to be a gradual intergradation of the two races. This area of intergradation takes in most of Bland, Smyth and Washington Counties and the northwestern part of Wythe County. In this area most of the specimens examined did not appear to be typical of either race. Further mention of these specimens will be found under "Remarks" of the race under discussion.

General characters. - The eastern cottontail is a large rabbit with reddish brown back, lighter sides and white belly.

Color of pelage. - The top of the head and back is a rusty buff with an overwash of black-tipped guardhairs giving a pencilled or streaked appearance. The nape is a rich rufous color. The rump patch is distinct, grayish, while the top of the tail is a faded rufous. The sides are paler light buff. The ears are grayer than the body with usually a narrow indefinite edging along the anterior margin and tips. The insides of the ears are light gray and thinly furred. The underside of the tail and belly is white except for a golden tan under the neck. The white undersurface extends out onto the legs. The tops of the legs and fore-feet are a pale rufous while the tops of the hind feet are white or mixed pale buff and white. This is average

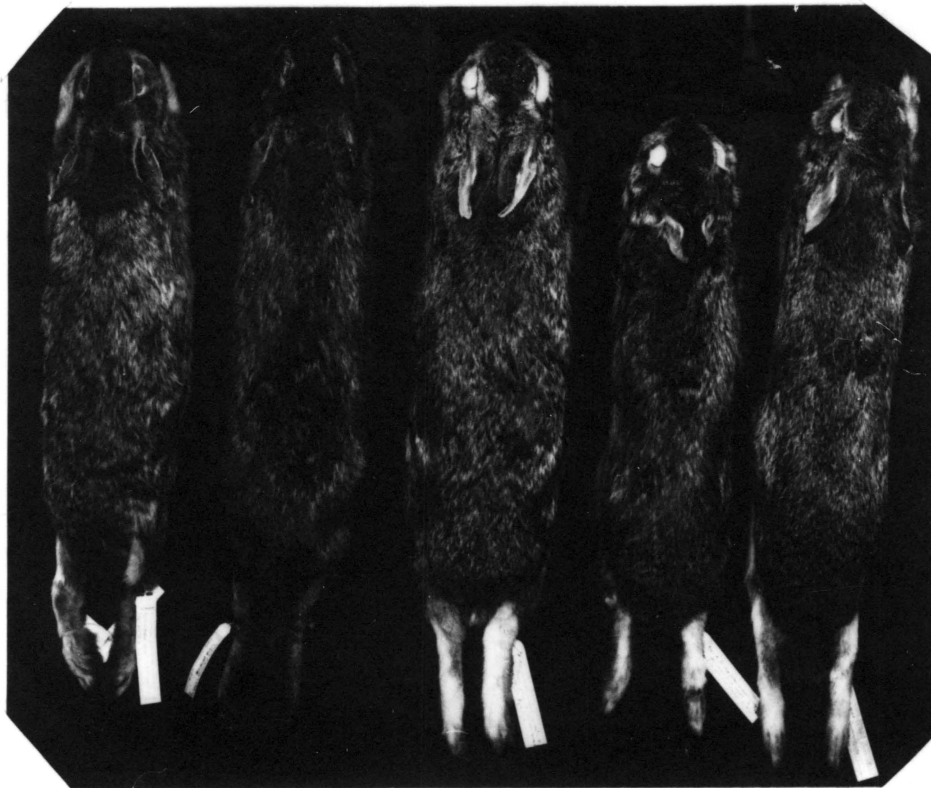


Fig. 3. SPECIES AND SUBSPECIES OF RABBITS FOUND IN VIRGINIA

Reading from left to right:

Hitchens cottontail (*Sylvilagus floridanus hitchensi*)

Marsh rabbit (*Sylvilagus palustris palustris*)

Eastern cottontail (*Sylvilagus floridanus mallurus*)

New England cottontail (*Sylvilagus transitionalis*)

Mearns cottontail (*Sylvilagus floridanus mearnsii*)

coloration for fresh pelage. The coloration for the race as a whole shows considerable individual variation as well as seasonal variation.

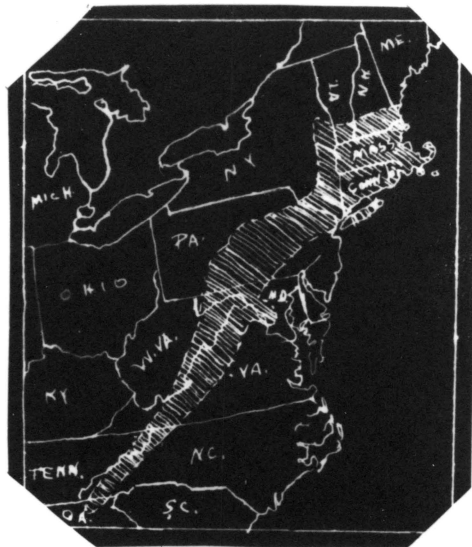
Average skin measurements. - The following measurements are based on 152 adult specimens measured in the flesh.

1. Total length	426.9 mm.
2. Tail vertebrae	48.9 mm.
3. Hind foot	94.1 mm.
4. Ear (from notch)	62.5 mm.

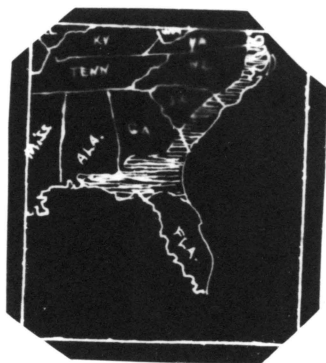
Average skull measurements. - The following measurements are based on approximately 100 skulls:

1. Basilar length.....	60.0 mm.
2. Total length of skull.....	73.4 mm.
3. Length of nasals.....	31.6 mm.
4. Parietal breadth.....	27.2 mm.
5. Interorbital breadth.....	18.1 mm.
6. Breadth of rostrum above premolars...	16.1 mm.
7. Depth of rostrum above premolars.....	15.6 mm.
8. Diameter of audital bullae.....	10.3 mm.

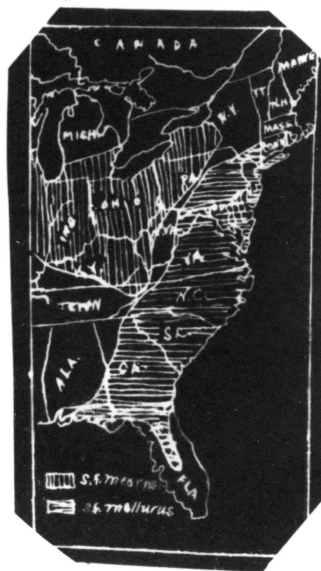
Remarks. - A few specimens taken in the area shown on the map (Fig. 6), as the area of intergradation, did not fit the description of S. f. mearnsii or S. f. mallurus. These rabbits had a sandy cast to the sides and stood out distinctly when compared to specimens of the two races mentioned. These specimens were considered as hybrids.



New England cottontail



Marsh rabbit



Eastern cottontail
Mearns cottontail

Fig. 4. RANGES OF RABBITS AS GIVEN IN NORTH AMERICAN FAUNA

NO. 29 (Redrawn from Nelson)

Apparently the two races hybridize freely as in most cases there was a gradual change from one race to the other. This factor will have an important bearing on management as the chances are that there will be little detrimental effect due to subspecific differences when transplanting from one racial area to another.

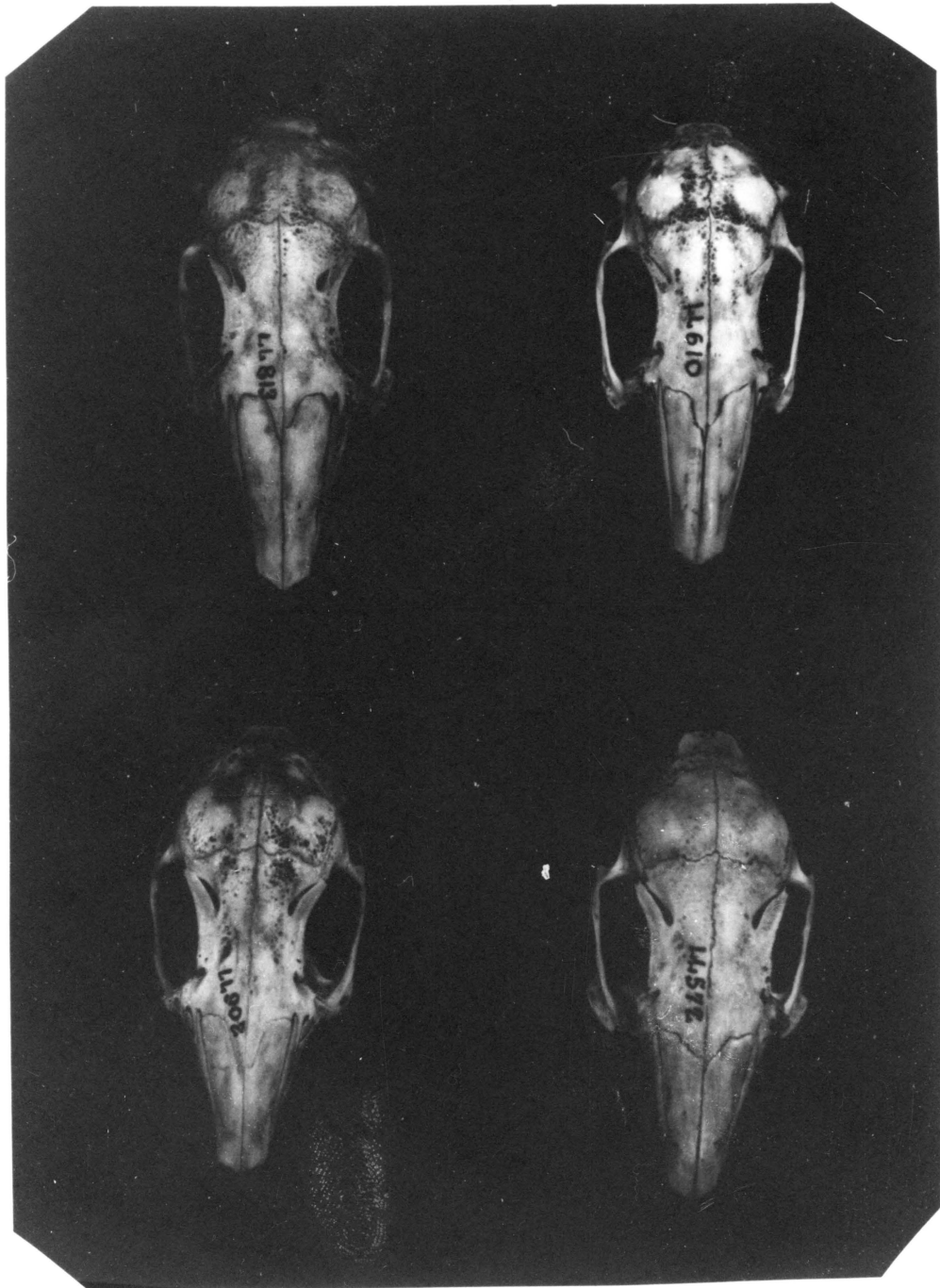


Fig. 5. SKULLS OF EASTERN COTTONTAILS SHOWING
INDIVIDUAL VARIATION (Nat. size)

SYLVILAGUS FLORIDANUS MEARNsii (ALLEN) MEARN'S COTTONTAIL

Synonyms: Lepus sylvilagus mearnsii Allen (Allen 1894)

Type specimen: From Fort Snelling, Minnesota; No. $\frac{4483}{3498}$ male, adult, American Museum of Natural History; collected by Dr. E. A. Mearns, March 29, 1891.




General geographic distribution. - "West of the Allegheny Mountains ... Central Pennsylvania, western West Virginia and eastern Kentucky and eastern Tennessee; west through southern Michigan and Wisconsin to southeastern Minnesota and south through Iowa to Trego County, Kansas, northern Missouri and Illinois, with all of Indiana and Ohio. Zonal range mainly upper Austral, extending into the lower part of the Transition Zone." (Allen 1909). See Fig. 4).

Distribution in Virginia. - The distribution of this rabbit in Virginia has been delimited to the western corner of the state. This includes the counties of Lee, Wise, Dickenson, Buchanan, Scott, Russell, and the western part of Tazewell (See Fig. 6). Since there is considerable overlapping of the eastern and western races, some specimens found in the eastern part of this area may resemble more closely S. f. mallurus while those in the western area resemble more closely S. f. mearnsii.

General Characters. - This is a large cottontail being about equal in size to S. f. mallurus. It has a paler cast to the skin and is less rufous. Skulls from Virginia specimens are indistinguishable to S. f. mallurus.

Color of pelage. - The description here is from Virginia specimens that seem most nearly to typify the typical description of S. f. mearnsii. The top of the head and back is reddish buff darkened with an overwash of black. The sides are paler light buff even though the black overwash persists. The under side of the body is white except under the neck which is a golden tan. The outsides of the ears are gray with a definite, although narrow, dark edging along the anterior margin and tip, while the insides are light gray and thinly furred. The upper part of the forelegs are chestnut, except for a white streak extending up from the belly on the inside of the legs. The white streak on the hind legs is more pronounced with less chestnut on the upperparts.

When compared to the eastern cottontail, the Mearn's cottontail is more grayish, as there is less pinkish buff on the back, darkened by an overwash of guardhairs. This dark overwash, however, is not as characteristic in specimens from Virginia as in specimens examined from some of the central states. The rump patch averages more conspicuous, although a few specimens of the eastern cottontail examined from Virginia had a grayer rump patch than any of the Mearn's cottontails. The chestnut nape patch averages smaller and duller than that found in the eastern cottontail. The top of the tail is less rufous while the black streak on the cheek is heavier. However, it must be understood that most of these characteristics have to be noted in a compared series in which both races is well

-  Sylvilagus floridanus mallurus
-  Sylvilagus floridanus mearnsii
-  Area of intergradation

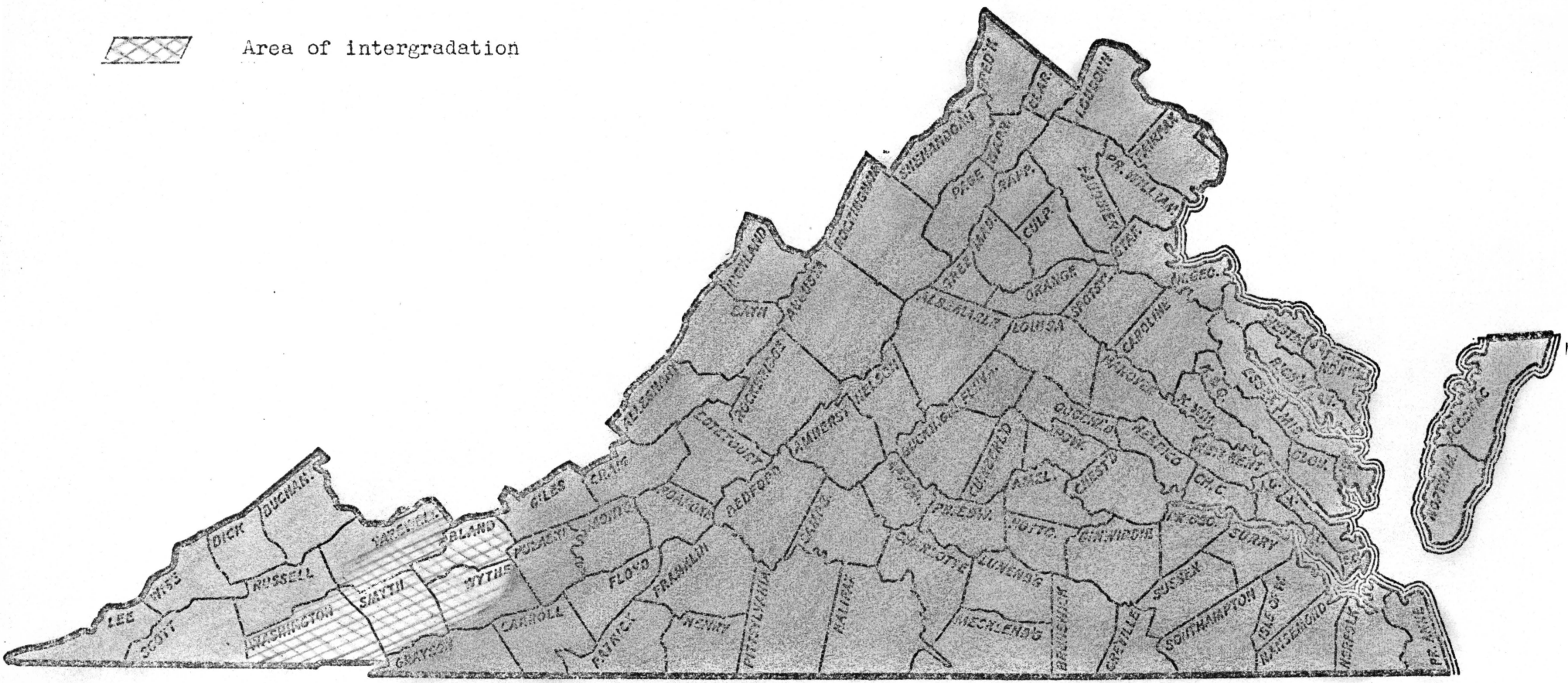


Fig. 6 Distribution of Sylvilagus floridanus mallurus and Sylvilagus floridanus mearnsii

true and found that there was even no significant difference in the ear measurements.

There have been no previous printed records of this species occurring in Virginia. No Virginia specimens of it were found in museum collections examined. The nearest record to Virginia seems to be one given by Howell when he states: "A specimen of this form was received from a collector at High Cliff, Campbell County, Tennessee. No specimens were secured at other points in East Tennessee, but this subspecies probably ranges over the Cumberland Plateau." (Howell 1909). The nearest point from Virginia to Campbell County, Tennessee is less than 20 miles. In West Virginia, A. B. Brooks states that, "This is the common rabbit of the middle and western parts of the state. Specimens collected in Oglebay Park in 1929 were identified as of this species." (Brooks 1932).

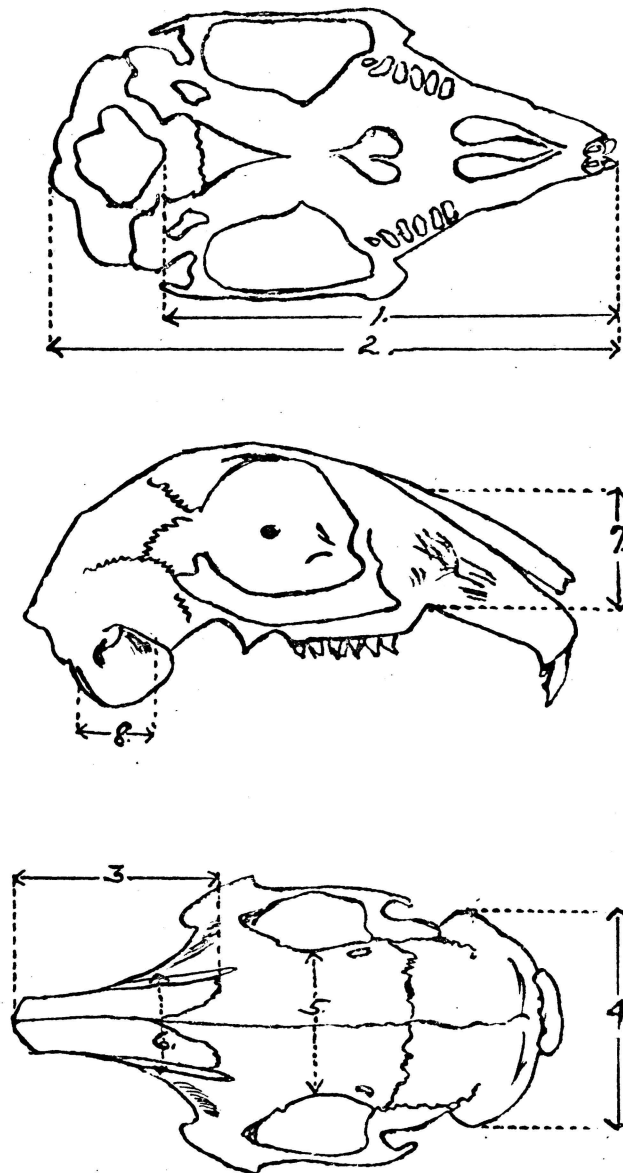


Fig. 7. EXPLANATION OF SKULL MEASUREMENTS

1. Basilar length
2. Total length of skull
3. Length of nasals
4. Parietal breadth
5. Interorbital breadth
6. Breadth of rostrum
above premolars
7. Depth of rostrum
above premolars
8. Diameter of audital
bullae

SYLVILAGUS FLORIDANUS HITCHENSI (MEARNS) HITCHEN'S COTTONTAIL

Synonym: Sylvilagus floridanus hitchensi Mearns (Mearns 1911)

Type specimen: From Smith's Island, Northampton County, Virginia; No. 155,577, adult female, U. S. National Museum; collected by Edgar A. Mearns, May 13, 1910.

Distribution. - This race is known only from Smith's Island and Fisherman's Island off the Atlantic coast of Northampton County, Virginia. (See Fig. 8)

General characters. - This race is about the size of Sylvilagus floridanus mallurus; however, it is paler in color and the skull is larger and heavier.

Color of pelage. - The color of the Hitchen's cottontail is distinctly paler than that of the other cottontails of Virginia. There is also less contrast between the colors. The overwash of black on the guardhairs is absent. The brown of the guardhairs of the back aligns itself to form streaks of varying sizes and patterns, while the light brown is so predominant that a general sandy appearance results. The line marking the darker back from the lighter sides is not as distinct as in the average eastern cottontail of the mainland. The chestnut nape is not as distinct as in the mainland form and seems to carry back broader. There is less hair on the inside of the ears than in the eastern cottontail; furthermore, the outside margin of the ears is only


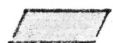

slightly darker than the adjacent color and no distinct marginal line is apparent. The chestnut on the back of the hind legs is darker than that of the mainland form of the eastern cottontail and the fur has the appearance of being coarser and heavier, giving the animal a shaggy appearance.

Skin Measurements. - The total length of one specimen, an adult female, was given as 375 mm. The head-and-body measurements of the other specimens, an adult male and an adult female, are given as 370 mm. and 407 mm. respectively. Three hind foot measurements averages 94 mm. (90, 97, 95). The ear from the notch averages 56 in four of the dried specimens. These measurements compare favorably with those of the eastern cottontail (S. f. mallurus).

Skull characters. - The skull of Hitchen's cottontail appears to be heavier than that found in the eastern cottontail. The teeth are also heavier, making the length of the molar series longer; the interorbitally breadth is greater; the rostrum is thicker; and the audital bullae are greater in diameter.

Skull measurements. - The following measurements are based on the average of four adults:

1. Basiliar length	61.0 mm.
2. Total length of skull	75.0 mm.
3. Length of nasals	32.4 mm.
4. Parietal breadth	28.9 mm.
5. Interorbital breadth	18.1 mm.

-  Sylvilagus transitionalis
-  Sylvilagus floridanus hitchensi
-  Sylvilagus palustris palustris

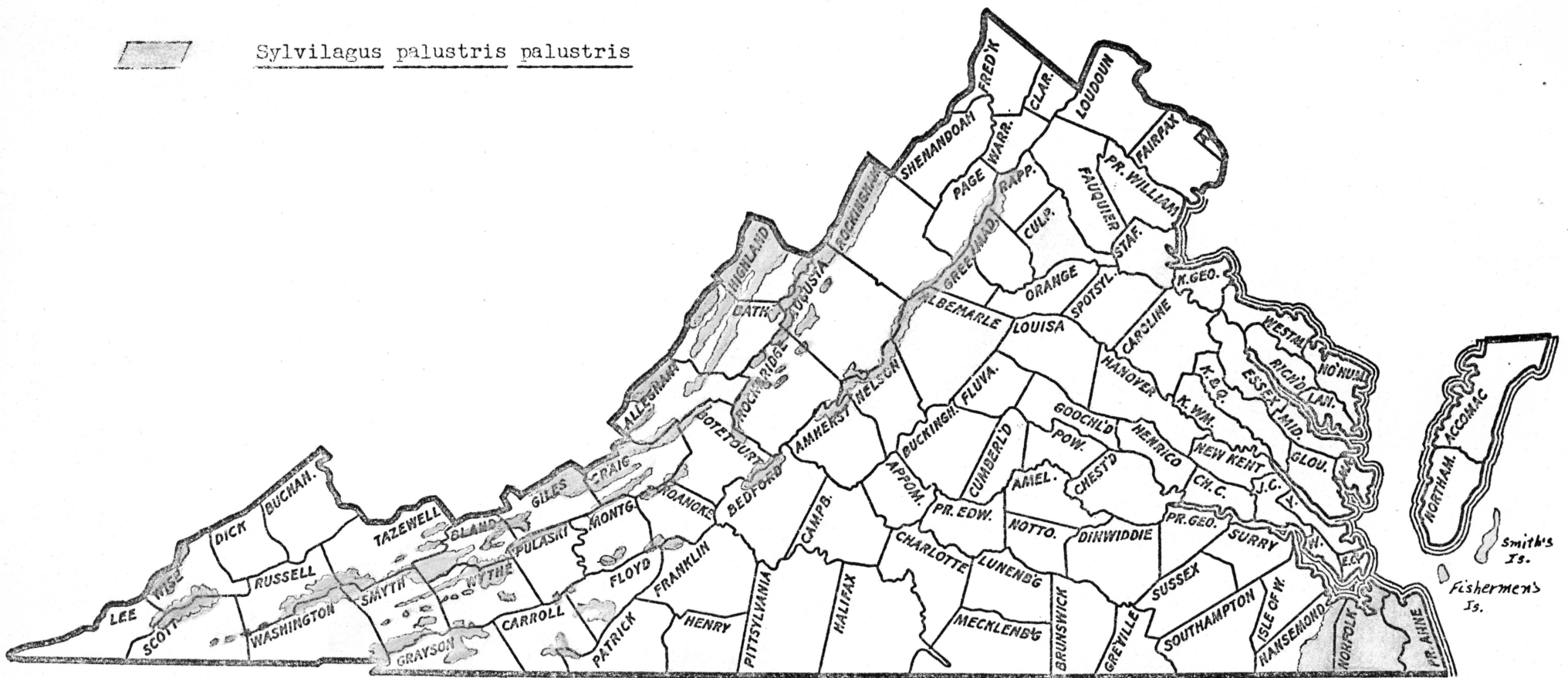


Fig. 8 Distribution of Sylvilagus transitionalis, Sylvilagus floridanus hitchensi and Sylvilagus palustris palustris

Skull measurements. -(Cont.)

6. Breadth of rostrum above premolars.. 21.4 mm.
7. Depth of rostrum above premolars.... 17.8 mm.
8. Diameter of audital bullae..... 11.4 mm.

Remarks. - This race stands out distinctly when compared to the mainland form of the eastern cottontail. It was thought by some to be a hybrid but Mearns writes, "At one time a number of 'Australian rabbits' were introduced but speedily died out... It is in fact a pure cottontail, showing no trace of admixture with the genus Oryctolagus". (Mearns 1911)

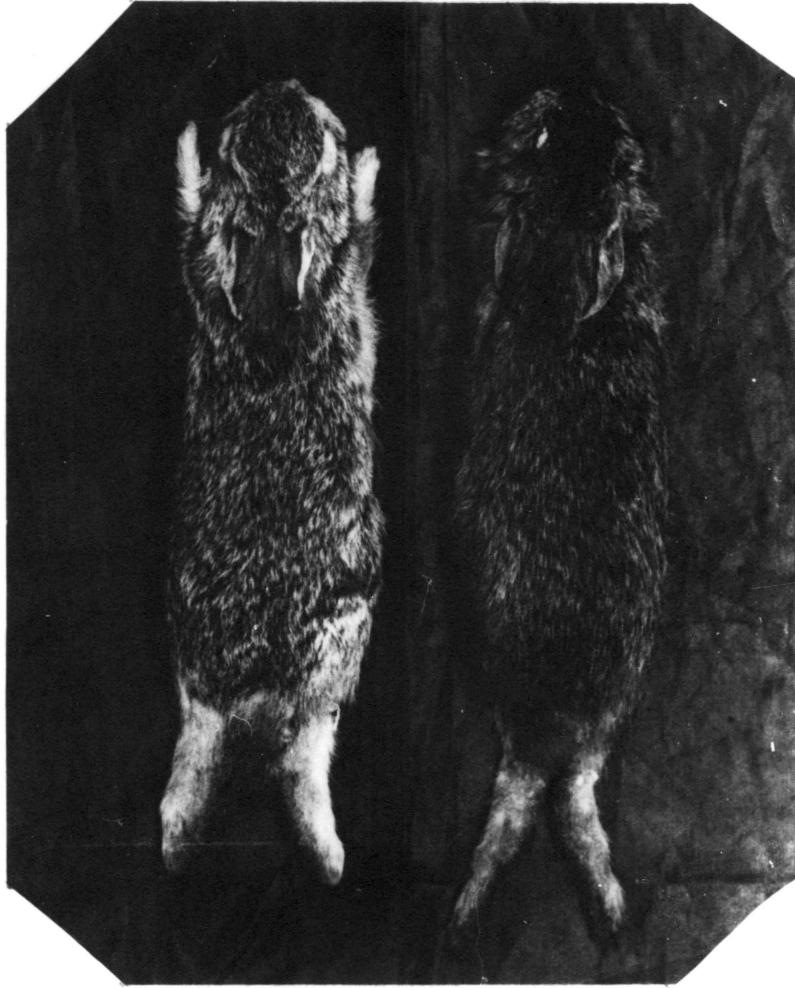


Fig. 9. IMMATURE OF HITCHENS COTTONTAIL (LEFT)
AND MARSH RABBIT (RIGHT)

SYLVILAGUS TRANSITIONALIS (BANGS) NEW ENGLAND COTTONTAIL

Synonym: Lepus sylvaticus transitionalis Bangs (Bangs 1895)

Type specimen: From Liberty Hill, Connecticut; No. 2407, Bang's collection; male, adult. Museum of Comparative Zoology. collected by Outram Bangs, November 6, 1894.

General distribution. - "New England States north to Utland, Vermont, southern New Hampshire, extreme southwest Maine, and southwest through eastern New York (including southern end of Lake George and Long Island), New Jersey and eastern Pennsylvania and Maryland to Alexandria, Virginia; also along the Alleghenies through West Virginia to Roan Mt., North Carolina and Brasstown Bald Mountain in extreme northern Georgia. Vertical range from near sea level in Virginia to 6,000 feet on Roan Mt., North Carolina. Zonal range mainly transition and thence down into the Upper Austral Zone." (Nelson 1909) (See Fig. 8).

Distribution in Virginia. - With few exceptions, it seems that this species is definitely limited in Virginia to the higher Allegheny and Blue Ridge Mountains. Nelson's reference above which includes Alexandria, Virginia and "near sea level in Virginia" was evidently based on a specimen prepared by Vernon Bailey. Mr. Bailey clears this record up by stating "... a specimen which I bought on January 1, 1904, of a colored man on the street, who said he killed it at Alexandria, probably came from West Virginia where they are common and are often included in shipments of rabbits to market. At that time I did not

know that men posing as hunters went about the streets selling game from the market stalls, and recognizing an interesting specimen, I saved it and labelled it as coming from Alexandria. These cottontails belong to the Transition Zone of the Allegheny Mountains..." (Bailey 1923)

All specimens examined were taken at elevations above 3000 feet in the Alleghenies and Blue Ridge Mountains. Signs indicate that cottontails occupy the woods and brush along most of the higher crests and ridges of the state. For the purpose of this paper, the range has been delimited to the 3000 foot contour.

General characters. - This species is the smallest found in Virginia. It is similar to the eastern cottontail (S. f. mallurus) in color, except for specific differences noted below. The skull is also lighter and readily distinguishable from any other Sylvilagus in Virginia.

Color of pelage. - The short rounded ears have a black margin on the outside, making a distinct black line (i.e. the black does not gradually blend into the browner color of the ear as is true in most specimens of the eastern cottontail). A definite black patch is found between and just in front of the ears. The underfur is dark gray (much darker than that of the eastern cottontail). The back is dark ochraceous buff overlaid with an overwash of black-tipped guardhairs that in some specimens give the back a dark appearance. Virginia specimens

examined do not have the "rich reddish" color so often attributed to the New England cottontail. In fact, many of the eastern cottontails examined from Virginia have a much "richer reddish" than the species under discussion.

Skin measurements. - The following measurements are based on five specimens:

1. Total length	391.2 mm.
2. Tail vertebrae	45.0 mm.
3. Hind foot	92.2 mm.
4. Ear (from notch)	57.5 mm.

Skull characters. - The skull is light and slender. The inter-orbital breadth is narrow and the rostrum is thin and decurved anteriorly. The supraorbital process is very thin, narrowing in front so that the anterior process and notch is practically absent. The posterior process narrows to a thin lanceolate point quite frequently free of the skull, leaving a distinct foramen. The zygomatic arch is thin and the jugal small. The characteristic supraorbital process will at once serve as a distinguishing criterion when an adult skull is available.

Skull measurements. - The following measurements are based on five skulls:

1. Basilar length.....	56.5 mm.
2. Total length of skull.....	68.5 mm.
3. Length of nasals.....	29.5 mm.
4. Parietal breadth.....	28.4 mm.

Skull measurements. - (Cont.)

5. Interorbital breadth..... 16.5 mm.
6. Breadth of rostrum above premolars.... 17.0 mm.
7. Depth of rostrum above premolars..... 14.2 mm.
8. Diameter of audital bullae..... 9.5 mm.



Fig. 10. UNDERSURFACE OF EASTERN COTTONTAIL (RIGHT)
AND MARSH RABBIT (LEFT)

SYLVILAGUS PALUSTRIS PALUSTRIS (BACHMAN) CAROLINA MARSH RABBIT

Synonym: Lepus palustris Bachman (Bachman 1839)

Type specimen: None; from specimens collected near the coast of South Carolina.

General geographic distribution. - "Lowlands along rivers and coast of the southeastern states from Dismal Swamp, Virginia, south to extreme northern Florida, and west through most of southern Georgia and the Gulf coast of northwestern Florida to the east side of Mobile Bay, Alabama. Vertical range from sea level to an undetermined altitude (probably less than 500 feet). Zonal range Lower Austral." (Nelson 1909) (See Fig. 8)

Distribution in Virginia. - The marsh rabbit is known to occupy the lowlands and marshes and swamps of Nansemond, Norfolk and Princess Anne Counties. This species has been collected from Lynhaven, Princess Anne County south to Back Bay (Patton 1939 - quoted from Bailey 1930). Specimens collected in Dismal Swamp are recorded in North American Fauna No. 29 (Nelson 1909). It is likely that this rabbit inhabits most of the suitable habitats of the three counties named above.

General characters. - This species is about the same size as the eastern cottontail but is much darker in color and lacks the white "cottontail".

Color of pelage. - The back is generally dark with heavy overwash of black. The nape has a small patch of faded buff with a lighter grayish streak in front that extends to the base of the ears and covers most of the interior of the ears. The forehead loses part of its overwash of black and appears more rufous. The color of the back runs well down on the sides, partially covering the belly. Only about half, or a little over, of the belly is grayish white. The underchin is dark gray with some tips of white guardhairs protruding. Upperparts of legs and tail have a faded chestnut color. The toenails of the hind feet are very conspicuous and the feet appear small because of the absence of the heavy covering of hair found in other races of Sylvilagus from Virginia. The dark underside of the tail distinguishes this species at once from the "cotton-tails". (See Fig. 10.)

Skin measurements. - The following measurements are the average for an adult male and an adult female from Virginia.

1. Total length..... 447.5 mm.
2. Tail vertebrae..... 40.0 mm.
3. Hind foot..... 99.0 mm.
4. Ear (from notch)..... not available.

Skull characters. - The skull is massive being larger and heavier in every way than that of any other race of Sylvilagus in Virginia. There is usually a small notch in the anterior process and a slit foramen in the postorbital process. This process is

fused to the skull by a broad tip. The zygomatic arch is very heavy and the jugal is deeply grooved. The bullae are comparatively small and firmly joined to a heavy basioccipital.

Skull measurements. - The following measurements are taken from an adult male collected at Lake Drummond, Dismal Swamp:

1. Basilar length..... 66.9 mm.
2. Total length of skull..... 82.8 mm.
3. Length of nasals..... 31.1 mm.
4. Parietal breadth..... 30.6 mm.
5. Interorbital breadth..... 18.3 mm.
6. Breadth of rostrum above premolars... 13.4 mm.
7. Depth of rostrum above premolars..... 18.8 mm.
8. Diameter of audital bullae..... 11.0 mm.

SUMMARY OF BODY MEASUREMENTS
(given in mm.)

Table 1.

Source of Measurement	Species				
	<u>S. f. mallurus</u>	<u>S. f. mearnsii</u>	<u>S. f. hitchensi</u>	<u>S. trans-itionalis</u>	<u>S. palustris</u>
Total length	426.9	422.9	375.0	391.2	447.5
Tail	48.9	49.1	---	45.0	40.0
Hind foot	94.1	95.1	94.0	92.2	99.0
Ear (from notch)	62.5	62.6	56.0*	57.5	---

* dried skin measurement

SUMMARY OF SKULL MEASUREMENTS
(given in mm.)

Table 2.

Source of Measurement	Species				
	<u>S. f. mallurus</u>	<u>S. f. mearnsii</u>	<u>S. f. hitchensi</u>	<u>S. trans-itionalis</u>	<u>S. palustris</u>
Basiliar length	60.0	60.9	61.0	56.5	66.9
Total length	73.4	72.9	75.0	68.5	82.8
Length of nasals	31.6	31.7	32.4	29.5	31.1
Parietal breadth	27.2	27.7	28.9	28.4	30.6
Interorbital breadth	18.1	18.8	18.1	16.5	18.3
Breadth of rostrum above premolars	16.1	16.9	21.4	17.0	18.4
Depth of rostrum above premolars	15.6	15.4	17.8	14.2	18.8
Diameter of audital bullae	10.3	10.4	11.4	9.5	11.0

LIFE HISTORY NOTES

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Fig. 11. LITTER OF THREE DAY OLD COTTONTAILS

BREEDING DATA

Table 3 summarizes the breeding data for the female rabbits collected in the preparation of this work. The earliest breeding date available for the Mountain Region is from a specimen (LL No. 935) in which parturition had recently occurred when collected on March 21, 1941. This date is probably a week or ten days earlier than the average for this region. A specimen collected in the Piedmont on March 29, 1940 was found to be pregnant. The former case would indicate that breeding had taken place before the middle of February and the latter shortly afterwards. A female (LL No. 937) collected on March 25, 1941 contained embryos 14 mm. in length. This record would probably more nearly indicate the beginning of the normal breeding season. All females collected during April were either pregnant or lactating. With two exceptions, this was true also for May.

The number of embryos found in 21 specimens of the eastern cottontail ranged from 2 to 6. These were distributed as follows: 1 with 2 embryos; 1 with 3; 7 with 4; 7 with 5; and 5 with 6 embryos; an average of 4.7 per litter. (See Fig. 12, upper graph). The average for this small series corresponds fairly well with that given by Trippensee (1934) in which he states the average number of young is 5, Haugen (1943) in Michigan gives the average number of young for the Mearns cottontail as 5.4.

The breeding condition of 63 males was checked during January, February and March by noting the weight of the testes and whether or not they had descended into the scrotum. These were collected as follows: from the Mountain Region -- January 8, February 14, March 11; from the Piedmont and Coastal Regions -- January 7, February 9, March 14. It was found that the second criterion was not always reliable, since recently or partly descended testicles would often recede when the animal was picked up or jerked by the hind legs. In weighing the testes, it was found that in a few cases both testes were of the same size but in most instances there was a difference. This difference was at times as high as 25 per cent but in most cases was less than 5 per cent. On averaging the weights of all the testes for the period, no significant difference in the weight of the right and left testicle was found. The right testicle averaged 8.3 grams and the left, 8.4 grams.

Fig. 12 (lower graph) gives the average weights of the paired testes as broken down into two week periods from January 16th to March 16th by the region in which the specimens were collected. The weights show a definite trend toward an increase during the whole of the period, except in the Mountain Region for February 1-15, when only three specimens were available for examination. It is interesting to note also that there is a trend for the increase in the size of the testicles in the

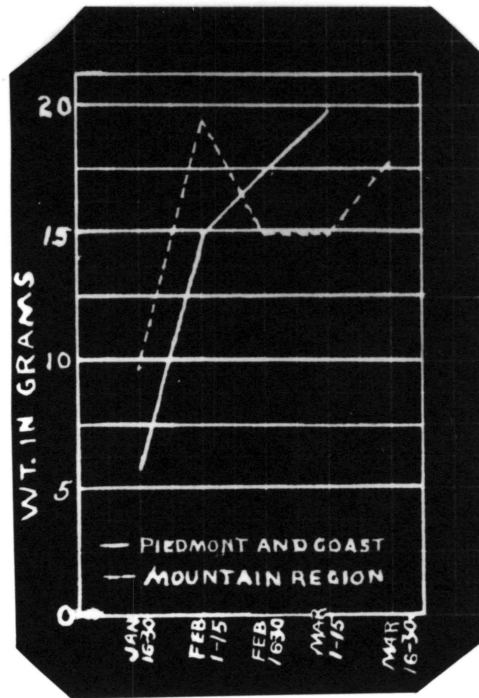
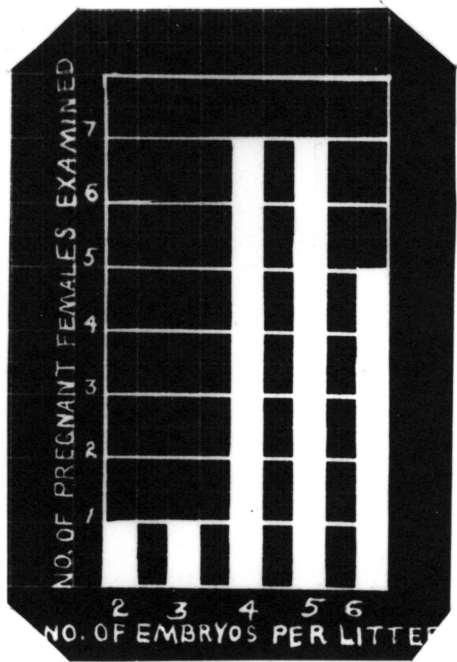


Fig. 12. NUMBER OF EMBRYOS PER LITTER (ABOVE)

AVERAGE WEIGHT OF TESTES (BELOW)

Mountain Region to lag behind that of the lowlands. It is admitted that this phase of the study to be significant should be carried out for an entire year. It is given here only as a basis for further work.

Table 3.

BREEDING DATA

L.L. No.	Date	Locality	No. of Embryos	Length of Embryos	Remarks
643	3/29/40	Camp Lee, Prince George Co.	4	55 mm.	Mammary glands in advanced stage of functional development
648	4/7/40	" " "			Parturition had occurred recently as judged by appearance of uterus and mammary glands.
649	4/8/40	" " "			Same as #648
651	4/8/40	" " "	4	7 mm.	
654	4/10/40	" " "	6	6.6 mm.	Mammary glands approaching function.
655	4/12/40	" " "	6	18 mm.	
660	4/16/40	" " "	6	26 mm.	Mammary glands approaching function.
661	4/16/40	" " "	?		Mammary glands approaching function.
662	4/16/40	" " "	5	17 mm.	
663	4/16/40	" " "	5	15 mm.	
664	4/16/40	" " "	5	20 mm.	
666	4/23/40	" " "			Lactating.
669	4/24/40	New Bohemia Prince George Co.	4	68 mm.	
671	4/30/40	Sussex Refuge Sussex Co.	4	17 mm.	

Table 3. (cont.)

BREEDING DATA

L.L. No.	Date	Locality	No. of Embryos	Length of Embryos	Remarks
674	5/2/40	Frederick Co.			Lactating.
675	5/2/40	Frederick Co.	6	30 mm.	
676	5/2/40	Frederick Co.	5	20 mm.	
682	5/10/40	Camp Lee Prince George Co.	4	39 mm.	
683	5/10/40	" " "	5	22 mm.	
692	5/20/40	Waverly, Sussex Co.	5	76 mm.	
693	5/20/40	Waverly, Sussex Co.	4	28 mm.	
694	5/20/40	" "			Lactating.
695	5/20/40	" "	2	80 mm.	
696	5/20/40	" "	5	68 mm.	
697	5/21/40	Camp Lee Prince George Co.	6	70 mm.	
698	5/21/40	" " "	3	23 mm.	
935	3/21/41	Mountain Grove, Bath Co.			Parturition had occurred about one day previous to death. Mammary glands lactating.
937	3/25/41	Blacksburg, Montgomery Co.	4	14 mm.	

SEX RATIO

Table 4 summarizes the sexes of the rabbits collected by months and Regions. Data on 234 cottontails were available for the summary. Of these, 123 were males and 111 females, a ratio of 111 to 100 or 53 to 47. In the monthly summary, it is interesting to note the preponderance of males over females during the months of February and March which would imply that there is some truth in the statement so often made by hunters that the females are less active during severe weather. During the height of the breeding season in April and May, this ratio is reversed.

The criticism that selective collecting has resulted in an unbalance of sexes is therefore lessened in this case, where the methods of collecting the specimens were:--hunting at night with jacklight, hunting with dogs and gun, and trapping.

MONTHLY DISTRIBUTION OF SEXES

Table 4. OF THE RABBITS COLLECTED

	Piedmont and Coastal Regions		Mountain and Western Region		Higher Mountains		Totals	
	male	female	male	female	male	female	male	female
October			1				1	0
November	4	1	5	6			9	7
December	10			10			10	10
January	2	7	11	8	2	2	15	17
February	19	9	12	14			31	23
March	13	14	27	11			45	25
April	6	13					6	13
May	6	11		5			6	16
Totals	65	55	56	54	2	2	123	111

WEIGHTS

The data on weights of the rabbits collected are summarized in Table 5. This is broken down into species and the months in which collected. There is no significant difference in the yearly average of 1144.0 grams for male of S. f. mallurus and 1179.5 grams for male of S. f. mearnsii. This is true also for the 1231.2 grams and 1233.9 grams, respectively, for the females of the two forms. There is a significant difference, however, between the weights of the above two races and the weights of S. transitionalis, the latter averaging 990.0 grams and 868.5 grams for male and female, respectively. It might be added that the New England cottontails (S. transitionalis) were taken in January during a spell of severe weather and deep snow which may be responsible for their weight being slightly below normal.

There is a general trend for the animals to fatten for the winter and hold this weight during the winter. With the coming of spring, the males lose weight slightly and the females gain. It is to be presumed, however, that much of the additional weight of the females is due to the presence of unborn young.

AVERAGE WEIGHTS OF RABBITS COLLECTED
(given in grams)

Table 5.

		<u>S. f. mallurus</u>		<u>S. f. mearnsii</u>		<u>S. trans- itionalis</u>	
		male	female	male	female	male	female
October	No. of specimens	1					
	Average weight	1040					
November	No. of specimens	3					
	Average weight	1187.3					
December	No. of specimens	9	6		1		
	Average weight	1198.2	1195.2		1440.0		
January	No. of specimens	5	14	5	2	2	2
	Average weight	1208.0	1089.9	1130.5	1238.0	990.0	868.5
February	No. of specimens	26	16	1	4		
	Average weight	1141.3	1190.4	1197.0	1240.8		
March	No. of specimens	27	20	4	3		
	Average weight	1227.4	1147.2	1055.0	1153.4		
April	No. of specimens	6	13				
	Average weight	1137.3	1347.1				
May	No. of specimens	4	13				
	Average weight	1110.5	1469.8				
Total	No. of specimens	87	82	10	10	2	2
	Yearly average	1144.0	1231.2	1179.5	1233.9	990.0	868.5

PARASITES

It is not the intention of the writer to make a complete coverage of the parasites of the rabbits but only to summarize the findings as an incidental part of this work. Most of the parasite identification was made in connection with the cooperative study of tularemia by the United States Public Health Service and acknowledgment is hereby made to that Division.

In considering the ectoparasites, it was found that practically all specimens collected were infested with fleas and all, except the winter specimens, contained ticks in varying numbers. The flea found in greatest numbers was the species Cediopsylla simplex. A large number of Odontopsyllus multispinosus and a few Ctenocephalides canis were also found. The fleas on some specimens would number 100 or more. Mites of the species Trombiculi microti were often found on the cottontails and at times in numbers as high as 50 or more.

Ticks were found mainly during the warm weather and at times were so abundant as to be very annoying, if not debilitating, to the rabbit host. For example, 300 ticks were removed from one specimen collected early in October. The species found most commonly was the rabbit tick Haemaphysallis leporis-palustris. Ixodes dentatus was found frequently but usually in less numbers than the rabbit tick. Necrotic nodules were often found under the skin at the site of attachment of these parasites.

It is interesting to note here that the rabbit is an important host for the common chigger Entrombicula alfredeugesi Oudemans. In this connection, Ewing (Ewing 1929) states, "The rabbit of all our wild mammals ... appears to be important host of chiggers."

Less attention was paid to internal parasites but a few of the macroscopic parasites were so much in evidence as to deserve mention. Practically every specimen showed evidence of infestation by the tapeworm Taenia pisiformis. These were evidenced by the cysts which were often found in the peritoneal and thoracic cavities; and the liver often showed scars caused by these parasites.

Summer and fall specimens often were infested with the warble fly (Cuterebra). These larva were usually found under the neck and sometimes on the back. They apparently cause little injury to the animal but are very unsightly.

A few specimens (averaging about 2 per cent infection) were found to be infested with the nematode Dirofilaria scaphiceps. These were usually found in coils in the inter-muscular fasciae of the hind leg, although, in one specimen they were found in the subcutaneous fasciae on the back just back of the shoulders.

The intestinal tract of one specimen submitted for tularemia study was examined for the presence of internal parasites with the following results: "The stomach contained

a few specimens of Obeliscoides cuniculi, the rabbit stomach nematode; and the small intestine had a heavy infestation of the trematode Hasstilesia tricolor, and one tapeworm of the genus Cittotaenia was found. Two Trichurus leporis, the rabbit whipworm, were found in the cecum, and 16 specimens of the nematode Dermatoxys veligera were present in the large intestine. In addition, this rabbit suffered from a severe infection of coccidia." (Communication Frederick Bell and William Chalgren 1940).

VIRGINIA, 1933

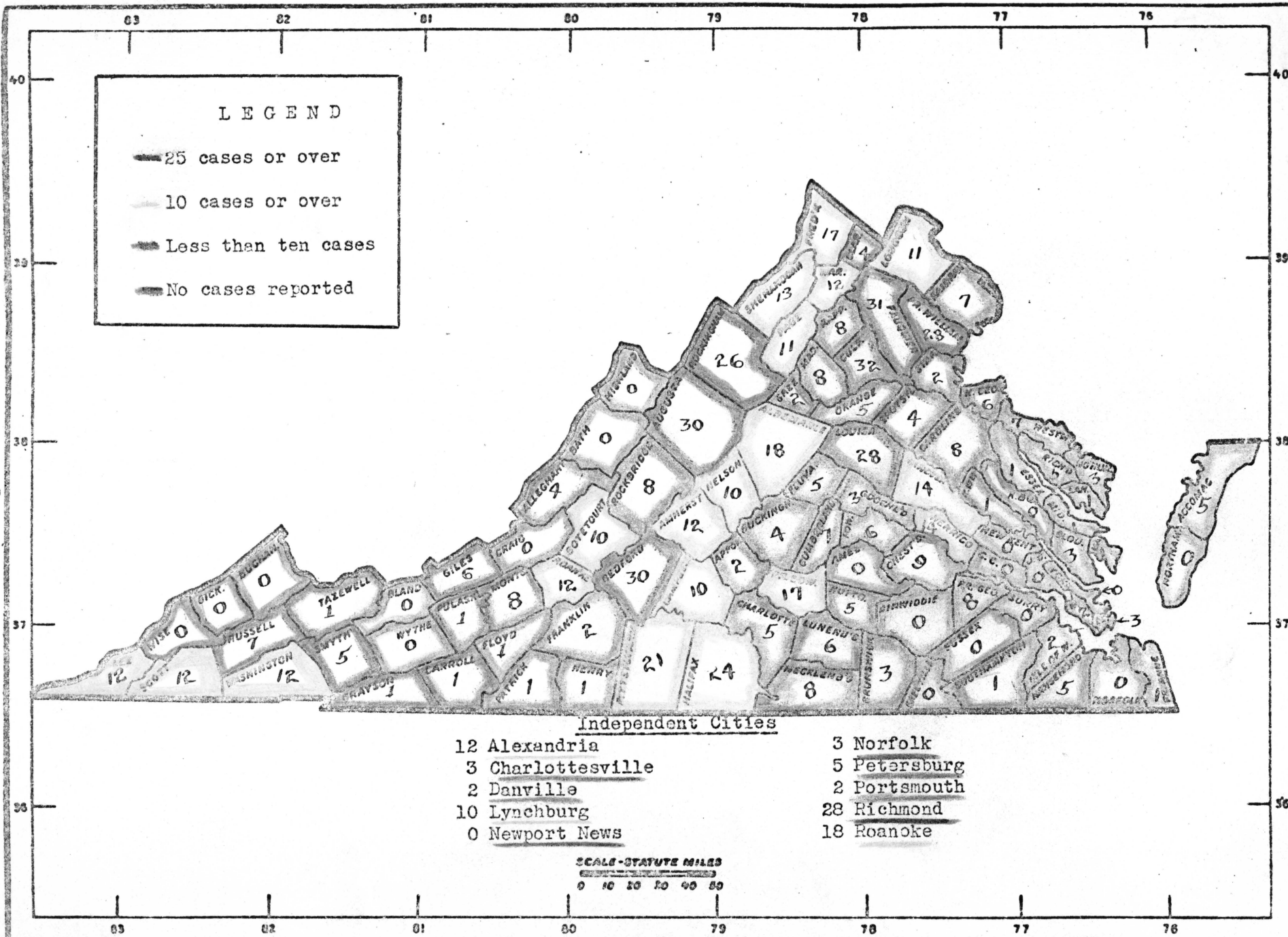


Fig. 13. PREVALENCE OF TULAREMIA, 1931 THROUGH 1940

38 A

TULAREMIA IN VIRGINIA

Tularemia is not a major disease in Virginia but its occurrence is frequent enough to cause considerable fear among hunters and persons handling wild rabbits.

Most of the cases of tularemia in Virginia have come from handling rabbits. In this connection Dr. William Grossman, Director of Bureau of Communicable Diseases, states: "Though we are unable to give you any exact figures at this time, we do know that by far the majority of these cases were infected as a result of dressing or preparing wild rabbits. A few cases have been reported resulting from the bites of ticks."*

The total number of cases in Virginia for the ten year period 1931-1940 is given as follows (See fig. 14):

1931 - 43	1935 - 101	1939 - 81
1932 - 105	1936 - 57	1940 - 49
1933 - 78	1937 - 49	
1934 - 57	1938 - 144	

This is broken down into a county tabulation in Fig. 13, with Culpepper Co. having the highest number of cases for the ten year period, twenty counties reporting no cases at all.

In collecting specimens for this study, no rabbits were encountered with tularemia as judged from gross post mortem examination. No bacteriological cultures were made or injections into test animals attempted. However, the writer always used the precautionary measure of wearing rubber gloves while skinning and preparing specimens.

* Communication March 28, 1941.

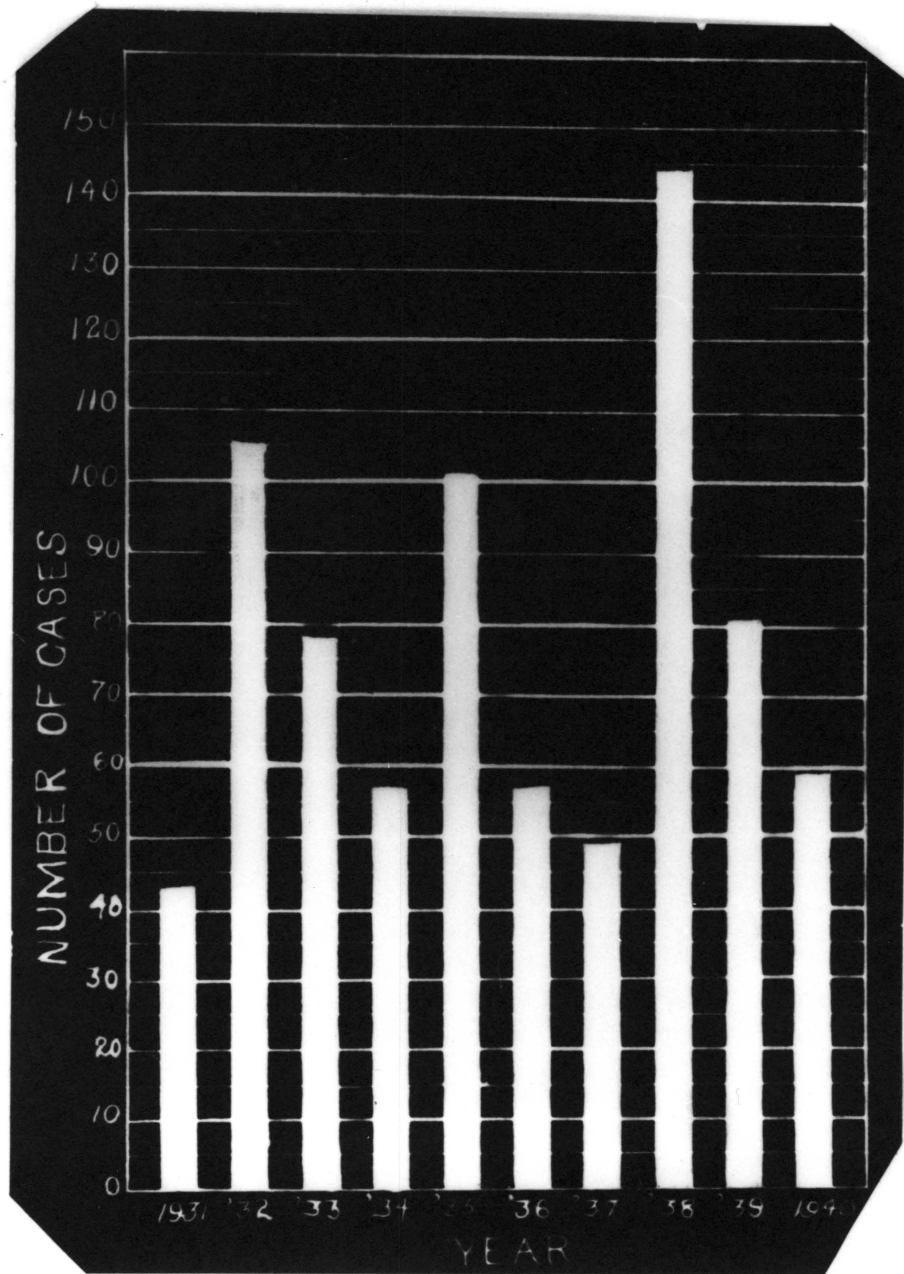


Fig. 14. NUMBER OF CASES OF TULAREMIA IN VIRGINIA
1931 THROUGH 1940

In addition to the specimens collected for study skins, approximately 75 specimens were collected for the United States Public Health Service's Rocky Mountain Laboratory. These animals were killed and placed in tightly closed cloth bags and shipped at once to the laboratory where the ectoparasites were removed and a necropsy made of the animal. Tissues and ectoparasites were injected into test animals with the results as reported by Dr. R. R. Parker, Director in Tables 6 and 7. It is interesting to note that in no instance was an infection demonstrated by the injection of the tissues of the host animal itself, but in every case reported, the infection was recovered from the ectoparasites. This would indicate that these parasites serve as a reservoir for these infections and may eventually infect the host animal itself.

DATA* PERTAINING TO THE RECOVERY OF SIX STRAINS OF ROCKY MOUNTAIN SPOTTED FEVER, ONE OF AMERICAN Q FEVER, AND THREE OF TULAREMIA, FROM RABBIT TICKS (HAEMAPHYSALIS LEPORIS-PALUSTRIS) FROM VIRGINIA. EACH GROUP OF TICKS TESTED WAS FROM ONE COTTONTAIL RABBIT^{II} (S. F. MALLURUS).

Test and Strain No.	R.Mt.LAB.(a) and U.of P.(b) accession numbers	Date coll. 1940	State	County	Locality	Test Data		
						Date Tested 1940	No. of Ticks Tested	Infection Recovered
13-7	(a)17586 (b)B1199	3-29	Va.	Prince George	State Game Farm Petersburg	4-6	17	Rocky Mtn. spotted fever
13-21	17665 B1231	4-16	Va.	Prince George	State Game Farm Petersburg	4-23	62	" "
13-37	17704 B1272	4-24	Va.	Prince George	New Bohemia	5-3	80	" "
13-74	17814 B1336	5-20	Va.	Sussex	Waverly	5-29	56	" "
13-10	17634 B1208	4-7	Va.	Prince George	State Game Farm Petersburg	4-16	67	American Q Fever
13-6 ²	17585 B1196	3-28	Va.	Prince George	State Game Farm Petersburg	4-5	68	Tularemia
13-14 ³ 13-14a	17639 B1217	4-9	Va.	Prince George	State Game Farm Petersburg	4-22	50 50	Tularemia Tularemia

* As reported by Dr. R. R. Parker, Director Rocky Mountain Laboratory, U. S. Public Health Service.

II In test 13-14 both groups of ticks were from the same host animal.

a - Rocky Mountain Laboratory, Hamilton Montana.

b - Department of Animal Pathology, University of Pennsylvania.

2 - A strain of American Q Fever was recovered from I. dentatus from same rabbit (see table 4)

3 - A strain of tularaemia was recovered from I. dentatus from same rabbit (see table 4)

DATA* PERTAINING TO THE RECOVERY OF FIVE STRAINS OF AMERICAN Q FEVER, ONE OF TULARAENIA, AND ONE OF ROCKY MOUNTAIN SPOTTED FEVER FROM THE TICK IXODES DENTATUS FROM VIRGINIA. EACH GROUP OF TICKS TESTED WAS FROM ONE COTTONTAIL RABBIT¹¹.

Table 7.

Test and Strain No.	R.Mt.Lab.(a) and U.of P.(b) accession numbers	Date coll. 1940	State	County	Locality	Test Data		
						Date Tested 1940	No.of Ticks Tested	Infection Recovered
2-1 ²	(a)17585 (b)B1196	3-28	Va.	Prince George	Camp Lee	4-5	13	American Q Fever
2-9	17663 B1230	4-16	Va.	Prince George	State Game Farm Petersburg	4-23	17	" "
2-6 ³	17639 B1217	4-9	Va.	Prince George	State Game Farm Petersburg	4-22	18	Tularemia
2-27	17705 B1270	4-24	Va.	Prince George	N. Disputanta Twp.	5-3	7	Rocky Mtn. Spotted Fever

* As reported by Dr. R. R. Parker, Director Rocky Mountain Laboratory, U. S. Public Health Service.

¹¹In test 2-60 both groups of ticks were from the same host animal.

a - Rocky Mountain Laboratory, Hamilton, Montana.

b - Department of Animal Pathology, University of Pennsylvania.

2 - A strain of Rocky Mountain spotted fever was recovered from H. leporis-palustris from same rabbit (see table 3).

3 - Two strains of tularamia recovered from H. leporis-palustris from same rabbit (see table 3).

SUMMARY

Employing the use of skins collected during the study and those examined from various collections, the author has attempted to delimit the ranges of the species and subspecies of the cottontails known to inhabit the state of Virginia. The ranges have been outlined as follows: Sylvilagus floridanus mallurus, ranging from the coast in the east, westward practically through the mountains; S. f. mearnsii is limited to the western corner of the state; S. f. hitchensi, known only from Smith's Island and Fisherman's Island off the Atlantic coast to Northampton County; S. transitionalis, limited to the higher elevations of the Blue Ridge and Allegheny Mountains; and S. palustris palustris, known to occupy the lowlands, marshes, and swamps of Nansemond, Norfolk, and Princess Anne Counties.

In addition, life history notes and observations have been added.

In Virginia, the height of the breeding season was found to be in March and April with breeding continuing practically throughout the year, except perhaps December and January. An average of 4.7 young per litter was found by embryonic count in a small series of females taken in Virginia. In the males it was found that there was a steady increase in the weight of the testes during the period checked (January, February, March).

The sex ratio of 234 specimens available for this summary was found to be 53 to 47 or 111 males per 100 females.

No significant difference was found between the yearly average weights of S. f. mallurus and S. f. mearnsii but the difference between these two races and S. transitionalis was significant.

Practically all specimens collected were infested with fleas and all, except the winter specimens, had ticks. Mites also were found in varying numbers, as was nematodes and coccidia.

In summarizing the incidence of tularemia, it was found that it was not a major disease but frequent enough to cause considerable apprehension among a good many sportsmen and those handling or dressing wild rabbits.

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Fig. 15 THE END