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A SYSTEMATIC STUDY OF THE WATER RAT
(*NEOFIBER ALLENI*)

BY ALBERT SCHWARTZ

INTRODUCTION

LITTLE has been published on the habits and taxonomy of the swamp rat, water rat, or round-tailed muskrat, as the animal is variously called. Chapman (1889) was the first to report on the habitat and habits of the water rat, from observations on its workings at Oak Lodge, Brevard County, Florida. He described the dome-shaped houses in the mangrove-studded salt savannas bordering the Indian River, the tunnels and diggings in the substrate, the feeding platforms, and the general activities of the animal. He also gave measurements and descriptions of three specimens taken at this locality. Later, Chapman (1894: 334-35) stated that *Neofiber* is doubtless a common animal in favorable localities in Florida. He cited records from Oak Lodge and also from Gainesville, Alachua County, and Enterprise, Volusia County. He did not, however, see the animals, even at night. Bangs (1898: 182-83), whose observations are similar to those of Chapman, made additional contributions to the knowledge of the life history of the water rat as known to him at Oak Lodge and Gainesville. He saw *Neofiber* actively working on lodge construction during the day. Baker (1889) abstracted Chapman's notes on *Neofiber* and gave a brief description and measurements of a single individual which he himself had taken at Oak Lodge. Elliot (1901*b*: 45-48), quoting from field notes of Surber, who had considerable experience in collecting these rats in north-central Florida, recorded in some detail the structure of the nests and the taking of two young from a nest. It remained for Harper (1927: 360-68) to describe the habits of *Neofiber* from observations made in the Okefinokee Swamp in southern Georgia, a location from which he (Harper, 1920: 66) had previously recorded the occurrence of these rats. Rand and Host (1942: 20) briefly described the occurrence of *Neofiber* at the north end of Lake Okechobee, Florida.

The paucity of information concerning the bionomics of *Neofiber* in the southeastern United States is reflected in the small amount of systematic work that has been done on this interesting genus, first described by True in 1884. Bangs (1898) commented upon differences between coastal and interior specimens then available to him, but apparently was unwilling to describe the interior form as new. Miller (1896), Bailey (1900), and Bangs (1898) considered the differences which exist between *Microtus* and *Neofiber* of subgeneric value only. Harper (1920) and Howell (1920) regarded these water rats as distinct from *Microtus* and consequently accorded *Neofiber* generic status. Howell (1920) described *Neofiber a. nigrescens* from Ritta, Palm Beach County, Florida. No additional systematic work was done until 1952, when Schwartz described *N. a. struix* from the southern part of the Florida Peninsula. Sherman (1945: 201) recorded an extension of the known range of *Neofiber* to the westward as far as Carrabelle, Franklin County, Florida. Schantz and Jenkins (1950) recorded skulls taken in owl pellets at Woodbine, Camden County, Georgia, thus extending the known range of *Neofiber* some 40 miles to the east in southeastern Georgia.

I wish to thank the following persons for the generous loan of material in their respective collections: H. E. Anthony, American Museum of Natural History; C. C. Sanborn, Chicago Natural History Museum; B. Patterson Bole, Jr., Cleveland Museum of Natural History; W. J. Hamilton, Jr., Cornell University; Miss Barbara Lawrence, Museum of Comparative Zoology; David H. Johnson, United States National Museum; Stanley P. Young and Miss Viola S. Schantz, United States Fish and Wildlife Service; H. B. Sherman, University of Florida; E. Raymond Hall and Rollin H. Baker, University of Kansas. Thanks are due Raymond P. Porter for his continued help in collecting specimens in Florida and for his sustained interest in securing material for both systematic and life-history work. Others whose assistance is gratefully acknowledged are: Thomas M. Uzzell, Jr., University of Michigan, who spent two weeks collecting with me in February, 1952; Grady Lanier, who collected *Neofiber* in southern Florida; Wilfred T. Neill and E. Ross Allen, of the Ross Allen Reptile Institute, for providing an excellent series of near-topotypical material of *N. a. nigrescens* from the southern shore of Lake Okeechobee. The plates are the work of Thomas M. Oelrich, of the University of Michigan. W. H. Burt has offered guidance and criticism during this study, and his advice has aided greatly in solving certain problems and in bringing this work to completion.

CRITERIA AND MEASUREMENTS

In the present study an adult is defined as any individual in adult pelage, with the two supraorbital ridges well marked. The supraorbital ridges are nonexistent in the very young and are but poorly developed in those individuals between immaturity and maturity. In fully adult animals the ridges are prominent and either approach each other closely, though remaining distinct, or fuse to form a single ridge, bifurcate at both ends, immediately above the orbits; the bones of the skull are dense; the areas of muscle attachment and the general angularity of the skull are prominent.

I took the standard external measurements, which are shown in Table I. Data from specimens collected and measured by others are included in the averages for the various races. This combination of measurements obtained by various collectors, undoubtedly in different ways, is open to criticism. I believe, however, that the averages do show trends and that they are of sufficient value to be included. The eight cranial measurements were all taken by myself and consequently are more consistent than are the external measurements. These cranial measurements are:

Condylbasal length.—The least distance between the posterior limits of the occipital condyles and the anterior limits of the premaxillae

Zygomatic breadth.—The greatest distance across the zygomata

Palatal length.—Measured from the posterior projection of the palate to the anterior limit of the premaxillae

Length of nasals.—The greatest length of the nasals

Breadth of nasals.—The greatest breadth of both nasals

Length of upper molar tooth row.—The alveolar length of the three upper molar teeth

Interorbital constriction.—The least distance between the orbits

Length of palatine slits.—The greatest longitudinal measurement of the palatine slits

Measurements are in millimeters unless otherwise indicated. Capitalized color names are from Ridgway (1912).

The following abbreviations are used:

AMNH—American Museum of Natural History, New York

AS—collection of Albert Schwartz, Ann Arbor

BSC—Biological Survey collection, U.S. Fish and Wildlife Service, Washington

CLM—Cleveland Museum of Natural History, Cleveland

CNHM—Chicago Natural History Museum, Chicago

- CU—Cornell University, Ithaca
DBUF—Department of Biology, University of Florida, Gainesville
HBS—collection of H. B. Sherman, Gainesville
KU—Museum of Natural History, University of Kansas, Lawrence
MCZ—Museum of Comparative Zoology, Cambridge
UMMZ—University of Michigan Museum of Zoology, Ann Arbor
UMRC—University of Miami reference collection, Coral Gables
USNM—United States National Museum, Washington

GENUS *Neofiber* TRUE, 1884

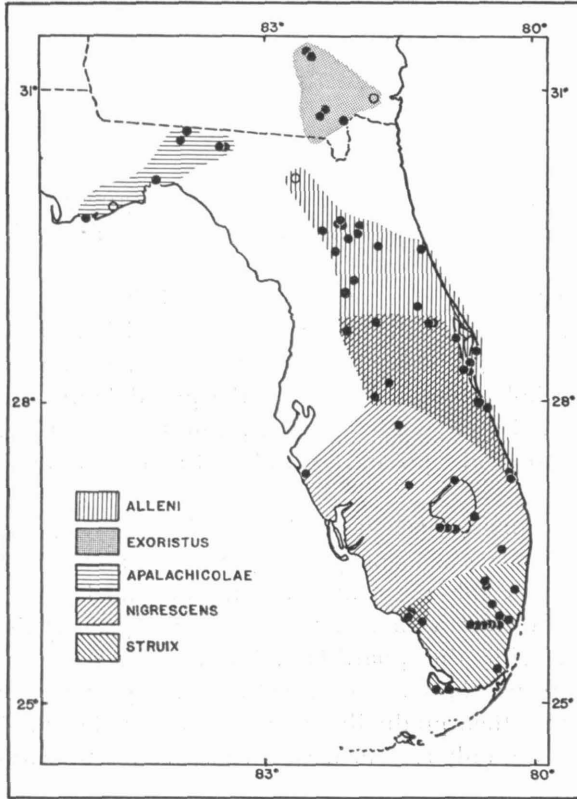
GEOGRAPHICAL DISTRIBUTION.—The Florida Peninsula, as far north as the Okefinokee Swamp and Woodbine, Georgia, and as far west as the Apalachicola River in the Florida Panhandle (Map 1).

PALEONTOLOGICAL DISTRIBUTION.—Known from the Pleistocene of Kansas and Texas (*N. leonardi* Hibbard) and the Pleistocene of Florida (*N. alleni* True). For description of *N. leonardi* and comparison of this form with *alleni*, see Hibbard (1943) and Meade (1952).

CHARACTERS.—A moderately large microtine, smaller than *Ondatra* and larger than any member of the genus *Microtus* in North America. Dorsal pelage soft and lustrous; guard hairs long, glossy, tipped with some shade of brown, and gray basally; soft underfur gray with brownish tips. Ventrally, underfur soft, dense, and grayish, overlaid with scattered pale guard hairs. Ears of moderate size, almost hidden in the fur. Hind feet with naked soles, five tubercles, and long claws; webbing and hairy fimbriae not so well developed as in *Ondatra*. Front feet small, with naked soles. Tail of moderate length, terete, and scantily to moderately haired; scales readily visible. Mammae, one to three pairs, of which two pairs may be inguinal and one pair pectoral. The inguinal pairs are the most persistent. A long tuft of hairs dorsal to the base of the tail. Baculum (Hamilton, 1946) trifold distally, with only a limited degree of ossification in the lateral digitate processes; shaft broadened proximally, narrow centrally, and rounded distally. Os clitoris not known.

Skull (Pls. I–III) typically microtine in appearance. Rostrum relatively short; zygomata moderately spreading. Anterior margin of zygomatic arch strongly notched dorsally. Brain case not swollen, longer than broad, and flattened dorsally. Interorbital constriction pronounced. Lambdoidal crest well developed laterally. Upper tooth rows nearly parallel, diverging slightly posteriorly. Bony palate, cancellous between tooth rows, extending to about anterior third of M³. Anterior part of palate flatter and less arched than in *Ondatra*. Palatine slits

well developed, but not reaching anterior margin of M^1 . Tympanic bullae of moderate size. Lower tooth rows almost parallel. For a detailed discussion of skull and skeleton, see True (1884b).



MAP 1. Distribution of five subspecies of *Neofiber alleni* in peninsular Florida and southeastern Georgia. Exaggerated lines along part of the east coast show the occurrence of *alleni* on offshore islands and mainland salt marsh. Crosshatching indicates intergrading populations of *alleni* and *nigrescens* in fresh-water ponds of the mainland. Open symbols represent records from pertinent literature and from observation; solid symbols represent localities from which specimens have been examined. Records of specimens from the University of Kansas are not included.

PELAGES AND MOLTS.—The juvenal and adult pelages of *Neofiber* and the time of molt or molts have never been studied previously, as far as can be ascertained. Howell (1920: 79) mentioned the dark coloration of the young. There are at hand 29 specimens, representing the

known races of *Neofiber*, which show the juvenal pelage in some stage of development and/or the transition from juvenal to adult pelage.

Six specimens (total length, 218–239 mm.) show the juvenal pelage. The guard hairs on the sides and dorsum are long and silky, definitely less glossy than in adults. The underfur is dark, and the brownish apices are less apparent than in adults, resulting in a more grayish, less brownish pelage. Generally, the same condition exists on the belly, where the guard hairs are very fine and are easily overlooked. In one individual their tips are barely visible in the surrounding underfur. The distal band of color (which is usually some shade of buffy or white in the adult) is very narrow, giving the belly a grayish rather than a whitish or buffy appearance. The ventral underfur is very dense and its texture is cottony or woolly.

A series of twelve specimens (total length, 220–272 mm.) shows the next stage, wherein the long, glossy, adult guard hairs are not so lax as are those of the juvenal pelage. The underfur still imparts a grayish cast to the whole animal. Ventrally, the guard hairs are better developed; in the larger members of this group the belly fur has lost the cottony texture and appearance and is less kinked and somewhat harsher.

A single specimen (total length, 253 mm.) deserves special mention. In this individual the adult, glossy, guard hairs clothe the sides of the body and possibly the venter, but the dorsum has a band of old juvenal hair down its center, noticeably darker (grayer) than the surrounding fur, with adult guard hairs beginning to come in. From this specimen it seems that the adult pelage first appears laterally (and ventrally?) and then gradually encroaches along the mid-line of the back. This is the only specimen which has such a transitional condition.

The remaining ten specimens (total length, 263–290 mm.) show the final stages of the growth of the adult pelage and the reduction or obliteration of the juvenal pelage. The last vestige of the grayish, juvenal pelage appears to be in the region of the rump; in fact, the grayness of the rump can often be used to distinguish nearly adult skins from those which are fully adult.

It is of interest to note that the peculiar tuft of guard hairs above the base of the tail, which is characteristic of the adults, is present in the entire series of juveniles.

Of all the adult skins available for study, only 11 have any indications of molt. As in *Ondatra*, which, according to Hollister (1911: 11), has a single molt each year, *Neofiber* appears to molt but once a year

after becoming adult. Hollister (1911) stated that *Ondatra z. rivalicia* from the Louisiana coastal marshes may molt twice. It might be expected that the more southerly *Neofiber* would also molt twice; this, however, does not appear to be the case.

The time of occurrence of molt in nature, to judge from ten specimens at hand, is from March to July. A single individual, which had been kept in captivity, molted in August. By months, the ten wild-taken specimens may be thus allocated: one each in March, April, May, and July; six in June. As far as is known, there is no corresponding molt in midwinter. The pattern of the molt cannot yet be satisfactorily determined. In general, the new hair appears to come in first on the crown, then advances between the ears, over the shoulders, and down the center of the back. It next appears along the sides and venter, coming in finally along the posterior part of the abdomen. One specimen shows the new pelage coming in last on the posterior part of the venter and also on the left shoulder, a spot which one would normally expect to be covered with new hair shortly after the inception of the molt rather than at its termination.

DESCRIPTION OF SUBSPECIES

Neofiber alleni alleni True

Neofiber alleni True, 1884a: 34; 1884b: 170-72; 1885: 325-30; Chapman, 1889: 119-22; Baker, 1889; 271-73; Elliot, 1901a: 202-3; Howell, 1932: 98.

Arvicola (Neofiber) alleni, Merriam, 1891: 59; Chapman, 1894: 334-35.

Microtus (Neofiber) alleni, Miller, 1896: 69-71; Bangs, 1898: 182-83; Elliot, 1901b: 45-48; 1905: 252; 1907: 286.

Microtus alleni, Bailey, 1900: 79 (part).

Neofiber alleni alleni, Sherman, 1936: 120; Schwartz, 1952: 3.

Neofiber alleni nigrescens, Sherman, 1936: 120-21 (part); Moore, 1946: 57; 1949: 64; Rausch, 1952: 151-56.

HOLOTYPE.—Adult male, skin, skeleton, and viscera in alcohol, No. 14065/21948, United States National Museum; taken near Georgiana, Brevard County, Florida, by William Wittfeld. Bangs (1898: 183) stated that the original specimen, which Wittfeld sent to True, was collected by Fritz Ulrich. Received at the National Museum December 24, 1883.

DISTRIBUTION.—Intergrades between *alleni* and *nigrescens* occur in Seminole, southern Lake, and northern Polk counties (Map 1). Water rats that occur at Lake City, Columbia County, are probably referable to this form.

DESCRIPTION OF FRESH MATERIAL.—Three fresh near-topotypes from 3 mi. E Merritt Island P.O., Brevard County, taken June 14, 1952, including two adult females and one adult male, and three specimens from salt marsh on the mainland, 2.4 mi. S Malabar, Brevard County, taken June 15 and 16, 1952, may be described as follows. Dorsum: apices of long, glossy, guard hairs Clove Brown; tips of underfur Natal Brown, bases Neutral Gray. Sides: apices of underfur shade to Sorghum Brown; cheeks and shoulders Walnut Brown. Venter: guard hairs Tilleul-Buff; underfur tipped with Light Drab, Deep Neutral Gray basally. Crown and tail Bone Brown, the latter well haired; feet Army Brown, toes somewhat darker.

CHARACTERS AND COMPARISONS.—Representatives of *N. a. alleni* are paler (more brownish) than those of *nigrescens* or *struix*, somewhat darker than those of *exoristus* or *apalachicolae*. In size *alleni* is about intermediate (Table I).

REMARKS.—*N. a. alleni* occurs in a wide variety of habitats, from the salt marshes and savannas of the Indian River to the sphagnum prairies and sand-bottomed lakes of central Florida. The series of adults at hand reflects this wide variety of habitats to some extent, since differences in pelage color exist between populations. Even along the coast the population is not continuous, since salt marsh and salt savanna do not extend continuously along the entire east coast of the Florida Peninsula. It may well be that the local populations of *alleni* are the most disjunct of any of the subspecies, with the possible exception of *apalachicolae*, since in the central Florida area as well as along the coast, as noted above, suitable habitat is scattered and often extremely local in occurrence.

Comparison of several good series of specimens with the fresh near-topotypes from Merritt Island shows this variation to some extent. Five adults from Oak Lodge, east peninsula opposite Micco, Brevard County, Florida (AMNH 1841/1114, 1843/1116; BSC 70867; MCZ 3399, 3400), are lighter in over-all color than the fresh specimens; the guard hairs are tipped with Warm Sepia and the underfur is Cinnamon Drab. Seven specimens from Enterprise, Volusia County (AMNH 7857/6212; CNHM 7894-7899), taken in 1894 and 1900, are again paler than the fresh specimens, the guard hairs being tipped with Mars Brown and the underfur tipped with Sayal Brown. The venters of the Volusia series have a cream to buffy wash. Finally, a series of 11 adults from the vicinity of Gainesville, Alachua County (AMNH 1542/2536; CNHM 7903-7904, 7911-7914; UMMZ 83575),

TABLE I
Measurements of the Subspecies of *Neofiber alleni*

	<u>alleni</u>	<u>exoristus</u>	<u>apalachicola</u>	<u>nigrescens</u>	<u>struix</u>
Subspecies					
Specimens measured (male)	25	8	6	11	14
Total length	331 (302-368)	311 (297-334)	347 (303-381)	339 (325-375)	337 (302-368)
Length of tail	128 (105-152)	122 (109-136)	137 (122-149)	136 (126-155)	146 (130-168)
Length of hind foot	43.1 (40-47)	42.1 (40-45)	44.0 (42-46.5)	43.5 (38-47)	45.5 (43-50)
Specimens measured (female)	22	4	4	11	12
Total length	325 (285-377)	306 (288-324)	347 (338-358)	344 (306-368)	323 (278-343)
Length of tail	126 (99-161)	122 (119-126)	138 (136-145)	137 (120-150)	136 (103-152)
Length of hind foot	43.2 (39.7-48)	41.1 (40-42.5)	44.5 (42-46)	44.9 (42.5-47)	44.3 (42-47)
Cranial Measurements					
Specimens measured (male)	25	8	6	11	14
Condylbasal length	46.2 (43.5-50.1)	44.9 (44.3-45.7)	47.5 (44.7-50.1)	46.8 (45.3-49.8)	47.8 (46.4-49.7)
Zygomatic breadth	27.9 (26.2-30.4)	26.7 (26.1-27.3)	28.3 (27.2-29.5)	28.1 (26.8-30.3)	28.7 (28.1-29.6)
Palatal length	27.1 (25.7-29.3)	26.0 (25.1-26.5)	27.5 (26.2-29.0)	27.6 (26.6-29.2)	28.3 (27.2-29.6)
Length of nasals	13.6 (12.6-15.4)	13.1 (12.3-13.5)	13.5 (13.1-14.2)	13.8 (12.7-15.4)	13.9 (13.1-14.3)
Breadth of nasals	5.3 (4.9-6.0)	5.4 (5.1-5.7)	5.4 (5.2-5.7)	5.4 (4.9-5.8)	5.6 (5.0-6.0)
Upper molar row	11.7 (11.1-12.8)	11.6 (10.8-12.1)	11.9 (11.5-12.2)	12.0 (11.1-12.5)	12.0 (11.4-12.5)
Interorbital constriction	5.1 (4.6-5.7)	5.1 (4.8-5.6)	5.2 (5.1-5.4)	5.1 (4.8-5.5)	5.1 (4.9-5.4)
Length of palatine slits	7.8 (7.1-8.5)	8.1 (7.9-8.3)	8.6 (7.9-9.2)	8.1 (7.6-8.6)	8.2 (7.7-9.1)
Specimens measured (female)	22	4	4	11	12
Condylbasal length	46.1 (43.0-49.3)	43.6 (41.5-44.6)	47.3 (46.7-48.0)	47.6 (43.6-49.7)	45.9 (42.5-47.2)
Zygomatic breadth	27.9 (25.5-29.8)	26.1 (25.3-26.6)	28.6 (28.4-28.8)	28.2 (26.3-30.0)	27.9 (25.3-29.7)
Palatal length	27.1 (25.5-29.1)	25.4 (24.5-26.1)	27.7 (27.2-28.2)	27.8 (26.3-29.2)	27.3 (25.3-28.6)
Length of nasals	13.6 (12.7-14.3)	12.2 (11.6-13.1)	13.7 (13.3-14.2)	13.9 (13.1-15.1)	13.2 (12.3-13.5)
Breadth of nasals	5.5 (5.1-6.0)	5.1 (5.0-5.2)	5.5 (5.2-6.0)	5.5 (5.3-6.0)	5.3 (5.1-6.0)
Upper molar row	11.9 (11.0-12.7)	11.3 (11.1-11.6)	12.1 (12.1-12.2)	11.8 (11.1-12.7)	11.7 (11.2-12.6)
Interorbital constriction	5.0 (4.5-5.5)	4.9 (4.5-5.3)	5.1 (5.0-5.2)	5.0 (4.8-5.3)	5.0 (4.6-5.4)
Length of palatine slits	8.1 (7.2-9.1)	7.6 (7.4-7.9)	8.7 (8.4-9.1)	8.1 (7.5-9.1)	8.0 (7.3-8.9)

is paler than any of the other series at hand; the guard hairs are tipped with Mars Brown, and the underfur is close to Light Ochraceous Salmon, the skins having a pale, dusted appearance.

Special mention must be made of three adults from 1.8 mi. W Flagler Beach, Flagler County (AS 2348, 2350, 2351). These individuals were taken June 26 and 28, 1952, at a locality which, so far as is known, marks the northeastern limit of *N. alleni* on the east coast of Florida. The coloration is dark, in fact darker than that of any other specimen, regardless of date of collection, which is here assigned to the race *alleni*. The guard hairs are Light Seal Brown, and the underfur is tipped with Sorghum Brown. These specimens lack the warm reddish tint along the shoulders and upper back of the fresh near-topotypes of *alleni* and resemble the more southern *nigrescens* and *struix*. So far as is known, the fresh-water marsh in which specimens were taken is the only locality in the vicinity where these rodents occur, and the dark coloration is here regarded as a purely local variation restricted to this marginal locality and not worthy of recognition by a racial designation.

Two topotypes (USNM 16299/23111 and USNM 16300/23112) were taken at Georgiana by W. Wittfeld and were received by the National Museum in October, 1888. True's (1884*b*: 171; 1884*c*: 326) description of the pelage color of the type as "rich rufous at the upper two-fifths and lead-colored at the base" could apply to these two old topotypes, the guard hair being Chestnut Brown, and the underfur tipped with Sayal Brown. Poole and Schantz (1942: 284) stated that the type of *alleni* was originally preserved (by Wittfeld, presumably) in alcohol. The coloration of these two topotypes, collected by Wittfeld just a few years after the collection of the type, indicates that they also might originally have been subjected to the same alcoholic treatment and only later were made up as conventional skins and skulls. The coloration can be matched closely by no other specimen of *alleni* available. Five adults from Oak Lodge, Brevard County, collected in 1889 and 1895, resemble the fresh material far more closely than do Wittfeld's topotypic specimens; the Oak Lodge specimens were taken at about the same time as the Georgiana specimens, but were originally prepared as conventional study skins.

Fresh specimens from Putnam and Marion counties agree well with the Merritt Island material, whereas the material at hand from Eden, St. Lucie County (BSC 17182/24114), and Canaveral, Brevard County (BSC 16505/23450, 16509/23454), taken in 1889, shows the somewhat lighter and redder coloration of the series from Enterprise.

Ten young individuals, assignable to *N. a. alleni*, show the complete transition from juvenal to young adult pelage. The earliest pelage is shown by three specimens. Two coastal specimens from Oak Lodge, Brevard County (MCZ 3404, 3405; total length, 233, 239 mm., respectively; taken February 17 and 20, 1895), have guard hairs tipped with Bone Brown, the underfur tipped with Natal Brown, and the bases of all hairs Dusky Neutral Gray. The general aspect of the dorsal pelage is brownish gray. Guard hairs are beginning to appear among the woolly, gray underfur of the abdomen. One specimen from .8 mi. E Grandin, Putnam County (AS 2308; total length, 240 mm.; taken June 11, 1952), is somewhat darker than the other two; the guard hairs are tipped with Clove Brown, the underfur with Natal Brown, and the bases are Deep Neutral Gray. Two slightly older individuals from Oak Lodge (MCZ 3402, 3403; taken February 16 and 17, 1895; total length, 272 and 268 mm., respectively) show the general coloration of the young from the same locality described above, but the ventral guard hairs are exposed and tend to cover to some extent the gray, woolly underfur. Three still older specimens from Oak Lodge (AMNH 1842/1115), Gainesville, Alachua County (DBUF 126), and Crescent City, Putnam County (HBS 2610), show the almost complete growth of the long guard hairs, both dorsally and ventrally; the young curly gray underfur is still present. Finally, three specimens from 2.4 mi. S Malabar (AS 2321), Oak Lodge (MCZ 3401), and Gainesville (UMMZ 83576) show the transition from the juvenal to adult pelage, with the long guard hairs almost completely covering the juvenal underfur. Perhaps the best criterion for this stage is the covering of the gray underfur by the long guard hairs on the rump. Young individuals have a gray rump, which disappears as the guard hairs gradually cover the woolly underfur, when the adult condition is approached.

WEIGHTS.—Adult male, Welaka, Putnam County (DBUF 207), 203.5 grams; adult female, Bivin's Arm, near Gainesville, Alachua County (DBUF 593), 288.5 grams; adult female, near Santa Fe Lake, Alachua County (HBS 2066), 264 grams; adult female, 1 mi. E Courtenay, Brevard County (KU 27124), 155 grams; adult female, Belleview, Marion County (CLM 16424), 330 grams.

SPECIMENS EXAMINED.—Florida: *Alachua Co.*, Gainesville, 8 (AMNH, 2; DBUF, 1; UMMZ, 2; MCZ, 3); 3 mi. S Gainesville, 1 (CNHM); 3½ mi. S Gainesville, 5 (CNHM); Bivin's Arm, near Gainesville, 2 (DBUF, 1; HBS, 1); near Santa Fe Lake, 1 (HBS); 1 mi. NW Lake Santa Fe, 1 (HBS); 4 mi. NW Orange Heights, 1 (HBS); *Putnam Co.*,

3 mi. E Hawthorn, 5 (AS); 5.6 mi. W Interlachen, 2 (AS); .8 mi. E Grandin, 1 (AS); Welaka, 2 (DBUF, 1; HBS, 1); Crescent City, 1 (HBS); Marion Co., McIntosh, 1 (BSC); 12 mi. E Silver Springs, 1 (AS); Bellevue, 5 (CLM); Flagler Co., 1.8 mi. W Flagler Beach, 3 (AS); Volusia Co., Enterprise, 8 (AMNH, 1; CNHM, 7); Brevard Co., Titusville, 1 (BSC); Banana River, 2 (AMNH, 1; CNHM, 1); 1 mi. E Courtenay, 9 (KU); Canaveral, 2 (BSC); 3 mi. E Merritt Island P. O., 3 (AS); Georgiana, 3 (USNM); 2.4 mi. S Malabar, 4 (AS); Oak Lodge, east peninsula opposite Micco, 11 (AMNH, 3; BSC, 1; MCZ, 7); St. Lucie Co., Eden, 2 (BSC).

Neofiber alleni exoristus, new subspecies

Neofiber alleni, Harper, 1920: 65-66; Schantz and Jenkins, 1950: 460-61.

Neofiber alleni nigrescens, Harper, 1927: 360-68; 1935: 276.

HOLOTYPE.—Adult male, skin and skull, No. 99028, University of Michigan Museum of Zoology; taken 12.1 miles southeast of Waycross, Ware County, Georgia, by Thomas M. Uzzell, Jr., February 6, 1952. Original number 2205.

DISTRIBUTION.—Known by specimens from the Okefinokee Swamp in Georgia. Occurs probably in Baker County, Florida, in the southern part of the Okefinokee, and probably near Woodbine, Camden County, Georgia (Map 1), as Schantz and Jenkins (1950) have recorded from owl pellets found in that locality.

DESCRIPTION OF HOLOTYPE.—External measurements (in mm.): total length, 334; tail, 136; hindfoot, 45; ear from notch, 17. Cranial measurements: condylobasal length, 45.3; zygomatic breadth, 27.0; palatal length, 26.5; length of nasals 13.2; breadth of nasals, 5.7; length of upper molar row, 12.1; interorbital constriction, 5.1; length of palatine slits, 8.2.

Color: Dorsally, tips of guard hairs Bone Brown, tips of underfur Sorghum Brown, shading to Verona Brown on cheeks and shoulders and to Drab Gray on the sides; underfur and guard hairs Deep Neutral Gray basally; crown, Hay's Brown. Ventrally, underfur Pale Drab Gray at tips, Slate Color at bases; guard hairs silvery to Tilleul-Buff. Tail Light Seal Brown, moderately well haired; feet Sorghum Brown.

CHARACTERS AND COMPARISONS.—This is apparently the smallest of the five races of *Neofiber alleni*. The skull is generally smaller than in the other subspecies.

N. a. exoristus is paler than all forms living south of it on the Florida Peninsula; it is slightly darker than the western race *apalachicola*.

A series of seven adults from the Okefinokee Swamp and its environs agrees well in characters with those given for the type. An individual (BSC 223854) taken in 1917 at Floyd's Island Prairie is somewhat more reddish than the type; three others from Floyd's Island Prairie (AMNH 91141, 91142; CU 220) are even more reddish, possibly because of initial care and also because of fading. Three fresh specimens, taken in March, 1948 (KU 27110-27112), resemble the type in coloration; of these, two have the dorsal guard hairs tipped with Bone Brown, the other with Light Seal Brown. The ventral guard hairs are tipped with Wood Brown in two cases and with Fawn Color in the other.

REMARKS.—*Neofiber a. exoristus* is apparently confined to the Okefinokee Swamp region and probably occurs as far south as northern Baker County, Florida. Aside from the occurrence of water rats in Columbia County, the most northern records are from Alachua County. To the west, the specimens from Madison County are the closest geographically to the Okefinokee Swamp region. The habitat in general in Baker, Columbia, Nassau, and Duval counties in northern Florida, to judge from personal observation, has extensive areas highly unsuitable for water rat habitation. It seems most likely that the southern Georgia populations are separated from the remainder of the *Neofiber* both to the south and to the west, and that they occupy the isolated sphagnum- and muck-bottomed ponds and prairies of southeastern Georgia. The name *exoristus* is an allusion to the separation of this most northern form of the species. The Lake City population, which has not been sampled, probably should be relegated to *alleni*, the Alachua County population, rather than to *exoristus*, which lives to the north.

No water rats have been taken along the Suwannee River, which has its northern source in the Okefinokee Swamp. Following rivers to suitable habitat would seem an obvious method of dispersal for these microtines. So far as I know, water rats are absent not only from the Suwannee but also from the area into which the Suwannee courses in Dixie, Levy, and Gilchrist counties. It must be stated, however, that these elusive animals may occur in areas from which at this time they seem to be absent. In this connection, the account of the west Florida form is of interest.

There are four immature individuals of *exoristus* at hand. Of these, the smallest (CU 220), taken June 19, 1921, measures 218 mm. in total length. This individual is definitely in juvenal pelage. The dense, woolly underfur is gray basally, slightly lighter (more white-tipped) on the venter. Dorsally, the apices of the underfur and the long,

scattered guard hairs are Deep Brownish Drab. The general appearance of this specimen is brownish. Two specimens (AS 2207, 2208), taken 17.3 miles SE Waycross on February 7, 1952, measure 281 mm. and 268 mm., respectively, in total length. Dorsally, the general color of these two individuals is grayish, the tips of the underfur and the guard hairs being close to Benzo Brown. Finally, a specimen (BSC 223856) taken January 8, 1917, shows the almost complete acquisition of the adult pelage. This individual measures 270 mm. in total length; the guard hairs and tips of the underfur are close to Hay's Brown.

A single specimen (CU 386), taken July 6, 1922, shows extensive molt on the shoulders and sides of the body.

WEIGHTS.—An adult male (BSC 223854) from Floyd's Island Prairie, weighed one-half pound and was slightly fat when captured; an adult female (KU 27112) from 2 mi. W Camp Cornelia weighed 162 grams.

SPECIMENS EXAMINED.—Georgia: *Charlton Co.*, Floyd's Island Prairie, Okefinokee Swamp, 6 (AMNH, 2; BSC, 3; CU, 1); Billy's Island, 1 (CU); *Ware Co.*, $\frac{1}{4}$ mi. W Chesser's Island, 3 (CU, 1; KU, 2); 2 mi. W Camp Cornelia, 3 (KU); 12.1 mi. SE Waycross, 2 (AS, 1; UMMZ, 1); 17.3 mi. SE Waycross, 2 (AS).

Neofiber alleni apalachicola, new subspecies

Neofiber alleni, Sherman, 1945: 201.

HOLOTYPE.—Adult male, skin and skull, No. 263704, Biological Survey collection, United States Fish and Wildlife Service; taken at Apalachicola, east side of river (Apalachicola River?), Franklin County, Florida, by Luther C. Goldman, April 11, 1938. Original number 569.

DISTRIBUTION.—Florida, from Apalachicola, Franklin County, east along the coast as far as St. Marks, Wakulla County, thence northeast to Jefferson and Madison counties (Map 1).

DESCRIPTION OF HOLOTYPE.—External measurements (in mm.): total length, 368; tail, 149; hindfoot, 45. Cranial measurements: condylo-basal length, 50.1; zygomatic breadth, 29.5; palatal length, 29.0; length of nasals, 14.2; breadth of nasals, 5.7; length of upper molar row, 12.2; interorbital constriction, 5.4; length of palatine slits, 8.7.

Color: Dorsally, guard hairs tipped with Light Seal Brown; underfur tipped with Sorghum Brown; on cheeks and sides, underfur tips Wood Brown, the over-all appearance being pale; crown, Light Seal Brown. Ventrally, guard hairs Wood Brown at tips, Deep Neutral Gray basally; underfur tipped with Pale Pinkish Buff, Deep Neutral Gray basally. Tail Benzo Brown, rather sparsely covered with Vinaceous Buff hairs over entire length; feet Sorghum Brown.

CHARACTERS AND COMPARISONS.—*N. alleni apalachicola* differs from the two neighboring races, *exoristus* and *alleni*, in its slightly larger size (Table I) and paler coloration. From *nigrescens* and *struix*, *apalachicola* differs in being slightly larger, although females of *nigrescens* approach females of *apalachicola* in over-all size. The ranges of *apalachicola* and *nigrescens* are separated by that of *alleni* and by a strip of territory which is apparently unoccupied by any member of the species.

REMARKS.—The series of *apalachicola* at hand resembles the type closely. Three specimens (AS 2273, 2360, 2361), taken June 7 and 29, 1952, have poorly defined, irregular molting areas on the anterior half of the body. A single immature specimen (BSC 246569) with full adult pelage can be assigned to *apalachicola* (total length, 300 mm.; St. Marks River, Wakulla County, May 8, 1926). The dorsal guard hairs are tipped with Warm Sepia. The general tone of the animal is close to that of the type, but the texture of the fur is softer.

The distribution of *N. a. apalachicola* on the north Gulf coast may be comparable to that of *alleni* along the Atlantic coast in that both apparently occur in brackish or saline situations. Since ecological data are not available for the type and topotype, nor for the specimens from the St. Marks River, the presence of this animal in salt marsh is questionable. Sherman (1945: 201) was the first to record *Neofiber* from the Panhandle of Florida; his specimen, from Carrabelle, Franklin County, is preserved in formalin and cannot be used for color comparisons. On geographic grounds, this specimen may be referred to *apalachicola*.

By visiting the western range of *Neofiber* in January, June, and July, 1952, I discovered that the absence, for the most part, of suitable ponds, lakes, or bogs in coastal Franklin and Wakulla counties restricts the range of these animals. I visited suitable habitat in the St. Marks National Wildlife Refuge and in Franklin County in the vicinity of St. Theresa. In the former locality the fresh-water marshes, supporting good growth of *Sagittaria* and other aquatic vegetation which serves as food for *Neofiber*, were found to be apparently unoccupied. There were a few old houses, but no evidence of active occupation was noted. In the St. Theresa area I saw several bogs and muck-margined lakes; here signs of old water rat habitation were abundant, but again no sign of recent occupation was observed. The coastal, salt-water marsh in the St. Marks area and at Carrabelle, and indeed the whole Gulf coast from St. Marks to Apalachicola, seems inhospitable to these microtines. Food appears to be absent, and the bottom is in general not of the mucky type with which *Neofiber* is most often associated. The habitat

which these animals occupy at Apalachicola is unknown. Local inquiry resulted in no information; the old residents were unfamiliar with *Neofiber* or its workings. I had, however, reports of a fresh-water swamp along the east side of the Apalachicola River. Although I did not see the swamp, the description of it seems to indicate the sort of area usually occupied by the water rat.

The specimens from Jefferson and Madison counties were taken from cypress ponds and cypress-margined lakes. Here the workings were of the usual nature, constructed against the base of a cypress tree or cypress stump or merely in aquatic vegetation.

It seems that the range of *N. alleni apalachicola* does not meet that of either *alleni* to the southeast or *exoristus* to the northeast. The closest locality from which specimens are known is Gainesville, Alachua County (*alleni*), and the Okefinokee Swamp, Charlton County, Georgia (*exoristus*). Signs of water rats were observed at Lake City, Columbia County, but no specimens were taken there. This locality is about 55 miles to the southeast of the easternmost record for *apalachicola*. It is possible that *alleni* and *apalachicola* meet in Suwannee or Lafayette counties, but no specimens are available from those areas.

The western limit of the range of *apalachicola*, and of the genus, appears to be the Apalachicola River. Why the range of *Neofiber* does not continue west of the Apalachicola is unknown, unless the cause is a lack of available and suitable habitat. Travel by automobile over the remaining part of the Florida Panhandle as far west as Pensacola, Escambia County, both along the coast and inland, revealed no suitable habitat. Neither this fact, however, nor the lack of information on the part of local residents should be seriously considered, since it has become apparent that *Neofiber* can utilize a small marsh or cypress pond, one which is easily overlooked or one which is not on the main-traveled highways. Moreover, the water rat, because of its secretive ways, often is present when the natives have no knowledge of its identity or its activities.

SPECIMENS EXAMINED.—Florida: *Franklin Co.*, Apalachicola, 1 (BSC); Apalachicola, east side of river, 1 (BSC); *Wakulla Co.*, St. Marks River, 3 (BSC); *Jefferson Co.*, Lake Miccosukee, 1 (BSC); 6.5 mi. W Monticello, 2 (AS); *Madison Co.*, 6.2 mi. W Madison, 2 (AS); 2 mi. W Madison, 2 (AS).

Neofiber alleni nigrescens Howell

Microtus (Neofiber) alleni, Bangs, 1898: 183 (part).

Neofiber alleni nigrescens Howell, 1920: 79–80 (part); Sherman, 1936: 120–21 (part); Schwartz, 1952: 2–3.

HOLOTYPE.—Adult male, skin and skull, No. 228392, Biological Sur-

vey collection, United States National Museum; taken at Ritta (south shore of Lake Okeechobee), Palm Beach County, Florida, by A. H. Howell, March 2, 1918. Original number 2269.

DISTRIBUTION.—Florida, from southern Polk County, south and west to the vicinity of Sarasota, Sarasota County; also in the vicinity of Lake Okeechobee. Southern limits of range not known with certainty, but I regard specimens from central Palm Beach County as *nigrescens* and material from southern Collier County, in the vicinity of Everglades, as showing intergradation with *N. a. struix*. To the north, *nigrescens* shows a wide area of intergradation with *alleni*, from northern Martin County along the coast as far north as Seminole County, and thence west to Sumter County and south to northern Polk County (Map 1).

DESCRIPTION OF FRESH MATERIAL.—Nine fresh specimens from Clewiston, and 4 mi. W Clewiston, Hendry County, were secured in April and May, 1952. This series of adults is used here for the description of *nigrescens*. The series is somewhat variable, two specimens being much paler than the others and two much grayer than their fellows. The five remaining individuals have the tips of the dorsal guard hairs Fuscous Black; the tips of the underfur are close to Fawn Color. Basally, the dorsal fur is Neutral Gray. Ventrally, the guard hairs and underfur are tipped with Pinkish Buff. The silvery-tipped underfur at the side of the throat is especially noticeable in contrast to the buffy bellies. Of the two paler specimens noted above, the underfur of one is tipped with Mikado Brown and of the other with Snuff Brown; these browns are more orange than the typical Fawn Color of the rest of the series. These two specimens resemble those from Oak Lodge and Gainesville, here assigned to *alleni*. In two grayish specimens the dorsal underfur is tipped with Benzo Brown; both are adults, and the grayish cast thus seems not to be due to age. Tails of the entire series are Chaetura Black, well haired; feet Benzo Brown.

Howell described *nigrescens* (1920: 79) as: "upperparts fuscous-black, sometimes with a slight brownish tinge." The old series of Howell no longer retains this dark coloration, but is much browner than the freshly collected specimens. This is almost certainly due to fading.

The color of several other groups of specimens deserves comment. Four adults (AMNH 139894, 139895, 139897, 142650) from Hicoria, Highlands County, collected in January and February, 1943, and kept in captivity until July and August, 1943, are browner and less blackish than the fresh specimens. Two specimens (CU 6197, 6198) from south of Sarasota, Sarasota County, collected in April, 1951, and

kept in captivity until December, 1951, are paler than near topotypes; the sides are paler (Vinaceous Buff tips on the underfur), and the center of the back is more grayish than is that of topotypical material. Three adults (AS 2242, 2243, 2245) from .5 mi. N mouth of Kissimmee River, Okeechobee County, resemble topotypes. Finally, three specimens (UMRC 456-458) from 14 mi. NW Delray Beach, Palm Beach County, are slightly paler than topotypes.

CHARACTERS AND COMPARISONS.—*N. a. nigrescens* is intermediate in coloration between *alleni* to the north and *struix* to the south. *N. a. nigrescens* averages slightly larger than *exoristus* and somewhat smaller than *apalachicola*.

REMARKS.—It has already been noted that there is a wide area of intergradation between *N. a. alleni* and *N. a. nigrescens*. This area embraces a large part of the central section of the Florida Peninsula, extending south along the east coast to the vicinity of Stuart, Martin County, and north to Geneva, Seminole County. Specimens from Sumter County and from Tavares, Lake County, and Davenport, Polk County, are here regarded as intergrades. Three adults from 1 mi. NE Stuart, Martin County, and four adults from .8 mi. S Rockledge, Brevard County (on the mainland almost opposite Georgiana, the type locality of *alleni*), resemble topotypical *nigrescens* in color, but their skulls are slightly smaller than those of *alleni*. Five adults from Geneva and from 1 mi. E Geneva, Seminole County, are slightly darker than specimens of *alleni*. Two adults from 3.1 mi. S Tavares, Lake County, are almost perfect intergrades as to both pelage color and cranial measurements. Finally, four adults from 1½ mi. NE Davenport, Polk County, are small, but are intermediate in color between *nigrescens* and *alleni*.

Two skins and skulls (AS 2393; BSC 231483) and one skull only (BSC 231613) from southern Collier County are here regarded as representing intergrades between *nigrescens* and *struix*. The skins show the lighter coloration of *nigrescens*, but on the basis of skull characters they seem to be intermediate between the two forms.

Three immature individuals are referable to *nigrescens*. The youngest (AS 2262, taken May 13, 1952; total length, 236 mm.) has the entire juvenal pelage. The long silky dorsal guard hairs are tipped with Dusky Purplish Gray; the underfur is tipped with Dark Purplish Gray. Both types of hair are Slate Gray basally. The entire aspect of the animal is quite dark dorsally, because of the combination of the grays and the absence of browns. The venter has the typical juvenal cottony pelage, underfur that is tipped with Pale Mouse Gray and is Dark Gull Gray basally. The guard hairs are not present ventrally. The second

specimen (AS 2233, taken April 3, 1952) shows the condition intermediate between the gray juvenal pelage described above and the full adult pelage. The dorsal guard hairs are Chaetura Drab at their tips, and the dorsal underfur is Fuscous distally. Both are basally Deep Neutral Gray. Ventrally, the guard hairs are present and are silvery white; the ventral underfur is tipped with Pale Smoke Gray and is Neutral Gray basally. A third specimen (AS 2244, taken May 2, 1952) shows the almost complete development of the adult pelage. The adult guard hairs, both dorsal and ventral, are characteristically dark brown. The juvenal condition of the animal is made clear by the decidedly grayish cast of the dorsal pelage, especially on the rump.

WEIGHTS.—Two adult males (AMNH 139897, 139894), Hicoria, Highlands County, 270 and 239 grams, respectively; female, same locality, 224 grams; adult male (CU 6198), south of Sarasota, Sarasota County, 316.5 grams; adult female (AMNH 143084), young adult female (AMNH 143089), and young adult male (AMNH 143091), 1½ mi. NE Davenport, Polk County, 216, 220, and 212 grams, respectively.

SPECIMENS EXAMINED.—Florida: *Polk Co.*, 2.8 mi. E Frostproof, 1 (AS); *Sarasota Co.*, south of Sarasota, 3 (CU); *Highlands Co.*, Hicoria, 4 (AMNH); *Okeechobee Co.*, .5 mi. N mouth of the Kissimmee River, 4 (AS); *Hendry Co.*, 4 mi. W Clewiston, 4 (AS); Clewiston, 7 (AS); *Palm Beach Co.*, Ritta, 14 (BSC, 12; USNM, 2); Canal Point, 1 (BSC); Lake Okeechobee, 1 (USNM); 14 mi. NW Delray Beach, Loxahatchee Wildlife Refuge, 3 (UMRC); *Glades Co.*, 1 (BSC); county indeterminate, south of Lake Okeechobee, 1 (CU).

Intergrades between *N. a. alleni* and *N. a. nigrescens*, as follows: *Sumter Co.*, 1 (UMRC); *Lake Co.*, 3.1 mi. S Tavares, 2 (AS); *Seminole Co.*, Geneva, 1 (BSC); 1 mi. E Geneva, 5 (AS); *Polk Co.*, 1½ mi. NE Davenport, 5 (AMNH); Winterhaven, 1 (HBS); *Brevard Co.*, .8 mi. S Rockledge, 6 (AS); *Martin Co.*, 1 mi. NE Stuart, 4 (AS).

Intergrades between *N. a. nigrescens* and *N. a. struix*, as follows: *Collier Co.*, Everglades, 1 (BSC); 2.5 mi. W Ochopee, 1 (AS); 8 mi. E Chokoloskee, 1 (BSC).

Neofiber alleni struix Schwartz

Neofiber alleni nigrescens, Howell, 1920: 79–80 (part); Sherman, 1936: 120–21 (part).
Neofiber alleni struix Schwartz, 1952: 1–3; Schwartz and Duellman, 1952: 226.

HOLOTYPE.—Adult male, skin and skull, No. 97732, University of Michigan Museum of Zoology; taken 21 miles west of Miami, Dade County, Florida, by Raymond P. Porter, February 3, 1951. Original number 1676.

DISTRIBUTION.—Southern tip of the Florida Peninsula; intergrades with *N. a. nigrescens* in southwestern Collier County (Map I).

DESCRIPTION OF FRESH MATERIAL.—Thirteen adults from various localities in Dade County, close to the type locality, collected in February and March, 1951, resemble the type in coloration; guard hair tips range from Blackish Brown to Chaetura Black; dorsal underfur, Cinnamon Drab at tips and Pale Neutral Gray basally. The dorsal coloration grades to Light Drab on sides; cheeks, Light Drab to Avellaneous. Tips of ventral guard hairs vary from silvery-white to Vinaceous-Buff or Avellaneous; ventral underfur Deep Neutral Gray basally, tips vary from almost white to Avellaneous. White hairs on sides of throat distinctly separated from pigmented hairs on abdomen. Tail, Light Seal Brown, scantily to moderately well haired.

An adult female topotype (AS 2238, taken January 3, 1952), kept in captivity until April 22, 1952, is somewhat paler than the remainder of the series and resembles specimens of *nigrescens*. This difference in color is almost certainly due to the artificial conditions under which the animal was kept.

Comments on the several lots of *struix* from localities other than the type locality seem in order. Two specimens from 7.5 mi. SE Florida City, Dade County (AS 2225, 2227), resemble the topotypes closely in darkness of the pelage, but are a bit more reddish. These specimens were taken from a marl-bottomed canal in an area where the encroachment of mangroves was noted. The reddish color is possibly related to the brackish conditions obtaining there. Two adults from 2 mi. NW Miami Springs, Dade County (AS 2113, 2128), are identical in color with the topotypical series. A single specimen from Hialeah, Dade County (AS 1967), shows an interesting scattering of white-tipped guard hairs over the crown and entire dorsum and sides; otherwise the coloration is that of *struix*. Unfortunately, the skull of this individual is not available; consequently the age of the animal cannot be ascertained. The size is not unusually large for *struix* (total length, 317 mm.), and it is likely that these scattered gray hairs are a chance mutation rather than a sign of age. Of the series of *struix* available, males average slightly larger than females (Table I).

CHARACTERS AND COMPARISONS.—*N. a. struix* is the darkest of the five races described, and averages somewhat smaller than *apalachicolae* and larger than *exoristus* (Table I).

REMARKS.—*N. a. struix* is the darkest of the subspecies; it is approached in color only by *nigrescens*. In size, *struix* is almost equal to

alleni, *apalachicola*, and *nigrescens*, and is slightly larger than *exoristus*.

As a result of the efforts of Raymond P. Porter, who, while gathering data for study on the life history of *Neofiber*, collected several young specimens in the vicinity of Miami, there is a graded series of nine immature specimens at hand from Dade County. Two young (AS 2121 and UMRC 454, taken December 27, 1951, and February 14, 1952, respectively) are in the same stage of pelage. The long, lax guard hairs are tipped with Light Seal Brown, and the tips of the underfur are Hay's Brown; both are Light Neutral Gray basally. Ventrally, the whitish guard hairs are just appearing over the Pale Drab-Gray tips of the underfur, which is Neutral Gray proximally. These two individuals measure, in total length, 224 mm. and 215 mm., respectively. Two slightly larger individuals (AS 2122, UMRC 455; 257 mm. and 220 mm., respectively; killed December 27, 1951, and March 20, 1952) show the next stage of pelage development. Here the whitish-tipped abdominal guard hairs are quite evident, and the dorsum is clothed with lax guard hairs and woolly underfur of the same color as that described for the younger specimens. The second of these individuals was captured January 3, 1952, and was kept in captivity until the date of preservation; therefore the animal was at least two and one-half months old. Another specimen (UMRC 453; total length, 254 mm.; taken February 1, 1952) shows a similar condition, except that there seems to be a greater development of adult guard hairs laterally than dorsally, and consequently there is a dorsal strip which appears much more grayish because of the exposure of the underfur. The next stage is demonstrated by a specimen (AS 1733; taken February 8, 1951; total length, 254 mm.) which has the customary admixture of juvenal and adult coats—the adult guard hairs overlying the woolly underfur, the whole animal having a grayish appearance. Finally, three specimens (AS 1791, 2226, 2228; total length, 288, 278, and 290 mm., respectively; taken March 21, 1951, and March 27, 1952) show about the same stage of development. In one specimen the grayish juvenal underfur is incompletely covered by the long, shiny guard hairs of the adult pelage, whereas in the other two specimens the adult coat is present, but the grayish rump still persists.

SPECIMENS EXAMINED.—Florida: *Broward Co.*, about 22 mi. NW Ft. Lauderdale, 3 (AS); .6 mi. N Dade-Broward county line on U.S. 27, 2 (AS); *Zona*, on the North New River Canal, nr. Ft. Lauderdale, 1 (BSC); *Dade Co.*, Hialeah, 1 (AS); 2 mi. NW Miami Springs, 6 (AS, 4; UMRC, 2); 17 mi. W Miami, 1 (AS); 19 mi. W. Miami, 1 (AS); 20 mi.

W Miami, 7 (AS); 21 mi. W Miami, 7 (AS, 5; UMMZ, 1; UMRC, 1); 32 mi. W Miami, 3 (AS, 2; UMMZ, 1); 26.5 mi. W Miami, 1 (AS); 7.5 mi. SE Florida City, 4 (AS); *Monroe Co.*, Cape Sable, 3 (BSC); *Flamingo*, 1 (MCZ).

DISCUSSION

Although the genus *Neofiber* is today restricted to the Florida Peninsula and southern Georgia, fossil evidence indicates a previously more extended geographic range. As far as is known, the species *alleni*, Recent and Pleistocene, has been taken only in Florida and Georgia. Texas and Kansas fossils have been accorded full specific rank as *Neofiber leonardi*. It is thus concluded that the species *alleni* has persisted *in situ* in Florida since the Pleistocene. It is possible that members of the genus *Neofiber*, which was previously more widespread, along with many other mammals during the Pleistocene were forced into the Floridian cul-de-sac by increasingly rigorous conditions to the north. This was probably responsible in part for the variety of the Pleistocene Floridian fauna, as has already been pointed out by Simpson (1931: 258-76).

Assuming that the present area occupied by *Neofiber* is an asylum for the genus, an area into which the species was forced by the rigorous climatic conditions during the Pleistocene, what factors have restricted *Neofiber* to this area? As a corollary to this question, what factors have allowed *Ondatra*, which has much the same habitat requirements as does *Neofiber*, to leave peninsular Florida, into which it also was forced during the Pleistocene? Concerning this question, Simpson (1931: 272) said: "Just what subtle local advantage decreed that in Florida . . . *Neofiber* [in contrast to *Ondatra*] should be successful is not clear." Indeed, the similarities between *Neofiber* and *Ondatra* in habitat and food requirements and in general conditions for life make one wonder just what factors could have allowed *Ondatra* to expand as far as the Arctic and yet confined *Neofiber* to an area of mild climatic conditions. Possibly the extension of *Neofiber* to the north, past the Okefinokee, is prevented by the lack of suitable local habitat; the same may apply also to spread toward the west. The food plants of *Neofiber* are not restricted to the Florida Peninsula; *Neofiber* seems to be fairly catholic in its food requirements, eating not only a variety of vegetable food, but also some animal food. Competition has been invoked as an explanation; however, we know from fossil evidence that *Neofiber* and *Ondatra* formerly occurred together in Florida. Today, the ranges of these two genera do not meet. As far as is known (with the exception

of coastal Louisiana), the larger microtine does not occur farther south than central Georgia and Alabama. There is little possibility, in my opinion, that competition with *Ondatra* restricted *Neofiber* to Florida.

Possibly biological pressure is a factor. The little evidence available from records of Elliot (1901*b*), Harper (1927), and Raymond P. Porter (personal communication) and from my own observations suggests that there are one or two young per litter in *Neofiber*. The number of mammae, however, may be as large as six, and presumably litters of more than two individuals do occur. Nevertheless, the reproductive rate appears to be low. In no place where I have observed these animals in Florida are they abundant. They have never been observed in the tremendous abundance noted for muskrats in west Gulf coast marshes. This may be due to biological pressure on the small numbers that result from the low reproductive rate. Certainly, the water rat occupies a habitat in the south where enemies are legion. Snakes (water moccasin, diamondback rattler) occur in the swamps themselves or along their margins; alligators occur in abundance, as in the Okefinokee or in the southern Everglades; mammalian predators (bobcat, raccoon, mink) undoubtedly take their toll of young and adults. That raptorial birds find *Neofiber* to their liking is evidenced by the fact that Schantz and Jenkins (1950) reported finding the skulls of *Neofiber* in barn owl pellets in southeastern Georgia, and I have taken *Neofiber* skulls from the pellets of barn owls in Dade County. In this latter locality, of 81 mammal skulls retrieved from owl pellets, 13 were *Neofiber*. Thus, it seems that *Neofiber* may be restricted to Florida and prevented from expanding its range farther by these various biological factors which, acting together, tend to keep the population low, even in what is apparently excellent habitat.

With these biological factors are certain ecological ones which likewise have a deleterious effect. In southern Florida, especially, the drying of ponds or low areas in the Everglades would seem to make life somewhat difficult and precarious for these rodents. *Neofiber* persists in such areas, abandoning its exposed lodges and leading a subterranean existence to a large extent. Just what effect a prolonged drought would have upon the existence of these "dry" outposts is unknown. In central and western Florida, the habitat is probably never destroyed as completely by drying as it is in southern Florida. Fluctuations in populations, however, occur there also. During 1952 there was practically no evidence of water rat activity in the Florida Panhandle. Presumably, after a period of some years these ponds and bogs, suited eminently for water rat habitation, will again be popu-

lated from small nuclei which doubtless remain there. Nothing is known concerning the cause of these population fluctuations, but that they do occur, as in other microtines, is evident.

Even in Florida itself there are wide areas which do not seem to be occupied today by water rats. An example of this is the western third of the peninsula, from Taylor and Suwannee counties south to Hillsborough County. That *Neofiber* has in the past occupied some of this territory is evident from fossil remains of *N. alleni* from Saber-tooth Cave, near Lecanto, Citrus County, and Seminole Field, Pinellas County (*vide* Simpson, 1929: 264). If water rats are present in this area, they have been as yet undetected. The area of Nassau, Duval, Baker, and Clay counties, which lies between the ranges of *alleni* and *exoristus*, appears likewise to be uninhabited by water rats, although I saw at least one suitable locality for their occupation in Baker County in 1952.

In summary, the present range of *Neofiber* appears to be a remnant of one which was previously more extensive. The reasons for the lack of expansion of this range are unknown, but probably a combination of unsuitable habitat, low reproductive potential, high biological pressure, low populations, and possibly fluctuations of populations over more or less extensive areas, all play a part in forcing *Neofiber* to retain its present small range.

Although the water rat is the second largest microtine in North America, it appears to lead a rather restricted life and does little wandering. In certain areas, as in central and western Florida where suitable habitats may be spotted throughout a region of generally unsuitable habitat, localized populations occur. It is doubtful if there is much, if any, interchange of individuals between adjacent ponds, and thus there is a strong tendency for local variations to become fixed. In confirmation of this supposition is the difference in coloration between specimens of *alleni* from Flagler County and those from Alachua and Volusia counties. Likewise, within the range of *alleni*, specimens from Volusia County are smaller than are those from most other localities. Isolation of small populations seems clearly to have been a factor in the development of *exoristus* in the Okefinokee region and of *apalachicolae* in a rather limited area in western Florida. *N. a. exoristus* is morphologically uniform throughout its range, a fact that may be related to the essential continuity of its habitat in the Okefinokee Swamp. *N. alleni apalachicolae* is geographically more variable and, correlatively, its populations are more discontinuous than are those of *exoristus*. *N. a. struix* also is morphologically constant, and

its populations probably are essentially continuous throughout its range in the southern part of the Everglades. *N. a. nigrescens* varies but little geographically. It seems to have differentiated in the area of Lake Okeechobee. To the south of the lake, along the expanse of the Everglades, it merges with *struix*. To the west it appears to have spread along certain rivers (Myakka and Peace rivers) from the central lake region.

Where the two major drainages of the Florida Peninsula interdigitate, *alleni* and *nigrescens* intergrade. There, in Brevard County, the St. Johns River originates and flows northward, and in the lake region in Osceola and Polk counties the Kissimmee River begins its southward course. Although the evidence indicates that these water rats prefer marshes and swamps with standing water, it seems likely that the running streams are used, or have been used in the past, as avenues of dispersal. In any event, *alleni* and *nigrescens* meet and intergrade in the area where the two drainages start on their separate ways.

The subspecific differences here regarded as salient must be of rather recent origin. The Florida Peninsula has risen gradually from the ocean, to achieve its present conformation, only during and since Pleistocene time. Spread of the water rats along this emerging peninsula may likewise have been gradual. The morphological differences among the subspecies are slight; they involve coloration, proportions, and size. These facts point to a recent differentiation of the five subspecies on and near the Florida Peninsula.

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PLATE I

Dorsal views of skulls of five subspecies of *Neofiber alleni*, as follows: (A) *N. alleni apalachicola*, adult male, holotype, BSC 263704; Apalachicola, Franklin County, Fla. (B) *N. a. exoristus*, adult male, holotype, UMMZ 99028; 12.1 mi. SE Waycross, Ware County, Ga. (C) *N. a. alleni*, adult male, AS 2322; 2.4 mi. S Malabar, Brevard County, Fla. (D) *N. a. struix*, adult male, holotype, UMMZ 97732; 21 mi. W Miami, Dade County, Fla. (E) *N. a. nigrescens*, adult male, AS 2264; Clewiston, Hendry County, Fla.

PLATE I



A



B



C



D



E

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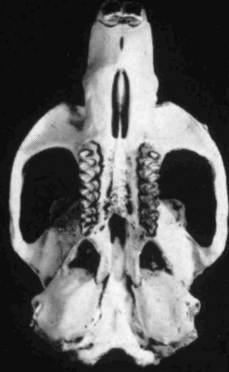
PLATE II

Palatal views of skulls of five subspecies of *Neofiber alleni*, arranged as in Plate I.

PLATE II



A



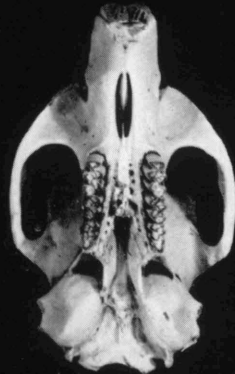
B



C



D



E

Albert Schwartz

PLATE III

Lateral views of skulls of five subspecies of *Neofiber alleni*, arranged as in Plate I.

PLATE III

