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THE UNIVERSITY OF MIAMI

A CONTRIBUTION TO THE
LIFE HISTORY OF THE WATER RAT,
Neofiber alleni

BY

Raymond Paul Porter

A THESIS

Submitted to the Faculty
of the University of Miami
in partial fulfillment of the requirements for
the degree of Master of Science

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Subject

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This thesis has been
approved by the Department
of Zoology and by the
Committee on Graduate Study

J. Riis Owre
Dean of the
Graduate School

PREFACE

There have been many attempts in the past to study the habits of the Florida Water Rat, Neofiber alleni. Few papers have been published on the occurrence and taxonomic status of this semiaquatic rodent since it was first described in 1884. In Florida and Georgia, some of the previous investigators found it very difficult even to locate colonies of water rats. In the Everglades region, in 1951, in such places as were readily available to me, I found many signs of their working and began this investigation.

My indebtedness to many persons who helped in this undertaking is very great. Mr. Roy Woodbury of the Botany Department of the University of Miami identified the plants cited in the present paper. Dr. Albert Schwartz supplied me with data from his mammal collection, and aided me in the collecting of specimens. Mr. Earl Moore furnished air-boat transportation deep into the Everglades. Mr. Jerald Baker of the U. S. Fish and Wild Life Service helped greatly by arranging for my collecting trips into the Loxahatchee Wild Life Refuge. Mr. Paul Kreager of the U. S. Fish and Wild Life Service also arranged for

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investigations in the St. Marks Wild Life Refuge, and Mr. Roy Moore, Superintendent of the Okefenokee Wild Life Refuge, graciously arranged for transportation, and accompanied me into that Refuge. Thanks is here also given to Dr. W. H. Leigh, Zoology Department of the University of Miami, and Dr. E. W. Baker, U. S. Department of Agriculture, for identifications of parasites. Dr. W. H. Burt, University of Michigan, arranged for a place for study while visiting that University. Mr. J. C. Moore, Biologist of the Everglades National Park, has supplied valuable data from that area. To my family, who helped in many ways, I wish to express special gratitude for their tolerance and help. I wish also to acknowledge the assistance of my Graduate Committee, and in particular my thesis advisor, Dr. J. D. Corrington, who offered me friendly guidance and good-natured criticism.

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ZOOLOGICAL HISTORY

The genus Neofiber was defined by True in 1884. The type specimen was collected at Georgiana; this locality is on Merritt Island, Frevard County, along the Indian River. Bangs (1898) mentions collecting this species at the type locality and reports them as not abundant; he also describes collecting them in a wet prairie called Bivin's Arm, near Gainesville, where they were quite common. Elliot (1901) quoting from Surber's accounts of this animal, comments that collecting at the type locality was poor; they were abundant, however, at Enterprise, on the headwaters of the St. Johns River. At this locality, in February, Surber found the first young. Howell (1920) described the race Neofiber a. nigrescens from Ritta, Palm Beach County, on the south shore of Lake Okeechobee. In Howell's original description, specimens are cited from as far south as Cape Sable. In the Okeechobee region the animals were taken in muck fields at a considerable distance from the lake shore. Harper (1927) described the habitat and distribution of the water rat in the Okefenokee swamp region of Georgia, giving an account of their life history. Band and Host (1942)

recorded specimens from Micoria, Highlands County, Florida. Hibbard (1942) noted a fossil, Neofiber, as part of the Pleistocene Fauna from Lincoln County, Kansas; he designated this a new species Neofiber leonardi. Schwartz (1952) described a new subspecies of Neofiber alleni from the southern Everglades to be known as N. a. struix.

The genus Neofiber holds the distinction of being the most recently named genus of mammals to be described from North America. Neofiber is a genus of the subfamily Microtinae, and bears resemblance, on one hand, to Onychomys leucogaster, and on the other to Microtus. In fact, Bailey, in his revision of the genus Microtus, considers Neofiber as a subgenus of Microtus.

Schwartz at present is revising the genus and will include (personal communication) five identifiable subspecies of N. alleni. These races occur as far west as Apalachicola and as far north as the Okefenokee Swamp in Georgia.

Neofiber is not well known by local residents. In areas where it is known, it goes by the name of water rat, Florida water rat, muskrat, round-tailed muskrat, Florida round-tailed muskrat, and muck rat. Water rat has been accepted by the writer as a common

name for Neofiber alleni since water rat identifies this rodent in nearly all areas where it is found.

GENERAL DESCRIPTION OF GENUS

The water rat's appearance is that of a diminutive northern muskrat (Ondatra) with a round, sparsely-haired tail. The hairs directly above the base of the tail are longer than the rest, and form a tuft. The pelage is composed of long, glistening guard hairs and soft underfur. The underfur around the base of the tail extends out over the first few vertebrae. The ears are nearly hidden in the fur. The sexes are colored alike and no seasonal variation is evident. The upper parts are uniformly some shade of brown, ranging from light brown in specimens from Apalachicola to dark blackish-brown in specimens from the Everglades. The underparts are silver-grey or tinged with buff. The color of the basal portions of the guard hairs and underfur is cream to white over the site of the side gland; this gland is present in most microtines, but is absent in Neofiber. Young specimens are uniformly plumbeous above and have whitish underparts. Testes are: 2-2 inguinal, 1-1 pectoral. Measurements for adults throughout the range of the species: total

length, 238-381 mm.; tail vertebrae, 99-168 mm; hind foot, 38-50 mm.. Abundance: Locally common wherever suitable habitat is available. Most common in the Everglades region in Florida, and in the Okefenokee Swamp of Georgia, where there is an abundance of plant food over an extensive area. A population in one area may show a large drop or an increase in number in a short length of time. There is a possibility that this fluctuation is due to some cyclic phenomenon.

HABITAT AND AREAS OF POPULATION

In comparison to its northern relative Ondatra, Neofiber has a very restricted range. However, this was not always the case, for the present range is the remainder of a previously more extensive one. Neofiber remains have been found in the Pleistocene of Texas and Kansas; these fossils are assigned to Neofiber leonardi Hibbard. The factors that have limited its present range have not been determined. When the water rat was first discovered in 1884, it was thought to be restricted to the coast region; when these microtines were not found at the old collecting sites in the following years, it was wondered if they were becoming extinct. Since 1900, more and more suitable localities have been discovered and these rats are now known to be quite common locally in peninsular Florida. Possibly Neofiber will be found farther to the west along the Gulf coast and also up the Atlantic seaboard to the north if suitable habitats are available.

This study has covered the known range of Neofiber from the Okefenokee Swamp in Georgia, to Cape Sable, Florida, and to the west as far as the Apalachicola region. Since most of the present investigation has been in South Florida (a little-known area), it is proposed

to begin the discussion with the Everglades, the largest unit area available to Neofiber. All locality records are in Florida unless otherwise stated. The Everglades is a vast expanse of muck land covered by a continuous plant growth, mainly of saw grass (Mariscus), aquatic herbaceous plants, and willows; it includes nearly a million acres of habitat usable for Neofiber. The Everglades is in reality a runoff basin for the waters of Lake Okeechobee; the waters of this large lake flow through the Everglades and empty into the Gulf of Mexico to the southwest along the Ten Thousand Islands.

For aid in locating the places mentioned in the text, numbers in brackets will follow each locality mentioned. These numbers refer to points numbered on a folding map at the end of this thesis.

Howell (1920) saw skulls of Neofiber taken from the prairies of Cape Sable ⁽¹⁾. It is believed that the water rat does not inhabit this region at the present time, since canals have allowed salt water to seep into these once fresh-water prairies, and they are now salt marshes. However, the Everglades National Park personnel have dammed these canals in an attempt to build up the fresh-water level, and Neofiber may be found there again. A colony of water rats was observed, and four specimens collected, 7.5 miles southeast of Florida

City, in a shallow canal along highway U. S. 1 (2).

The rats were not numerous here, but represented a good colony in 1952. At this locality, the water rats make their nests exclusively of the sedge Eleocharis flaccida (Plate V). The only food available was Sagittaria lancifolia. The water is fresh most of the year, since plants such as Sagittaria do exist there. However, red mangrove, Rhizophora is beginning to grow near the south end of the canal, which connects with the salt-water Florida Bay.

On the extreme lower southwest coast of the Florida peninsula, behind the great stands of mangroves and buttonwood, the water rat has also been found. Nests were observed along the marshes from east of Marco, Collier County, southeast to Choep, (3) Collier County. These colonies exist on down the coastal marshes and lie behind the mangrove swamp for some distance. A specimen has been collected by Howell (1920) eight miles East of Chokoloskee, (4) Monroe County (Lopez River). Joseph C. Moore, Biologist of the Everglades National Park, has seen their workings at the headwater branches of Broad and Lostmans rivers (5) in Monroe County. In 1952, the writer has observed a small isolated colony at Gum lough in upper Monroe County (6).

Northward in the Everglades basin, water rats are quite common at the present time. They have been collected along the Tamiami Trail in Dade County (7), were found along the Okeechobee Road in Broward (11), Broward (9), and Palm Beach counties (10); in the township of Medley (8), Dade County (N.W. of Miami), they have been found around the muck borrow pits in 1951 and 1952.

The plants of the Everglades region with which Neofiber has been found associated are:

- 1 Eleocharis flaccida sedge
- 2 Rhynchospora tracyi sedge
- 3 Mariscus jamaicensis saw grass
- 4 Cephalanthus occidentalis Button bush
- 5 Salix amphibia Willow
- 6 Sporobolus sp. a grass
- 7 Panicum hemitomon Maiden-cane grass
- 8 Sagittaria lancifolia Arrowhead
- 9 Pontederia sp. Pickerel weed
- 10 Panicum geminatum

Items one and two are utilized as feeding-stand material; three, four, and five for foundations for nest; three, six, and seven for nest materials, and six, seven, eight, nine, and ten are used for food.

A very excellent area for Neofiber in the Everglades is found in the Loxahatchee Wild Life Refuge, (known geographically as the Hillsborough Flough) Palm Beach County (12). This area is a deep muck basin on the east side of the main basin of the Everglades, and abounds

with water life; it is quite comparable to the prairies of the Okefenokee Swamp of Georgia. Here the waterlevel is more constant, and aquatics are very numerous indeed (Plate VI). The more openwater places or "sloughs" are dotted with large and small islands ("hammocks") of trees, mostly myrtle and bay types, which grow on tussocks of muck held together by their own living roots. The soil of these hammocks quakes when walked upon and traversing the sloughs on foot is practically impossible. Here, as well as in the rest of the Everglades, the use of the air-boat is a necessity (Plate VI). Around the edge of the hammocks of the Loxahatchee Wild Life Refuge the water rat digs its tunnels in the muck and builds its nests on the open marshes. The nest is made of sedges and maiden cane, and the feeding stands are composed of various materials; the rats here feed on the maiden cane grass, yellow bonnet water lily (Nymphaea lutea) and arrowhead. Some feeding stands made of Pontederia with half-eaten fruits of yellow bonnet water lily were found in Big Lake in the Refuge (Plate IV).

On two occasions, trapping was attempted in the refuge. The first night, fourteen traps gave no return. This was attributed to disturbance by the air-boat wash

as it approached the mounds. On the next attempt sets were made in places where the nests were on a more stable foundation of bushes, and three rats were taken in eight traps in one night.

All the Everglades wild life along with Neofiber bears a terrific loss whenever a fire rages across the muck lands, especially when the water table is low in the spring of the year. The fire of 1945 which swept over two-thirds of these one million acres caused a high loss of rodent life and, what is worse, burned out the muck down to the rock foundation; thus the basis for the Neofiber habitat was destroyed. Water rats in the Everglades are found most abundant where the muck is deep enough for them to dig to water during the dry time of year.

Mr. Homer Rhodes, Jr., of Miami (in litt.) explained to the author that mounds made by water rats were seen by him in the 1930's in the cypress stands north of the Tamiami Trail in Collier County between the Marco Road and Naples ⁽¹³⁾. Rhodes knows the water rat quite well. The author has not been able to find any sign of them there at the present time. However, this may be indicative of a population drop in that area, as will be noted later.

The water rat can be found today along the small canals and irrigation ditches about the Lake Okeechobee region, the marshes north of Moore Haven (14), along the northwest shore of the lake at the mouth of the Kissimmee River near Okeechobee City, on Kings Bar out from the Kissimmee River's mouth (15), and on the east shore of the Lake in Martin County (16).

Water rats have been taken at Nicoria, Highlands County (17), by Rand and Host of the American Museum in February 1943, and the Cornell University Museum has three adult specimens taken from "below Sarasota", (18) Manatee County.

Mr. H. Rhodes, Jr., (in litt.) says, "Found water rats in abundance on the Myakka River (19), Manatee and Sarasota counties, and on the Peace River (20), Hardee and DeSoto counties, when I was state trapper in the 1930's." The writer could not find any sign of them there in 1952.

Dr. A. Schwartz collected Neofiber in small ponds north of Stuart, Martin County (21), in 1952, and found a moderate population there. The plants in association there were: Food: yellow-eyed grass (Xyris sp.), maiden cane, Panicum hemitomonum, Sagittaria and Pontederia. Nest materials: maiden cane, Rhynchospora tracyi and Furnena scirpoides.

(22)
On Merritt Island , Brevard County, where the type specimen of Neofiber alleni alleni was taken in 1884, the author, after many attempts, found a few isolated colonies. The rat was reported to be in abundance in this area when Neofiber was first discovered, but in the years immediately following, they became scarce and have not been reported there since the turn of the century.

In June 1952, the writer, with Dr. Albert Schwartz, collected a few adults and one young specimen from a small brackish-water marsh along the Banana River, Brevard County. These rats were in a colony which was established in the matted grass, Paspalum vaginatum, which the rats ate, and from which they made their nests. These areas had been passed in earlier surveys as the grass beds appeared uninhabited; it was only after a reconnaissance on foot that we found them to be inhabited by Neofiber. Specimens were also collected from another similar locality 2.5 miles south of Malabar, Brevard County, on the Indian River . Beds of Paspalum were seen along the Indian River above Titusville, Brevard County , where specimens in the past have been collected by the Biological Survey.

Water rats have been reported by local inhabitants to be abundant around the St. Johns marsh west of Melbourne, in Brevard County ⁽²⁵⁾, and there are also records from central Florida in Polk, Sumter, and Lake Counties.

The author collected Neofiber one mile east of Geneva, Seminole County. There, water rats were found in a number of small ponds located in the pine lands. The food here was maiden cane, yellow-eyed grass, and yellow bonnet water lily. Most of the nests were constructed in either evening primrose or button bushes.

At Lake Monroe on the St. Johns River, Seminole County ⁽²⁶⁾, near the old collecting site of Surbers, the author observed the workings of Neofiber along the shore amongst the high cane grass. Here they dug tunnels in the sand on the shore and fed on maiden cane.

Another focus for collecting in the past has been in the lake and prairie region around and to the east of Gainesville, in Alachua, Putnam, and Marion counties. The author collected near Grandin, Interlachen, and Hawthorn in Duval County in 1951 and 1952 and found the rats quite abundant. At 0.8 miles east of Grandin ⁽²⁷⁾, the habitat of a small drying glade was found to be quite similar to the Everglades region of South Florida, but on a much smaller scale. The rats here

were burrowing under a muck where the roots of the vegetation were close enough to maintain the stability of the roofs of the tunnels. Sagittaria was very abundant and was the main food available at this station.

(28)

At 5.6 miles west of Interlachen, where Neofiber were collected from a small open-water lake, which had only grass growing at the shoreline, the water rat fed on and lived in one grass, Tursia hexanola. The nests were either made in Hypericum fasciculatum bushes or on the shore in the grass. These two localities, no more than five miles apart, offer examples of diverse habitats in which Neofiber make their abode. In this region, these two habitats occur at the same time of year, but in the Everglades and Okefenokee swamp these two stages occur in the same places at different times of year, depending on the water level.

Another interesting locality for Neofiber in Putnam County was visited but not trapped. This was at the Florahome Humus Company, 1.5 miles east of Florahome. Excavations of peat in this five hundred yard-wide bog have made numerous open water pits. Along the shore of these pits where the peat had not quite filled in, a number of tunnels were found and also a few nests. The nests were made of the sedge Eleocharis elongata and built on top of the sphagnum. At three miles west

of Hawthorn in a similar peat bog, Neofiber were collected by the author on August 8, 1951. At that time the water level was low and the nests were not in use. However, the rats were taken in the subsurface burrows in the sphagnum-covered peat. Other nearby localities are Gainesville and Orange Heights, Alachua County⁽²⁹⁾, Welaka and Crescent City, Putnam County⁽³⁰⁾, McIntosh and eleven miles east of Silver Springs, Marion County⁽³¹⁾.

North of these situations at the Okefenokee Swamp⁽³²⁾ of Georgia, there is found another extensive area occupied by Neofiber. Harper (1927) in his report on this tract recorded them as very numerous at that time on Chase, Chesser, Floyd's Island, and Cow House Prairies. He estimated the population then to be around 10,000. On August 4, 1952, the author went into Chesser and Chase prairies by boat, with Mr. Roy Moore, Superintendent of the Okefenokee Wild Life Refuge, to observe the water rats. We found no sign of Neofiber at Chesser Prairie, but did find a few old mounds on a small arm of prairie south of Coffee Bay Landing. These were made of fine sedges and were infested with ants. Farther down the Suwanee Canal, we went into Chase Prairie (Plate VII). Although we poled and motored for over

three hours, few Neofiber workings were observed. However, Dr. C. F. Walker, of the University of Michigan, told the author (personal communication) that he had found Neofiber very abundant on the prairies off from the canal in February, 1948. From this evidence and other to follow, it appears that there are times when Neofiber populations fluctuate tremendously, from great abundance to nearly complete disappearance.

In northern Florida, specimens were collected by the author and Dr. Albert Schwartz two miles west of Madison, Madison County ⁽³³⁾. This collection was made from an arm of a cypress-fringed pond that was choked with maiden cane (Plate VII). The nests here were made exclusively of maiden cane and constructed against the bases of the cypress trees. Food, as ascertained, consisted of maiden cane and yellow bonnet water lily. Nests made of maiden cane were also observed in a small lake in Watertown, Columbia County ⁽³⁴⁾.

The author and Schwartz have also taken Neofiber 6.5 miles west of Monticello, Jefferson County, at Lake Miccosukee (Plate IX). The food plant here was also maiden cane, and nest materials were maiden cane and the sedge Eleocharis capillacea.

Other populations to the west occur in Franklin County (35), and in Wakulla County, along the St. Marks River (37).

The author and Schwartz spent two days looking for Neofiber in the St. Marks Wild Life Refuge, on June 8 and 9, 1952. Although this area seemed promising for Neofiber, it was found that they had been there in the past, but were not present then. On July 1, 1952, Schwartz looked for water rat workings 20 miles northeast of Carrabelle, Franklin County, and found many old mounds, but no new ones. This indicates another large drop in population along the coast. It is quite possible that high tides caused by hurricanes force salt water into the fresh-water areas and cause the fresh-water food plants of Neofiber to be killed off; the rats then die from lack of food. The Apalachicola region is the most western area from which Neofiber has been recorded.

Two promising areas for Neofiber that did not have any sign at this writing are: Lake Tsala Apopka in Citrus County (38), and near Tarpon Springs, Pinellas County (39), both near the west coast of the Florida Peninsula.

Undoubtedly, there are many other areas in peninsular Florida, which the author has not had time to visit, where Neofiber will be found in the future.

WORKINGS AND FOOD HABITS OF NEOFIBER

The water rats construct nests, feeding stands, and dig burrows in the earth. The nest, also known by the name of "mound" or "house", is built over wet areas and is used for living quarters. It is usually dome-shaped and varies in size from that of a small soup bowl to that of a bushel basket. With few exceptions, there are two exits or "plunge holes", one opposite the other, on either side of a platform in a chamber usually no larger than necessary to allow the animal to turn around.

The feeding stands are of two sorts: one is no more than a spot chosen a little above the water level in a swamp or lake where the rats feed on materials brought there for this purpose. The other is a fabricated platform made of sedges, grasses, or other aquatic vegetation found nearby. These feeding stands, when made of sedge, have a buoyancy somewhat as the nest of the pied-billed grebe, Podilymbus podiceps. They are not built upon the swamp floor, but rather float up and down as the water level fluctuates; they are, however, attached to the live sedge tops and each stand is fixed in one locality (Plate VI). When these stands are made

of other materials, they are constructed from the ground up or on some other plant as a foundation. As the stands are used, two distinct plunge holes develop on opposite sides. These holes are used as exit-entrances by the rat.

The mound is no more than a feeding stand which has been elaborated upon. Night after night, a rat or rats may bring material up to one or a number of mounds to add a little more to the existing fabrication. Materials known to be used are sedge, Eleocharis; saw grass, Mariscus; arrowhead, Sagittaria; pickerel weed, Pontederia, and many different grasses. They sometimes construct their nests in clumps of switch grass, Spartina. The construction is accomplished by adding new material, first on the sides parallel to the axis of the plunge holes, and gradually completely covering the chambers so as to have a hollow cylinder arched from one plunge hole to the other. Then a spiral binding of building material that holds together quite well is inaugurated. As far as the writer knows, no one has observed the water rat swimming with the housing materials. It is presumed they carry grasses in their mouth with ends trailing behind as they swim; possibly the front limbs are used to hold the material. Not all

feeding platforms are transformed into mounds; some remain as open feeding stands. The mound is enlarged from the inside out in nearly all cases. The rats may repair breaks in the sides and top of the mound whenever they occur. Much work may be done in one night, repairing a number of nests opened the preceding day, although not all nests are repaired. As the water level rises during the rainy season, the floors of the nests are built higher and higher to cope with the inundation. If the water rise is too abrupt, or raises to unusual heights (three or four feet), new nests are made, using tree or bush limbs for their foundation. Evidence of this was seen in the Everglades following recession of the water after the 1948 flood. Some nests in the saw grass and willows were four feet from the ground level, demonstrating beautiful engineering ability. A few nests were observed that had hollowed grass cylinders four inches in diameter and three feet in length, following the limbs of willows from the ground to the elevated mound.

From observations made on construction and design of hundreds of mounds, the author believes they are in reality of two distinctly different kinds; one I will call the "feeding mound", used much as the "feeding

stand" of the water rat, and the other "nest mound". The nest mound is actually also a feeding mound, but with a distinct side chamber. This chamber, being made of dry soft grass, is up above and to the side of the main platform, which is always wet and covered with the remains of foods. One out of every six mounds examined showed evidence of being a nest mound. This porportion is based on a year-around census. It is believed that the nest mounds are constructed only by the fully adult animals. Evidence shows (see Reproductive Studies) that the young are not kept in these nest mounds, but may be born there. In the Everglades and other areas, as the water recedes, the mound platform is left higher and higher above the water level. The rats use these mounds until the water level approaches the general soil surface; then they begin the burrowing in the substrate. In certain instances, the base of the mound is then excavated and a chamber is made in its side at ground level. Instead of being an addition, this is simply an excavation of the tightly packed, and now nearly rotten mound material to make a simple hiding chamber. Old nests are seldom used the next year due either to infestation with ants, or a complete collapse; they may be used, however, for the foundation of a new nest. In regions where nests are used the year

around (Loxahatchee, central Florida lakes), the nests are kept in good condition and may be used from year to year.

BURROWING

In certain sections of the muck lands of the Everglades, and other areas of Florida and Georgia, the water rat lives in the muck during the dry periods of the year. Along the south margin of Lake Okeechobee, the water rat lives in extensive burrows made in the canal banks, and in the fields. Before the area was drained, irrigated, and put under cultivation, these animals lived a normal existence, building houses when the area became inundated and burrowing in the muck when it periodically became dry. Now their environment has been drastically changed, and their territory normally remains dry throughout the year. Consequently, to survive in this extensively farmed area, they have retreated to the drainage canals where they are often abundant.

At the sugar-cane fields of the Okelanta Sugar Corporation, Okelanta, Palm Beach County, water rat workings were observed by the author in November, 1951, and January, 1952. They had undermined the edges of many small eight-foot-wide canals to such an extent that

it was hazardous to walk too close to the edge of the banks. This condition was also noticed at other areas near Lake Harbor, and Clewiston, Hendry County. Mr. B. A. Bourne, vice-president of research for the United States Sugar Corporation, at Clewiston informed me on November 28, 1951 (in litt.) that, "the water rat, Neofiber alleni nigrescens is not abundant in the cane fields, but nevertheless does considerable damage to sugar cane when present. They not only damage stalks, but undermine the stools and weaken them so that they cannot withstand high winds without uprooting easily."

The local inhabitants say the water rats build nests in the water in the same way as they do elsewhere, but I believe this is in areas where there is little, if any, human activity to disturb them. Most of these canals in the muck land are kept clear of vegetation to facilitate the flow of water, and water rats would hardly have a chance to do any building in them.

Howell (1920) stated that Neofiber was found in the fields and dooryards around Ritta on Lake Okeechobee where their tunneling undermined the muck. Around the deep muck land west of Medley, Dade County, there is much evidence of this behavior in the muck banks of the borrow pits. In February, 1952, the author dug up a series of burrows

in a small pile of muck left standing in a muck pit that always contained water. The pile of muck was eight by ten feet in diameter and three feet high. Around the perimeter there were four entrances, which led to a central area two feet above the water level, at that time. These burrow exits were well camouflaged and were below the water surface a few inches. In sections where the burrow had broken through to the surface, it had been repaired by plugs of grass and/or muck. In this particular instance, in the central area of communication of the four burrows, there was a dry, soft nest made of torn grasses, probably where the animal spent the sleeping hours of the day. This locality was still in use a few weeks later as was evidenced by green cuttings of grass drawn up to the entrance of new tunnels constructed since the time that the muck pile had been torn apart.

In the flat Everglades region where the water has a yearly fluctuation from very wet to very dry, the water rat does extensive tunneling or burrowing. The excavation begins as soon as the water is a few inches below the surface. One area, twenty-one miles west of Miami, was watched closely for a period of a full year, and the following can be noted on the activities of this colony:

Before the water receded, nests were evident over a large area in the saw grass, but mostly in the more open spaces in between saw grass "islands". The feeding stands and a few houses were to be seen in those areas that were not so densely covered with vegetation. This type of situation I will call the "open sedge marsh". Walking across this open sedge marsh, one would cross few underground tunnels which connect between nests. As the water level sinks far enough below the surface, water rat digging begins in areas that support a good stand of rooted vegetation, i. e., Sagittaria, Pontederia, grasses and sedges (Plate III). In a one-half acre plot, which supported a population of about a dozen to fifteen rats, the place looked as if a plow had gone through, bringing up yards of earth.

The water rat, when making its home in this dry muck earth, digs for months before digging activities cease. The tunnel begun in the muck would continue through the roots of the vegetation until the distance from the digging to the clean-out hole was over two feet in length; then, at a breakthrough, another clean-out hole was made and the main tunnel continued. Afterward, the first clean-out hole was by-passed and plugged to make the tunnel continuous. These tunnels were used as living quarters and as a place to eat foods

dragged down there for that purpose. Presumably, all the rats in the colony used the various tunnels since the tunnelings ran together. As the water level becomes lower and lower, there is evidence of one of the holes of each colony being used for drinking. These were noticed when one or two clean-out muck piles were day after day more wet than the others. Two of these burrows were excavated and it was found that they went all the way down to water (18 inches). They were dug at a forty-five-degree angle with a nearly horizontal bottom. The mounds of muck at the entrances of holes were used as sites of defecation, as evidenced by the scats accumulating there from night to night. The rats do not begin building mounds until the ground is completely covered with water. Other areas of the Everglades show this extensive type of digging, as do also the headwaters of the mangrove rivers to the south.

Mr. J. C. Moore relates (in litt.) "Headwaters Rookery Branch, April 27, 1952, 13:45; We took three glades buggies across several of the headwaters tributaries of these creeks in open saw grass interspersed with willow heads. Round-tailed muskrat burrows were abundant in the saw grass and Pontederia near the banks of these. I spent several minutes examining their bur-

row entrances. We found only two grass houses and although these were old and not recently repaired, they were evidently being used. In a great many places they had piled muck five or six inches high and a foot long... also found much burrowing by these animals where we crossed the headwater branches of the Broad River, April 27, and Lostmans River, April 28."

In areas where grasses grow in a matted carpet, as at Ochopsee and on Merritt Island, the rats begin to use the ground surface as runways, making tunnels among the grass bases. In certain instances, however, they tunneled below the surface for short distances under the roots of the grass.

ECOLOGY OF NEOFIBER WORKINGS

It was found that many forms of life, other than Neofiber, utilize the water rat's engineering work. Harper (1926) says that the rice rat, Oryzomys palustris, in the Okefenokee Swamp may use the mounds of Neofiber alleni nearly as much as does Neofiber. He often trapped the rice rat in the mounds, and therefore they, too, apparently use the underwater tunnels to some extent.

The author has frequently trapped the cotton rat, Sigmodon hispidus in the muck runways of Neofiber where the tunnels were near roads or other high ground. Sigmodon were trapped in Neofiber sets in the following localities: eighteen miles west of Miami, Dade County, and on Merritt Island, Brevard County.

Amphibians and reptiles have been found to use the workings of Neofiber also. Harper (1935) reports, "On June 16, 1929, I secured a 590 mm. Siren lacertina specimen in a Schuyler trap baited with bacon and cheese and set on a feeding-stand of... Neofiber alleni, on Floyd's Island Prairie. The animal was caught by the head, and the rest of the body extended into one of the two tunnels leading to the feeding stand."

On June 9, 1952, the author took the salamander Manculus quadridigitatus in an inhabited Neofiber nest. This nest was found in a small cypress-fringed pond west of Madison, Madison County. Other amphibians found in Neofiber nests at this same locality were the frogs Rana pipiens and Rana clamitans.

During March, 1952, six Dicamptylus viridescens were found aestivating under old nests of Neofiber. These nests, located twenty-five miles west of Miami, offered a moist and protected place of refuge in which the salamanders could survive the long dry season. In these nests carton ants, Crematogaster ashmeadi Mayr were found along with the bug Triatoma, and millipeds.

The fact that Neofiber nests are often used by turtles is well demonstrated by the facts that: (1) The author found eggs of the three-lined mud turtle, Kinosternon bauri, in a water-rat's nest located twenty-one miles west of Miami; (2) on July 1, 1952, Schwartz found a clutch of three Kinosternon subrubrum eggs in one nest, and in still another nest five Sternotherus odoratus eggs. (3) C. Huber collected an adult Sternotherus odoratus and also a mouse, Peromyscus l. gessaypinus, in a deserted Neofiber mound. All these records are from 20.7 miles northeast of Carrabelle, Franklin County. These turtle eggs were hatched and

identified by Mr. L. Neil Bell, of the University of Miami.

On the shores of Lake Okeechobee near the mouth of the Kissimmee River (Plate VIII) several eggs of the skink Eumeces inexpectatus were found in a Neofiber nest constructed of water hyacinth roots.

The marsh rabbit, Sylvilagus palustris paludicola, often utilizes the tops of Neofiber mounds. These nests offer a convenient, dry, resting place for the rabbit after he swims through the marshes. Evidence of the rabbit using Neofiber mounds is apparent by the presence of their seats on the top of the nest.

In June, 1952, while setting traps for Neofiber at a locality west of Ochopee, Collier County, a shrew, either Blarina or Cryptotis, was discovered hiding in the base of a mound. The shrew was seen to dart away and disappear in the grass. Some of these nests were constructed in the hollow stumps of the cabbage palm, Sabal palmetto, while others were built in the open grassy portion of the marsh. During periods of high water, these nests offer a usable refuge for small animals since, as the water rises, there is very little "Lebensraum" left for a terrestrial existence. Here the environmental pressure was so great that both new

Neofiber mounds and carton ant nests were constructed on the same tuft of high grass.

Mr. Homer Rhodes, Jr., of Miami, who was State Trapper for the Fish and Game Commission during the 1930's, informs me (personal communication) that during the years 1933, 1934, and 1935, the glossy ibis, Plegadis falcinellus, along with thousands of other ibis, egrets, and herons, nested in great numbers on King's Bar, located in Lake Okeechobee at the mouth of the Kissimmee River. At this time, King's Bar was also overpopulated with water rats. The ibis had constructed their nests on the tops of water rat mounds and on the ground where the rats were digging their tunnels. The digging activities of the rats were disturbing the nesting procedures of the birds by causing eggs to fall from the nests. In order to protect the ibis, a poisoning campaign was inaugurated by the Fish and Game Commission. Arsenic, cyanide, and strychnine were used in an attempt to kill the rats. The poisons were dusted in the runways so that the rats would, of necessity, collect the chemical on their underparts and consequently poison themselves by cleaning their fur with their tongues. By this method the rat population was reduced.

In an attempt to visit King's Bar in July, 1952, it was discovered that at the present water level of the lake it was virtually impossible to reach the land portion of the island due to dense willows, bullrushes and water hyacinths congested about the island. Mr. J. W. Scott, Wildlife Officer with the Fish and Game Commission, who furnished the author transportation to the island via his air boat, said that water rats, along with marsh rabbits, are extremely abundant there. During periods of high water the island becomes so covered with water that they are the only terrestrial mammals able to survive.

In the Okefenokee Swamp, in February, 1948, Dr. C. F. Walker of the University of Michigan informed me that he saw snakes of the genera Natrix and Akistrodon sunning themselves on the tops of Neofiber mounds that were then abundant on Chase and other prairies.

It can be seen from the above records that Neofiber engineering works offer various aids for the existence of other swamp-inhabiting animals.

REPRODUCTIVE STUDIES ON
NEOFIBER

The first published record of Neofiber young is given us by Elliot (1901), "Mr. Surber's account of this animal as observed at Enterprise and Gainesville... On opening a nest on February 22nd I was delighted to find it contained two young ones, male and female, their eyes yet unopened and I should judge about a week old, but odd-looking fellows. Their noses being very blunt, and resembling nothing so much as the picture of young hippopotami I have seen... This nest was far more substantially built than any of the others and the interior was very dry and nice. The little fellows must have been born about the 15th of February...". Mr. Surber's description of young Neofiber is indeed a good one; the author can not add to his graphic words.

During the course of this study the writer has found four young water rats at an early developmental stage and Schwartz has turned over to me four more he collected during his work on the genus. Dr. W. B. Quay of the University of Michigan (in litt.) says, "From a specimen (of Neofiber) collected April 12, 1950, I found two fetuses in the right horn of the uterus,

both the same size; one fetus was removed from the uterus, photographed and serially sectioned; this fetus was 34 mm. in crown-rump length;...left horn of the uterus empty." From a female taken by the author near Geneva, Seminole County, on June 12, 1952, two fetuses, both nearly full term, were removed from the right horn of the uterus. No measurements were taken. These four are the only prenatal records of Neofiber. One of the youngest of the postnatal offspring known is represented by an animal from Merritt Island, Brevard County, taken on June 12, 1952. This is UMRC (University of Miami Reference Collection) #463. Its measurements (in millimeters) are: total length, 85; tail, 37; hindfoot, 14. This specimen was found dead, lying on the grass next to the nest and being eaten by ants. The skin was gone, except that on the hind legs and tail. From the appearance of the hair length on the legs and from its size it was no more than a day or two old. The little fellow was probably thrown out after it died in the nest.

Dr. A. Schwartz collected two nest young with their eyes yet unopened, in one nest, two miles west of Madison, Madison County, on June 29, 1952. These are UMRC #464 and UMRC #465; measurements (in millimeters)

respectively are: total length, 85; tail, 23; hindfoot, 13; and total length, 87; tail, 25; hindfoot, 14; and another young, UMRC #461, measuring total length, 100; tail, 23; hindfoot, 18; from still another nest at the same place. The following is an account of Schwartz's collecting of the above specimens. "While setting traps for water rats at 5:00 P. M. in a medium-sized lake (Plate IX), A. Schwartz and C. Huber took three nest young from two nests.

"Nest #1; this nest had been opened at about 3:00 P.M. on a preliminary trip along the lake margin. When it was approached at 4:45 P. M. Schwartz noted that the hole in the roof had been repaired since 3:00 P. M. A single young was taken from the nest and a trap was set for the female.

"Nest #2; this nest had been trapped on the night of the 28th of June by C. Huber and the trap was removed at about 10:30 P. M. on the 28th of June. No Neofiber in evidence then. When Schwartz opened the nest on the 29th of June, he heard squeaks of young. These were not, however, in the main nest, but rather in an auxiliary chamber. It was not ascertained whether the central chamber and the brood chamber communicated; both were damp. A trap was set for the female..... Female taken from Nest #2 on the 30th of June, 1952;

after death, a bloody mucous exudate was voided via the vulva. Upon dissection, two hemorrhagic dilatations were visible in the right horn of the uterus. From the condition of the uterus and other facts, the two young mentioned above must have been born very recently, possibly 24 hr." Since the measurements of the young from Madison and Merritt Island coincide quite well, it is presumed the size of Neofiber at birth is between 75 and 80 mm.

Another Schwartz record of Neofiber young is from 11.2 miles east of Silver Springs, Marion County, on July 11, 1952. This specimen, UMRC #460, measures (in millimeters): total length, 110; tail, 32, hindfoot, 12, and its eyes are yet unopened. Dr. H. B. Sherman, University of Florida, has in his collection a young Neofiber with eyes still closed, collected by A. C. Chable, in Lake Howard, Polk County, on September 1, 1940.

The author collected a young Neofiber from a nest on the shore of a small lake, 5.6 miles west of Interlachen, Putnam County. This nest was damp and did not have a dry, soft nest chamber. This young specimen was more brownish than young animals seen from the Everglades. Its measurements (in millimeters) are: total length, 131; tail 49; hindfoot, 23.

A fortunate event occurred when, on January 3, 1952, the author recovered two nest young and captured the mother unharmed. These were taken twenty-two miles west of Miami, Dade County. A nest was opened about 3:30 P. M. and the young were taken. The floor of the nest was surprisingly damp and made of rather large pieces of grass and other plant stems. One of the entrances was plugged with duck and grass and the chamber itself was very small. The other entrance apparently led to another nest no more than three feet away. One of the young rats, which had its eyes closed, went down the open plunge hole and out of sight. A search at arm's length down the plunge hole revealed the rat to be at least one and a half feet under water. The nest by this time was completely disturbed and could not be used for a trap site. The live trap (mentioned in trapping methods) was, however, set in the nest three feet away. The site was again visited soon after dark and the mother was found in the trap. The mother rat and her two suckling young were put in a 2' x 2' x 2' cage where she nursed and reared them. The measurements (in millimeters) of one of the two young on January 6, 1952, were: total length, 130; tail, 48; hindfoot, 25.

The mother rat made a nest of rags and grasses given her for that purpose, and took good care of her offspring. One rat was kept alive until the middle of February and the other until mid-March.

Since there is no report in the literature of observations on young Neofiber the following represents the first account.

Measurements and weights were taken about every week and will be presented later. At first the mother rat was observed nursing her young almost constantly, the young rats remaining attached to her inguinal teats. They would allow themselves to be dragged around even when she would climb the wire sides to get to a second landing of the cage.

They utilized all of the four inguinal teats but were not observed suckling at the pectoral pair. On January 10, 1952, at an estimated age of two weeks, the left eye of one of the young opened and then the little rodent became frisky, running around the cage. The mother rat never was very friendly and kept her distance, but she soon lost her fear and would, in defense, rush at a hand advanced toward her, making contact with her fore limbs. Before making these feints she would sit on her haunches and gnash her teeth and vibrate

her vibrissae. A bowl of drinking water was kept in the cage at all times. This bowl was used by the rats for defecation and had to be cleaned twice a day. When cleaned in the morning the bowl remained fresh until about noon, when a few droppings were observed. The bowl was noticed as being very soiled by about one hour after dark. By January 15, at an estimated age of 19 days, both young had their eyes open and moved around quite well. They now looked very much like meadow mice (Microtus). When water was introduced into the bowl in the cage, the adult rat seemed to enjoy a bath in the stream of water flowing from a nozzle. A chronological journal, beginning thirteen days after their capture, of the main events in the lives of these captives now follows.

January 16, 1952: young still receiving nourishment from the mother but are beginning to utilize the same foods as the mother. Both the mother and the young bathe themselves in the water bowl during the evening. When put in a tub of water the young feel perfectly at home and swim well, even at this early age. The underfur remains dry while swimming and they seem quite buoyant. Swimming is accomplished with their hind feet almost entirely. Incidentally, it has been

mentioned by Baker (1889) that, "In swimming the tail moves in a peculiar gyratory manner, the tip describing circles." The author has observed both young and a number of adults while swimming and it appears that the tail does gyrate, especially when the animal is trying to turn in open water. This tail movement seems to be an attempt at righting its hind quarters since the animal has a difficult time remaining right side up when in open water, and is not a propulsive action.

January 23: young very frisky, one bit the author's brother's finger hard enough to bring blood. Teeth, which were barely erupted and white in color on January third, are now much larger and the enamel is yellow.

February 7: mother still suckling young. They are not with the mother as much as they used to be and hide by themselves. The fact that they still nurse at this age may be due to their confinement and perhaps does not represent a normal behavior. However, this is the last date when these young were nursed by their mother. This gives a period of six weeks of nursing before they are completely weaned.

February 17: one young rat died. Caused by subcutaneous infection.

February 20: two remaining water rats changed to larger observation pen (see "Observations on Neofiber in simulated habitat pens".)

March 19: oldest of the two litter mates dies.

March 22: mother dies (both mother and young died with subcutaneous cysts filled with pus (see "Parasites and Diseases of Neofiber").

By comparison with the sizes and measurements of other young, the two young taken on January 3 were approximately ten days old. Total length measurements taken at intervals of about a week have enabled the author to determine the approximate date of birth of other juvenile individuals that have been taken throughout the years, and which are scattered throughout the country at various museums. Dr. Schwartz, who is working on the taxonomic status of members of the genus, had most of the available skins of Neofiber assembled at the University of Michigan Museum in August of 1952 and, through his courtesy, allowed the author to examine the more than 180 study skins. By extrapolating birth dates from date of collection the majority of juvenile specimens taken were found to have been born in the months of October, November, December and January, with no records from April through August. However, the

young of suckling stages that have been taken were found to be born around June and December. A check was made on collecting dates of the 180 skins, and it was obvious why the juvenile's birth dates were grouped from October to December. By far the most favored collecting months were February and March, with very few taken from August to December. This fact would account for the presence of two, three, and four month-old young being more numerous in the collections. From the assembled data it is believed that Neofiber alleni breeds all-year-round, and the brood number apparently is two; it is not known whether there is more than one litter per year.

Food items upon which the captive water rats fed are: Sagittaria, Pontederia, yellow bonnet water lily fruit, maiden cane, crayfish, fresh apples, dried apples, fresh corn, cabbage, lettuce, carrots, cucumbers, green beans, banana, celery, papaya, tomato, and white, wheat, and rye breads.

As a field experiment on food preference, fresh apples, cabbage, cucumber, carrot, and celery were placed in a tunnel entrance that was being used to drag local foods to a feeding stand, to see if the rats eating near-by swamp foods would take the introduced foods. After three days the introduced food had been moved

but not eaten in the least. This seems to indicate that Neofiber prefers to utilize its natural foods in preference to introduced ones.

OBSERVATIONS ON NEOFIBER
IN SIMULATED HABITAT
PENS

Much can be learned from the observations of caged animals that can not be known from examining their workings in the field. A special type of pen had to be constructed for the observation and study of Neofiber. The pen had to have a solid bottom to receive water about six inches deep and be of an overall size that would not limit activities to a great extent. A pen was built using a three by seven-foot mortar box to serve as the bottom, and for the sides and top construction one-half-inch hardware cloth was used. The sides of the pen were three feet high, and the top was a necessity since these rats climb quite well.

In one end of the pen, one quarter-yard of Everglades muck was piled and leveled to a height of eight to ten inches. The box was flooded to a height of six inches, and Sagittaria and Pontederia plants were installed at the water's edge, and the pen was left to develop for a few days. On the day live water rats were to be introduced into the pen, fresh grasses from the swamp were piled on top of the muck for use in construction of a nest. An adult and her seven-weeks old young,

which had been raised by her in another cage, were introduced to the pen at 8:00 A. M. By 2:00 P. M. she had dug three feet of tunnel in the muck from the water's edge toward the center of the muck pile and back to the Sagittaria. When approached, both rats retreated to the water to hide. By 6:00 P. M. more tunnels had been dug and the mother had made a nest by hollowing out muck under the pile of grass. Food placed in the pen this first day was not touched until dark.

The next morning a beginning nest was observed at the base of the Sagittaria and Pontederia. After another day of observation, it was obvious just how expert the water rat is at hiding itself. Before the rats became more accustomed to human presence and before the nest was completely constructed, the rats would always go for the murky water when the pen was approached. The rats would dive in head first and remain completely submerged for an average period of four and one-half minutes. After the first emergence period they would come up for air only shortly, then submerge again, each time in the water being shorter than the preceding one. When they did rise for air their nostrils and eyes were the only parts raised above the water level. The longest length of time of observed submergence was for

a juvenile, less than two months old, that stayed under a timed seven minutes. This ability may explain why the adults are seldom seen when the nests are opened for examination. The rats can dive down the exit into the water and hide under the surface of the water until danger has passed without being noticed.

After three days, the two rats had become adjusted to their new environment and their habits could be studied. The nest that had been constructed was constantly being made more complete from the inside. Food placed in the pen was sometimes eaten a little during the day, but the greatest activity was usually from about 8:00 P. M. to midnight. Besides the mound, the rats also made a muck chamber on which they had to work continuously, since the roof was not substantial enough to hold its own weight.

Nine days following the introduction of the rats into the pen the water was drained and the pen allowed to dry. During these few days most of the muck that was in the one end was moved by the rats and formed into an alluvial fan, two or three inches deep, at the other end, save for the mound of muck left for the muck chamber. In this delta, formed by the rat's activity, furrows had been cut leading directly to the nest entrance.

Since the pen was now dry, a water pan was installed for drinking water. Invariably the rats used this water pan for their site of defecation. Usually the water pan was used for this purpose at night, but it was also noticed as having been used during the day to a small extent. This fact would show that Neofiber must come out and move around during the day since fecal matter is seldom seen in the covered mounds in the field. By the fifteenth day the pen was quite dry and the mound was allowed to go into disrepair by the rats. Extensive tunneling was now evident.

A 300-watt bulb placed on top of the cage gave illumination for observations at night. The light was set up in such a manner that the rats could be observed from outside, the observer being unnoticed by the subjects. With this arrangement, hours were spent watching the captives. The rats would come out, busy themselves with digging, eating, and running about. In one instance the mother rat was seen sitting on her haunches eating the last remaining piece of food in the cage, but when her own offspring approached, she roughly ran it off. The young one seemed generally to be more secretive and did not show itself as much as did the mother. When time came for its measurements to be taken, the young rat was hard to find and much more difficult than the female to catch.

OBSERVATIONS OF DIGGING
OF A MUCK TUNNEL

At night, with the light on, the female was seen excavating tunnels. She would go into the tunnel head first, and above the site of excavation the surface of the muck was seen to vibrate for about two minutes or more; then the rat would reappear head first, pushing bits of muck about the size of large marbles ahead of herself, using her nose and forelimbs. After several such runs, pushing muck ahead of her, she would come out about two feet from the entrance, scooting along the muck with her body so as to make a pathway for the muck that was to follow. She would then return to the entrance and, while facing it, she would pull muck with her front feet up and under herself and continue the stroke with a scratching kick of the hind feet. Digging in this fashion she would back out along the two paths she had previously made, one to the right and one to the left. Following these outside manipulations she would again dig in the tunnel. At times she would come out, listen for a few seconds, then return to the work. At another instance she came out and visited the water pan, getting in, staying a minute, scratched herself a few times, then returned to the tunnel. In

this small pen the digging of only one adult rat quickly expanded all the available space. She then proceeded to tunnel the mounds of muck thrown up from previous excavations. All these digging stages can be correlated with digging stages as caused by lowering of water level in the Everglades.

It is the author's belief that an investigator could arrange a powerful flood light to shine over a marsh, where the water rat is abundant, and make interesting observations of them in the field, after giving them a night or two to become accustomed to the light.

In early April seven water rats received from Mr. L. E. Thompson at Clewiston were put into the observation pen. The pen had only damp muck in it at this time and no surface water. The behavior of defecating in the water pan at night was observed with these rats also. These seven rats seemed to get along well with each other and stayed together as a group under a pile of grass where a depression had been made the first night. After a few days they were sacrificed for museum specimens and examined for parasites.

P R E D A T I O N R E C O R D S

The first available record of predation on Neofiber is recorded by Maynard (1895), who tells of seeing a Ward's heron on the Indian River in 1885 carrying a rat in its bill. Firing at the bird caused it to drop the rat, which proved to be a specimen of Neofiber alleni, at that time known only from the type specimen described the previous year.

Another record is from Howell (1932), and pertains to the Florida barred owl, Strix varia alleni. "Of nine stomachs recently examined in the biological survey from various parts of Florida... three contained mammals--cottonrat, (Sigmodon hispidus), deer mouse (Peromyscus), and water rat (Neofiber alleni)."

Schantz and Jenkins (1950) report six Neofiber skulls taken from barn-owl pellets collected at Woodbine, Camden County, Georgia. Schwartz (1952) reports, "A series of barn-owl pellets taken nineteen miles west of Miami in early February, 1951, showed that Neofiber made up sixteen percent of the mammalian diet of these birds at that time." Owl pellets from the vicinity of Pennsuco, Dade County, were over eighty percent Neofiber.

Harper (1927), reports taking a specimen of Neofiber away from a domestic house cat in the pine land in the

Okefenokee Swamp. Another Neofiber in the collection of the University of Miami was also taken away from a domestic cat along the highway around the lake region of Sumter County, at night. When the cat was fired upon, it dropped the rat.

One of the specimens of water rat taken by the author in the Foxahatchee Wild Life Refuge, March, 1952, was badly eaten while in a steel trap by a Florida red-shouldered hawk, Buteo Lineatus alleni. When the set was approached by air-boat, at 8:00 A. M., the hawk was seen wildly attempting to take off with the rat it had killed and begun to eat, but it could not get away with the "catch" because both the water rat and the trap were secured by the trap chain. The hawk was approached to within fifty feet before it finally gave up the prize.

Still another instance of predation was observed while setting traps at the Medley, Dade County, location. The author found a dead Neofiber and a dead water moccasin, Akistrodon niscivorus, lying face to face in the middle of an old Everglades road. Apparently, the moccasin was killed by some person striking it on the head when it was found eating the rat. While checking Neofiber sets west of Schopee, Collier County, June, 1952, at 11:00 P. M., the writer surprised a water

moccasin attempting to swallow a trapped Neofiber. The snake was about three feet long, and whirled away, not to be captured. It was evident by the wetted fur of the rat that the moccasin had been attempting to swallow the rat head first. The rat was presumably too large for the snake to swallow.

The first evidence which the author found of Neofiber in the southern Everglades was a half-eaten specimen from twenty miles west of Miami on the Tamiami trail at the Krome Road intersection. It was determined from the proprietors of roadside gas stations at this and other localities that cats and dogs prowl at night along the road and bring into the station yards cotton rats, rice rats, shrews, marsh rabbits, and water rats.

Besides the mentioned records of house cat, barred owls, barn owls, red-shouldered hawk, Ward's heron, and moccasin, the following should also be included as possible predators: the mink, Mustela vison, which occurs in the salt marshes of South Florida's west coast, the Indian River region and the St. Marks area; the Florida bobcat, Lynx rufus floridanus; eastern diamondback rattlesnake, Crotalus adamanteus; canebreak rattlesnake, Crotalus horridus atricaudatus; kingsnake,

Lampropeltis getulus; Indigo snake, Drymarchon corais
couperi; snapping turtle, Chelydra serpentina;
alligator, Alligator mississippiensis; and other large
hawks, owls, and herons.

PARASITES AND DISEASES
OF NEOFIBER

PARASITISM

Rats of the genus Neofiber serve as the hosts of some external and internal parasites. There has been no mention of helminth or arthropod infection in any of the literature until recently. Bauch (1952) records four helminth species (a trematode and three cestodes) from Neofiber collected in Putnam County. Two of these, Quinqueserialis floridensis, a small trematode found in the cecum, and Paranoplocephala neofiberinus, a cestode found in the small intestine, were described as new. Cittotaenia praecoquus Stilles, a cestode from the small intestine, and Taenia lymcis (?) cysticerci from the liver, constitute new host records.

The present investigation reveals a nematode infestation in the small intestine of Neofiber from Dade and Hendry Counties. This nematode was identified as belonging to the genus Longistriata in the subfamily Heligmosominae. The specimens were tentatively identified as Longistriata adunca Chandler, since they conform closely to the diagnosis of that species. These reddish nematodes were threaded into the mucosa and were found in six of twelve Neofiber examined. The

highest incidence recorded was in a male rat which harbored 170 worms, 100 of which were in the first sixty millimeters of intestine. The finding of this species in Neofiber constitutes a new host record.

Two cestodes were recovered from a female Neofiber collected by the author in June, 1952, 6.5 miles west of Monticello, Jefferson County. One cestode of the genus Paranoplocephala was removed from the anterior end of the small intestine. Although the scolex of this specimen is missing, a study of the morphology of the worm fails to disclose any character which is incompatible with its assignment to the species P. neofiberinus Rausch. The other specimen was removed from the cecum, and clearly represents the genus Cittotaenia. However, a specific designation could not be made.

These two helminth records represent a northwestern range extension of about 130 miles for P. neofiberinus, and a second record of a Cittotaenia from Neofiber. No other cestodes were recovered although many water rats were examined.

Approximately fifteen nematodes of the genus Litomosoides were found in the pleural cavity of an adult Neofiber, collected 2.5 miles south of Malabar,

Brevard County. The average length of these worms is 30 millimeters. The finding of these filarial worms in a Neofiber constitutes a new record for Litomosoides.

Many mites were taken from water rats and preserved. Since identification of material of this nature is extremely difficult, all mites were forwarded to Dr. E. W. Baker, Division of Insect Identification, U. S. Dept. of Agriculture. Dr. Baker's identification of mites of Neofiber from Dade and Hendry Counties shows that some of the mites are (1) Laelaps, n. sp., closely related to the mite Laelaps multispinosus Banks, which is from the northern muskrat (Ondatra), and belongs to the family Laelapidae. (2) Two others which are predators upon other mites, (Garmania bul-bicola (Oudemans) of the family Phytoseiidae and Macrocheles sp. of the family Macrochelidae. (3) Trombicula (Eutrombicula) splendens of the family Trombiculidae. These were forwarded by Dr. Baker to Dr. G. W. Wharton, Duke University, for identification.

Mites from Neofiber from 2.5 miles south of Malabar proved to be Tyrophagus lintneri of the family Acaridae (Tyroglyphidae) which are not parasites but general feeders on foods and fungi.

INFECTIONS

Death of Neofiber in live cages has been attributed to bacterial infection (?) following slight breaks in the skin. At various parts of the body, cysts swollen with pus develop following confinement. These cysts were subcutaneous in nature and the cyst walls were incorporated in the skin and muscle fibers. One adult water rat died with a cyst under its front leg that measured over 50 millimeters in diameter. Cyst development was observed and could be seen daily to increase in size. The animal was active until the day before death, on which day the eyes were tightly closed by a hardened mucoid secretion. It probably died from starvation and/or toxemia. All water rats that died in captivity showed this condition, but it was never observed in over fifty rats from nature.

T R A P P I N G M E T H O D S

The author hopes this section will help investigators of the future in securing specimens of the heretofore elusive water rat. Trapping of Neofiber is actually a simple matter once a colony has been located. It is hoped the presentation of localities and habitats in the text and plates will offer some information as to where to look for Neofiber workings. The need to get out and look over an area on foot can not be too greatly emphasized, since Neofiber workings can not usually be noticed from any great distance unless the rats are in extreme abundance.

In areas where the population of Neofiber was low or restricted, i.e., Merritt Island, south of Florida City, and shores of Lake Okeechobee, their workings became obvious only after getting out in the habitat and looking closely at the suspected places. A feeling for what to look for was soon developed after known areas were studied carefully.

The usual place to trap Neofiber is in their mounds. If there is a large colony of rats and many mounds are present, the collector can be particular and look for the best trap sites possible. To obtain the best results

the collector should find either a freshly-made mound, or a mound that has obviously been used the night before, the former having mound material still green, the latter with fresh pieces of food drawn up on the platform. The floor of the mound should be at least large enough to accommodate the open jaws of a No. 1 steel trap.

An attempt should be made to approach the mound area without disturbance, remembering there are underwater ways that can be deranged and thus deter the rat from going to that nest. If a collector is trapping in an area where a colony covers a very large expanse of accessible terrain, one should space the traps at least seventy-five feet apart to obtain the best results.

In certain areas where mounds are not too often made or in places where the habitat of Neofiber periodically becomes dry and tunneling systems are being used, such as the salt marshes of the Indian River, the Everglades region, and central Florida, it becomes more difficult to trap Neofiber. In these cases a steel trap should be placed in the center of the runway or down the mouth of the clean-out hole. Fresh cuttings are usually indicative of recent activity. A moderately concealed trap in such a run will make a fair trap set. If the trap can be placed down in the run so as to be covered slightly by standing water,

it need not be camouflaged with grasses. Since the body of the rat is buoyed up in the water, a trap set more than two inches deep in the water is not effective, the feet of the rat being too far above the treadle as the animal passes over.

If one is trapping in an area near enough to visit a few hours after dark (10-11 P. M.) such a visit is recommended since predators steal and disfigure specimens, and live rats trapped on only one leg will wring that leg off at the jaw of the trap. The fact that the water rat usually becomes active soon after darkness was brought out while trapping at Medley, Dade County. The writer visited sets as soon as the light of day had left the sky and retrieved a young individual and an adult. The adult was still quite alive although the jaws of the trap were choking it around the neck. The young individual was dead, with the jaws of the trap around its small body, which was still warm. The next morning another young rat was in the same reset trap. Harper (1927) reports trapping four water rats on four consecutive nights at one nest in the Okefenokee Swamp of Georgia. Therefore it can be said that more than one rat uses one mound at one time, but it is not known whether individuals other than those in one family use the same nest.

To obtain live Neofiber for study, an effective live trap was constructed by the author's father. The trap was made of one-half-inch hardware cloth formed into a cylinder, with swinging doors, made of 14-gauge annealed iron wire, hung at an angle. The doors were pivoted on a bar across the top of the ends of the cylinder, and swung inward only. The shape of this nine-inch-long trap was such as to fit the contours of the inside of the nest, the swinging doors facing the plunge holes (Plate X).

Live and unharmed Neofiber have been caught by dredging crews while dredging water hyacinths from canals in the vicinity of Clewiston. Mr. L. L. Thompson of the Everglades Wild Life Farm, Clewiston, has secured over twenty specimens of Neofiber from these dredging crews during the clearing of Nine Mile Canal, Hendry County, in March, 1952. These seemed to be none the worse for wear and survived well.

PLATE I

Upper figure: Live Neofiber alleni. Note sparsely-haired round tail and glistening guard hairs. (all photographs in plates are by the author unless otherwise stated).

Lower figure: Photograph of museum specimens of (lower) Ondatra zibethica, Douglas County, Kansas, (total length 459 mm.); (middle) Neofiber alleni, Putnam County, Florida, (total length, 345 mm.); (top) Microtus p. pennsylvanicus, Dorchester County, Maryland, (total length 169 mm.). Comparison can be made from this photograph and measurements between Neofiber and better known genera.

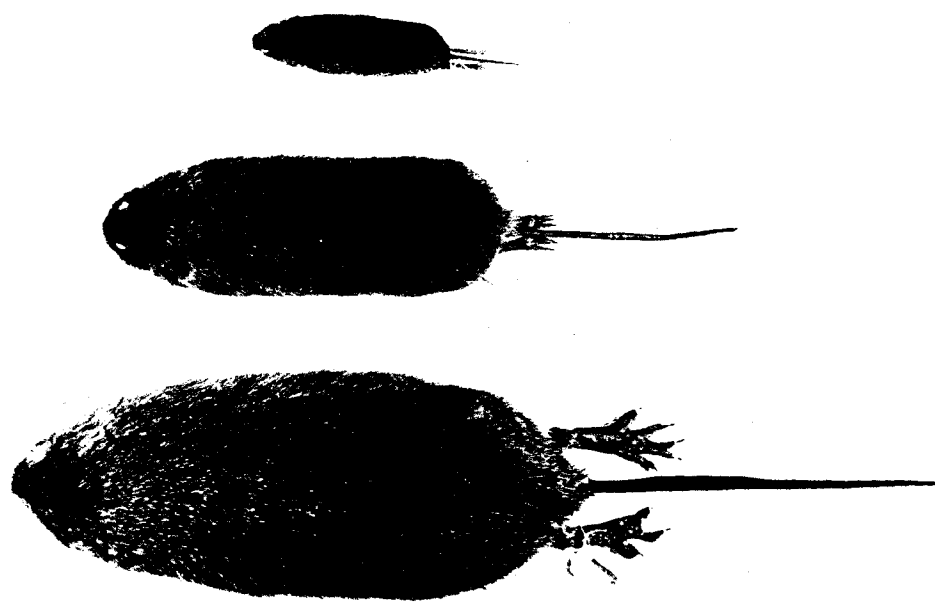
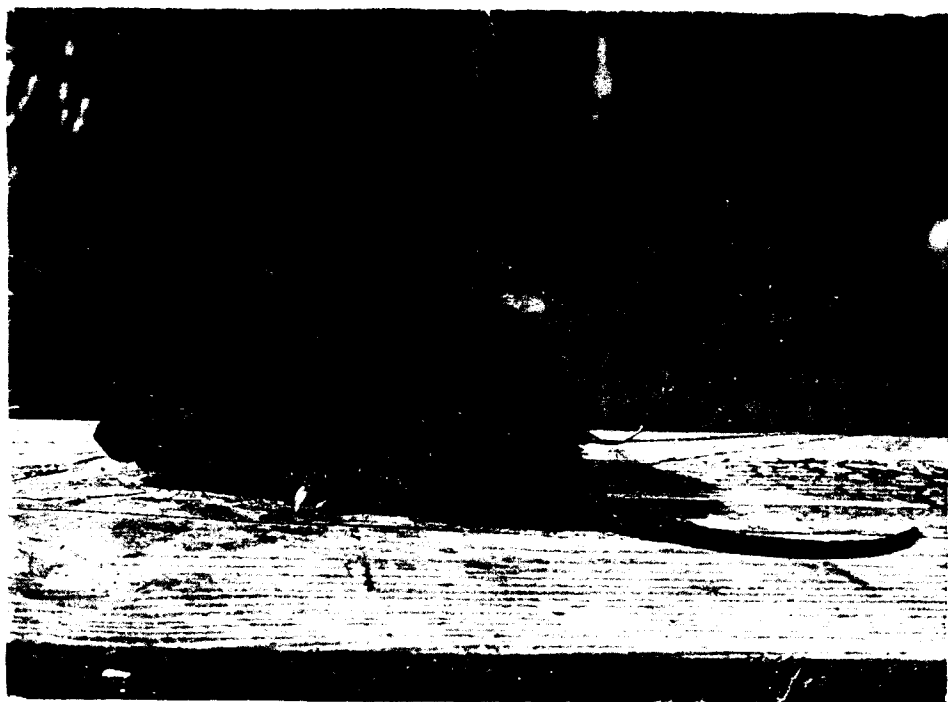


PLATE II

Upper figure: Two young Neofiber alleni taken on January 3, 1952, 21 miles west of Miami, Dade County. Age approximately one week, eyes still closed.

Lower figure: Young Neofiber alleni. Age approximately two months.





PLATE III

Upper figure: Typical habitat for Neofiber alleni in the Everglades west of Miami, Dade County. This growth of Sagittaria and Pontederia was leveled in four months of activity, March through June, 1952.

Lower figure: A mound or "house" of Neofiber constructed around the boughs of a willow in water one foot deep. Photographed in the Everglades.

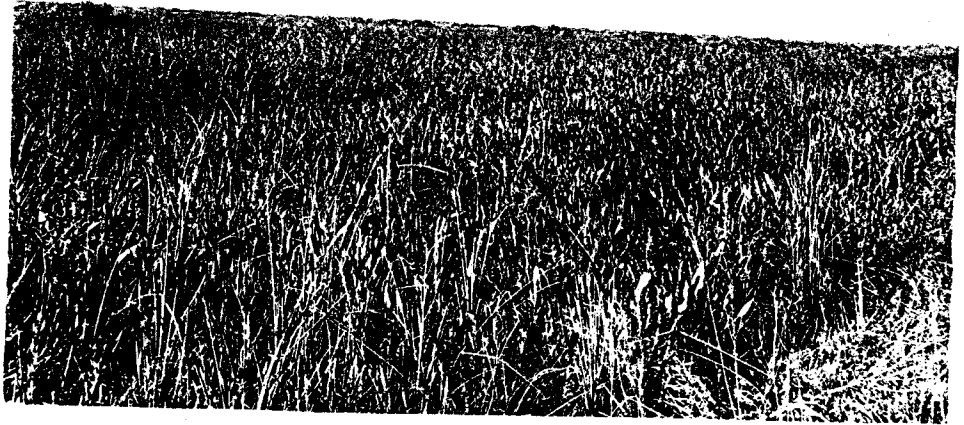


PLATE IV

Upper figure: A live Neofiber alleni in captivity
in observation pen.

Lower figure: Feeding stand of Neofiber made in a
floating tussock of Pontederia and
yellow bonnet water lily, Big Lake,
Loxahatchee Wild Life Refuge. Note
pieces of yellow bonnet water lily
fruit on center of stand remaining from
the night before.





PLATE V

Upper figure: Tunnel of Neofiber in the Everglades.

This tunnel led from the open water of a muck borrow pit into a muck bank. Note bits of grass dragged into the tunnel.

Lower figure: Mound of Neofiber made of the sedge, Eleocharis. Size of nest can be estimated by comparison with the beer can to the right. Photograph taken along Highway U. S. 1 below Florida City, Dade County, a few miles from the mangroves.



PLATE VI

Upper figure: Feeding stands of Neofiber alleni constructed of sedge, Eleocharis Flaccida. The stand is in ten inches of water where Eleocharis was the only plant growing. Nest and feeding grounds were nearby. Photographed 21 miles west of Miami.

Lower figure: Typical situation in the Loxahatchee Wild Life Refuge. An air boat here is a necessity. In this and other places in the Everglades, the water is not deep and clear enough for an outboard motor, but too wet and boggy to walk.



PLATE VII

Upper figure: Chase Prairie, Okefenokee Wild Life Refuge, Charlton County, Georgia. White-flowered water lily and arrowhead make up the major part of the aquatic vegetation in the foreground. Harper found this prairie to be densely populated with Neofiber alleni in the 1920's. In 1952 Neofiber were very scarce here.

Lower figure: A grass-choked arm of a medium-sized lake west of Madison, Madison County. In this and other lakes Neofiber was found to be very abundant in 1952. The water rats feed on the maiden cane grass, shown in this photograph, as well as construct nests of it around the base of cypress trees.



PLATE VIII

Upper figure: The shore of Lake Okeechobee a few hundred yards north of the mouth of the Kissimmee River. The water hyacinths in the center of the scene afford a specialized place of shelter for Neofiber. They construct their nests of the hyacinth roots, and feed on their stems. The nests, along with the hyacinth masses, float up and down with the tide.

Lower figure: Habitat of Neofiber alleni along the Indian River, Brevard County. Here the water rats live in the matted grass, Paspalum vaginatum, in front of the white mangrove along the lagoons on the mainland. Not only is this grass used for their food, but also it is utilized as their abode (photograph by Schwartz).



PLATE IX

Upper figure: A view of the south end of Lake Miccosukee, Jefferson County. Typical vegetation of maiden cane and water lilies is shown in the foreground and affords an excellent habitat for Neofiber.

Lower figure: This photograph reveals the clogged condition of many of the lakes of north and central Florida. The heavy grass shown in this scene is an excellent place for Neofiber workings.

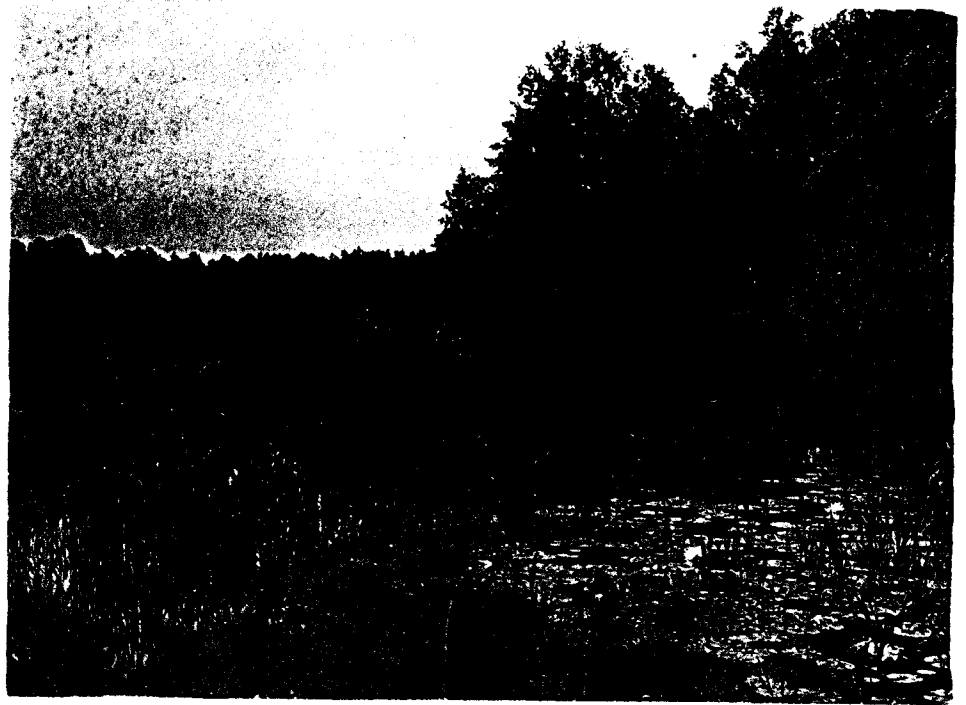
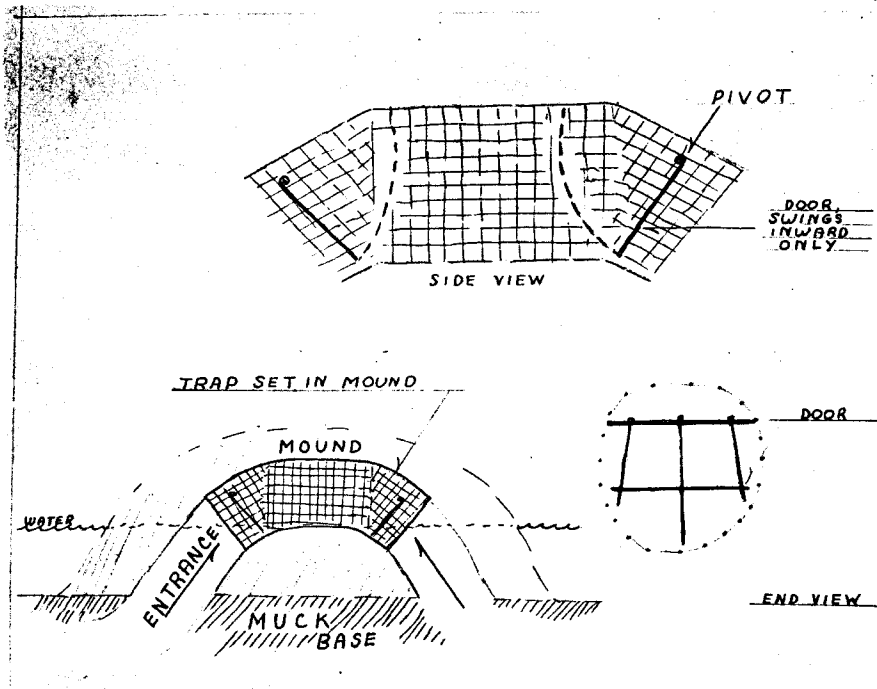


PLATE X

Upper figure: A diagram of a trap for the capturing
of water rats alive.



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V I T A

Raymond Paul Porter was born in Miami, Florida, on January 6, 1928. His parents were Philip Raymond Porter and Irene D'Eon Porter. He received his elementary education in Gesu Parochial School, Miami, Florida. In September, 1946, he entered the College of Liberal Arts of the University of Miami, from which he was graduated with the B. S. degree in February, 1951.

In February, 1951, he was admitted to the Graduate School of the University of Miami. He was granted the degree of Master of Science on February 4, 1953.

Permanent address: 1280 N. W. 28th Street, Miami, Florida.