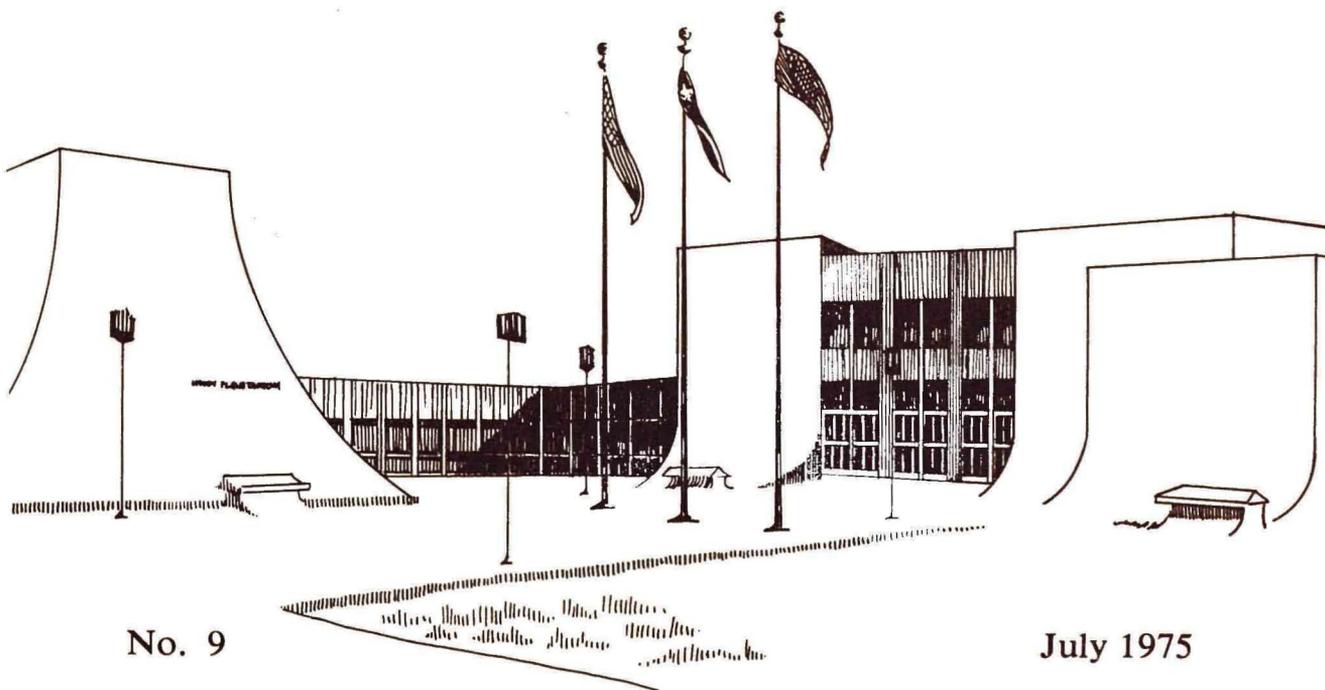


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Distribution and Biogeography of Mammals of Iowa

John B. Bowles



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Texas Tech Press, Lubbock, Texas

1975

Robert D. Bradley

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Distribution and Biogeography of Mammals of Iowa

John B. Bowles

INTRODUCTION

The state of Iowa, with a geographical area of 55,986 square miles, is situated approximately between 40° 30' and 43° 30' north latitude and 90° and 97° west longitude. The eastern and western geographic borders are formed by the Mississippi and Missouri rivers, respectively, but the northern boundary with Minnesota and the southern border with Missouri are political lines bearing no relationship to topographic features. In fact, because of regional glacial history, the topography and, to some extent, the biota of northern Iowa and southern Minnesota are similar. Prior to settlement by European emigrants, the generally flat, upland till plain of the Cary lobe of the Wisconsin glacier was covered predominantly by tall-grass prairie with few trees except along moraines or slopes of larger river valleys. Areas outside the Wisconsin lobe—including southern Iowa and northern Missouri—were covered by earlier glacial advances and the resultant terrain, therefore, is considerably more hilly and the river valleys broader and steeper. The former vegetation of such areas consisted primarily of tall-grass prairie on the hills and ridges, and eastern deciduous forest along the rivers and adjacent hillsides. The Recent mammalian fauna of Iowa includes many species that occur throughout the central United States, some clearly associated with the central grasslands, and others with the eastern deciduous or northern boreal forests. Several species reach distributional limits within the state.

The earliest published reference to mammals in Iowa seems to be that of the French explorers Louis Joliet and Jacques Marquette, who recorded observations on bison and deer on the banks of the Mississippi River near the present town of McGregor, Clayton County, on 17 July 1673. Subsequently, explorers, fur traders, and missionaries passed through Iowa in the seventeenth and eighteenth centuries. Among the most notable of the early fur traders that entered Iowa were J. J. Astor, J. B. Faribault, and Manuel Lisa (see especially Robeson, 1925). At that time, Iowa was included in the Louisiana Territory, subsequently sold to the United States in 1803; shortly afterward, the western border of Iowa (the Missouri River) was traversed by Lewis and Clark in 1804 and 1806 (the reader is here referred to "The Story of Iowa," by W. J. Peterson for complete historical details), and these explorers recorded significant observations on mammals. Other noteworthy naturalists and explorers who entered Iowa and who reported information on mammals included Z. M. Pike in 1805-06, H. M. Brackenridge in 1811, Maximilian (Wied-Neuweid) in 1833-34, C. A. Murray in 1835, and J. J. Audubon in 1843. Edwin James (1823) recorded observations by Thomas Say on the mammals encountered on the Stephen H.

Long Expedition to the Rocky Mountains in 1819-20; although the party spent the winter at the Engineer Cantonment, Washington County, Nebraska, small groups crossed the Missouri River into Iowa, especially to the area along the Boyer River. Comments relative to the occurrence of large mammals, as well as important habitat information also were recorded by members of the United States Army expeditions—especially those led by Stephen W. Kearney in 1829 and again in 1835 (then accompanied by Albert M. Lea), and by Captain James Allen in 1844. The historical literature of Iowa contains many diaries of early pioneers in which pertinent data on mammals can be found; those I found particularly useful were written by Brewer-Bonebright (1921), and Savage (1933).

The first attempts to describe the larger mammals on a statewide basis were those of Isaac Galland in 1840 (1921 reprint) and J. B. Newhall (1841), but the earliest published checklist of Iowan mammals was compiled by J. A. Allen (1870), based mostly on his collections and observations in the state in 1867 and on information published by Baird (1858). Subsequent lists of Iowan mammals were published by Goding (1883), Osborn (1890, 1892), and Van Hyning and Pellett (1910). Little has been published on mammals of specific areas in the state, the exceptions being papers by Ruthven and Wood (1912), Spurrell (1917), Gabrielson (1921), Stephens (1922), and Brown (1917). Also, historical volumes of several southern counties published in 1881 and 1882 by the State Historical Company of Des Moines contained lists of mammals supposedly found in those counties; because the authors of these historical accounts are anonymous and because no specimens are available to substantiate the records (many of which clearly are inaccurate), I included them only when additional information exists to give credence to the past or present occurrence of a given species in the counties concerned (see especially accounts of *Tamias* and *Tamiasciurus*). Additional information relative to the occurrence of large mammals found in historical accounts published early in this century was included if such records were clearly authenticated and contributed to determination of distributional patterns prior to, and during, early settlement of Iowa (see especially those published by B. F. Bowen and Company of Indianapolis, Lewis Publishing Company and S. J. Clarke Company of Chicago, in addition to Bowles, 1971).

The most comprehensive work on mammals in the state was published by T. G. Scott (1937), whose work later was supplemented by E. B. Polder (1953, 1958). In addition, Errington (1963 and elsewhere) contributed considerable information on muskrats, Scott (1947 and elsewhere) published on the red fox, and Stoner (1918) wrote on the orders Lagomorpha and Rodentia in Iowa. There also are numerous unpublished theses on game and fur-bearing mammals in the Iowa State University Library. Aside from current work by the author, most recent published work on small mammals in Iowa has been concerned with distribution and biology of bats (see Kunz and Schmitter, 1968; Watkins, 1970).

For the most part, however, little concentrated work has been done on mammals in the state of Iowa, perhaps because there are no intriguing topographic irregularities—mountain ranges, deserts, and the like—as are found in states to

the west of Iowa. Thus Iowa was a stopping place for survey parties passing through on their way, perhaps, to the Rocky Mountains, Badlands, or Black Hills. Representatives of the United States Biological Survey, for instance, made collections in the late 1800's at Knoxville, Marion County, and Hillsboro, Henry County, but these are the only localities at which extensive collecting was done by that organization.

I began work in Iowa in December of 1964 and continued to conduct at least some field work each year in the state until the autumn of 1970, with the bulk of my collections and observations being made from 1965 to 1967 and in the summer of 1968. In the course of this study, I have examined most of the specimens of Iowan mammals housed in various museums that were brought to my attention prior to 31 October 1970. To my knowledge, specimens that I was unable to examine were duplicated in other collections, but it seems reasonable to assume that some nonduplicated material has escaped my attention.

TREATMENT AND ACKNOWLEDGMENTS

The principal overall objective of this study was to summarize the present knowledge concerning mammalian distributional patterns in Iowa in order to stimulate further work on the biogeography of the central part of the United States, revision of several mammalian species occurring in that region, ecological and paleontological studies of vertebrates in Iowa, and especially study of the effects of changing land use on local habitats and distribution of small mammals in the state. To realize this objective, the specific aims of the study were: 1) the determination of kinds of Recent mammals occurring within the boundaries of the present state of Iowa in historic times and the geographic distribution of each in the state; 2) to determine the biogeographic affinities of the Recent Iowan mammals and to relate distributional patterns with varying environmental conditions from the late Pleistocene (Wisconsin) to the present; and 3) to provide workable keys for the identification of the mammals of Iowa and comments on variation in the species studied in order to facilitate future studies on the mammalian fauna of the state.

METHODS

The information summarized in the following accounts of species is the result of examination of 5635 specimens from Iowa and a summary of literature records of the 72 species and subspecies of mammals presently occurring within the boundaries of the state, or considered by me to have occurred there within historic time. Entries in both categories were completed as of May 1971. The arrangement of taxonomic categories follows Hall and Kelson (1959) to the level of genus; species and subspecies of polytypic genera and species, respectively, are arranged alphabetically for sake of convenience. The 70 species of mammals recorded within the political boundaries of Iowa belong to 22 families representing seven orders.

Each account of a subspecies or monotypic species is headed by the currently recognized scientific name in accord with the International Rules of Zoological Nomenclature. The synonymy includes only the citation to the original description and the first use of that name combination employed in this study if different from that as originally proposed. Following is an abbreviated description of current distributional status in the state (accompanied by a distribution map on which is plotted the geographical source of specimens examined and records from the literature), including my estimate of the area in the state in which the species probably occurs in suitable habitat. Remarks that follow generally include a complete analysis of statewide distribution, notes on general habitat requirements, specific comments relative to biogeographic relationships, and particular information about infraspecific or geographic variation where appropriate (external or cranial measurements included therein are given in millimeters, and weights, in grams); where means are mentioned, extremes and one standard deviation (SD) also are given. Notes on specific ecology, reproduction, or other biological phenomena are included only if they are pertinent to the dis-

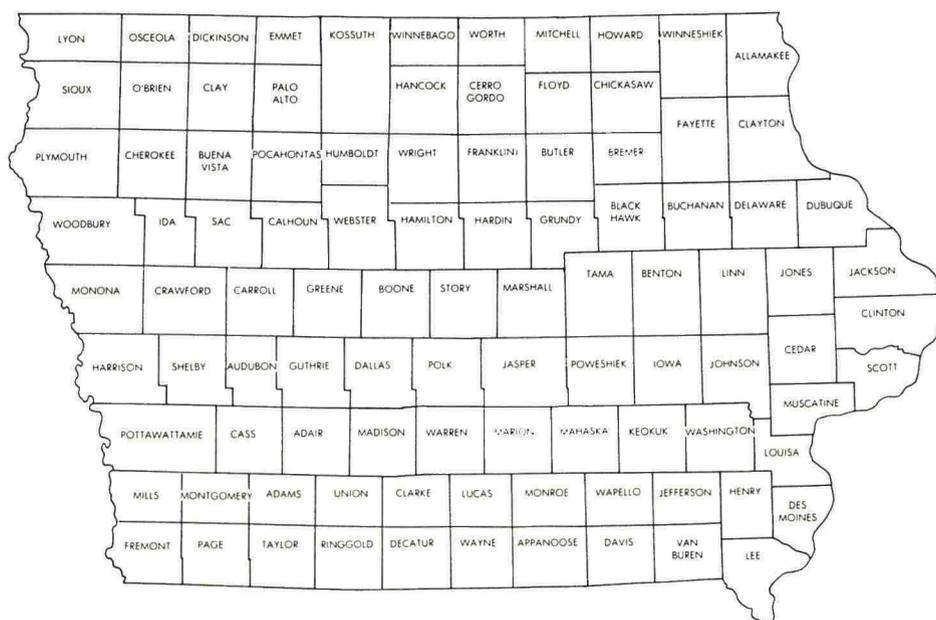


FIG. 1.—Outline map of Iowa showing the location of the 99 counties in the state.

cussion of distribution or biogeography of a particular species. The section entitled *Specimens examined* includes the total number of specimens of the taxon that I have examined. County names are listed in alphabetical order (see Fig. 1 for location of the 99 counties in Iowa) and within each county the localities are listed from north to south or, if at the same latitude, from west to east. Records are not plotted (or occasionally are slightly offset) on distribution maps if several occur so close together (usually within eight miles) that undue crowding of symbols would have occurred; localities not plotted on maps are italicized in lists of specimens examined and additional records. Symbols used on maps are explained in the legend to Fig. 3; hatching is used on maps only when the taxa concerned are not thought to be statewide in distribution.

Many of the specimens I examined are housed in the Museum of Natural History of The University of Kansas (KU). Abbreviations used for other collections are as follows: AMNH (American Museum of Natural History); BV (Department of Biology, Buena Vista College, Storm Lake, Iowa); BYU (Department of Zoology, Brigham Young University); CC (Department of Biology, Coe College, Cedar Rapids, Iowa); CUI (Department of Biology, Central College, Pella, Iowa); DPM (Davenport Public Museum, Davenport, Iowa); FMNH (Field Museum of Natural History); IHM (Iowa Historical Museum, Des Moines); ISU (Department of Zoology and Entomology, Iowa State University); NWM (Department of Biology, Northwest Missouri State College, Maryville); SM (Sanford Museum, Cherokee, Iowa); TTU (The Museum, Texas Tech University); UMMZ (Museum of Zoology, University of Michigan); UNI (Department of Biology, University of Northern Iowa); USNM (United States National Museum of

Natural History—including collection of the U.S. Biological Survey); WSU (Museum of Natural History, Wisconsin State University at Stevens Point).

Additional records include localities recorded in the literature (or field notes) from which no specimens were examined by me. Literature records no more precise than to county were not included unless no precise distributional information was available from that county. If more than one citation to a single locality exists, I have cited the most recent publication in most instances.

Most place names included in the species accounts can be found either on commercial road maps or on the general highway and transportation maps of counties printed by the Iowa State Highway Commission. In the few instances where towns no longer exist, I consulted the "Abandoned towns, villages and post-offices of Iowa" by David C. Mott, a series of articles published in the *Annals of Iowa* in 1931 and 1932.

ACKNOWLEDGMENTS

I am indebted to many individuals who have assisted me, directly or indirectly, in the completion of this report. First must come my immediate family who accompanied me on numerous collecting trips, have patiently "kept quiet while Daddy was writing," and encouraged and aided me in every possible way to complete my formal education; my wife, Gay C. Bowles, also helped type the rough draft. My parents, Dr. and Mrs. Herbert E. Bowles, were a constant source of encouragement and, when necessary, aided my family financially when I was formally enrolled in graduate training. Financial help during our stay at The University of Kansas also came from Dr. and Mrs. M. G. Andreassian (my sister-in-law). Research grants from Watkins Fund at the Museum of Natural History of The University of Kansas helped to defray costs of field work in the summer of 1968, as well as trips to examine specimens in the various museums.

For permission to examine specimens at institutions, or on loan, I am grateful to the following individuals: S. Anderson, G. G. Musser, K. F. Koopman, and R. G. Van Gelder, American Museum of Natural History; R. E. Smith, formerly Department of Biology, Buena Vista College, Storm Lake, Iowa; C. L. Hayward, Department of Zoology, Brigham Young University; R. V. Drexler and K. E. Goellner, Department of Biology, Coe College, Cedar Rapids, Iowa; Carol Hunt and P. C. Peterson, Jr., Davenport Public Museum, Davenport, Iowa; J. C. Moore, Field Museum of Natural History; J. W. Musgrove, State Historical Building, Des Moines, Iowa; M. W. Weller, Department of Zoology and Entomology, Iowa State University; D. A. Easterla, Department of Biology, Northwest Missouri State College, Maryville; Maurine Heider, Sanford Museum, Cherokee, Iowa; G. C. Schrimper, Museum of Natural History, State University of Iowa; Robert J. Baker and Robert L. Packard, The Museum, Texas Tech University; E. T. Hooper, Museum of Zoology, University of Michigan; V. E. Dowell and Pauline L. Sauer, Department of Biology, University of Northern Iowa; C. O. Handley and D. A. Schlitter, U.S. National Museum of Natural History; J. L. Paradiso, U.S. Fish and Wildlife Service (Biological Surveys Collection); and

C. A. Long, Museum of Natural History, Wisconsin State University at Stevens Point.

Some of the persons at the Museum of Natural History of The University of Kansas who collected specimens in Iowa that were used in this study include: J. R. Choate, J. A. Dick, H. H. Genoways, T. H. Kunz, D. M. Mortimer, J. D. Rising, D. A. Schlitter, and L. C. Watkins. Space does not permit the names of all individuals in Iowa who contributed specimens or accompanied me in the field, but I would like to single out the following for special recognition: R. E. Brunk, M. Bruns, the Robert Burggraaf family, B. Golden, J. F. Lally, H. G. Putnam, and N. A. Wilson. W. N. Berg, Department of Biology, Loras College, Dubuque, Iowa, kindly gave me permission to publish the new state record for *Sigmodon hispidus*. Glen C. Sanderson, Illinois Natural History Survey, directed a statewide survey of Iowan mammals in 1950 when he was with the Iowa Conservation Commission and willingly turned over to me the results of this survey. When I used information from his distribution maps, I indicated Sanderson as the source by personal communication. In addition, R. Velich of Omaha, Nebraska, kindly allowed me to cite recent records of mammals from eastern Nebraska and western Iowa included in an unpublished manuscript.

Several individuals of the Iowa Conservation Commission contributed specimens or were helpful in providing information relative to game or fur-bearing mammals. Among those I especially wish to thank are L. Ford, L. Gladfelter, and P. D. Kline, as well as E. B. Speaker and F. A. Priewart, the two directors during the period of my study who issued me scientific collecting permits. I profited from discussions with Holmes A. Semken, Jr., Department of Geology, University of Iowa, and thank him also for critically reading parts of the manuscript. My gratitude is likewise extended to professors Wakefield Dort, Jr., and Robert S. Hoffmann who were members of my doctoral committee and who critically read this manuscript.

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ENVIRONMENT

CLIMATE

The climate of Iowa is typically midcontinental and thus is characterized by seasonal extremes, year-to-year temperature and precipitation variation, and frequent local, rapid changes in weather. Such seasonal weather is the result of convergence in the midcontinental region of three major air masses—cold and dry arctic air from Canada, warm and moist maritime (tropical) air from the Gulf of Mexico, and mild Pacific air that is cool and dry as a consequence of moisture loss over the Rocky Mountains. The fronts that result from the conflict of these air masses are associated with a generally eastward moving system of high (anti-cyclonic) and low (cyclonic) pressure areas. Because Iowa lies in a region where few topographic features impede air movements, the frontal systems often move rapidly across the state, bringing frequent changes in weather patterns.

Winter weather is dominated by cold, dry air from Canada. Precipitation during this time is largely of frontal origin (Trewartha, 1954:330) and, consequently, there is widespread cloudiness and attendant rain or snow—the latter making up about one-third of the winter precipitation. Not infrequently, mild Pacific air crosses Iowa, bringing cool (but not cold), dry air, and the Pacific front reaches its mean winter position somewhat to the southeast of Iowa (see Bryson and Wendland, 1967, map on p. 275). Summer months are characteristically warm and humid as the weather in Iowa at that time is predominantly controlled by unstable maritime (tropical) air with the arctic front then lying to the north and east of the state (Bryson and Wendland, *loc. cit.*). Summer precipitation is primarily of the convectional type caused especially by periodic invasions of mild, dry Pacific air and the resulting local thunderstorms have the “advantage of permitting maximum sunshine and heat along with an abundance of rain” (Trewartha, 1954:312). In addition, hot and dry winds originating in the southwestern United States occasionally enter Iowa during the summer months (Waite, 1967:1). This complex of weather patterns results in conditions that are ideal for present day corn production and hence Iowa falls in the center of the “corn-belt climate” (Bryson and Wendland, *loc. cit.*).

Although climatic data were recorded in Iowa as early as 1819, adequate detailed information for complete analysis was not available until 1873 (Waite, 1968:13). The average temperature in Iowa varied less than one degree between 1840 and the 1880's, but there was a “remarkably strong [nearly 4° F] half century of warming,” which culminated in the 1930's. Since then an equally sharp cooling trend has occurred (temperatures are now equivalent to those in about 1899), which is manifested primarily in winter months (Waite, *loc. cit.*). The mildest winters “were bunched around the winter ending in 1929,” and subsequently, “winter temperatures began a cooling trend—about eight years before the cooling trend was reflected in the annual average temperatures for the state” (Waite, *op. cit.*, 14-15).

The average annual temperature ranges from 46° F in the northern counties of Iowa to 52° in the southeastern part of the state with average maximal July

temperatures varying from 86 to 90° minima varying from 60 to 66°. Corresponding mean January temperatures are 24 to 34° maxima and 4 to 14° minima (all above temperature data are from the period 1931 to 1952). The average number of days with temperatures of 90° or more ranges from 47 in southwestern Iowa to six in the northeastern corner. Temperatures below zero are reached, on the average, about 10 to 30 times a year in the south and north, respectively. The average annual precipitation in Iowa is 31 inches per year but ranges from 34 in the southeast to 25 in the northwest, about two-thirds falling between April and September. Measureable precipitation occurs about 100 days out of the year and the growing season for warm-weather agricultural crops lasts from about mid-May to early October (all above precipitation data from 1931 to 1955; all data on temperature and rainfall in Iowa included herein are from Waite, 1967, 1968).

Actually, Iowa lies near the contact zone between the dry and humid climatic zones of the Great Plains and the eastern United States, respectively. The dry Pacific air mass, which moves eastward across the Great Plains toward its mean frontal positions east of Iowa, has a dominating effect on the overall weather patterns in central North America and the result is a drier ("subhumid") climate than would be expected at this latitude (Trewartha, 1954:330). According to him (p. 339), this "subhumid" climate is characteristic of a wedge-shaped geographical region—roughly corresponding to Bryson and Wendland's (1967:275) "corn-belt climate"—which extends from "central Kansas and Nebraska on the west to the Atlantic Seaboard and including, besides those states mentioned, Iowa, northern and central Missouri, Illinois, Indiana, Ohio, and portions of Pennsylvania, Maryland, New Jersey, and Connecticut." It is of interest to note here that prior to settlement by European man, the vegetation of this "wedge" was predominantly tall-grass prairie in the west and deciduous hardwood forest in the east (see especially Wright, 1968).

The environmental factors causing a preponderance of tall-grass prairie in the western half of the "corn-belt climate" and, for that matter, the grasslands in the central United States have been debated for some time. Shimek (1948:89), for example, regarded the tall-grass prairie as a climax vegetation with climate (not including fire) as the major factor in its maintenance. On the other hand, others (including White, 1870; Gleason, 1913; Curtis, 1959) have discussed evidence for fire as a major factor in preservation, if not origin, of grasslands. Wells (1965), while emphasizing the importance of fire as an environmental factor in the Great Plains, suggested (p. 246) that "physiography outweighs climate as a factor in the distribution of extensive treeless grasslands" and that scarps or abrupt topographic breaks (p. 249) "may have served primarily as refugia from grass fires for the nonriparian woodlands of the plains region." Komarek (1968: 191-192) pointed out that the eastern border of "tension" between the tall-grass prairie and eastern deciduous forest is rather wide and that erratic weather patterns along with cyclic droughts may well have favored, at times, more extensive "fire periods," and at other times prevented fires. Additionally, Komarek (1962 and elsewhere) suggested that lightning is an important element of the

climate of the grasslands, being especially prevalent in the summer months when combustibility of the vegetation was highest. Lightning fires, once started, then spread easily and rapidly over large expanses of land.

GEOLOGY

Unconsolidated Pleistocene glacial till, outwash, and loess, which form a mantle of varying thickness across most of Iowa, overlie consolidated materials deposited in earlier geologic times. The latter materials dip downward from northeast to southwest. Precambrian rock, for example, occurs at depths varying from 800 to 5200 feet in those respective parts of the state (Steinhilber and Horick, 1969:30), although they also are exposed in the extreme northwestern corner. The Precambrian basement complex is overlain by strata of Paleozoic carbonates, shales, and sandstones, which are subsided into a broad trough, the "Iowa Basin," with eroded surfaces of the Paleozoic structure exposed only in the extreme northeastern part of Iowa (Steinhilber and Horick, *loc. cit.*). Rocks of Cretaceous age, primarily sandstones from the inland sea, directly underlie the Pleistocene mantle in the northwestern part of the state. Pre-Pleistocene outcrops are restricted almost entirely to the area adjacent to the Mississippi River and the larger rivers in central and southeastern Iowa. Exposed bedrock in these areas forms habitats that are markedly different from those found elsewhere in the state. Mammals, such as large canivores, utilize these rocky habitats, whereas bats frequent limestone caves and mines in eastern Iowa throughout the year and sandstone crevices and hollows (especially along the Des Moines and Iowa rivers) during autumn and spring migrations.

During the Pleistocene, Iowa was entirely or partially covered by four continental glaciers—Nebraskan, Kansan, Illinoian, and Wisconsin, from oldest to youngest. Each glacier was followed by a comparatively warm, dry interglacial period—Aftonian, Yarmouth, Sangamon, and Recent, respectively. During interglacial times, according to Ruhe (1970:240), "the landscape was worked on by processes of erosion, deposition, weathering, and soil formation such as are effective today." Nebraskan drift is generally overlain by Kansan deposits over most of the state (as both reached their limits south of Iowa), but the former is covered directly by Wisconsin loess in extreme northeastern Iowa (the "Driftless Area"), a region of about 1500 square miles bordered by Kansan drift on the west and the Mississippi River on the east. Trowbridge (1966) concluded that there actually is no Driftless Area in Iowa and that the rugged topography of this region evidently formed as a result of "drainage lines . . . and erosion of valleys started before the Nebraskan ice advance" (p. 25); thus most glacial deposits probably would have eroded quickly.

The Illinoian glacier entered the state from the south in the southeastern corner and till of that age is covered directly by Wisconsin loess. Until recently, Wisconsin ice was thought to have covered most of the northern half of Iowa in that early workers interpreted then available evidence as suggestive of four, or possibly five, substages in Iowa—Farmdale, Iowan, Tazewell, Cary, and Mankato (from oldest to youngest). Ruhe (1970), however, summarized present

interpretations based primarily on evidence obtained through soil study, pollen analysis, and radio-carbon dating. He recognized (p. 112), only the Tazewell and Cary as Wisconsin substages occurring in Iowa. The "controversial" Iowan substage is regarded by Ruhe (*op. cit.*, 95) as an eroded surface on Kansan till (referred to as the "Iowan erosion surface") covered either by Wisconsin loess or sediment of Kansan age. Thus, according to Ruhe, Iowan drift of the Wisconsin glaciation "does not exist" and the Farmdale and Mankato are regarded by him as occurring only outside of Iowa. The Wisconsin glacier, therefore, entered only north-central Iowa. The largest area—the Des Moines glacial drift lobe (Cary)—which occupies 12,300 square miles, has "four major belts of aligned ridges [and] end moraines [that] pass around the lobe. Each major belt is set inward and northward from an older system of ridges, and from south to north the end moraines are the Bemis, Altamont, Humboldt, and Algona" (Ruhe, *op. cit.*, 54). The Tazewell drift, covered by loess of Cary age, lies to the west of the Cary lobe. According to Ruhe (p. 112) approximate radio-carbon times of the major Wisconsin deposits are: Wisconsin loess—30,000 to 14,000 years BP; Tazewell drift—22,000 to 14,000 years BP; Cary drift—14,000 to 13,000 BP; Recent—less than 13,000 BP.

TOPOGRAPHY AND LAND SURFACE

Pleistocene glaciation and subsequent stream erosion have formed a topography of level (zero to two per cent slope) to undulating (two to six per cent slope) upland till plains in the north-central part of Iowa, and rolling (six to 13 per cent slope) loess-till plains in the southern and eastern parts of the state (Anderson and Welp, 1960:17). Hilly land (13 to 50 per cent slope) occurs chiefly in the northeastern counties adjacent to the Mississippi River and along narrow ridges separating river valleys elsewhere in the state.

Except for the end moraines of the Cary drift lobe, the loess bluffs of western Iowa, and other locally rugged terrain, the elevation varies little across the state—gradually decreasing from northwest to southeast. The highest point in Iowa is 1669.85 feet, located NE $\frac{1}{4}$, sec. 29, T. 100 N, R. 41 W, Osceola County (H. A. Semken, personal communication), and the lowest (477 feet) is at the mouth of the Des Moines River—see Waite (1967:1). One of the most distinctive topographic features in the state is the series of thick loess bluffs along the Missouri River floodplain.

The Pleistocene loess province (see discussion in Ruhe, 1970:114-127), covering 37,180 square miles or 66 per cent of the land area of Iowa, is composed of eolian material deposited between 30,000 and 14,000 years BP over preexisting topographic features. These loess deposits generally vary in thickness and texture in proportion to their distance eastward from the Missouri River Valley; consequently, several related characteristics of the land surface are correlated with this distance. Some of the important changes with distance eastward from the Missouri River that directly relate to soil characteristics and, therefore, have influenced local flora and fauna, as summarized by Ruhe (1970:123-125), include the following: 1) thinning of the loess; 2) decrease in particle size; 3)

broadening of summit widths; 4) decrease in local relief; 5) progressively shallower position of the impermeable paleosol layer as the loess thins; 6) decreasing depth of the deoxidized zone (zone of former or present water saturation); and 7) increasing amounts of clay in the B horizons of soils as the loess thickness decreases. In the loess province, the interfluvial summits descend as a "staircase of levels" into intervening valleys. In southern Iowa, the "upper steps" are underlain by paleosols, which sometimes outcrop locally, and on the "lower steps" the loess covers the erosion surfaces previously cut into till or other deposits. In the "Iowan erosion surface" of northeastern Iowa, the loess lies directly above the Kansan till with no intervening paleosol.

The drift province (see Ruhe, 1970:127-129) is composed of the Cary drift lobe in the north-central part of the state and the "loess-mantled area of the Iowan erosion surface in northeast Iowa" (p. 128). The major landscape features of the Cary drift—end moraines, ground moraines, outwash plains, and valley trains—are younger than 13,000 years. The drainage nets of the "loam-mantled Iowan erosion surface" intergrade throughout the region and "change imperceptibly to hillslopes which descend to valleys which equate in time to the Cary drift surface and hence are also younger than 13,000 years old" (Ruhe, *loc. cit.*).

At the stream source on the Wisconsin till in north-central Iowa, the natural drainage is primarily from shallow trenches at the bottoms of broad sags, but more mature stream systems exist in older adjacent areas. In the latter parts of the state, streams that cut through glacial till or shale tend to have broad, flat, floodplains, whereas narrow or steep-sided valleys occur where limestone or sandstone occurs at the surface (Anderson and Welp, 1960:24).

HYDROLOGY

Iowa is located in the upper Mississippi drainage basin and is bordered by the Mississippi River on the east and the Missouri and Big Sioux rivers on the west. The eight major tributaries of the Mississippi that drain the eastern two-thirds of Iowa are long and narrow and generally run parallel to each other in a southeasterly direction. The rivers of the Missouri drainage flow in the southwesterly direction and are shorter and more highly branched. The divide between the two river systems "lies roughly along the arc crossing both the north and south borders of the state so that the west one-fourth of the north part of the state and the west one-half of the south part are drained to the Missouri" (Anderson and Welp, 1960:24).

Both surface runoff from precipitation (rain or snow) and water discharged from underground sources feed the streams. The amount of runoff varies in each watershed because of dependence on both the character of precipitation and nature of the watershed. Subsurface water is replenished by percolated snow melt and rain, hence the quantity of water in the soil and the elevation of the water table both depend on the balance between the rate of replenishment and the rate of withdrawal.

Recharge occurs primarily during short periods in spring and autumn when the water tables rise. During most of the year, subsurface water is being drained

into streams and the water table tends to be gradually depressed (Anderson and Welp, 1960:36).

Subsurface water generally moves more slowly than that on the surface, with the direction and rate of flow dependent on the direction and angle of slope of the water table, and on soil permeability. Wisconsin drift, for example, is relatively flat and has poor natural drainage owing to its young age. Consequently, there were many shallow lakes and marshes prior to settlement in north-central Iowa; agricultural tiling substantially lowered the water table and many bodies of water thus were drained. In areas of loess, especially over Kansan till in southern Iowa, the well-drained soils in the west lie primarily where loess is thickest, and impermeable paleosol (relict gumbotil) and the water table that overlies it occur at considerable depths. Progressing eastward, the internal drainage becomes poorer as loess thins and paleosol is increasingly nearer the surface. Thus, in southeastern Iowa, the water table, which undulates with the general surface of eroded glacial till, is at or near the surface in stream beds, but lies somewhat below the surface on divides. On the broader, tabular divides with low relief, the internal and lateral natural drainage is impeded and hence a moist soil environment occurs under such conditions (see especially Ruhe, 1970:117-119; also the 1953-55 inventories of "Water Resources and Water Problems" published by the Iowa Natural Resources Council, Des Moines).

SOILS

Most soils in Iowa were formed from one of three kinds of parent material—glacial drift, loess, and alluvium. Drift soils occur principally in the north-central (Cary lobe) and northeastern ("Iowan erosion surface") parts of the state; loess-derived soils cover much of the remaining upland surface of Iowa, with alluvium providing the parent material for soils formed on the flood plains of major rivers and streams. Additionally, colluvial soils occur in some narrow stream valleys and residual soils formed from sedimentary rocks (chiefly sandstone, limestone, and shale) exist in northeastern Iowa and along some major river valleys. In formerly wet, poorly drained areas (notably in the Cary drift lobe and tabular ridge tops elsewhere), the parent material was organic (see especially Ruhe, 1970: 114-129).

Nine of the so-called Great Soil Groups are represented in Iowa, of which those identified as Brunizem, Gray Brown Podzolic, Humic Gley, Planosol, and Alluvium cover about 90 per cent of the state. The remaining four—Regosol, Chernozem, Lithosol, and Bog soil—are of minor importance.

Brunizem.—This soil group was developed under the tall-grass prairie and includes nearly two-thirds of the soil associations in Iowa. The Brunizems ("Prairie Soils") occur chiefly on nearly level to rolling topography, typically have a dark, medium to moderately textured upper surface, and are among the most productive soils of the world. Drainage in these soils is variable throughout the state, depending primarily on the nature of the parent material and the subsoil. It is of interest to note here that Ruhe (1970:117-118) emphasized that Brunizem soils were formed under grass regardless of whether the internal drain-

age was good (as in southwestern Iowa) or poor (as in situations farther to the east where the solum of the soil is near the relict saturation zone, and where the clay content of the B horizon is high).

Gray Brown Podzolic.—These soils developed under the hardwood forest of eastern Iowa and along the wooded river valleys of the southern part of the state, and hence occur primarily on gently rolling to steep topography. The dark upper horizon is considerably thinner and natural fertility lower than in Brunizem soils. As with the Brunizems, drainage is variable, depending on the parental source and the nature of the subsoil.

Planosol.—This group of soils was formed primarily on broad, nearly level, upland areas, and is found chiefly in southern and southeastern Iowa, often associated with both Brunizem and Gray Brown Podzolic types. Thus, Planosols were formed under either grassland or forest vegetation. Although Planosols have a dark gray upper surface and are of medium texture, water movement and root development are restricted because clay content of the B horizon is high.

Humic Gley.—These soils were formed throughout the tall-grass prairie, especially in north-central and northeastern Iowa, in sites of poor natural drainage and typically have a thick, dark upper layer.

Alluvium.—Alluvial soils occur along the floodplains and terraces of the larger streams and rivers of interior Iowa in addition to the bottomlands adjacent to the Missouri and Mississippi rivers. Alluvial soils do not have distinct horizons, although layers due to variable sedimentation may be present and the physical properties of alluvial soils are variable because of differential sedimentation, clay and sand content, flooding, and water table depth. Some Brunizems and Humic Gley soils have developed from alluvium in bottomlands and, in such situations, are closely associated with alluvial soils.

Chernozem.—Although minor soils in Iowa, the Chernozems, nevertheless, are of interest because they occur in extreme northwestern Iowa and were formed under grass cover. As was noted earlier, this is an area of relative dryness. Chernozems were formed on gently to moderately sloping topography; the profiles are thinner and the carbonates are at shallower depths than in Brunizem soils. Chernozems occur extensively in contiguous areas of Minnesota, South Dakota, and Nebraska.

Regosols.—Substrata of this nature are typical of steep slopes throughout the state, but are most prevalent in western Iowa. On these sites, erosion exceeds soil development, so that the B horizon generally is lacking. Regosols are typically calcareous in nature and have a silt loam or loam texture throughout the profile.

Lithosols.—Lithosols, formed on strongly sloping sites of rock outcroppings, are stony or rocky in nature and usually less than 12 inches in depth. These soils occur primarily in northeastern Iowa and along larger waterways where run-off is high and profile development is poor; they rarely have a B horizon.

Bog soils.—Bog soils occur chiefly in Iowa in poorly drained depressions in the north-central part of the state. Organic content is high due to slow decay and may be more than 12 inches thick. Peat and muck thus are major constituents of the soils.

The major soil groups discussed above include combinations of local soil associations throughout Iowa. The major soil associations and their specific properties are discussed in detail by Oschwald *et al.*, 1965. Additionally, soil surveys have been published for most of the 99 counties in Iowa by the United States Department of Agriculture.

VEGETATION

Much of the early work on the flora of Iowa was undertaken by Bohumil Shimek, whose manuscript of the first section of a treatise on "The plant geography of Iowa" was edited by H. S. Conard and published in 1948. This work subsequently was completed by Conard (1952). In the later paper, Conard (p. 15) divided the vegetation of the state into nine communities—woodland, shrubland, grassland, emersed aquatic, submersed aquatic, moss and lichen, fern and flower, weed, and cultivated plants—and each in turn was subdivided into associations based on dominant species. Kùchler (1964), on the other hand, mapped the potential natural vegetation of Iowa and, based on the predominant life form and taxa, included the following plant communities: bluestem prairie, oak-savannah, northern floodplain, maple-basswood, and oak-hickory.

Any discussion of the vegetation of the state with respect to its effect on mammalian distribution and abundance must include both prehistoric and present patterns of plant cover, including agricultural usage of the land by man. Changes wrought by European settlers and present actual vegetational patterns are discussed beyond in a section dealing with the influence of man. The probable prehistoric vegetation of Iowa, as synthesized primarily from Braun (1950), Conard (1952), Kucera (1952), Shimek (1911 and elsewhere), and Weaver and Fitzpatrick (1934) is here divided physiognomically into forest and grassland. Correlated with local geological features and topography, there are three distinctive types of forest communities in the state, but, although at least three floristically different associations of prairie grasses and forbs once occurred in Iowa, there were no clearly separable communities and the term "tall-grass prairie" is applicable to all prehistoric grasslands of the state.

Grasslands

Land surveys completed in 1859 showed that tall-grass prairie covered most of the western and central parts of the state (see Fig. 2) and extended also along the ridge tops between stream valleys into southern and eastern Iowa—a total of about 85 per cent of the state (Dick-Peddie, 1953:112). In the rough terrain in the latter areas, prairie on the ridges came into direct contact either with oak-hickory forest on the slopes or with a zone of invading shrubs (Shimek, 1924: 209-210; Weaver, 1960:41). Similar contact between woods, shrubs, and grassland existed along streams and rivers elsewhere in the state (Weaver, *loc. cit.*). The commonest species of shrub indicative of such invasion was (and still is) smooth sumac, *Rhus glabra*. Additionally, coral berry, *Symphycarpos orbiculatus*, invaded grasslands in dry, upland situations in eastern and southern parts of the state, but was replaced to the west by wolfberry, *S. occidentalis*. The

principal invasive shrubs on the more mesic slopes and river bottoms, in addition to smooth sumac, included wild plum, *Prunus americana*, hazel, *Corylus americana*, sandbar willow, *Salix interior*, elderberry, *Sambucus canadensis*, and indigobush, *Amorpha fragrans* (Conard, 1952:42; Weaver and Fitzpatrick, 1934:278).

Three principal grassland associations identified by Weaver and Fitzpatrick (1934) in western Iowa as indicative of the topographic and drainage features that probably affected local distribution and abundance of small mammals are discussed below. Such plant associations, named according to the single dominant species, were regarded by Conard (1952:56) as applicable to the tall-grass prairie throughout the state.

Big Bluestem Association.—The big bluestem, *Andropogon gerardi*, probably statewide in distribution, was abundant in moist lowland and stream valleys in western Iowa, and on poorly drained upland soils in the central part of the state. In exceptionally favorable habitats, nearly pure stands of this species occurred, but on the more xeric slopes or better drained soils, *A. gerardi* often shared dominance with the little bluestem, *Andropogon scoparius*. Additionally, Weaver and Fitzpatrick (1934:278) found that on wet, poorly aerated lowland soils in western Iowa, the big bluestem commonly occurred with sloughgrass, *Spartina pectinata*, switchgrass, *Panicum vergatum*, and wild-rye, *Elymus canadensis*. However, Conard (1952:61) was unable to locate similar floristic combinations of grasses elsewhere in the state and suggested that switchgrass occurred only on sandy soils with a high water table, and wild-rye only on loess.

Little Bluestem Association.—On the drier uplands, little bluestem, *Andropogon scoparius*, was the dominant species, sometimes forming nearly pure stands as on the loess bluffs along the Missouri River (Weaver and Fitzpatrick, 1934:149). This species frequently associated with prairie dropseed, *Sporobolus heterolepis*, and needlegrass, *Stipa spartea*, on dry soils in western Iowa (Weaver and Fitzpatrick, 1934:151-155), as well as with big bluestem in wetter situations throughout the state.

Sloughgrass Association.—Sloughgrass, *Stipa pectinata*, grew on soil that was too wet and poorly drained for big bluestem and, in some areas, as along the Missouri River bottoms, Weaver and Fitzpatrick (1934:146) found this species in pure stands or in association in swamps with the cattail, *Typha latifolia*.

Forests

Prior to settlement of Iowa by European man, deciduous forests existed on slopes and bottomlands of larger stream valleys in eastern and southern Iowa, as well as along waterways and on fire-protected scarps and hillsides elsewhere in the state (see Fig. 2). The three forest communities discussed below varied floristically according to local environmental conditions and geological history.

Maple-Basswood Community.—This community, dominated by sugar maple, *Acer saccharum*, and basswood, *Tilia americana*, represented the westward extension of the mesophytic deciduous forest (Braun, 1950:328), and was most extensively developed on the cool, moist lower slopes of the deeply eroded area

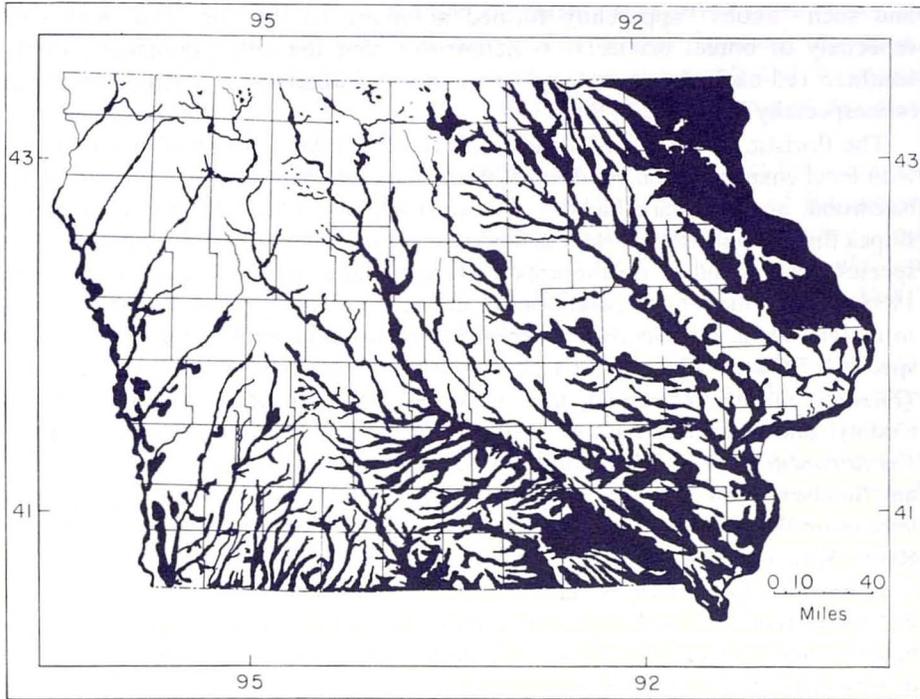


FIG. 2.—Original forest cover of Iowa (designated by black) drawn from map of Iowa State Planning Board Project 1033 completed on 17 August 1859. White area represents tall-grass steppe.

of northeastern Iowa (Conard, 1952:18-19). Scattered sugar maple-basswood forests were also reported from similarly protected slopes in southeastern Iowa (Davidson, 1960:163; Larsen and Dilworth, 1939:142-143) and in central Iowa (Kucera, 1952:294). Sugar maple was generally replaced westward by red oak, *Quercus rubra* (Conard, 1952:27), but basswood was found in suitable habitat throughout most of the state and thus in association with species other than *A. saccharum*. Clark (1926:131), for example, found red oak and basswood dominant in Black Hawk County with maple present only in occasional moist ravines.

Oak-Hickory Community.—This was the most extensive forest community in the state, occurring primarily along valley slopes and upland ridges in eastern and southern counties; elsewhere in the state, it occurred in broken series of barely connected or isolated groves, often surrounded by grassland (Shimek, 1930:673). Perusal of histories of several southwestern counties written in the 1880's, for example, suggests that fairly heavy stands of timber occurred in river valleys during the early period of settlement and evidently enough contiguous forest was present to support populations of the eastern chipmunk, a mammal evidently no longer extant in that part of the state. In addition, oak-hickory stands of various sizes, separated by either wet grasslands or sloughs, grew on the lateral Cary drift moraines in north-central Iowa and south-central Minnesota,

and such "knobs" apparently formed a unique habitat for small mammals, especially of boreal origin. It is noteworthy that the only populations of the southern red-backed vole in Iowa occur in such situations in north-central Iowa (see especially Blagen, 1967).

The floristic composition of the oak-hickory community varied in accordance with local environmental conditions. White oak, *Quercus alba*, red oak, *Q. rubra*, basswood, and shagbark hickory, *Carya ovata*, dominated the moist, protected slopes throughout the central and southern parts of the state, with the latter two species most abundant on the upper, more gentle slopes (Aikman and Smelser, 1938:146). In more xeric conditions to the west, and on upper south facing slopes in eastern Iowa, the bur oak, *Quercus macrocarpa*, generally was the dominant species (Conard, 1952:19). Clark (1926:131), however, reported black oak, *Quercus velutina*, to be as common as bur oak on dry, sandy soils in Black Hawk County, and these two oaks commonly were associated with bitternut hickory, *Carya cordiformes*, on drier upper slopes and summits in central Iowa (Aikman and Smelser, 1938:146). In extreme western Iowa, the bur oak was the dominant species on the protected slopes and valleys of the loess bluffs along the Missouri River (Weaver, 1960:41).

Floodplain Community.—The floodplain forest formed a nearly continuous belt along rivers and tributaries throughout the state, with the greatest development along the wide floodplains of the Missouri and Mississippi rivers. The dominant species on the river or stream terraces were box elder, *Acer negundo*, silver maple, *Acer saccharinum*, American elm, *Ulmus americana*, slippery elm, *U. rubra*, white ash, *Fraxinus americana*, green ash, *F. pennsylvanica*, hackberry, *Celtis occidentalis*, and walnut, *Juglans nigra*, but these trees often merged with the oak-hickory forests on lower valley slopes (Conard, 1952:16-19; Davidson, 1960:163; Larsen and Dilworth, 1939:142). The most abundant trees along the smaller or upland streams, which formed the riparian forests, included cottonwood, *Populus deltoides*, black willow, *Salix nigra*, peachleaf willow, *S. amygdaloides*, and sandbar willow, *S. interior*, whereas the river birch, *Betula nigra*, often occurred in dense thickets on high, dry river banks (Weaver, 1960:45; Conard, 1952:15-16). The three willows and the cottonwood are the only trees formerly found along the headwaters of intermittent streams in western Iowa (Weaver, 1960:62).

INFLUENCE OF MAN

Prehistoric man probably inhabited Iowa before the final retreat of the Wisconsin glacier, although the earliest definite signs of human presence have been dated as about 12,000 BP (McKusick, 1964:43). The influence of early man on populations of Recent mammals in Iowa, either directly or indirectly, is difficult to assess. The clearing and cultivation of land, generally near rivers, perhaps had minimal or at least only local effects on mammalian populations, and hunting parties undoubtedly went into the tall-grass prairie in search of the larger food species. There is some evidence, for example, of a bison kill on the west bank of the Little Sioux River, Cherokee County, dated about 8500 BP (McKusick, *op.*

cit., 59-61). In addition to the hunting pressure, prehistoric man in Iowa undoubtedly influenced mammalian distributional patterns indirectly by setting prairie fires, which, along with those of natural occurrence, affected the vegetation of the region and may thereby have contributed to maintenance of the grasslands (see especially Stewart, 1963).

Perhaps the earliest influence of European man on mammals in Iowa resulted from the pressure of fur-trading companies. Trapping activities of Europeans, in addition to those of Indian tribes in Iowa, were instrumental in reducing populations of some furbearers to low levels in the state by mid-1800's. In addition, white man extirpated several large predatory and game species by the late 1800's and drastically reduced populations of others (Bowles, 1971).

Because European man came to Iowa primarily from forested areas east of the Mississippi River, he tended to settle initially in or near similar habitats, especially along waterways, and proceeded to remove timber for building materials and fuel in addition to preparation of land for cultivation. Such activities were responsible for reducing populations of some forest species of mammals, especially in southwestern Iowa. Planted groves of timber, on the other hand, probably accounted for westward expansion of other species. The primary change in areas of tall-grass prairie resulted from cultivation, which occurred first in the naturally well-drained sites and later in the remainder of the prairie. Many sloughs and other wet sections of the tall-grass prairie were drained before the turn of the century. Cultivation of the tall-grass prairie also resulted in a decrease of prairie fires. Perhaps the last of such fires were in Cherokee County in 1880 (McCulla, 1914:107) and Calhoun County in 1884 (Stonebraker, 1915:301). Decrease in the feared prairie fires and the completion of the North West Railroad across Iowa in 1867 (Peterson, 1952:587) undoubtedly encouraged rapid settlement of areas of virgin prairie, particularly in the western part of the state. Wherever land was cultivated, gulying and runoff of silt and topsoil occurred. This was aggravated by the replacement of "wild grass" by "tame grass" for pasture, as the latter was inefficient in retaining and holding the spring rains; hence soil was drier in July and August than under native grasses (Kilburn, 1915:245). In addition to over-all water loss, rapid run-off and consequent soil erosion resulted in a high rate of siltation in Iowa's streams and presently is one of the state's major environmental problems (Morris, 1969:108). As settlers moved progressively westward in the state, cattle were herded ahead of them; herding was prevalent in central and western counties until about 1860 and 1890, respectively (Hopkins, 1928:218-219). By 1890, bluegrass, *Poa pratensis*, previously in pastures in southeastern Iowa, appeared in western counties but the method of introduction is "obscure" (Hopkins, 1928:233, 237). Alfalfa, timothy, and various species of clover were introduced early as hay crops in the state where native prairie grasses had been eliminated.

By the early 1900's, most of the tall-grass prairie was obliterated, the extensive tracts of forest either eliminated or drastically reduced; newly planted woodlots existed on land previously devoid of trees. Subsequent to early cultivation and settlement of Iowa, corn became the principal agricultural crop in much of east-

ern and central Iowa (Aikman and Smelser, 1938:141), while pasture-hay land was converted to grain crops in southern and western counties (Ross, 1946:22, Weaver, 1954:178-184). Weaver (1958:738) reported that few uncultivated sections of prairie remained in the mid-1930's and that most of those were ploughed shortly thereafter. Although corn was the dominant cultivated crop in much of Iowa, crop rotation maintained at least some suitable habitats for grassland mammals. Recent trends toward continual corn, as well as a general increase in acreage of other row crops—especially soybeans—have drastically changed the nature of the vegetation in many parts of Iowa (see especially Nomsen, 1970).

The following four major tracts of tall-grass prairie were preserved by the state of Iowa: Cayler Prairie (120 acres), 3 mi. W Gull Point, Dickinson County; Kalso Prairie (110 acres), 4 mi. N Manson, Pocahontas County; Asa Hayden Prairie (199 acres), 4 mi. W Lime Springs, Howard County; and Sheeder Prairie (25 acres), 4 mi. W and 1 mi. N Guthrie Center, Guthrie County (Landers, 1966:418). Numerous other prairie remnants have been described in recent years, but these generally were in or near cemeteries, railroad rights-of-way, small uncultivated pastures, or other areas inaccessible for agricultural usage. Relatively few prairie species of plants presently exist in grassy habitats elsewhere in Iowa and the dominant elements generally are introduced grasses, especially bluegrass, *Poa pratensis*, and smooth brome, *Bromus inermis*. Except for some extensive sections of pasture in parts of western and southern Iowa, grassy habitats occur chiefly along roadsides, railroad rights-of-way, and other such areas related to man's non-agricultural usage.

The wooded areas of the northeastern counties are the least disturbed of the forest habitats in Iowa, undoubtedly due to the rough terrain. A few extensive oak-hickory groves remain in eastern and southern areas, but these are usually on hillsides, bluffs, or areas that are difficult to cultivate. In the denser stands, the species composition has been altered by selective cutting and, even along floodplains, much of the better timber has been removed (Larsen and Dilworth, 1939:142).

ACCOUNTS OF SPECIES

CHECKLIST OF IOWAN MAMMALS

There are 72 kinds (subspecies and monotypic species) of mammals reported from Iowa, of which four (indicated by an asterisk) were introduced; these 72 kinds belong to 70 species, 56 genera, and 22 families of seven orders. A list of 16 species not yet reported from the state but likely to occur there (or to have been present prior to the arrival of European man) is included at the end of the accounts of species.

Order MARSUPIALIA—Marsupials

Family Didelphidae—Opossums

Didelphis virginiana virginiana Kerr (Virginia Opossum) p. 28

Order INSECTIVORA—Insectivores

Family Soricidae—Shrews

Sorex cinereus haydeni Baird (Masked Shrew) p. 30

Microsorex hoyi hoyi (Baird) (Pygmy Shrew) p. 33

Blarina brevicauda brevicauda (Say) (Short-tailed Shrew) p. 34

Blarina brevicauda carolinensis (Bachman) (Short-tailed Shrew) p. 37

Cryptotis parva parva (Say) (Least Shrew) p. 38

Family Talpidae—Moles

Scalopus aquaticus machrinoides Jackson (Eastern Mole) p. 39

Order CHIROPTERA—Bats

Family Vespertilionidae—Vespertilionid Bats

Myotis keenii septentrionalis (Trouessart) (Keen's Myotis) p. 43

Myotis lucifugus lucifugus (LeConte) (Little Brown Myotis) p. 44

Myotis sodalis Miller and Allen (Indiana Myotis) p. 46

Lasionycteris noctivagans (LeConte) (Silver-haired Bat) p. 47

Pipistrellus subflavus subflavus (F. Cuvier) (Eastern Pipistrelle) p. 48

Eptesicus fuscus fuscus (Palisot de Beauvois) (Big Brown Bat) p. 49

Lasiurus borealis borealis (Müller) (Red Bat) p. 51

Lasiurus cinereus cinereus (Palisot de Beauvois) (Hoary Bat) p. 52

Nycticeius humeralis humeralis (Rafinesque) (Evening Bat) p. 54

Family Molossidae—Free-tailed Bats

Tadarida macrotis (Gray) (Big Free-tailed Bat) p. 55

Order LAGOMORPHA—Hares, Rabbits, and Pikas

Family Leporidae—Hares and Rabbits

Sylvilagus floridanus mearnsii (J. S. Allen) (Eastern Cottontail) p. 56

Lepus townsendii campanius Hollister (White-tailed Jack Rabbit) p. 58

Order RODENTIA—Rodents

Family Sciuridae—Squirrels and Allies

Tamias striatus griseus Mearns (Eastern Chipmunk) p. 61

<i>Marmota monax monax</i> (Linnaeus) (Woodchuck)	p. 63
<i>Spermophilus franklinii</i> (Sabine) (Franklin's Ground Squirrel)	p. 65
<i>Spermophilus tridecemlineatus tridecemlineatus</i> (Mitchill) (Thirteen-lined Ground Squirrel)	p. 67
* <i>Cynomys ludovicianus ludovicianus</i> (Ord) (Black-tailed Prairie Dog)	p. 153
<i>Sciurus carolinensis pennsylvanicus</i> (Ord) (Gray Squirrel)	p. 69
<i>Sciurus niger rufiventer</i> É. Geoffroy St.-Hilaire (Fox Squirrel)	p. 71
<i>Tamiasciurus hudsonicus minnesota</i> (J. A. Allen) (Red Squirrel)	p. 73
<i>Glaucomys volans volans</i> (Linnaeus) (Southern Flying Squirrel)	p. 76
Family Geomyidae—Pocket Gophers	
<i>Geomys bursarius majusculus</i> Swenk (Plains Pocket Gopher)	p. 77
Family Heteromyidae—Pocket Mice and Kangaroo Rats	
<i>Perognathus flavescens perniger</i> Osgood (Plains Pocket Mouse)	p. 81
Family Castoridae—Beavers	
<i>Castor canadensis missouriensis</i> V. Bailey (Beaver)	p. 82
Family Cricetidae—Native Rats and Mice	
<i>Reithrodontomys megalotis dychei</i> J. A. Allen (Western Harvest Mouse)	p. 85
<i>Peromyscus leucopus noveboracensis</i> (Fischer) (White-footed Mouse)	p. 87
<i>Peromyscus maniculatus bairdii</i> (Hoy and Kennicott) (Deer Mouse)	p. 90
<i>Onychomys leucogaster leucogaster</i> (Wied-Neuwied) (Northern Grasshopper Mouse) ..	p. 93
<i>Sigmodon hispidus texianus</i> (Audubon and Bachman) (Hispid Cotton Rat)	p. 94
<i>Clethrionomys gapperi loringi</i> (V. Bailey) (Gapper's Red-backed Vole)	p. 95
<i>Synaptomys cooperi gossii</i> (Coues) (Southern Bog Lemming)	p. 96
<i>Microtus ochrogaster ochrogaster</i> (Wagner) (Prairie Vole)	p. 98
<i>Microtus pennsylvanicus pennsylvanicus</i> (Ord) (Meadow Vole)	p. 100
<i>Microtus pinetorum nemoralis</i> V. Bailey (Woodland Vole)	p. 102
<i>Ondatra zibethicus zibethicus</i> (Linnaeus) (Muskrat)	p. 103
Family Muridae—Old World Rats and Mice	
* <i>Mus musculus</i> Linnaeus (House Mouse)	p. 149
* <i>Rattus norvegicus</i> (Berkenhout) (Norway Rat)	p. 151
Family Zapodidae—Jumping Mice	
<i>Zapus hudsonius intermedius</i> Krutzsch (Meadow Jumping Mouse)	p. 105
Family Capromyidae—Nutria and Allies	
* <i>Myocaster coypus</i> (Molina) (Nutria or Coypu)	p. 152
Family Erethizontidae	
<i>Erethizon dorsatum dorsatum</i> (Linnaeus) (Porcupine)	p. 107
Order CARNIVORA—Carnivores	
Family Canidae—Coyote, Wolves, and Foxes	
<i>Canis latrans thamnus</i> Jackson (Coyote)	p. 109
<i>Canis lupus nubilus</i> Say (Gray Wolf)	p. 111
<i>Vulpes vulpes regalis</i> Merriam (Red Fox)	p. 113
<i>Urocyon cinereoargenteus ocythous</i> Bangs (Gray Fox)	p. 115

Family Ursidae—Bears

Ursus americanus americanus Pallas (Black Bear) p. 117

Family Procyonidae—Raccoon and Allies

Procyon lotor hirtus Nelson and Goldman (Raccoon) p. 119

Family Mustelidae—Weasels, Skunks, and Allies

Martes pennanti pennanti (Erxleben) (Fisher) p. 121
Mustela erminea bangsi Hall (Ermine) p. 122
Mustela frenata primulina Jackson (Long-tailed Weasel) p. 123
Mustela frenata spadix (Bangs) (Long-tailed Weasel) p. 124
Mustela nivalis campestris Jackson (Least Weasel) p. 125
Mustela vison letifera Hollister (Mink) p. 127
Gulo gulo luscus (Linnaeus) (Wolverine) p. 129
Taxidea taxus taxus (Schreber) (Badger) p. 129
Spilogale putorius interrupta (Rafinesque) (Spotted Skunk) p. 131
Mephitis mephitis hudsonica Richardson (Striped Skunk) p. 133
Lutra canadensis canadensis (Schreber) (River Otter) p. 135

Family Felidae—Cats

Felis concolor schorgeri Jackson (Mountain Lion) p. 137
Lynx canadensis canadensis Kerr (Lynx) p. 139
Lynx rufus rufus (Schreber) (Bobcat) p. 139

Order ARTIODACTYLA—Even-toed Ungulates

Family Cervidae—Wapiti, Deer, and Allies

Cervus elaphus canadensis Erxleben (Wapiti) p. 141
Odocoileus hemionus hemionus (Rafinesque) (Mule Deer) p. 143
Odocoileus virginianus macrourus (Rafinesque) (White-tailed Deer) p. 144

Family Antilocapridae—Pronghorn

Antilocapra americana americana (Ord) (Pronghorn) p. 147

Family Bovidae—Bovids

Bison bison bison (Linnaeus) (Bison) p. 147

KEY TO ORDERS OF IOWAN MAMMALS

1. Hallux clawless and opposable; marsupium present in females; incisors 5/4 Marsupialia, p. 28
- 1'. Hallux, if present, with a claw and not opposable; marsupium lacking; incisors never 5/4 2
- 2.(1') Front limbs modified as wings; fingers (which support the wing) longer than forearm Chiroptera, p. 42
- 2'. Front limbs not modified as wings; fingers shorter than forearm 3
- 3.(2') Upper incisors absent; feet with two hooves Artiodactyla, p. 141
- 3'. Upper incisors present; feet with claws 4
- 4.(3') Toothrows continuous (lacking diastema); canines present 5
- 4'. Toothrows not continuous (diastema between incisors and cheekteeth); canines absent 6

- 5.(4) Total length less than 200; canines about equal in length to adjacent teeth Insectivora, p. 29
 5'. Total length greater than 250; canines conspicuously larger than adjacent teeth Carnivora, p. 108
 6.(4') Ears about equal to tail in length, incisors 2/1 Lagomorpha, p. 55
 6'. Ears clearly shorter than tail; incisors 1/1 Rodentia, p. 60

ORDER MARSUPIALIA—Marsupials

The family Didelphidae, members of which are widely distributed in the Neotropics, is represented in the United States by a single species.

Family DIDELPHIDAE—Opossums

Didelphis virginiana virginiana Kerr Virginia Opossum

1792. *Didelphis virginiana* Kerr, The animal kingdom . . . , p. 193 (type locality, Virginia).

Distribution in Iowa.—Statewide in suitable habitats (see Fig. 3).

The opossum presently is a common resident throughout Iowa, although it evidently is most abundant in the southern counties and locally elsewhere along wooded waterways. Records of occurrence in the late 1800's and early 1900's suggest that this species was more or less limited at that time to wooded areas in the southern part of the state, although individuals occasionally were reported from as far north as southeastern Minnesota (Allen, 1870:190; Brown, 1917:23). The establishment of the opossum in the northwestern prairie region of Iowa probably has taken place since 1900 (Spurrell, 1917:280; Scott, 1937:51). It seems likely that the northward movement has occurred along the drainage systems of both the Missouri and Mississippi rivers, and that movement away from water courses was facilitated by the activities of the early settlers (Jones, 1964:59; Wiseman and Hendrickson, 1950). Considering adjacent states, Jones (*loc. cit.*) suggested a northward and westward movement of the opossum in Nebraska in recent years, Gunderson and Beer (1953:31) considered it to be "a recent addition to Minnesota's fauna," and Findley (1956:20) noted its scarcity in southeastern South Dakota.

Specimens examined (68).—ALLAMAKEE COUNTY: 4 mi. SW New Albin, 1 (WSU). BLACK HAWK COUNTY: "local" [vicinity Cedar Falls], 1 (UNI). BENTON COUNTY: SE 1/4 of SW 1/4 of sec. 29, T. 82 N, R. 11 W, 1 (ISU). BREMER COUNTY: Janesville, 1 (UNI). BUENA VISTA COUNTY: 4 mi. N, 7 mi. E Storm Lake, 1 (BV); 2 mi. N, 2 mi. E Storm Lake, 1 (SM); 1 mi. N, 9 1/2 mi. E Storm Lake, 1 (BV); 6 mi. S, 2 mi. E Storm Lake, 1 (BV). DAVIS COUNTY: Bloomfield, 4 (2 CC, 2 ISU). DECATUR COUNTY: *no specific locality*, 1 (ISU). EMMET COUNTY: 2 mi. N Estherville, 1 (ISU). FREMONT COUNTY: 10 mi. E Hamburg, 1 (KU). HAMILTON COUNTY: Little Wall Lake, 1 (ISU). JOHNSON COUNTY: Madison Twp., 1 (CC); *no specific locality*, 23 (2 ISU, 21 SU1). KEOKUK COUNTY: 8 mi. W Sigourney, 1 (KU). LINN COUNTY: Spring Grove Twp., 1 (CC); near Marion, 1 (CC). MAHASKA COUNTY: 1 1/2 mi. S, 2 1/2 mi. E New Sharon, 4 (KU); 3 1/2 mi. N Oskaloosa, 1 (KU); Oskaloosa, 2 (KU); 6 mi. S Oskaloosa, 1 (KU). MUSCATINE COUNTY: vicinity Stockton, 2 (DPM). PAGE COUNTY: Shendoah, 1 (CC). PLYMOUTH COUNTY: 1 1/2 mi. N, 1 1/2 mi. W Kingsley, 1 (KU). POTTAWATTAMIE COUNTY: 7 mi. E Oakland, 1 (KU). SAC COUNTY: 1/2 mi. E Nemaha, 1 (BV). SCOTT

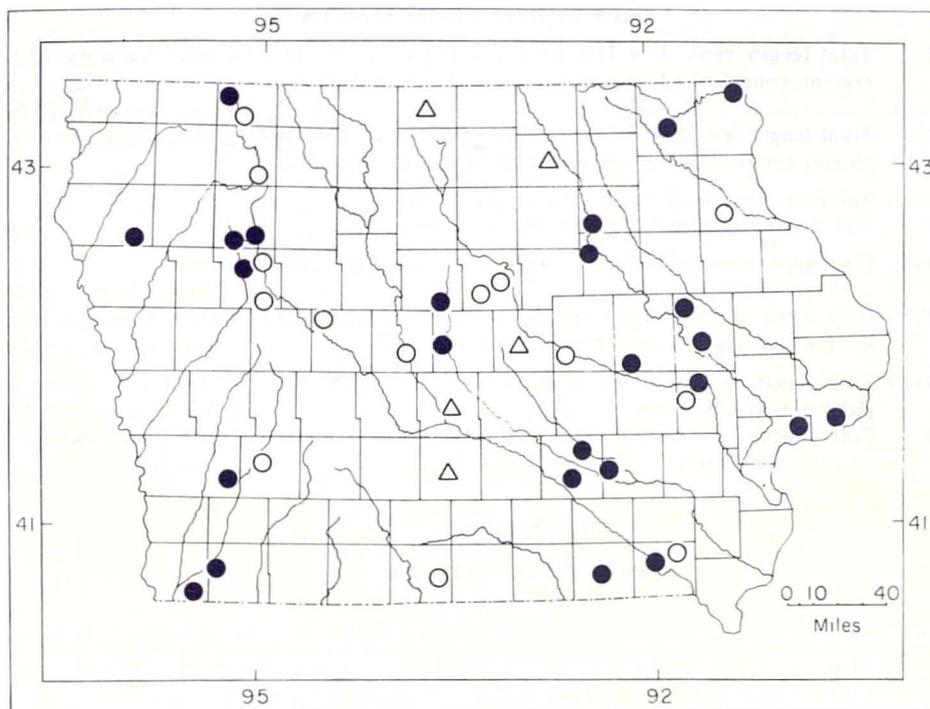


FIG. 3.—Distribution of *Didelphis virginiana virginiana* in Iowa. Solid symbols indicate specimens examined, whereas open symbols denote records from the literature. Circles represent known localities; triangles refer to records known only to county.

COUNTY: Davenport, 3 (DPM); no specific locality, 4 (DPM). STORY COUNTY: NE 1/4 of NE 1/4 of sec. 21, T. 83 N, R. 24 W, 1 (ISU); Ames, 1 (ISU). VAN BUREN COUNTY: sec. 24, Van Buren Twp., 1 (ISU). WINNEBAGO COUNTY: Decorah, 1 (UMMZ).

Additional records.—BOONE COUNTY: Moingona Fox Range, about 5 mi. S Boone (Scott, 1947:443). CASS COUNTY: Atlantic (Scott, 1937:51). CLAY COUNTY: Gillett Grove (Ruthven and Wood, 1912:280). CLAYTON COUNTY: 2 mi. S Elkader (Scott, 1937:51). DECATUR COUNTY: sec. 13, Woodland Twp. (Hendrickson, 1954:25). EMMET COUNTY: Ryan Lake (Scott, 1937:51). FLOYD COUNTY: no specific locality (Brown, 1917:23). GREENE COUNTY: Churdan (record on file, U.S. Biological Survey); no specific locality (Weller and Blagen, 1970:286). HARDIN COUNTY: 1/4 mi. E Steamboat Rock (Bowles, field notes); 6 mi. W Eldora (Bowles, field notes). JOHNSON COUNTY: near Oxford (Hartman, 1922:147). MARSHALL COUNTY: no specific locality (Gabrielson, 1921:147). POLK COUNTY: no specific locality (Scott, 1938:536). SAC COUNTY (Spurrell, 1917:280): Lee Grove [8 mi. N Sac City]; Sac City; Wall Lake; Grant Grove [= City]. STORY COUNTY: Ames (Elwell, 1962a:28). TAMA COUNTY: Tama (Joyce and Eddy, 1944:213). VAN BUREN COUNTY: Stockport and vicinity (Wiseman and Hendrickson, 1950:331). WARREN COUNTY: no specific locality (Weller and Blagen, 1970:286). WINNEBAGO COUNTY: no specific locality (Weller and Blagen, 1970:286).

ORDER INSECTIVORA—Insectivores

Two families and five genera of insectivores are found in Iowa. Each genus is represented by a single species.

KEY TO IOWAN INSECTIVORES

1. Total length more than 150; front feet twice as wide as hind feet; zygomatic arch present; condylobasal length more than 30 (family Talpidae) *Scalopus aquaticus*, p. 39
- 1'. Total length less than 150; front feet not twice as wide as hind feet; zygomatic arch absent; condylobasal length less than 26 (family Soricidae) 2
- 2.(1') Tail long, more than 30 per cent of total length 3
- 2'. Tail short, less than 25 per cent of total length 4
- 3.(2) Four upper unicuspid clearly visible in a lateral view (fifth is reduced) *Sorex cinereus*, p. 30
- 3'. Only three (of five) upper unicuspid clearly visible in lateral view (third and fifth minute and obvious only from occlusal view) *Microsorex hoyi*, p. 33
- 4.(2') Total length more than 90; condylobasal length more than 20; 32 teeth (five unicuspid on each side above) *Blarina brevicauda*, p. 34
- 4'. Total length less than 90; condylobasal length less than 17; 30 teeth (four unicuspid on each side above) *Cryptotis parva*, p. 38

Family SORICIDAE—Shrews

***Sorex cinereus haydeni* Baird**

Masked Shrew

1858. *Sorex haydeni* Baird, Mammals, in Reports of explorations and surveys . . . from the Mississippi River to the Pacific Ocean . . . , 8(1):29, 14 July (type locality restricted to Ft. Union, just west of confluence of Missouri and Yellowstone rivers, Williams Co., North Dakota, by Merriam, N. Amer. Fauna, 10:60, 31 December 1895).
1925. *Sorex cinereus haydeni*, Jackson, J. Mamm., 6:56, 9 February.

Distribution in Iowa.—Probably statewide, but unreported from extreme southern counties (see Fig. 4).

The masked shrew is relatively common in northern and central Iowa, where it chiefly occupies moist grassy areas but also a variety of other habitats, including forest and woodland. I know of no records of this species from the extreme southern part of the state or from adjacent areas in Missouri. The geographic ranges of *Sorex cinereus* and *Cryptotis parva* overlap throughout much of southern Iowa and one or the other species may be locally dominant where they occur together, as suggested by Jones (1964:63), in Nebraska.

Jackson (1928) referred specimens of *Sorex cinereus* from western Iowa to the subspecies *haydeni* and those from the eastern part of the state to *S. c. cinereus*. Subsequently, most authors have recognized two subspecies in Iowa (Scott, 1937; Polder, 1953 and 1958); the name *haydeni* has continued to be used for the western race but, since 1942, the name *leseurii* generally has been applied to shrews from eastern Iowa (Schlitter and Bowles, 1968:525).

Geographic races of *Sorex cinereus* in the central United States are not clearly defined and are in need of systematic review. In assigning individuals to subspecies, Jackson (1928) emphasized color and external measurements; I find color to be quite variable among Iowan specimens, both seasonally and locally, and external size varies locally also. Furthermore, a comparison of cranial measurements of *S. cinereus* from eastern and western parts of the state revealed

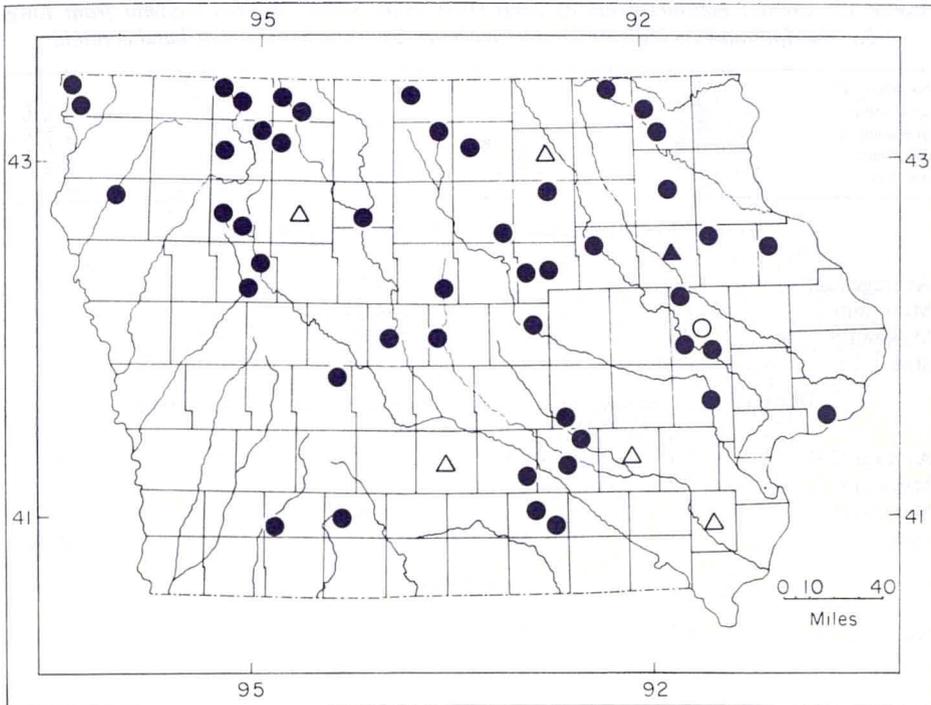


FIG. 4.—Distribution of *Sorex cinereus haydeni* in Iowa. For explanation of symbols see Fig. 3.

considerable individual variation and no significant differences (see Table 1) except that specimens from Adams and Union counties have skulls that are shorter and relatively broader than crania of any other specimens examined of the species; these could represent an isolated population in southwestern Iowa. Moreover, I was unable to detect consistent differences between Iowa-taken individuals and those of similar age from Nebraska and Indiana that have been referred sub-specifically to *haydeni* and *leseurii*, respectively. Mumford (1969:31) emphasized differences in color between specimens from Illinois and Indiana, while continuing to employ the name *leseurii* for specimens from the vicinity of the Wabash River (the type locality of *leseurii*).

I find no justification for recognizing two named subspecies within the geographic limits of Iowa and tentatively assign all specimens of *S. cinereus* from the state to the subspecies *haydeni*. I do so primarily because of the similarity between specimens from Iowa and Nebraska, and because I have not had the opportunity to examine adequate samples of masked shrews from Illinois and eastern Minnesota that have been designated as *leseurii* and *cinereus*, respectively (see distribution map of *Sorex cinereus*, Hall and Kelson, 1959:26).

Specimens examined (136).—ADAMS COUNTY: 4 mi. N, 3/4 mi. W Nodaway, 1 (KU). BLACK HAWK COUNTY: NW 1/4 of sec. 19, T. 90 N, R. 14 W, 12 (KU); Cedar Falls, 5 (UNI). BOONE COUNTY: sec. 8, Marshall [probably Marcy] Twp., 1 (ISU). BUCHANAN COUNTY: no specific locality, 2 (USNM). BUENA VISTA COUNTY: 1/4 mi. N, 2 mi. W Alta, 3 (KU); Storm

TABLE 1.—Cranial measurements of adult (first year) *Sorex cinereus haydeni* from Iowa. Superscript numbers indicate sample size when less than listed in left-hand column.

Number of specimens averaged or catalogue number	Condylobasal length	Cranial breadth	Maxillary breadth	Palatal length	Length of maxillary tooththrow
Western Iowa (Clay, Dickinson, Emmet, and Lyon counties)					
Average (22)	15.4	7.7 ²⁰	4.3 ²⁰	6.5	5.7 ²⁰
Minimum	14.8	7.2	4.0	6.0	5.4
Maximum	16.3	8.1	4.6	6.7	6.0
SD ±	0.24	0.24	0.14	0.14	0.14
Eastern Iowa (Boone, Humboldt, and Kossuth counties east thereof)					
Average (23)	15.4 ²¹	7.8 ²⁰	4.3	6.4	5.7
Minimum	15.0	7.3	4.0	6.2	5.6
Maximum	15.9	8.3	4.6	6.7	6.0
SD ±	0.34	0.21	0.13	0.20	0.13
Adams County					
KU 114156	14.7	7.7	4.4	6.2	5.6

Lake, 5 (BV). BUTLER COUNTY: 1/2 mi. S, 3 mi. E Greene, 1 (KU). CERRO GORDO COUNTY: Clear Lake, 1 (KU). CLAY COUNTY: Dewey's Pasture, 11 (ISU); sec. 12, Lone Tree Twp., 1 (ISU). DELAWARE COUNTY: Backbone State Park, 2 (ISU). DICKINSON COUNTY: Silver Lake, 3 (2 DPM; 1 BYU); *Caylor Prairie*, 1 (DPM); Lakeside Laboratory [West Okoboji Lake], 3 (1 DPM; 2 BYU); *Gull Point State Park*, 1 (BYU); *Arnolds Park*, 1 (ISU). DUBUQUE COUNTY: Dyersville, 1 (USNM). EMMET COUNTY: 3 1/2 mi. W *Estherville*, 1 (ISU); Fort Defiance State Park, 1 (ISU); 2 1/2 mi. S, 1/4 mi. E Wallingford, 3 (KU). FAYETTE COUNTY: SE 1/4 of NE 1/4 of sec. 35, T. 93 N, R. 9 W, 1 (ISU). GRUNDY COUNTY: 5 mi. S, 1/2 mi. E Wellsburg, 1 (KU); 5 1/4 mi. W Grundy Center, 2 (KU). GUTHRIE COUNTY: 1/4 mi. S Springbrook State Park, 1 (KU). HAMILTON COUNTY: sec. 27, Lyon Twp., 2 (KU); *Goose Lake*, 1 (USNM); *Little Wall Lake*, 9 (USNM). HANCOCK COUNTY: 5 mi. E [ESE] Forest City, 2 (UMMZ); SE 1/4 of NE 1/4 of sec. 4, T. 97 N, R. 23 W, 2 (ISU). HOWARD COUNTY: Hayden Prairie [1 mi. S, 5 mi. W Lime Springs], 1 (ISU). HUMBOLDT COUNTY: NE 1/4 of sec. 18, T. 91 N, R. 28 W, 1 (ISU). JOHNSON COUNTY: Iowa City, 1 (KU); 3 mi. E Iowa City, 1 (KU). LINN COUNTY: Wapsipinicon River, Troy Mills, 1 (CC); Cedar Rapids, 2 (CC); NE 1/4 of SE 1/4 of sec. 36, T. 83 N, R. 7 W, 1 (KU); sec. 7, Bertram Twp., 1 (CC); *Lakeside*, 1 (CC). LYON COUNTY: Gitchie Manitou State Park, 1 1/2 mi. N, 1 mi. W Granite, 2 (KU); sec. 26, Lyon Twp., 2 (ISU). MAHASKA COUNTY: 1/2 mi. S, 1/2 mi. E New Sharon, 2 (KU); Oskaloosa and 6 mi. radius thereof, 12 (KU). MARION COUNTY: 1/2 mi. W Tracy, 1 (KU). MARSHALL COUNTY: 3 mi. W Green Mountain, 2 (KU). MONROE COUNTY: Albia, 1 (KU); 3 mi. S, 6 1/2 mi. E Albia, 1 (KU). PALO ALTO COUNTY: Ruthven, 1 (BYU). PLYMOUTH COUNTY: 2 mi. N Le Mars, 1 (KU). POWESHIEK COUNTY: 2 1/2 mi. S, 1 mi. E Searsboro, 1 (KU). SAC COUNTY: 2 mi. W Sac City, 1 (USNM); Wall Lake, 1 (USNM). SCOTT COUNTY: Davenport, 7 (3 DPM, 4 BYU); *Bettendorf*, 2 (1 DPM, 1 KU). STORY COUNTY: E 1/2 of sec. 17, T. 84 N, R. 24 W, 1 (ISU); SE 1/4 of SE 1/4 of sec. 32, T. 84 N, R. 24 W, 1 (BYU); 1 mi. S Ames, 1 (ISU). UNION COUNTY: 1 3/4 mi. N, 1/2 mi. E Thayer, 1 (KU). WINNEBAGO COUNTY: Eden Twp., 1 (ISU); 4 mi. E Forest City, 1 (UMMZ). WINNESHIEK COUNTY: Ridgeway, 1 (UMMZ); Conover, 1 (UMMZ).

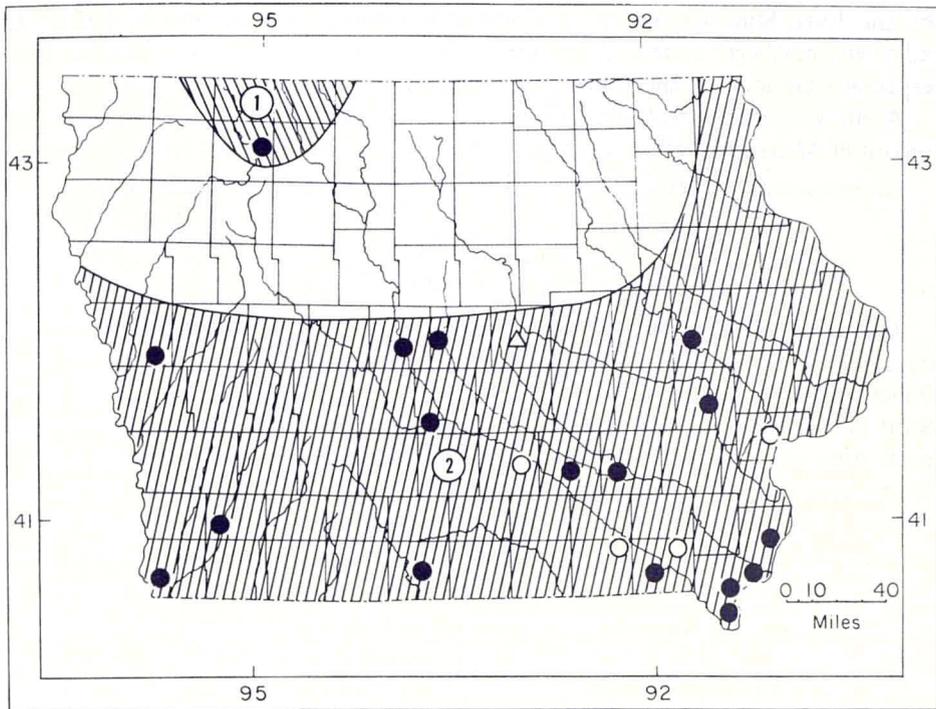


FIG. 5.—Distribution of two species of shrews in Iowa: 1, *Microsorex hoyi hoyi*; 2, *Cryptotis parva parva*. For explanation of symbols see Fig. 3.

Additional records (Weller and Blagen, 1970:286, unless otherwise indicated).—BLACK HAWK COUNTY: no specific locality. FLOYD COUNTY: no specific locality (Brown, 1917:27). GUTHRIE COUNTY: no specific locality. HENRY COUNTY: no specific locality. KEOKUK COUNTY: no specific locality. LINN COUNTY: 7 mi. N Marion (Polder, 1953:721). POCAHONTAS COUNTY: no specific locality. WARREN COUNTY: no specific locality. WINNESHIEK COUNTY: near Decorah (Hoslett, 1965:364).

***Microsorex hoyi hoyi* (Baird)**

Pygmy Shrew

1858. *Sorex hoyi* Baird, Mammals, in Reports of explorations and surveys . . . from the Mississippi River to the Pacific Ocean . . . , 8(1):32, 14 July (type locality, Racine, Wisconsin).

1901. *Microsorex hoyi*, Elliot, Field Columbian Mus., Publ. 45, Zool. Ser., 2:377, 6 March.

Distribution in Iowa.—Probably limited to north-central part of the state (see Fig. 5).

The pygmy shrew reaches the southern limit of its geographic distribution in Iowa. This species is known with certainty from only one locality, although it probably occurs elsewhere in suitable habitats in northern Iowa. The two known specimens, a male and pregnant female, were taken in Dewey's Pasture, Clay County, in 1938. This pasture was described at that time (Scott, 1939a:251) as a "blue grass tract of 392 acres bordering on the north shore of Mud Lake." He further pointed out (*loc. cit.*) that the tract "has not been grazed since its purchase

by the Iowa State Conservation Commission during the summer of 1934." In adjacent northern states, *Microsorex* occurs in a variety of habitats (see especially Gunderson and Beer, 1953:42; Jackson, 1961:41).

A shrew from Cerro Gordo County, reported by Scott (1937:54) as the first record of *Microsorex* from Iowa, subsequently was identified as *Sorex cinereus*.

Specimens examined (2).—CLAY COUNTY: Dewey's Pasture, 2 (1 ISU, 1 USNM).

Blarina brevicauda

Short-tailed Shrew

The short-tailed shrew is found throughout Iowa and has been reported to occur in a wide variety of habitats, both natural and disturbed (Van Hyning and Pellett, 1910:215; Spurrell, 1917:254; Miller, 1955:122; Hoslett, 1965:364). Scott (1937:55) suggested that this shrew might "be more numerous in wooded parts than open fields." Throughout most of the state, I have found the species to be common to abundant in grassy, open habitats, especially during the autumn population peak. However, Scott's statement may well apply to the northwestern section of Iowa, where in the late summer of 1968, for example, I found *Blarina* to be less common in grassy areas than in similar habitats in central and southern counties that were trapped in the same period.

Two subspecies, *B. b. brevicauda* and *B. b. carolinensis*, occur in Iowa, the latter restricted to the extreme southwestern part of the state. Specimens easily referable to one or the other have been taken at sites varying from 25 to 50 miles apart along the zone of contact; *carolinensis* from the southwestern counties of Fremont, Page, and Taylor, and *brevicauda* from adjacent counties of Mills, Montgomery, Adams, and Ringgold. I have found no evidence of intergradation among specimens taken in the mentioned counties (Jones *et al.*, 1973, accorded specific rank to *brevicauda* and *carolinensis*).

Blarina brevicauda brevicauda (Say)

1823. *Sorex brevicaudus* Say, in James, Account of an expedition from Pittsburgh to the Rocky Mountains . . . , 1:164 (type locality, "Engineer Cantonment," approximately 2 mi. E Ft. Calhoun, Washington Co., Nebraska).

1858. *Blarina brevicauda*, Baird, Mammals, in Reports of explorations and surveys . . . from the Mississippi River to the Pacific Ocean . . . , 8(1):42, 14 July.

Distribution in Iowa.—Statewide, except in extreme southwestern part (see Fig. 6).

Blarina brevicauda brevicauda can be distinguished from *B. b. carolinensis*, geographically adjacent to the southwest, by its markedly greater external and cranial size. All specimens examined from the southwestern periphery of the range of *brevicauda* in Iowa (Mills, Montgomery, Adams, and Ringgold counties) are as large as those from any other area in the state. The two races, *brevicauda* and *carolinensis*, seem to act more or less as distinct species where their ranges meet in southwestern Iowa. A similar situation exists in Nebraska (Jones, 1964), and possibly also to the east of Iowa, and the systematic relationships of these two subspecies are in need of review.

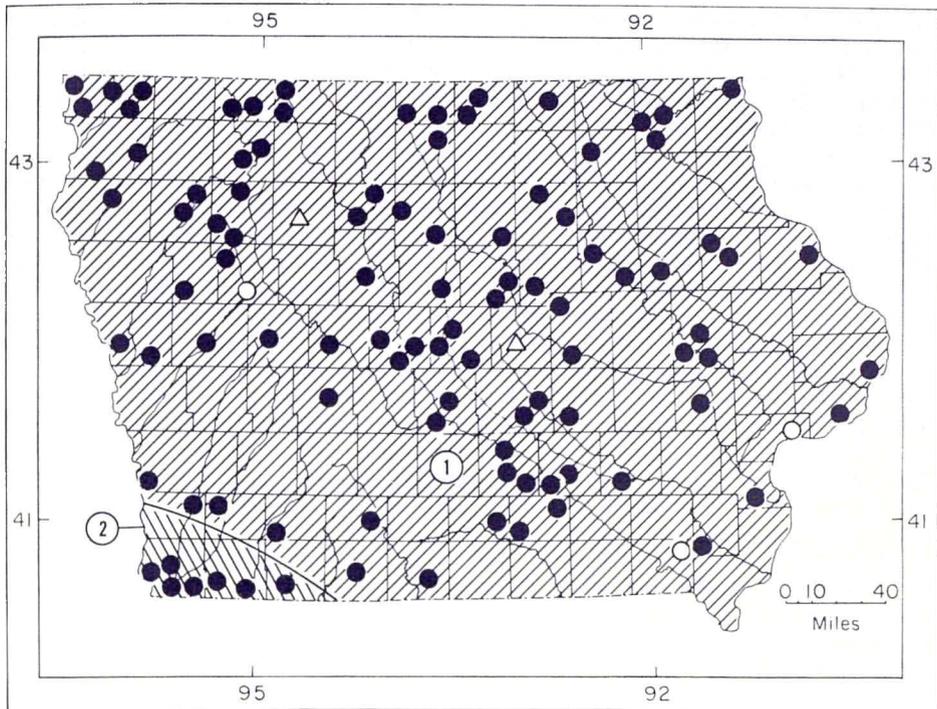


FIG. 6.—Distribution of *Blarina brevicauda* in Iowa: 1, *B. b. brevicauda*; 2, *B. b. carolinensis*. For explanation of symbols see Fig. 3.

Average and extreme external measurements (means followed by extremes and one standard deviation) of 18 specimens (five males, 13 females) from south-central Iowa (Mahaska and Marion counties) are as follows: 125.3 (120-138) \pm 4.65; 25.8 (23-28) \pm 1.69; 15.8 (14-17) \pm 0.76; weight, 22.3 (18.7-28.1) \pm 2.90. Corresponding measurements of 10 specimens (four males, six females) from the southwestern edge of the range in Iowa (Mills, Montgomery, Adams, and Ringgold counties) are: 128.2 (121-135) \pm 5.16; 27.2 (25-29) \pm 1.55; 16.1 (15-17) \pm 0.57; 23.0 (20.1-27.5) \pm 2.60.

Cranial measurements of 18 specimens (four males, 14 females) from Mahaska and Marion counties are: condylobasal length, 23.7 (22.9-24.6) \pm 0.49; cranial breadth, 13.1 (12.3-13.8) \pm 0.32; maxillary breadth, 8.5 (8.2-8.8) \pm 0.22; inter-orbital breadth, 6.1 (5.7-6.5) \pm 0.18; length of maxillary toothrow, 9.1 (8.9-9.5) \pm 0.21. Corresponding measurements of the 10 specimens from the southwestern counties mentioned previously are: 23.8 (22.4-24.9) \pm 0.86; 13.2 (12.2-13.9) \pm 0.53; 8.6 (8.2-8.9) \pm 0.21; 6.2 (5.7-6.4) \pm 0.21; 9.0 (8.6-9.4) \pm 0.23. For comparative measurements of *B. b. carolinensis*, see the following account.

Specimens examined (347).—ADAMS COUNTY: 4 mi. N, 3/4 mi. W Nodaway, 1 (KU). ALLAMAKEE COUNTY: 3 mi. SW New Albin, 2 (WSU); no specific locality, 1 (ISU). BLACK HAWK COUNTY: Cedar Falls, 13 (UNI); NW 1/4 of NW 1/4 of sec. 35, T. 88 N, R. 11 W, 1 (ISU). BOONE COUNTY: 2 mi. E, 4 mi. S Ogden, 1 (ISU); 4 mi. W Ames, 2 (KU); 3 1/2 mi.

S, 1/2 mi. W Courthouse, Boone, 1 (KU); 3 1/2 mi. S Courthouse, Boone, 2 (KU); *no specific locality*, 1 (ISU). BUCHANAN COUNTY: SW 1/4 of NW 1/4 of sec. 23, T. 88 N, R. 9 W, 1 (KU). BUENA VISTA COUNTY: 3 1/2 mi. E Sioux Rapids, 1 (ISU); 1/4 mi. N, 2 mi. W Alta, 2 (KU); Storm Lake, 1 (BV); *Little Storm Lake*, 1 (BV); *SW side Storm Lake*, 1 (BV). BUTLER COUNTY: 1/2 mi. S, 3 mi. E Greene, 6 (KU); NW 1/4 of sec. 5, T. 91 N, R. 15 W, 1 (KU); *Shell Rock*, 1 (ISU). CARROLL COUNTY: sec. 22, Maple River Twp., 2 (ISU). CHEROKEE COUNTY: 10 mi. N Aurelia, 1 (BV); 3 mi. N, 1/4 mi. W Cherokee, 1 (SM). CHICKASAW COUNTY: 1 mi. S, 1 mi. W North Washington, 10 (KU). CLAY COUNTY: Dewey's Pasture, 1 (ISU); intersection U.S. 71 and Iowa 240, 1 (ISU). CLINTON COUNTY: 1/2 mi. S, 1/2 mi. W Clinton, 2 (KU); 1/2 mi. S Clinton, 7 (KU). CRAWFORD COUNTY: sec. 8, Denison Twp., 1 (KU). DECATUR COUNTY: 3 1/4 mi. N, 1/4 mi. E Woodland, 1 (KU). DELAWARE COUNTY: Backbone State Park, 1 (ISU); Plum Springs [Greeley], 1 (USNM). DICKINSON COUNTY: Caylor Prairie, 1 (DPM); *Lakeside Laboratory [West Okoboji Lake]*, 5 (DPM); 1/8 mi. W Little Emerson Bay, [West] Lake Okoboji, 1 (TTU); *E side Garlock Slough*, 4 (TTU); *East Okoboji Lake*, 1 (ISU); SE 1/4 of SW 1/4 of sec. 24, T. 99 N, R. 36 W, 1 (KU). DUBUQUE COUNTY: Dubuque, 1 (ISU); *Palmers Creek, Dubuque*, 1 (ISU); *Peru Bottoms*, 1 (ISU). EMMET COUNTY: 5 mi. N Estherville, 1 (ISU); 3 1/2 mi. W Estherville, 1 (ISU); *Fort Defiance State Park*, 2 (ISU). FRANKLIN COUNTY: sec. 36, T. 90 N, R. 19 W, 1 (ISU). GREENE COUNTY: 4 mi. W Jefferson, 4 (KU); sec. 27, Jackson Twp., 2 (ISU). GRUNDY COUNTY: 4 mi. S, 1 1/2 mi. W Wellsburg, 2 (KU); 5 mi. S, 3 1/2 mi. W Wellsburg, 1 (KU); 5 mi. S, 1 1/2 mi. W Wellsburg, 5 (KU); 5 mi. S, 1/2 mi. E Wellsburg, 11 (KU); 5 1/4 mi. W Grundy Center, 2 (KU). GUTHRIE COUNTY: Springbrook State Park, 3 (ISU); 1/2 mi. E Springbrook State Park, 1 (KU); 1/4 mi. S Springbrook State Park, 1 (KU). HAMILTON COUNTY: Goose Lake, Jewell, 5 (USNM); sec. 27, Lyon Twp., 2 (ISU); *Little Wall Lake*, 1 (ISU). HANCOCK COUNTY: 5 mi. E [=ESE] Forest City, 1 (UMMZ); *Pilot Knob State Park*, 1 (ISU). HARDIN COUNTY: 1/2 mi. W Eldora, 9 (KU); 1 1/2 mi. N, 1 mi. E New Providence, 1 (KU); 1 mi. N, 1 1/2 mi. E New Providence, 5 (KU); 1 mi. S New Providence, 1 (ISU). HENRY COUNTY: Hillsboro, 2 (USNM). HUMBOLDT COUNTY: sec. 3, T. 93 N, R. 28 W, 1 (ISU); 1/2 mi. W Humboldt, 1 (ISU). IDA COUNTY: N 1/2, sec. 7, T. 86 N, R. 41 W, 1 (ISU). JASPER COUNTY: 2 mi. W, 1 mi. S Grinnell, 1 (KU); 2 mi. S Kellogg, 1 (ISU). JOHNSON COUNTY: Iowa City, 3 (USNM). KEOKUK COUNTY: Sigourney, 4 (KU). LINN COUNTY: 7 mi. N Marion, 3 (ISU); Cedar Rapids, 10 (CC); 8 mi. E Cedar Rapids, 1 (ISU); *Palisades [-Kepler] State Park*, 2 (ISU); *no specific locality*, 1 (CC). LOUISA COUNTY: NE 1/4 of sec. 35, T. 74 N, R. 3 W, 1 (ISU). LUCAS COUNTY: 2 1/2 mi. N, 2 1/2 mi. E Russell, 1 (KU); 1 mi. N, 2 1/2 mi. E Russell, 1 (KU); SE 1/4 of NW 1/4 of sec. 11, T. 71 W, R. 21 W, 1 (ISU). LYON COUNTY: Granite, 1 (ISU); sec. 33, Riverside Twp., 1 (ISU); sec. 26, Elgin Twp., 2 (ISU); sec. 35, Elgin Twp., 3 (ISU); sec. 20, Dale Twp., 1 (ISU); sec. 26, Lyon Twp., 1 (ISU). MAHASKA COUNTY: Oskaloosa and 6 mi. radius thereof, 14 (KU); 2 mi. S, 10 mi. W Oskaloosa, 1 (KU); 3 mi. S, 9 mi. W Oskaloosa, 1 (KU). MARION COUNTY: Des Moines River, 5 3/4 mi. N Knoxville, 1 (KU); 4 1/2 mi. N Knoxville, 4 (KU); Knoxville, 3 (2 USNM, 1 FMNH); 1/2 mi. W Tracy, 1 (KU); 1 1/4 mi. N, 2 1/2 mi. W Bussey, 2 (KU). MILLS COUNTY: 1/2 mi. S, 3 mi. W Henderson, 7 (KU). MITCHELL COUNTY: 1 1/2 mi. N, 2 mi. E Staceyville, 1 (ISU). MONONA COUNTY: Blue Lake, Franklin Twp., 1 (ISU); sec. 7, Franklin Twp., 2 (ISU); 1/2 mi. S, 2 mi. W Moorhead, 1 (KU); 1 mi. S, 3 1/2 mi. W Moorhead, 3 (KU). MONROE COUNTY: 5 1/2 mi. N, 3 1/2 mi. E Albia, 1 (KU); 1 1/2 mi. N Melrose, 2 (KU). MONTGOMERY COUNTY: 1 1/2 mi. S, 2 mi. E Wales, 4 (KU). PLYMOUTH COUNTY: 2 mi. N Le Mars, 10 (KU). POLK COUNTY: 1 1/2 mi. NE Ankeny, 1 (ISU); Des Moines, 1 (USNM). POTTAWATTAMIE COUNTY: Council Bluffs, 8 (USNM). POWESHIEK COUNTY: NE 1/4 of SE 1/4 of sec. 10, T. 79 N, R. 16 W, 1 (ISU). RINGGOLD COUNTY: 1/2 mi. N, 2 mi. E Mount Ayr, 3 (KU). SAC COUNTY: 4 mi. S, 1/2 mi. W Storm Lake Airport, 1 (BV). SCOTT COUNTY: Davenport, 5 (DPM). SIOUX COUNTY: 1/4 mi. NW Hospers, 1 (ISU); Ireton, 4 (UMMZ); *no specific locality*, 1 (ISU). STORY COUNTY: NW 1/4 of NW 1/4 of sec. 12, T. 84 N, R. 23 W, 1 (KU); *Soper Mills Game Management Area*, 1 (ISU); Ames and 6 mi. radius thereof, 13 (12 ISU, 1 KU); 1/4 mi. E Maxwell, 1 (KU). TAMA COUNTY: 1 mi. N;

1 1/2 mi. W Lincoln, 14 (KU); Tama, 2 (UMMZ). UNION COUNTY: 1 3/4 mi. N, 1/2 mi. E Thayer, 4 (KU). WEBSTER COUNTY: near Coalville, 1 (ISU). WINNEBAGO COUNTY: 1/2 mi. N, 3 1/2 mi. W Thompson, 2 (KU); 4 mi. E, 1 1/2 mi. N Forest City, 1 (ISU). WINNESHIEK COUNTY: Decorah, 9 (7 UMMZ, 2 FMNH); Ridgeway, 5 (UMMZ); Conover, 12 (UMMZ). WORTH COUNTY: SW 1/4 of NW 1/4 of sec. 12, T. 99 N, R. 21 W, 1 (ISU); SW 1/4 of NW 1/4 of sec. 26, T. 98 N, R. 22 W, 1 (ISU). WRIGHT COUNTY: SE 1/4 of NW 1/4 of sec. 33, T. 92 N, R. 26 W, 1 (ISU); E 1/2 of sec. 11, T. 90 N, R. 24 W, 1 (ISU).

Additional records.—BOONE COUNTY: *Moingona Fox Range, about 5 mi. S Boone* (Scott, 1947:445). DAVIS COUNTY: *Eldon Fox Range [1 mi. N, 5 mi. E Floris]* (Scott and Klimstra, 1955:30). DICKINSON COUNTY: *Lake Okoboji* (Stephens, 1922:61). HANCOCK COUNTY: *Pilot Knob State Park* (Miller, 1955:122). HENRY COUNTY: *no specific locality* (Weller and Blagen, 1970:286). MARSHALL COUNTY: *no specific locality* (Gabrielson, 1921:149). MUSCATINE COUNTY: *Fairport* (Scott, 1937:55). POCAHONTAS COUNTY: *no specific locality* (Weller and Blagen, 1970:286). SAC COUNTY: *Wall Lake* (Spurrell, 1917:284). STORY COUNTY: *Ames* (Elwell, 1962a:28). TAMA COUNTY: *Tama* (Joyce and Eddy, 1944:213). VAN BUREN COUNTY: *vicinity Stockport* (Crabb, 1948:206).

***Blarina brevicauda carolinensis* (Bachman)**

1837. *Sorex carolinensis* Bachman, J. Acad. Nat. Sci. Philadelphia, 7:366 (type locality, eastern South Carolina).

1895. *Blarina brevicauda carolinensis*, Merriam, N. Amer. Fauna, 10:13, 31 December.

Distribution in Iowa.—Extreme southwestern part of state (see Fig. 6).

For comparisons with *Blarina brevicauda brevicauda*, geographically adjacent to the north in Iowa, see account of that subspecies.

Several recent authors have indicated the need for a systematic revision of the genus *Blarina* (Jones and Glass, 1960; Genoways and Choate, 1972). Future study of the genus may reveal that Iowan shrews here referred to *carolinensis* (and other medium-sized *Blarina* west of the Mississippi River) are subspecifically distinct from those to the east. If this proves to be the case, the name *hulophaga* may be referable to Iowan specimens (Jones and Glass, 1960). Recent published records of *B. b. minima* in southern Missouri (Easterla, 1968:448) suggest that this small subspecies extends northward along the Mississippi River and may, therefore, separate populations now referred to *carolinensis* from the eastern and western sides of the Mississippi. The subspecies, *minima*, is smaller than *carolinensis* and is easily distinguished from it on that basis. I know of no specimens of *Blarina* from the two southeasternmost counties of Iowa (Lee and Des Moines) where small shrews assignable either to *carolinensis* or *minima* may possibly occur, but specimens from adjacent Henry, Louisa, and Scott counties all are typical of *B. b. brevicauda*.

Average and extreme external and cranial measurements (corresponding to those given previously for *B. b. brevicauda*) of 30 specimens (12 males, 18 females) from Fremont, Page, and Taylor counties are as follows: 107.7 (98-120) \pm 5.60; 22.7 (17-26) \pm 2.54; 14 (11-16) \pm 0.96; weight (15 specimens), 14.6 (12.9-16.8) \pm 1.13; 20.6 (19.5-21.5) \pm 0.49; 11.4 (10.9-12.1) \pm 0.34; 7.5 (7.0-7.9) \pm 0.26; 5.6 (5.2-6.0) \pm 0.23; 7.8 (7.1-8.2) \pm 0.29.

Specimens examined (53).—FREMONT COUNTY: 3 1/2 mi. S Sidney, 5 (KU); 4 mi. S, 9 mi. W Sidney, 2 (KU); 5 mi. S, 2 mi. W Sidney, 7 (KU); 4 mi. E Hamburg, 9 (KU); 13 mi. E

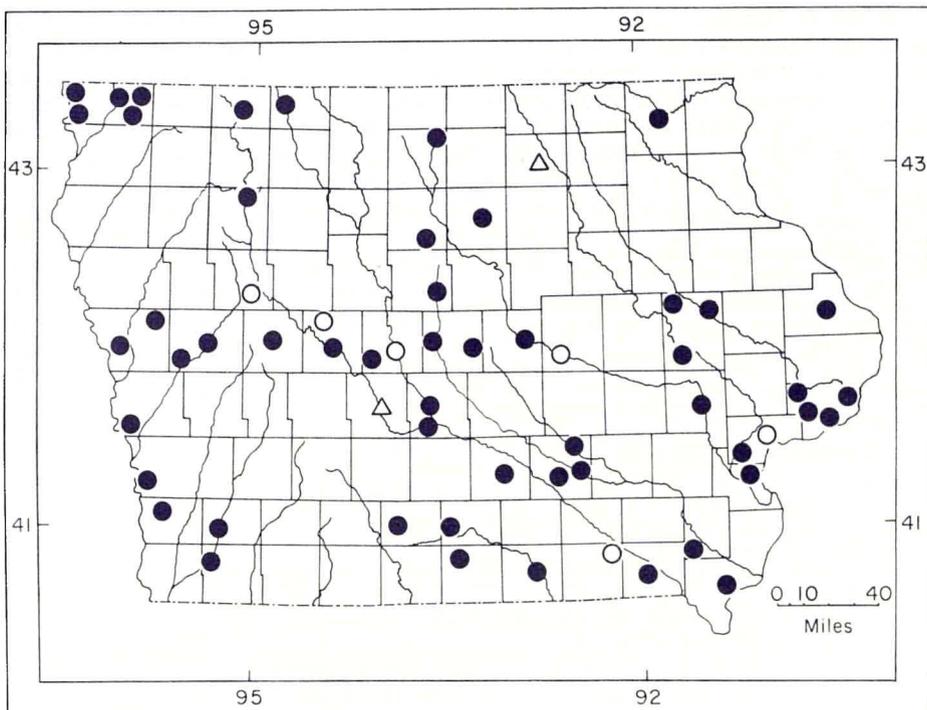


FIG. 7.—Distribution of *Scalopus aquaticus machrinoides* in Iowa. For explanation of symbols see Fig. 3.

Hamburg, 18 (KU); 1 mi. S Hamburg, 3 (KU). PAGE COUNTY: 7/10 mi. S Coin, 3 (KU); 2 mi. S, 1/2 mi. W Shambaugh, 1 (KU); 1 mi. S, 3 mi. E Northboro, 4 (KU). TAYLOR COUNTY: 2 mi. S, 3/4 mi. W Bedford, 1 (KU).

***Cryptotis parva parva* (Say)**

Least Shrew

1823. *Sorex parvus* Say, in James, Account of an expedition from Pittsburgh to the Rocky Mountains . . . , 1:163 (type locality, "Engineer Cantonment," approximately 2 mi. E Ft. Calhoun, Washington Co., Nebraska).

1912. *Cryptotis parva*, Miller, Bull. U.S. Nat. Mus., 79:24, 31 December.

Distribution in Iowa.—Seemingly limited to southern and eastern parts of the state (see Fig. 5).

The least shrew occurs throughout the southern half of Iowa and northward through the eastern part of the state to southeastern Minnesota (Gunderson and Beer, 1953:42). Because no specimens have been taken in areas in north-central Iowa that have been extensively trapped, it would seem likely that this species is rare or absent in that part of the state. To the west of Iowa, the distribution of *Cryptotis parva* is "more extensive in southern Nebraska than in the northern part" (Jones, 1964:70), although the species is known from as far north as south-central South Dakota (Findley, 1956:1). Little is known of the habitat requirements of this shrew in Iowa, but it probably occurs in brushy or moist grassy situations as, for example, in Illinois (Hoffmeister and Mohr, 1957:62).

Scott (1937:54) considered *Cryptotis* to be "found throughout Iowa." Apparently, however, there were few specimens available at that time and the suggested statewide distribution probably was based on earlier lists of Iowan mammals (Allen, 1870; Goding, 1883; Osborn, 1890), none of which cited specific records.

Specimens examined (29).—BOONE COUNTY: Polly Creek [5 mi. S Boone], 2 (USNM). DECATUR COUNTY: Leon, 2 (USNM). DES MOINES COUNTY: 2 mi. W, 1 mi. N West Burlington, 1 (KU). FREMONT COUNTY: 4 mi. S, 9 mi. W Sidney, 1 (KU). JOHNSON COUNTY: Iowa City, 1 (SUI). KEOKUK COUNTY: Sigourney, 1 (KU). LEE COUNTY: sec. 25, Washington Twp., 1 (USNM); sec. 33, Washington Twp., 1 (USNM); sec. 12, Jefferson Twp., 3 (USNM); sec. 28, Montrose Twp., 1 (USNM). LINN COUNTY: Cedar Rapids, 2 (1 CC, 1 SUI). MAHASKA COUNTY: 3 1/2 mi. W Oskaloosa, 3 (KU). MONONA COUNTY: 1/2 mi. S, 2 mi. W Moorhead, 1 (KU). MONTGOMERY COUNTY: Red Oak, 6 (USNM). POLK COUNTY: Des Moines, 1 (IHM). STORY COUNTY: Ames, 1 (USNM). VAN BUREN COUNTY: Lacey-Keosauqua State Park, 1 (USNM).

Additional records.—BOONE COUNTY: *Moingona Fox Range, about 5 mi. S Boone* (Scott, 1947:443). DAVIS COUNTY: Eldon Fox Range [1 mi. N, 5 mi. E Floris] (Scott and Klimstra, 1955:30). MARION COUNTY: 3 mi. N, 3 mi. W Harvey (Bowles, field notes). MARSHALL COUNTY: no specific locality (Gabrielson, 1921:149). MUSCATINE COUNTY: Fairport (Scott, 1937:55). STORY COUNTY: *no specific locality* (Scott, 1937:55). VAN BUREN COUNTY: vicinity Stockport (Crabb, 1948:206).

Family TALPIDAE—Moles

Scalopus aquaticus machrinoides Jackson

Eastern Mole

1914. *Scalopus aquaticus machrinoides* Jackson. Proc. Biol. Soc. Washington. 27:19, 2 February (type locality, Manhattan, Riley Co., Kansas).

Distribution in Iowa.—Statewide (see Fig. 7).

The eastern mole is found in both grassy and woodland habitats throughout Iowa, although probably is less abundant and somewhat more restricted locally to relatively moist situations in the northwestern part of the state. This species reaches the northwestern limit of its geographic range in adjacent southeastern South Dakota (Findley, 1954:20).

Scott (1937:51) followed Jackson (1915:42) in recognizing eastern and western races of *Scalopus aquaticus* in Iowa—*S. a. machrinoides* and *S. a. machrinus*, respectively—but detected no intergradation between the two. Jackson (*loc. cit.*) assigned Iowan moles to subspecies on the basis of single specimens from Hillsboro, Henry County, and Knoxville, Marion County, in eastern Iowa, and from Council Bluffs, Pottawattamie County, in western Iowa. The Council Bluffs specimen (USNM 31906) is an adult female, whereas the one from Hillsboro (USNM 31900) is an adult male with unworn teeth. The mastoidal breadth of the latter is 19.2 (my measurement) and that of the specimen from Knoxville, an adult male (FMNH 5551), is 19.5 (my measurement); both are less than the minimum of 20.0 given by Jackson for adult males of *machrinus*. Jackson (1915:31) apparently considered the mastoidal breadth and palatilar length as major diagnostic features at the subspecific level (see his key to subspecies of *Scalopus*, p. 30). The latter measurement is difficult to take and was not used in the present study (see Table 2 for external and cranial measurements of Iowan specimens).

TABLE 2.—External and cranial measurements of *Scalopus aquaticus machrinoides* from Iowa. Superscript numbers indicate sample size when less than listed in left-hand column.

Number of specimens averaged	Total length	Length of tail	Length of hind foot	Condylobasal length	Mastoid breadth	Postorbital constriction	Palatal length	Alveolar length P4-M3	Depth of skull
Western Iowa (Lyon County)									
Average 9 (σ)	185.7 ⁶	32.6 ⁷	23.9 ⁸	36.7	19.3	8.4	17.6	9.2	10.6
Minimum	170.0	25.0	22.0	34.7	18.0	8.2	16.5	8.8	9.9
Maximum	202.0	40.0	26.0	38.3	20.2	8.8	18.5	9.6	11.3
SD \pm	15.19	4.04	1.46	1.55	0.76	0.19	0.82	0.24	0.51
Average 3 (φ)	182.7	30.3	26.0	36.2	19.0	8.4	17.4	8.9	10.6
Minimum	178.0	30.0	24.0	34.6	18.3	8.2	16.7	8.6	10.3
Maximum	190.0	31.0	29.0	38.2	19.9	8.5	18.4	9.2	11.0
SD \pm	6.43	0.58	3.21	1.8	0.83	0.31	0.91	0.10	0.27
Central Iowa (see text)									
Average 9 (σ)	186.3 ⁸	30.5	24.2	37.5	19.9	8.3	18.1	9.4	10.9
Minimum	179.0	24.0	21.0	35.6	18.9	8.0	17.2	8.9	10.4
Maximum	194.0	37.0	26.0	38.7	20.6	8.5	18.7	10.0	11.4
SD \pm	7.63	3.64	1.98	1.09	0.63	0.20	0.54	0.42	0.31
Average ^a 3 (φ)	178.3	30.7	22.7	36.6	19.4	8.2	17.9	9.0	10.6
Minimum	173.0	29.0	22.0	35.4	19.0	7.9	17.3	8.9	10.2
Maximum	187.0	32.0	23.0	38.9	20.0	8.5	18.0	9.2	11.2
SD \pm	7.57	1.53	0.58	1.99	0.55	0.31	0.79	0.17	0.53
Eastern Iowa (see text)									
Average 13 (σ)	187.7	31.7	24.3	38.1	20.1	8.2	18.5 ¹¹	9.5	11.1
Minimum	170.0	25.0	22.0	35.9	19.0	7.9	17.3	9.2	10.5
Maximum	204.0	39.0	28.0	40.1	21.2	8.7	19.3	10.2	11.7
SD \pm	12.53	4.50	1.61	1.27	0.77	0.28	0.56	0.25	0.39
Average ^b 3 (φ)	184.3	28.0	24.7	36.6	19.4	8.2	17.9	9.0	10.6
Minimum	179.0	24.0	24.0	35.4	19.0	7.9	17.3	8.9	10.2
Maximum	190.0	31.0	26.0	38.9	20.0	8.5	18.8	9.2	11.2
SD \pm	9.29	2.52	1.15	1.03	0.26	0.31	0.29	0.06	0.61

^a Story and Hamilton counties only.^b Johnson County only.

A statistical comparison of external and cranial measurements of adult males from eastern (Henry, Johnson, Lee, Linn, Mahaska, Scott, Winneshiek, and Van Buren counties), central (Hamilton, Hancock, Polk, and Story counties), and northwestern Iowa (Lyon County) clearly indicates that there is a trend toward slightly larger size and longer, broader skulls in eastern Iowa. However, the differences are not statistically significant when tested by the Sums of Squares Simultaneous Testing Procedure (SS-STP) and do not seem to justify recognition of two subspecies within the state. Likewise, no significant statistical differences were found when Iowan specimens were compared (SS-STP) with *machrinoides*

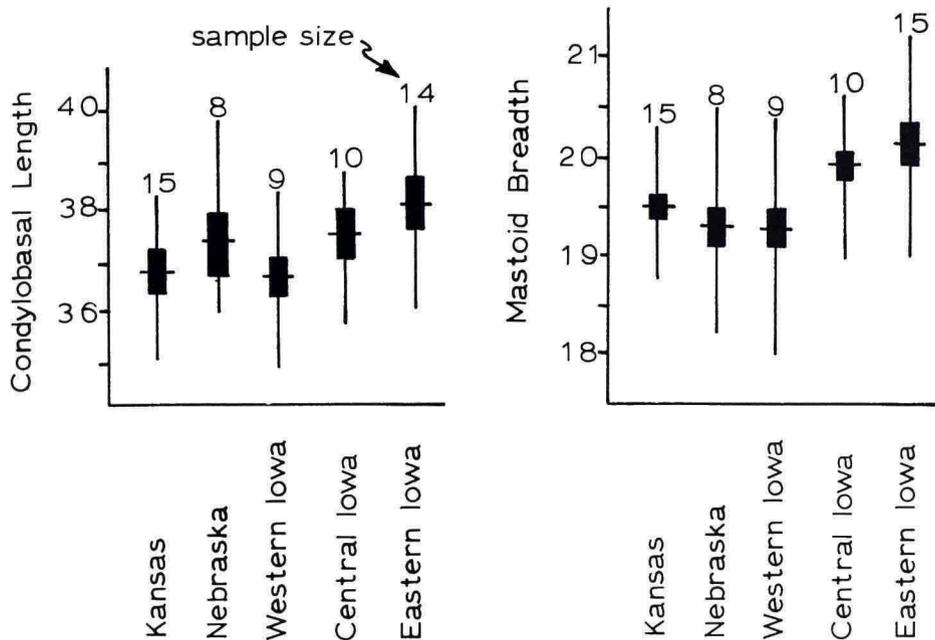


FIG. 8.—Comparison of mastoid breadth and condylobasal length (millimeters) in male *Scalopus aquaticus* from Douglas County, Kansas; Lancaster County, Nebraska; western Iowa (Lyon County); central Iowa (Hamilton, Hancock, Polk, and Story counties); and eastern Iowa (Henry, Johnson, Lee, Linn, Mahaska, Scott, Winneshiek, and Van Buren counties). The lines indicate the extremes and the mean, whereas the bar represents two standard deviations.

from Douglas County, Kansas (near type locality), and Lancaster County, Nebraska. Variation in mastoid breadth and condylobasal length among Iowan samples and those from Kansas and Nebraska are shown in Dice-grams in Fig. 8.

Because of the statistical similarity in SS-STP comparisons of external and cranial measurements among specimens from Iowa, Nebraska, and Kansas, and because of the paucity of comparative material from east of the Mississippi River, it seems best tentatively to consider all specimens from Iowa as representing *S. a. machrinoides*. With the assignment of Iowan moles to that subspecies, however, the need for a thorough review of the systematic status of *Scalopus aquaticus* in the north-central part of its geographic range is clearly evident.

Specimens examined (104).—APPANOOSE COUNTY: Centerville, 1 (USNM). BOONE COUNTY: sec. 22, Beaver Twp., 1 (ISU). BUENA VISTA COUNTY: 3 mi. E, 1 mi. S Cornell, 1 (BV). CARROLL COUNTY: sec. 23, Maple River Twp., 1 (ISU); sec. 25, Maple River Twp., 5 (ISU). CLARK COUNTY: 9 mi. W Osceola, 1 (KU). CRAWFORD COUNTY: sec. 14, Denison Twp., 1 (ISU); SW 1/4 of NE 1/4 of sec. 22, T. 28 N, R. 40 W, 1 (KU). DICKINSON COUNTY: East Okoboji Lake, 2 (ISU); Iowa Lakeside Laboratory [West Okoboji Lake], 1 (DPM). EMMET COUNTY: Fort Defiance State Park, 2 (ISU). FRANKLIN COUNTY: Hampton, 1 (IHM). GREENE COUNTY: sec. 9, Grant Twp., 1 (ISU). HAMILTON COUNTY: sec. 27, Lyon Twp., 1 (ISU); Jewell, 2 (USNM). HANCOCK COUNTY: Pilot Knob, 2 (ISU). HENRY COUNTY: Hillsboro, 1 (USNM). JACKSON COUNTY: SE 1/4 of SE 1/4 of sec. 18, T. 85 N, R. 3 E, 1 (ISU).

JOHNSON COUNTY: Iowa City, 11 (1 ISU, 9 USNM, 1 SUI); *no specific locality*, 1 (SUI). LEE COUNTY: sec. 12, Jefferson Twp., 1 (USNM). LINN COUNTY: Walker, 1 (CC); 2 mi. NE Waubeek, 1 (ISU); Cedar Rapids, 1 (CC). LOUISA COUNTY: NW 1/4 of sec. 26, R. 3 W, T. 75 N, 1 (ISU). LUCAS COUNTY: 1 mi. W Lucas, 1 (ISU). LYON COUNTY: Granite, 2 (ISU); sec. 33, Riverside Twp., 3 (ISU); sec. 35, Elgin Twp., 4 (ISU); sec. 3, Wheeler Twp., 2 (ISU); sec. 23, Lyon Twp., 2 (ISU). MAHASKA COUNTY: 1/2 mi. S, 5 mi. E New Sharon, 2 (KU); 1 1/2 mi. N, 1 1/2 mi. W Rose Hill, 1 (KU); 2 mi. N, 3 mi. E Oskaloosa, 2 (KU); Oskaloosa, 1 (KU). MARION COUNTY: Knoxville, 1 (FMNH). MARSHALL COUNTY: Marshalltown, 1 (USNM). MILLS COUNTY: sec. 12, Glenwood Twp., 1 (USNM); *Glenwood*, 1 (USNM). MONONA COUNTY: 4 mi. W Mapleton, 1 (BV); sec. 9, Franklin Twp., 5 (ISU). MONTGOMERY COUNTY: Red Oak, 1 (USNM). MUSCATINE COUNTY: Conesville, 1 (USNM). PAGE COUNTY: Shenandoah, 1 (USNM). POLK COUNTY: Johnston, 1 (KU); Des Moines, 1 (IHM). POTTAWATTAMIE COUNTY: Council Bluffs, 1 (USNM). SCOTT COUNTY: Dixon, 3 (DPM); Princeton Twp., 1 (DPM); Maysville, 1 (ISU); Davenport, 5 (DPM); *Bettendorf*, 1 (DPM). STORY COUNTY: 1 mi. N, 3 mi. W Ames, 1 (KU); Ames, 7 (ISU); 2 mi. S Colo, 1 (ISU). VAN BUREN COUNTY: Lacey-Keosauqua State Park, 1 (USNM). WAYNE COUNTY: 1 mi. S, 1 mi. W Cambria, 1 (ISU). WINNESHIEK COUNTY: Decorah, 3 (UMMZ). WRIGHT COUNTY: SE 1/4 of sec. 11, T. 90 N, R. 24 W, 1 (ISU).

Additional records.—BOONE COUNTY: Moingona Fox Area, about 5 mi. S Boone (Scott, 1947:444). DALLAS COUNTY: *no specific locality* (Scott, 1938:537). DAVIS COUNTY: Eldon Fox Range [1 mi. N, 5 mi. E Floris] (Scott and Klimstra, 1955:30). DICKINSON COUNTY: *Lakeside Laboratory*. [West] *Okoboji Lake* (Stephens, 1922:62). FLOYD COUNTY: *no specific locality* (Brown, 1917:27). GREENE COUNTY: 1 1/2 mi. SW Churdan (record on file, U.S. Biological Survey). MARSHALL COUNTY: *no specific locality* (Gabrielson, 1921:149). MUSCATINE COUNTY: Fairport (Scott, 1937:52). SAC COUNTY: Wall Lake (Spurrell, 1917:284). STORY COUNTY: *Ames* (Joyce and Eddy, 1944:210). TAMA COUNTY: Tama (Joyce and Eddy, 1944:210). WRIGHT COUNTY: *Wall Lake* (Scott, 1947:444).

ORDER CHIROPTERA—Bats

Iowan bats represent two families, Vespertilionidae with nine species and Molossididae with one. Several additional species of chiropterans may occur within the state. Bats are most numerous in the eastern two-thirds of Iowa where more suitable habitat is available, including winter hibernacula in caves along the Mississippi River.

Key to Iowan Bats

1. Tail extending nearly one-half its total length beyond uropatagium; lower incisors bifid (family Molossididae) *Tadarida macrotis*, p. 55
- 1'. Tail extending slightly or not at all beyond uropatagium; lower incisors trifold (family Vespertilionidae) 2
- 2.(1') Single pair upper incisors (total of 30 or 32 teeth) 3
- 2'. Two pairs upper incisors (total of 32 teeth) 5
- 3.(2) Upper surface of uropatagium bare or thinly furred at base; 30 teeth (single pair upper premolars) *Nycticeius humeralis*, p. 54
- 3'. Upper surface of uropatagium thickly furred; 32 teeth (two pairs upper premolars) 4
- 4.(3') Upper parts hoary (dark brownish tipped with grayish white); forearm more than 45; condylobasal length more than 15.5 *Lasiurus cinereus*, p. 52
- 4'. Upper parts reddish orange to yellowish brown; forearm less than 45; condylobasal length less than 14.5 *Lasiurus borealis*, p. 51

- 5.(2') Upper surface of uropatagium furred proximally for a third to a half of its length; 34 or 36 teeth 6
- 5'. Upper surface of uropatagium bare or with a few hairs at base; 32 or 38 teeth 7
- 6.(5) Color blackish frosted with white; forearm more than 36; 36 teeth (three pairs lower premolars) *Lasionycteris noctivagans*, p. 47
- 6'. Color reddish or yellowish brown; forearm less than 36; 34 teeth (two pairs lower premolars) *Pipistrellus subflavus*, p. 48
- 7.(5') Total length usually more than 110; condylobasal length more than 17.0; 32 teeth
 *Eptesicus fuscus*, p. 49
- 7'. Total length less than 105; condylobasal length less than 15.0; 38 teeth 8
- 8.(7') Ear 16 or more from notch; maxillary tooththrow more than 5.5; mandibular tooththrow more than 6.9 *Myotis keenii*, p. 43
- 8' Ear usually less than 15 from notch; length of maxillary tooththrow 5.5 or less; length of mandibular tooththrow 6.9 or less 9
- 9.(8') Calcar not keeled; fur on dorsum long, glossy brown; usually long, conspicuous hairs on toes; *Myotis lucifugus*, p. 44
- 9'. Calcar usually keeled; fur on dorsum dark, not glossy, faintly tricolored; hair on toes not long and conspicuous *Myotis sodalis*, p. 46

Family VESPERTILIONIDAE—Vespertilionid Bats

Myotis keenii septentrionalis (Trouessart)

Keen's Myotis

1897. [*Vespertilio gryphus*] var. *septentrionalis* Trouessart, *Catalogus mammalium* , fasc. 1, p. 131 (type locality, Halifax, Nova Scotia).
1928. *Myotis keenii septentrionalis*, Miller and G. M. Allen, *Bull. Nat. Mus.*, 144:105, 25 May.

Distribution in Iowa.—Probably statewide (see Fig. 9).

This species probably has a distribution in Iowa similar to that of *Myotis lucifugus*, and ultimately may be found to be as abundant as the latter (Kunz, 1968:25). Little has been published regarding the natural history of this species in the state. All summer-taken specimens have been netted over streams in wooded habitats; Kunz (1968:33) suggested that maternity colonies may be present in wooded areas in central Iowa. Keen's myotis is known to hibernate in Minnesota (Gunderson and Beer, 1953:50), Nebraska (Jones, 1964:81), and Kansas (Jones *et al.*, 1967:7); specimens taken in November and March from caves in eastern Iowa suggest that this species also hibernates in at least the eastern part of the state.

Kunz and Schlitter (1968:167) clarified the status of a specimen incorrectly referred to this species by Scott (1937:56).

Specimens examined (21).—BOONE COUNTY: Ledges State Park, 4 (KU). DES MOINES COUNTY: Starr's Cave, 1 mi. N Burlington, 6 (KU). HARDIN COUNTY: South Fork Iowa River, 2 1/2 mi. S Eldora, 1 (KU). JACKSON COUNTY: Hunter's Cave [4 mi. S LaMotte], 1 (DPM). JOHNSON COUNTY: Iowa City, 1 (SUI). KEOKUK COUNTY: Sigourney, 5 (KU). LINN COUNTY: Cedar Rapids, 3 (CC).

Additional record.—BENTON COUNTY: Blairstown (State Hygienic Laboratory, Iowa City, 1968 rabies report).

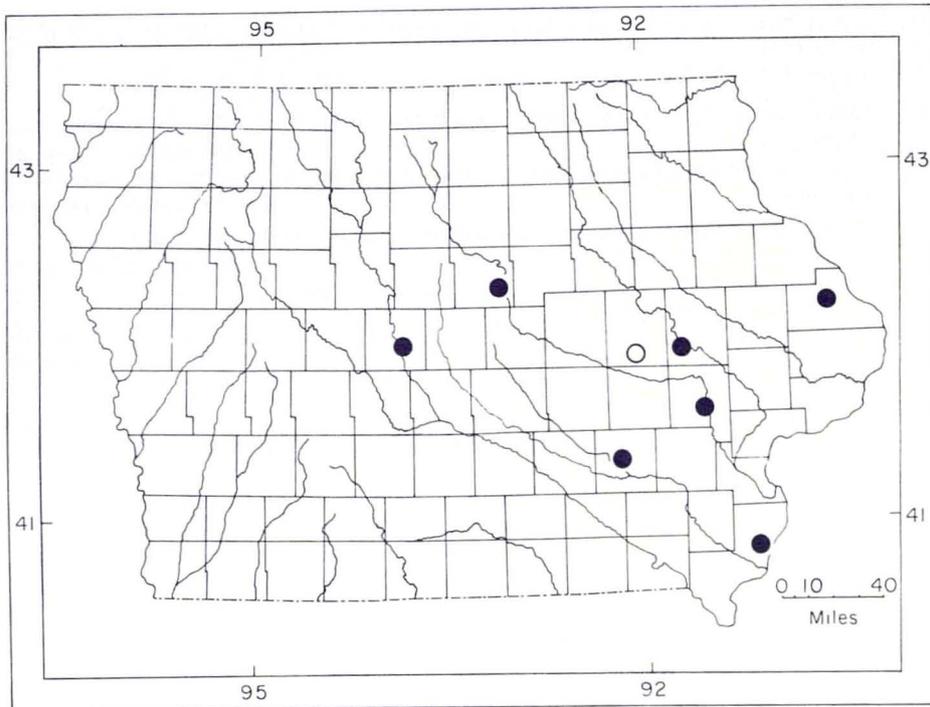


FIG. 9.—Distribution of *Myotis keenii septentrionalis* in Iowa. For explanation of symbols see Fig. 3.

***Myotis lucifugus lucifugus* (Le Conte)**
Little Brown Bat

1831. *V[espertilio]. lucifugus* Le Conte, in McMurtrie, The animal kingdom . . . by the Baron Cuvier . . . , 1:431 (type locality, Georgia, probably the Le Conte Plantation near Riceboro, Liberty Co.—but see Davis and Rippey, *J. Mamm.*, 49:115-117).
1897. *Myotis lucifugus*, Miller, *N. Amer. Fauna*, 13:59, 16 October.

Distribution in Iowa.—Statewide (see Fig. 10).

The little brown bat is one of the commonest bats in much of Iowa. In summer, this species may be found in buildings and other suitable shelters, especially near water courses. *M. lucifugus* presently is known to hibernate in Iowa only in caves along the Mississippi River (Muir and Polder, 1960), although other suitable areas probably are used as hibernacula; additionally, some individuals may migrate to the Ozark Plateau in Missouri (see Kunz and Schlitter, 1968:168). Regarding seasonal movements, Sherman (1929) reported spring arrival of this species in northeastern Iowa (Clayton County) from 2 May through 30 May, and autumn departure between 19 September and 16 October. Females arrived at two maternity colonies (old buildings) in Mahaska County, south-central Iowa, on about 9 May; autumnal departure from one of these buildings took place on about 25 September, during a relatively cold period.

This species appears to be relatively uncommon in western Iowa in spite of suitable places for summer colonies and roosts. Scarcity of hibernacula in the west

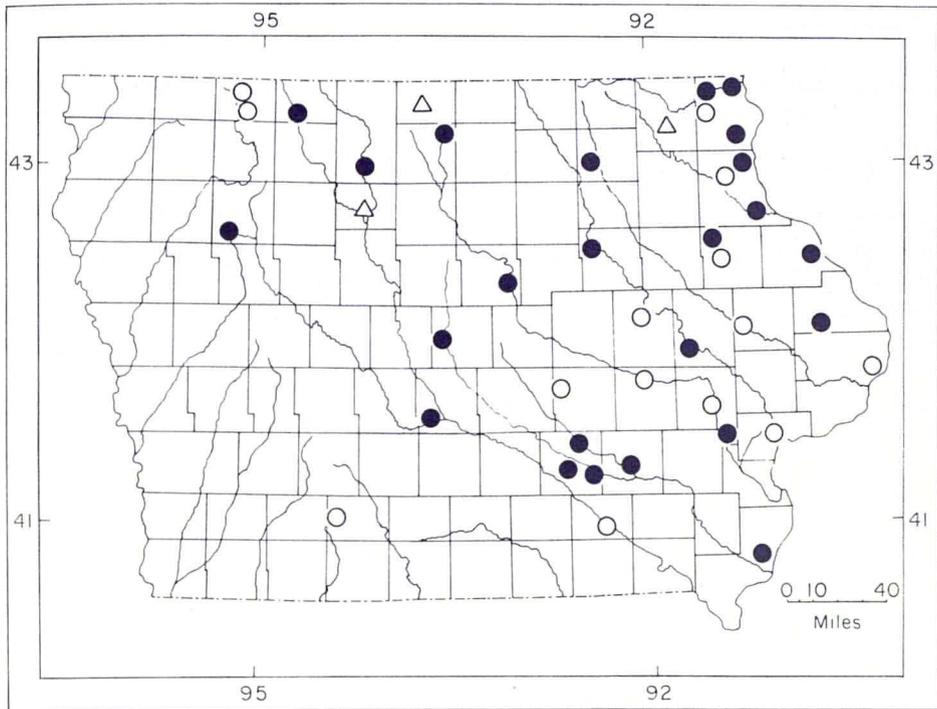


FIG. 10.—Distribution of *Myotis lucifugus lucifugus* in Iowa. For explanation of symbols see Fig. 3.

probably accounts for the paucity of records. *Myotis lucifugus* is known from a single locality in eastern Nebraska (Jones, 1964:83; Kunz, 1965:202), and its occurrence in eastern South Dakota is not well documented (Jones and Genoways, 1967:188).

Hoslett (1965:365) reported three individuals from "a deserted log cabin near the mouth of Canoe Creek." This led Kunz and Schlitter (1968:168) to conclude that these specimens were taken in Winneshiek County. Specimens (UMMZ 83513-16), lacking skulls and external measurements, from "Canoe Creek, Allamakee County," that were collected by Hoslett are judged to include those mentioned above.

Specimens examined (118).—ALLAMAKEE COUNTY: 6 mi. SW New Albin, 1 (UMMZ); Bear Creek, 1/2 mi. S, 1 1/4 mi. E Quandah, 8 (KU); Canoe Creek [near mouth], 2 (UMMZ); 6 mi. S, 3 mi. E Waterville, 10 (KU). BENTON COUNTY: *no specific locality*, 1 (CC). BLACK HAWK COUNTY: Cedar Falls, 1 (UNI). BUENA VISTA COUNTY: Storm Lake, 1 (BV). CHICKASAW COUNTY: 1 1/2 mi. N Ionia, 2 (KU). CLAYTON COUNTY: McGregor, 5 (KU); Guttenberg, 6 (KU). DELAWARE COUNTY: Backbone State Park, 4 (2 ISU, 2 UMMZ). DES MOINES COUNTY: Starr's Cave, 1 mi. N Burlington, 1 (KU). DUBUQUE COUNTY: Dubuque, 1 (USNM); *sec. 24, Dubuque Twp.*, 2 (ISU). EMMET COUNTY: West Des Moines River, 3 1/2 mi. S, 2 3/4 mi. E Wallingford, 12 (KU). HANCOCK COUNTY: Pilot Knob State Park, 5 mi. ESE Forest City, 3 (2 ISU, 1 KU). HARDIN COUNTY: South Fork Iowa River, 2 1/2 mi. S Eldora, 2 (KU). JACKSON COUNTY: *Ciro's Cave, Maquoketa*, 1 (DPM); Maquoketa, 2 (CC). JOHNSON COUNTY: Lone Tree, 25 (USNM). KEOKUK COUNTY: Sigourney, 1 (KU). KOSSUTH COUNTY: Algona, 1 (ISU). LINN COUNTY: Cedar Rapids, 2 (CC); *near Fairfax*, 1 (KU); 6-7

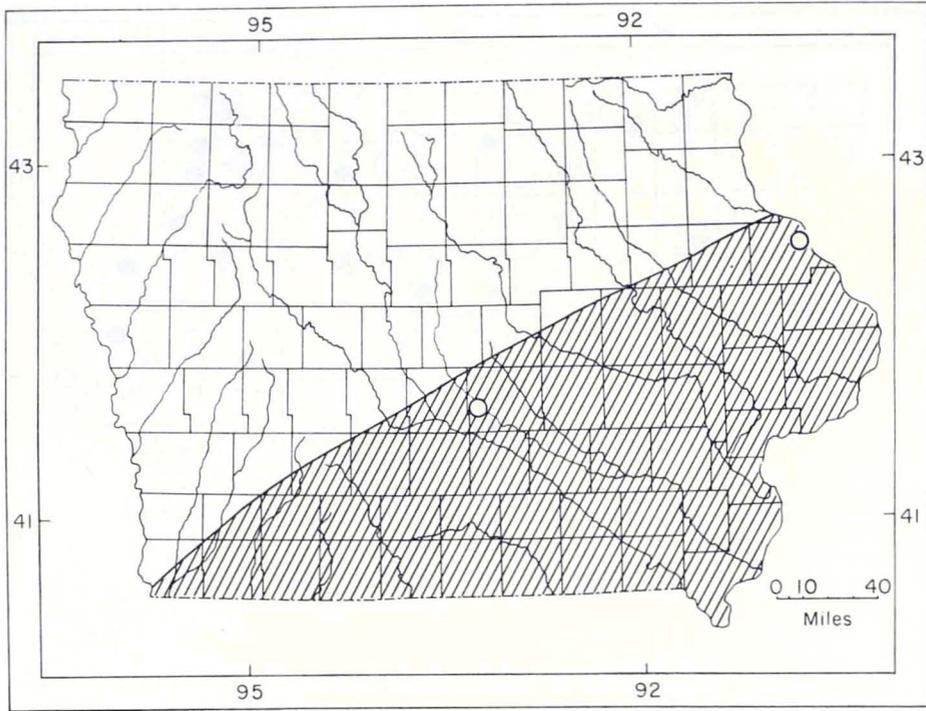


FIG. 11.—Distribution of *Myotis sodalis* in Iowa. For explanation of symbols see Fig. 3.

mi. SW Cedar Falls, 1 (KU). MAHASKA COUNTY: North Skunk River, 1/2 mi. S, 5 mi. E New Sharon, 10 (KU); Oskaloosa, 1 (KU); 3 1/2 mi. N, 1/2 mi. E Fremont, 10 (KU). POLK COUNTY: Birdland Park, Des Moines, 1 (KU). STORY COUNTY: Ames, 1 (USNM).

Additional records (Kunz and Schlitter, 1968:168, unless otherwise indicated).—BENTON COUNTY: Vinton (State Hygienic Laboratory, Iowa City, 1968 rabies report). BLACK HAWK COUNTY: Waterloo (State Hygienic Laboratory, Iowa City, 1969 rabies report). CLAYTON COUNTY: McGregor; National. CLINTON COUNTY: Clinton (State Hygienic Laboratory, Iowa City, 1969 rabies report). DELAWARE COUNTY: Manchester. DES MOINES COUNTY: no specific locality. DICKINSON COUNTY: Lakeside Laboratory [West Okoboji Lake]; Milford. DUBUQUE COUNTY: Becker's Quarry Cave, Dubuque; Crystal Lake Cave, 4 mi. S Dubuque. HANCOCK COUNTY: no specific locality. HUMBOLDT COUNTY: no specific locality. IOWA COUNTY: Marengo (State Hygienic Laboratory, Iowa City, 1968 rabies report). JACKSON COUNTY: Maquoketa (State Hygienic Laboratory, Iowa City, 1969 rabies report). JOHNSON COUNTY: Iowa City (State Hygienic Laboratory, Iowa City, 1969 rabies report). JONES COUNTY: Anamosa (State Hygienic Laboratory, Iowa City, 1969 rabies report). LINN COUNTY: Cedar Rapids (State Hygienic Laboratory, 1969 rabies report). MUSCATINE COUNTY: Fairport. POLK COUNTY: Des Moines (State Hygienic Laboratory, Iowa City, 1969 rabies report). POWESHIEK COUNTY: Grinnell. STORY COUNTY: no specific locality. UNION COUNTY: 5 mi. E Afton. WAPELLO COUNTY: between Eldon and Ottumwa. WINNEBAGO COUNTY: no specific locality. WINNESHIEK COUNTY: no specific locality (O. T. Kalin, University of Minnesota, personal communication).

***Myotis sodalis* Miller and Allen**
Indiana *Myotis*

1928. *Myotis sodalis* Miller and Allen, 1928, Bull. U.S. Nat. Mus., 144:130, 25 May (type locality, Wyandotte Cave, Crawford Co., Indiana).

Distribution in Iowa.—Known only from Dubuque and Jasper counties; probably occurs elsewhere in southern part of the state (see Fig. 11).

The Indiana myotis was first reported from Iowa by Muir and Polder (1960) on the basis of three individuals taken from a hibernaculum (Becker's Quarry Cave) in Dubuque County. Two of the bats were preserved and are presently in the private collections of the authors, whereas the third bat was released. The only other record of an individual from Iowa is that of a male banded in southern Missouri and recovered near Colfax, Jasper County (Myers, 1964:123). Easterla and Watkins (1969) reported summer-taken pregnant females of *M. sodalis* from wooded areas in northwestern Missouri, suggesting that this species will be found in adjacent parts of southwestern Iowa.

Specimens examined.—None.

Additional records.—DUBUQUE COUNTY: Becker's Quarry Cave, Dubuque (Muir and Polder, 1960:603). JASPER COUNTY: near Colfax (Myers, 1964:123).

***Lasionycteris noctivagans* (Le Conte)** Silver-haired Bat

1831. *V[espertilio]. noctivagans* Le Conte, in McMurtrie, The animal kingdom . . . by the Baron Cuvier . . . , 1:431 (type locality, eastern United States).

1866. [*Lasionycteris*] *noctivagans*, Peters, Monatsb. k. preuss. Acad. Wiss., Berlin, p. 648 (for 1865).

Distribution in Iowa.—Migrant; statewide in warm months (see Fig. 12).

The silver-haired bat is common throughout Iowa, both as a migrant and summer resident, primarily in deciduous woodlands adjacent to waterways and ponds (Kunz, 1968:36; Kunz and Schlitter, 1968:169). The earliest spring and latest autumn records of this species in the state are, respectively, 15 April and 2 October.

Evidently Iowa and northern Missouri (Easterla and Watkins, 1967) are within the southern limits of the summer range of *L. noctivagans* and it seems likely that this species may also be found to be a summer resident in states to the east and west of Iowa. Only specimens thought to be migrants have been reported from Kansas (Jones *et al.*, 1967:12), Nebraska (Jones, 1964:87), South Dakota (save for the Black Hills) (Turner and Jones, 1968:445), and Indiana (Mumford, 1969:45). This species was reported by Hoffmeister and Mohr (1957:75) as "moderately common throughout Illinois during the summer months," although they cited no specific records.

Recent winter records of *L. noctivagans*, in apparent hibernation, from the Black Hills, South Dakota (Turner and Jones, 1968:445), Minnesota (Beer, 1956:282), Illinois (Pearson, 1962:27), and Indiana (Mumford, 1969:45) indicate that this species may occasionally inhabit caves in eastern Iowa during that time of year.

Although the first published record of the silver-haired bat in Iowa was that of Easterla and Watkins (1967:327), an unreported specimen in the collection of the State University of Iowa (SUI 20154) was taken on 17 May 1904, in Iowa City.

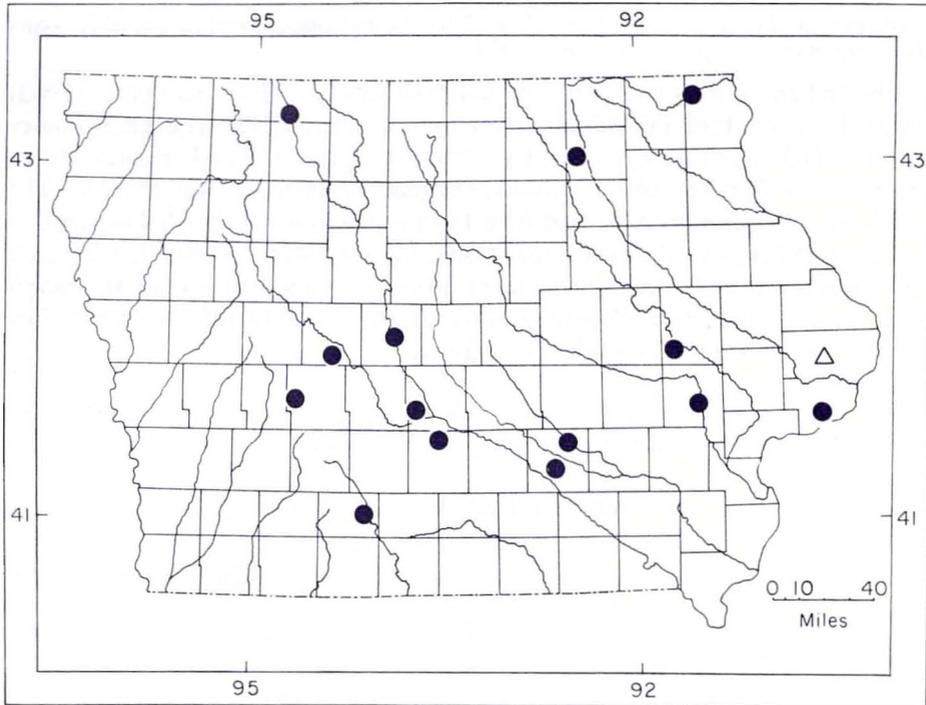


FIG. 12.—Distribution of *Lasionycteris noctivagans* in Iowa. For explanation of symbols see Fig. 3.

Specimens examined (27).—ALLAMAKEE COUNTY: Bear Creek, 1/2 mi. S, 1 1/4 mi. E Quandah, 2 (KU). BOONE COUNTY: McHose Park, Boone, 2 (KU); 1 1/2 mi. S, 2 mi. W Boone, 2 (KU); Ledges State Park, 3 (KU). CHICKASAW COUNTY: 1 1/2 mi. N Ionia, 1 (KU). EMMET COUNTY: West Des Moines River, 3 1/2 mi. S, 2 3/4 mi. E Wallingford, 1 (KU). GREENE COUNTY: sec. 13, Franklin Twp., 2 (ISU). GUTHRIE COUNTY: sec. 31, T. 80 N, R. 33 W, 1 (ISU). JOHNSON COUNTY: Iowa City, 1 (SUI). LINN COUNTY: Cedar Rapids, 2 (CC). MAHASKA COUNTY: North Skunk River, 1/2 mi. S, 5 mi. E New Sharon, 4 (KU); Oskaloosa, 3 (KU). POLK COUNTY: 1/2 mi. W Des Moines, 1 (KU). SCOTT COUNTY: Davenport, 1 (DPM). UNION COUNTY: 5 mi. E Afton, 1 (KU).

Additional record.—CLINTON COUNTY: no specific locality (Blankespoor, 1967:8).

***Pipistrellus subflavus subflavus* (F. Cuvier)**

Eastern Pipistrelle Bat

1832. *V[espertilio]. subflavus* F. Cuvier, *Nouv. Ann. Mus. Hist. Nat. Paris*, 1:17 (type locality restricted to 3 mi. SW Riceboro, Liberty Co., Georgia, by W. H. Davis, *J. Mamm.*, 40:522, 20 November 1959).

1897. *Pipistrellus subflavus*, Miller, *N. Amer. Fauna*, 13:90, 16 October.

Distribution in Iowa.—Probably statewide (see Fig. 13).

This pipistrelle has been taken in caves in eastern Iowa throughout the year and has been collected in the warm months elsewhere in the state along water courses bordered by deciduous forest.

P. subflavus may be absent or rare in extreme northwestern Iowa. There are no records of the species from South Dakota (Jones and Genoways, 1967), and

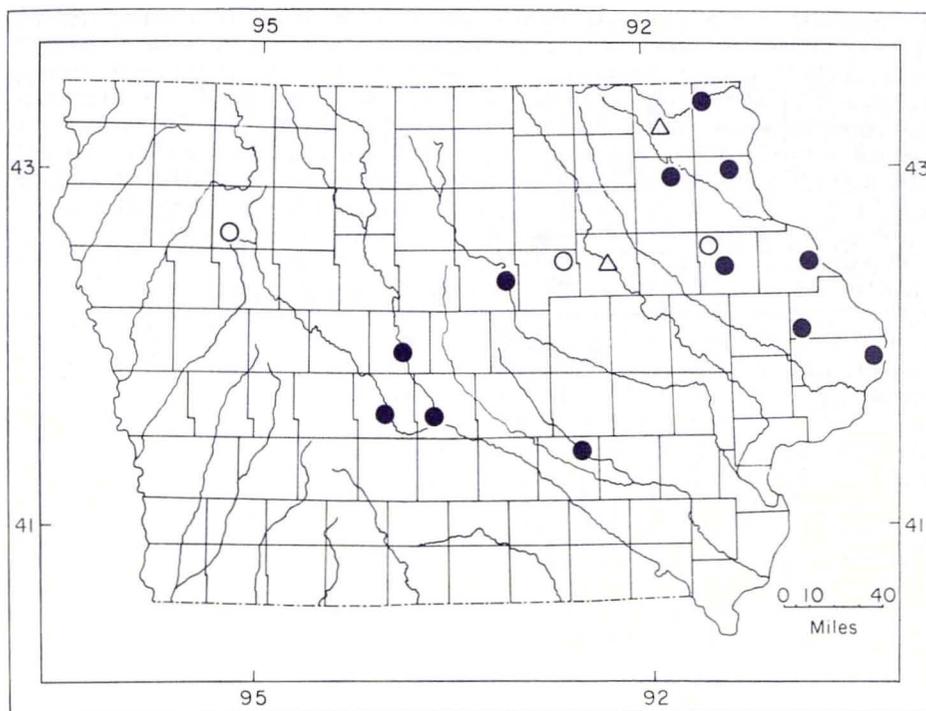


FIG. 13.—Distribution of *Pipistrellus subflavus subflavus* in Iowa. For explanation of symbols see Fig. 3.

it is known in eastern Nebraska only from two localities adjacent to the Platte River (Jones, 1964:89).

Specimens examined (25).—ALLAMAKEE COUNTY: Bear Creek, 1/2 mi. S, 1 1/4 mi. E Quandah, 1 (KU). BOONE COUNTY: 2 mi. W, 1 1/2 mi. S Boone, 1 (KU). CLAYTON COUNTY: Spook Cave, SE 1/4 of sec. 21, T. 95 N, R. 4 W, 1 (ISU). CLINTON COUNTY: 1/4 mi. N Clinton, 2 (KU). DALLAS COUNTY: Raccoon River, 1 mi. N Adel, 1 (KU). DELAWARE COUNTY: near Manchester, 2 (CC). DUBUQUE COUNTY: Dubuque, 4 (ISU). FAYETTE COUNTY: Dutton's Cave, 1 mi. N, 1 1/2 mi. E West Union, 1 (KU). HARDIN COUNTY: Rattlesnake Cave, 1/2 mi. N Eldora, 2 (KU). JACKSON COUNTY: Maquoketa Caves State Park, 4 (3 ISU, 1 KU); *Ciro's Cave, Maquoketa*, 1 (DPM). MAHASKA COUNTY: North Skunk River, 1/2 mi. S, 5 mi. E New Sharon, 4 (KU). POLK COUNTY: Beaver Creek, 1/2-1 mi. N Des Moines, 1 (ISU).

Additional records.—BLACK HAWK COUNTY: no specific locality (Blankespoor, 1967:8). BUENA VISTA COUNTY: Storm Lake (Kunz and Schlitter, 1968:170). DELAWARE COUNTY: Backbone Cave [Dundee] (Polder, 1953:719). DUBUQUE COUNTY: *Becker's Quarry Cave, Dubuque* (Muir and Polder, 1960:604); *Hill Street Cave* (Muir and Polder, 1960:605); *Julien Cave* (Polder, 1953:719); *Dubuque* (Scott, 1939b:239). GRUNDY COUNTY: Fairfield Twp. (Polder, 1953:719). WINNESHIEK COUNTY: no specific locality (O. T. Kalin, University of Minnesota, personal correspondence).

***Eptesicus fuscus fuscus* (Palisot de Beauvois)**

Big Brown Bat

1796. *Vespertilio fuscus* Palisot de Beauvois, Catalogue raisonné du muséum de Mr. C. W. Peale, Philadelphia, p. 18 (p. 14 of English edition by Peale and Palisot de Beauvois) (type locality, Philadelphia, Philadelphia Co., Pennsylvania).

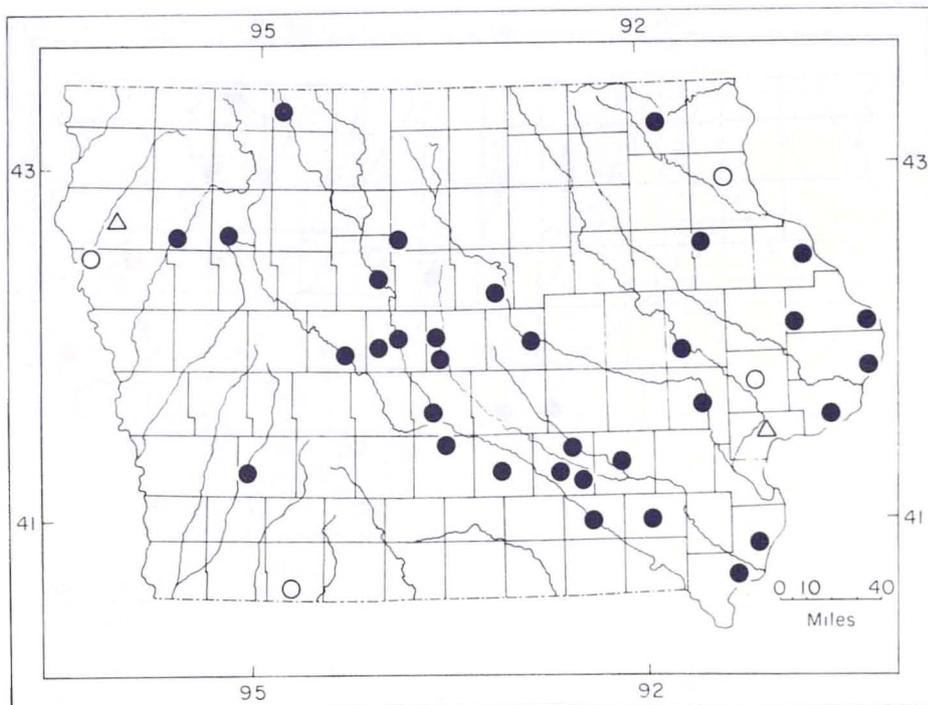


FIG. 14.—Distribution of *Eptesicus fuscus fuscus* in Iowa. For explanation of symbols see Fig. 3.

1900. [*Eptesicus*] *fuscus*. Méhely, Magyarország denevereinek monographiája (Monographia Chiropterorum Hungariae), pp. 208, 338.

Distribution in Iowa.—Statewide (see Fig. 14).

The big brown bat was reported by Kunz and Schlitter (1968:171) as “the most abundant and widely distributed bat in Iowa.” This species has been found in a variety of hibernacula in the state, including buildings, mines, and caves (Kunz and Schlitter, 1968:171; Muir and Polder, 1960). On 26 March 1966, a large number were found in a state of torpor in an abandoned, open wine cellar in Fort Madison. Most of these bats were wedged in crevices between the bricks, although a few of the more active individuals were suspended from the ceiling.

Female big brown bats apparently leave hibernacula in spring and form maternity colonies in other places (Beer, 1955:246; Kunz and Schlitter, 1968:171), whereas males and barren females may remain in the general vicinity of the winter quarters (Jones *et al.*, 1967:16). Kunz and Schlitter (1968:171) reported maternity colonies in old buildings in central Iowa. The only maternity colonies that I have found in south-central Iowa were in attics of houses or in peaks of barns.

Specimens examined (137).—BOONE COUNTY: McHose Park, Boone, 1 (KU); Ledges State Park, 6 (KU); sec. 19, Marcy Twp., 1 (ISU). BUENA VISTA COUNTY: Storm Lake, 1 (BV). CASS COUNTY: Lewis, 1 (KU). CHEROKEE COUNTY: near Washita, 1 (BV). CLINTON COUNTY: Clinton, 1 (KU). DELAWARE COUNTY: 2 mi. N, 2 mi. W Dundee, 3 (KU). DES MOINES

COUNTY: Starr's Cave, 1 mi. N Burlington, 3 (KU). DUBUQUE COUNTY: Dubuque, 7 (2 FMNH; 5 KU). EMMET COUNTY: Estherville, 2 (ISU). GREENE COUNTY: sec. 13, Franklin Twp., 1 (ISU). HARDIN COUNTY: South Fork Iowa River, 2 1/2 mi. S Eldora, 1 (KU). JACKSON COUNTY: Maquoketa Caves State Park, 11 (6 KU, 5 ISU); Sabula, 2 (ISU). JEFFERSON COUNTY: NE 1/4 of sec. 31, Buchanan Twp., Fairfield, 1 (ISU). JOHNSON COUNTY: Iowa City 6 (1 AMNH, 1 KU, 4 SUI). KEOKUK COUNTY: Sigourney, 1 (KU). LEE COUNTY: Fort Madison, 13 (KU). LINN COUNTY: Cedar Rapids, 8 (CC); 6-7 mi. SW Cedar Rapids, 1 (KU). MAHASKA COUNTY: North Skunk River, 1/2 mi. S, 5 mi. E New Sharon, 1 (KU); 1 1/2 mi. S, 2 1/2 mi. E New Sharon, 1 (KU); 2 3/4 mi. N, 1 mi. W Rose Hill, 14 (KU); Oskaloosa, 18 (KU); 3 1/2 mi. N, 1/2 mi. E Fremont, 6 (KU). MARION COUNTY: Knoxville, 1 (KU). MARSHALL COUNTY: Marshalltown, 2 (1 ISU 1 KU). POLK COUNTY: 1/2-1 mi. N Des Moines, 2 (ISU); no specific locality, 1 (CC). SCOTT COUNTY: Davenport, 2 (DPM). STORY COUNTY: sec. 4, T. 84 N, R. 24 W, 2 (ISU); Ames, 2 (ISU); 2 mi. S, 1 mi. E Ames, 1 (KU). WAPELLO COUNTY: Ottumwa, 7 (KU). WARREN COUNTY: 8 mi. N Indianola, 1 (KU). WEBSTER COUNTY: Dolliver Memorial Park, 1 (KU). WINNESHIEK COUNTY: Decorah, 2 (UMMZ). WRIGHT COUNTY: NW 1/4 of NW 1/4 of sec. 7, T. 91 N, R. 26 W, 1 (ISU).

Additional records.—CEDAR COUNTY: Tipton (State Hygienic Laboratory, Iowa City, 1968 rabies report). CLAYTON COUNTY: National (Sherman, 1929:320). DUBUQUE COUNTY (Muir and Polder, 1960:603): *Simpson Furnace Mine, 2 mi. W Dubuque; Becker's Quarry Cave and Hill Street Cave, Dubuque; Bronze Bottom Cave, 1 mi. S Center Grove; Crystal Lake Cave, 4 mi. S Dubuque.* MARION COUNTY: *Knoxville* (Long and Severson, 1969:623). MUSCATINE COUNTY: no specific locality (Blankespoor, 1967:8). PLYMOUTH COUNTY: no specific locality (Blankespoor, 1967:8). TAYLOR COUNTY: Bedford (L. C. Watkins, personal communication). WOODBURY COUNTY: Sioux City (State Hygienic Laboratory, Iowa City, 1969 rabies report).

***Lasiurus borealis borealis* (Müller)**

Red Bat

1776. *Vespertilio borealis* Müller, Des Ritters Carl von Linné . . . vollständiges Natursystem . . . , suppl., p. 20 (type locality, New York).

1897. *Lasiurus borealis*, Miller, N. Amer. Fauna, 13:105, 16 October.

Distribution in Iowa.—Migrant; statewide in warm months (see Fig. 15).

Lasiurus borealis is a common summer resident of Iowa and adjacent states, arriving in spring and migrating southward in autumn. The earliest spring record from Iowa is of a female taken on 21 April 1967 in Mahaska County, whereas the latest record in autumn is of a male taken on 6 October 1961 in Emmet County.

The red bat roosts during the day in trees and tall shrubs in urban areas and woodlands throughout the state. McClure (1942) found at Lewis, Cass County, that there was a gradual increase in the population of this species until a peak was reached in late July and early August, when a general dispersal of young occurred. Although adults of both sexes have been taken in Iowa, Kunz (1968: 42) reported that in central Iowa "females greatly outnumbered males except in August and September," when the sexes reached approximately equal numbers. A similar discrepancy in the sex ratio of this species in Kansas was noted by Jones *et al.* (1967:19), who suggested an influx of males from higher latitudes in late summer.

Specimens examined (83).—BLACK HAWK COUNTY: Cedar Falls, 6 (UNI). BOONE COUNTY: McHose Park, Boone, 1 (KU); *Honey Creek, 1 1/3 mi. S, 2 mi. W Boone, 3 (KU); 3 1/2 mi. S Boone, 1 (KU); Ledges State Park, 4 (KU).* BUENA VISTA COUNTY: Storm Lake, 3 (BV). CARROLL COUNTY: Carroll, 4 (ISU). CASS COUNTY: Lewis, 1 (ISU). CRAWFORD COUNTY:

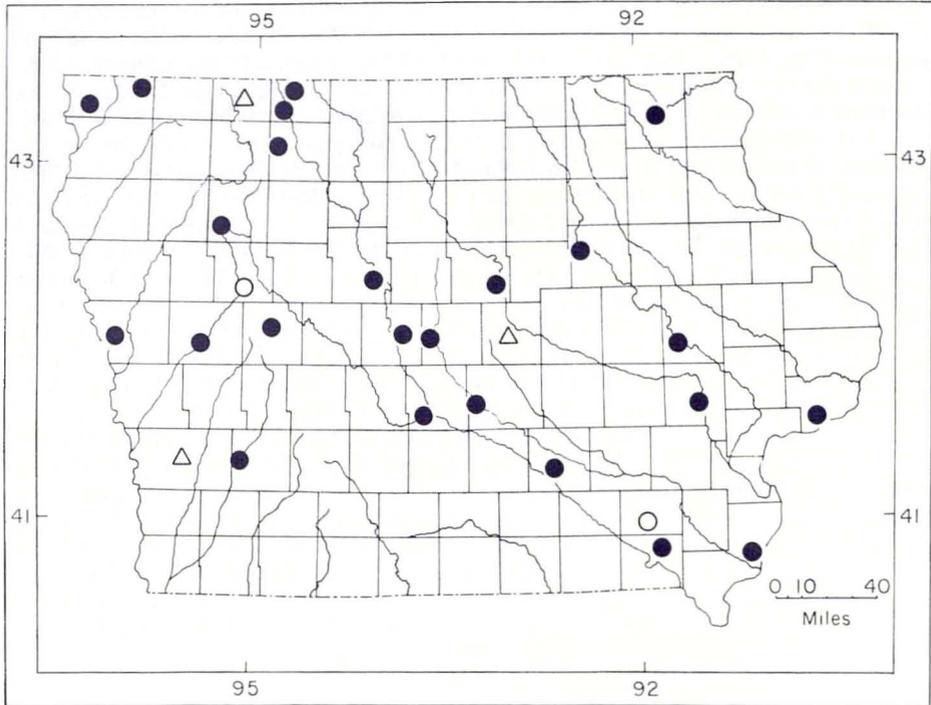


FIG. 15.—Distribution of *Lasiurus borealis borealis* in Iowa. For explanation of symbols see Fig. 3.

Denison, 1 (UNI). DES MOINES COUNTY: Burlington, 6 (USNM). EMMET COUNTY: 3 1/2 mi. N, 6 mi. E Estherville, 1 (ISU); 3 mi. S, 3 mi. E Estherville, 1 (ISU). HARDIN COUNTY: South Fork Iowa River, 2 1/2 mi. S Eldora, 2 (KU). JASPER COUNTY: 1/2 mi. N, 1/2 mi. W Colfax, 1 (KU). JOHNSON COUNTY: Iowa City, 9 (SUI). LINN COUNTY: Cedar Rapids, 9 (CC); 7 mi. SW Cedar Rapids, 2 (KU); no specific locality, 1 (CC). LYON COUNTY: sec. 26, Elgin Twp., 1 (ISU); sec. 35, Elgin Twp., 1 (ISU); sec. 12, Lyon Twp., 1 (ISU). MAHASKA COUNTY: Oskaloosa, 3 (KU). MONONA COUNTY: sec. 6, Franklin Twp., 1 (ISU). PALO ALTO COUNTY: east shore Lost Island Lake, 1 (UMMZ); Ruthven, 4 (UMMZ). POLK COUNTY: Brown Woods, 1/2 mi. W Des Moines, 2 (KU); Des Moines, 1 (KU). SCOTT COUNTY: 1/4 mi. N Davenport, 1 (DPM). STORY COUNTY: Ames, 7 (6 ISU, 1 UNI); 2 mi. S, 1 mi. E Ames, 1 (KU). VAN BUREN COUNTY: Stockport, 1 (KU). WEBSTER COUNTY: Dolliver Memorial Park, 1 (KU). WINNESHIEK COUNTY: Decorah, 1 (ISU).

Additional records.—CASS COUNTY: Lewis (McClure, 1942:430). DICKINSON COUNTY: no specific locality (Blankespoor, 1967:8). JEFFERSON COUNTY: Fairfield (State Hygienic Laboratory, Iowa City, 1969 rabies report). MARSHALL COUNTY: no specific locality (Gabrielson, 1921:149). POTTAWATTAMIE COUNTY: no specific locality (Constantine, 1966:35). SAC COUNTY: Wall Lake (Spurrell, 1917:284). STORY COUNTY: Ames (Elwell, 1962b:434). WINNESHIEK COUNTY: W of Decorah (Hoslett, 1965:365).

***Lasiurus cinereus cinereus* (Palisot de Beauvois)**

Hoary Bat

1796. *Vespertilio cinereus* (misspelled *linereus*) Palisot de Beauvois, Catalogue raisonne du museum de Mr. C. W. Peale, Philadelphia, p. 18 (p. 15 of English edition by Peale

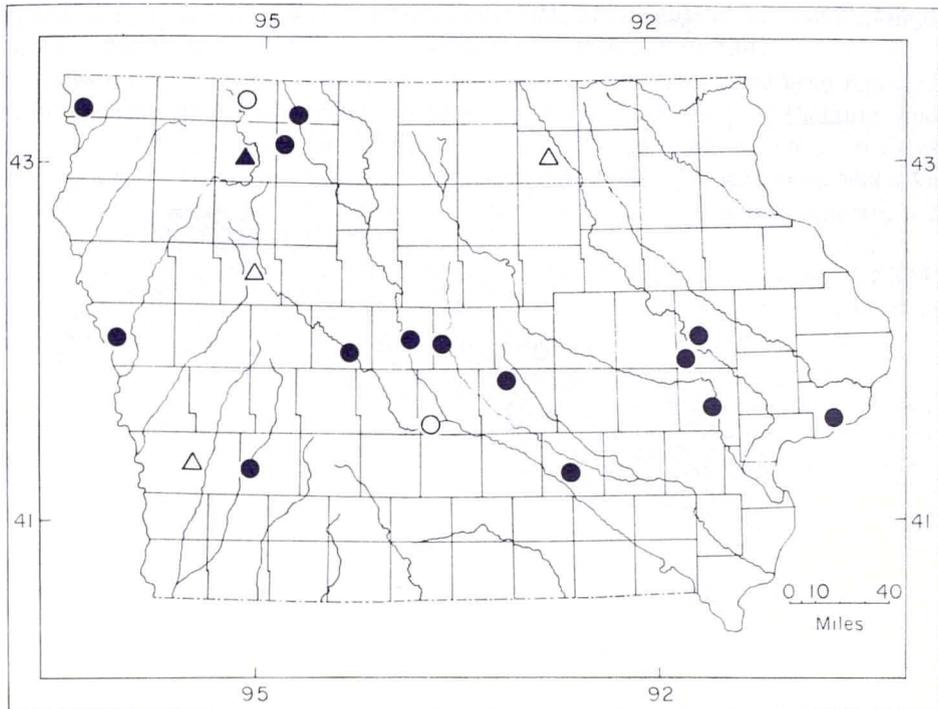


FIG. 16.—Distribution of *Lasiurus cinereus cinereus* in Iowa. For explanation of symbols see Fig. 3.

and Palisot de Beauvois) (type locality, Philadelphia, Philadelphia Co., Pennsylvania).

1864. *Lasiurus cinereus*, H. Allen, Smiths. Misc. Coll., 7 (165):21, June.

Distribution in Iowa.—Migrant; statewide summer resident (see Fig. 16).

Lasiurus cinereus is found throughout Iowa during the warm months, arriving at least by early May and probably migrating southward again by early September (Kunz and Schlitter, 1968:172). The roosting habits of this species are similar to those of the red bat, *Lasiurus borealis*, with daytime retreats located in trees in wooded rural and urban areas throughout the state.

Only adult females and young have been taken in Iowa and adjacent states during summer (Kunz and Schlitter, 1968:172; Jones *et al.*, 1967:20). Findley and Jones (1964) suggested that males of this species may range to the west and north of Iowa in the warm months. In South Dakota, Turner and Jones (1968:446) found adult males in the Black Hills, thus establishing "the Hills as one of the few places on the Central Great Plains where both sexes of *L. cinereus* occur together in summer."

Specimens examined (28).—BOONE COUNTY: McHose Park, Boone, 1 (KU); *Ledges State Park*, 4 (KU). CASS COUNTY: Lewis, 1 (ISU). CLAY COUNTY: no specific locality, 1 (USNM). EMMET COUNTY: West Des Moines River, 3 1/2 mi. S, 2 3/4 mi. E Wallingford, 1 (KU). GREENE COUNTY: sec. 13, Franklin Twp., 1 (ISU). JASPER COUNTY: Baxter, 1 (USNM).

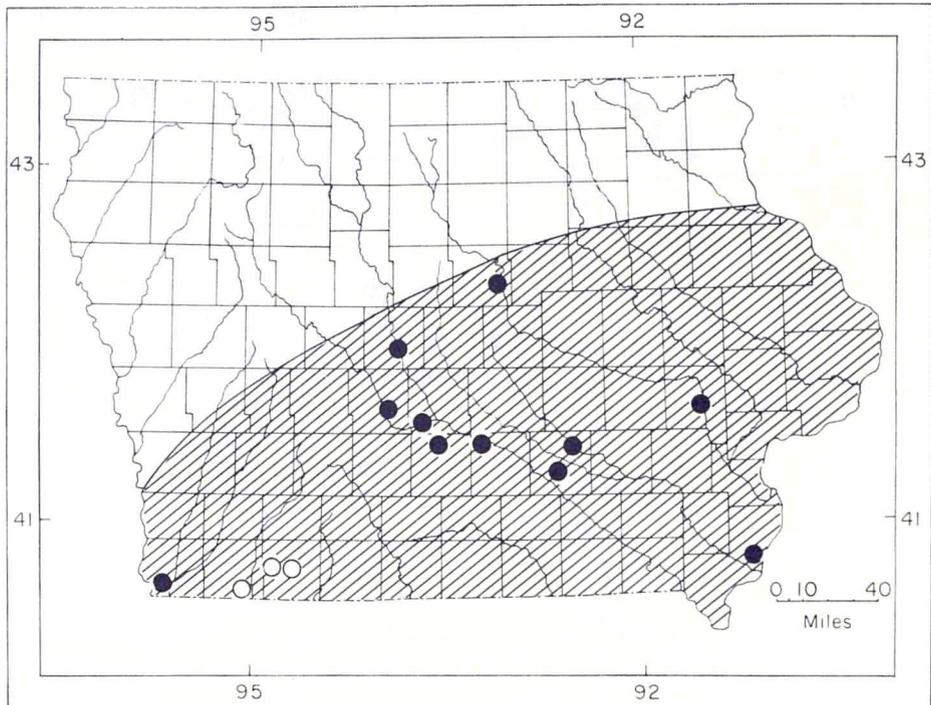


FIG. 17.—Distribution of *Nycticeius humeralis humeralis* in Iowa. For explanation of symbols see Fig. 3.

JOHNSON COUNTY: Iowa City, 1 (SUI); *no specific locality*, 3 (SUI). LINN COUNTY: Marion, 1 (ISU); *Cedar Rapids*, 2 (CC); *4 mi. SW Cedar Rapids*, 1 (KU); *7-8 mi. SW Cedar Rapids*, 1 (KU). LYON COUNTY: sec. 12, Lyon Twp., 1 (ISU). MAHASKA COUNTY: Oskaloosa, 1 (KU). MONONA COUNTY: sec. 6, Franklin Twp., 1 (ISU). PALO ALTO COUNTY: Ruthven, 2 (UMMZ). SCOTT COUNTY: Davenport, 1 (DPM). STORY COUNTY: Ames, 3 (ISU).

Additional records.—CASS COUNTY: *Lewis* (McClure, 1942:430). DICKINSON COUNTY: Lakeside Laboratory [West Okoboji Lake] (Stephens, 1922:63). FLOYD COUNTY: *no specific locality* (Brown, 1917:28—see Schlitter and Bowles, 1968:526). PALO ALTO COUNTY: *no specific locality* (Ruthven and Wood, 1912:205). POLK COUNTY: Des Moines (State Hygienic Laboratory, Iowa City, 1969 rabies report). POTTAWATTAMIE COUNTY: *no specific locality* (Constantine, 1966:35). SAC COUNTY: *no specific locality* (Spurrell, 1917:284).

Nycticeius humeralis humeralis (Rafinesque)

Evening Bat

1818. *Vespertilio humeralis* Rafinesque. Amer. Monthly Mag., 3(6):445, October (type locality, Kentucky).
 1819. *N[ycticeius]. humeralis*. Rafinesque, Phys. Chim. Hist. Nat. et Arts, Paris, 88:417, June.

Distribution in Iowa.—Probably migrant; resident in southern half of the state in warm months (see Fig. 17).

The evening bat is apparently a common summer resident in southern Iowa (Kunz and Schlitter, 1968:173) and extreme eastern Nebraska, where it reaches the northwestern limit of its range (Birney and Rising, 1968:522). The only

known nursery colonies of this species in the state are located in attics of buildings in Page and Taylor counties in the southwest (Watkins, 1970:334).

Pregnant or lactating females and flying young of the year have been reported from several counties in central and south-central parts of the state (Schlitter and Bowles, 1968:527; Kunz and Schlitter, 1968:173). The earliest and latest dates that specimens have been taken in Iowa are, respectively, 25 May from Mahaska County and 24 August from Fremont County. All specimens herein reported are either adult females or young of the year.

Kunz and Schlitter (1968:173) incorrectly listed three specimens (USNM, 114761-63) from Burlington, Des Moines County, as having been collected in Davenport, Scott County (see Schlitter and Bowles, 1968:527).

Specimens examined (36).—BOONE COUNTY: Ledges State Park, 1 (KU). DALLAS COUNTY: Raccoon River, 1 mi. N Adel, 2 (KU). DES MOINES COUNTY: Burlington, 3 (USNM). FREMONT COUNTY: 1 1/2 mi. N, 1/2 mi. W Hamburg, 1 (KU). HARDIN COUNTY: South Fork Iowa River, 2 1/2 mi. S Eldora, 1 (KU). JOHNSON COUNTY: Iowa City, 1 (SUI). MAHASKA COUNTY: North Skunk River, 1/2 mi. S, 5 mi. E New Sharon, 6 (KU); Penn Woods, Oskaloosa, 4 (KU). MARION COUNTY: 1-1 1/2 mi. W Percy, 1 (KU). POLK COUNTY: *Beaver Creek*, 1/2-1 mi. N Des Moines, 1 (ISU); 1/2 mi. W Des Moines, 6 (KU). WARREN COUNTY: 8 mi. N Indianola, 9 (KU).

Additional records.—PAGE COUNTY: 1 1/2 mi. W Bradyville (Watkins, 1970:334). TAYLOR COUNTY: 2 mi. E New Market (Watkins, personal communication); 4 mi. N Bedford (Watkins, 1970:334); 4 mi. S, 1 mi. E Bedford (Watkins, personal communication).

Family MOLOSSIDAE—Free-tailed Bats

Tadarida macrotis (Gray)

Big Free-tailed Bat

1839. *Nyctinomus macrotis* Gray, Ann. Nat. Hist., 4:5, September (type locality, interior of Cuba).

1931. *Tadarida macrotis*, Shamel, Proc. U.S. Nat. Mus., 78:15, May.

Distribution in Iowa.—Known only from Marshall and Linn counties (not mapped).

The big free-tailed bat is known from Iowa only by two autumn-taken specimens, one in 1910 from Cedar Rapids and the other in 1914 from Marshalltown. These records probably represent stragglers because the main center of the geographic distribution of this bat lies well to the south of Iowa (Kunz and Schlitter, 1968:173).

Considerable confusion has existed regarding the specific name of this bat, which was known for some years as *T. molossa*. Husson (1962) concluded that *macrotis* was the applicable name.

Specimen examined.—MARSHALL COUNTY: Marshalltown, 1 (FMNH).

Additional record.—LINN COUNTY: Cedar Rapids (Cory, 1912:477).

ORDER LAGOMORPHA—Hares, Rabbits, and Pikas

Lagomorphs are represented in Iowa by a single family and two species.

Key to Iowan Lagomorphs

1. Ear from notch more than 90; interpterygoid space more than 7.0; interparietal fused with parietals *Lepus townsendii*, p. 58

- 1'. Ear from notch less than 75; interpterygoid space less than 7.0; interparietal not fused with parietals *Sylvilagus floridanus*, p. 56

Family LEPORIDAE—Hares and Rabbits

***Sylvilagus floridanus mearnsii* (J. A. Allen)**

Eastern Cottontail

1894. *Lepus sylvaticus mearnsii* J. A. Allen, Bull. Amer. Nat. Hist., 6:171, 31 May (type locality, Fort Snelling, Hennepin Co., Minnesota).
 1904. *Sylvilagus (Sylvilagus) floridanus mearnsi*, Lyon Smiths. Misc. Coll. 45:336, 15 June.

Distribution in Iowa.—Statewide (see Fig. 18).

The eastern cottontail is common to abundant in suitable habitats throughout Iowa. Prior to settlement, however, *S. floridanus* may have been locally common only in forest-edge situations or open woods in southern Iowa, and in riparian communities in the tall-grass prairie. Subsequent removal or selective cutting of forests and cultivation of prairie increased the habitat and food supply of the cottontail (Allen, 1870:194; Scott, 1937:81).

The eight specimens from "Ruthven, Palo Alto County," reported by Nelson (1909:179) are probably those in the University of Michigan Museum of Zoology (UMMZ 3407-8, 3410-12, 35564-66), although the specimen labels give no specific locality within that county. Of the 13 specimens taken at Fort Des Moines, Polk County, in 1855 and catalogued at the U.S. National Museum (Coues and Allen, 1877:333-336), only one (USNM 2094) was seen by me; the remainder either have been destroyed or misplaced.

Specimens examined (134).—APPANOOSE COUNTY: Sharon Bluffs State Park, 1 (ISU). BENTON COUNTY: Vinton, 1 (SUI). BOONE COUNTY: Des Moines River, [2 mi. W] Madrid, 1 (ISU). BUENA VISTA COUNTY: 1/2 mi. SW Sioux Rapids, 1 (BV); 5 mi. N Newell, 2 (BV); 1 mi. N, 3 mi. W Newell, 1 (BV); 1/2 mi. N, 4 mi. W Newell, 2 (BV); 1/2 mi. N, 3 mi. W Newell, 1 (BV); 2 mi. E Newell, 1 (BV). BUTLER COUNTY: 1/2 mi. S, 3 mi. E Greene, 1 (KU). CERRO GORDO COUNTY: Owen Twp., 1 (SUI). CHEROKEE COUNTY: 3 mi N, 1/4 mi. W Cherokee, 1 (SM). CLAY COUNTY: 2 mi. N, 1 mi. E Spencer, 1 (BV); 2 mi. N Linn Grove, 1 (BV); no specific locality, 7 (UMMZ). CLAYTON COUNTY: McGregor, 1 (SUI). CLINTON COUNTY: 1/2 mi. S Clinton, 1 (KU). DES MOINES COUNTY: Burlington, 2 (USNM). DICKINSON COUNTY: no specific locality, 1 (SM). DUBUQUE COUNTY: Dubuque, 2 (ISU). FRANKLIN COUNTY: Alexander, 3 (UMMZ). FREMONT COUNTY: Sidney, 1 (ISU); Hamburg, 1 (ISU). HANCOCK COUNTY: 5 mi. ESE Forest City, 1 (ISU); 3/4 mi. S, 1 mi. W Hayfield, 1 (UMMZ); Donna [probably Duncan], 2 (USNM). HARRISON COUNTY: Logan, 1 (SUI). HENRY COUNTY: Wayland, 2 (SUI). JASPER COUNTY: 1/2 mi. S, 4 1/2 mi. W Sully, 1 (KU). JOHNSON COUNTY: Iowa City, 24 (20 AMNH, 1 SUI, 3 USNM). KEOKUK COUNTY: 6 1/2 mi. S, 1 mi. W Sigourney, 1 (KU). LINN COUNTY: Center Point, 2 (CC); Cedar Rapids, 6 (5 CC, 1 KU); NE 1/4 of NE 1/4 of sec. 18, T. 82 N, R. 6 W, 1 (ISU). LOUISA COUNTY: no specific locality, 1 (SUI). LYON COUNTY: sec. 3, Grant Twp., 1 (ISU); sec. 23, Lyon Twp., 2 (ISU); sec. 28, Wheeler Twp., 1 (ISU). MAHASKA COUNTY: 1 1/2 mi. S, 2 1/2 mi. E New Sharon, 1 (KU); 2 mi. N Oskaloosa, 1 (KU); Oskaloosa, 4 (KU). MARION COUNTY: Knoxville, 5 (FMNH). MUSCATINE COUNTY: 2 mi. E Conesville, 1 (ISU). OSCEOLA COUNTY: Ocheyedan, 1 (SUI). PALO ALTO COUNTY: no specific locality, 11 (UMMZ). POLK COUNTY: Des Moines, 1 (USNM). SAC COUNTY: 1 mi. E, 3 1/2 mi. N Galva, 1 (BV). SCOTT COUNTY: Davenport,

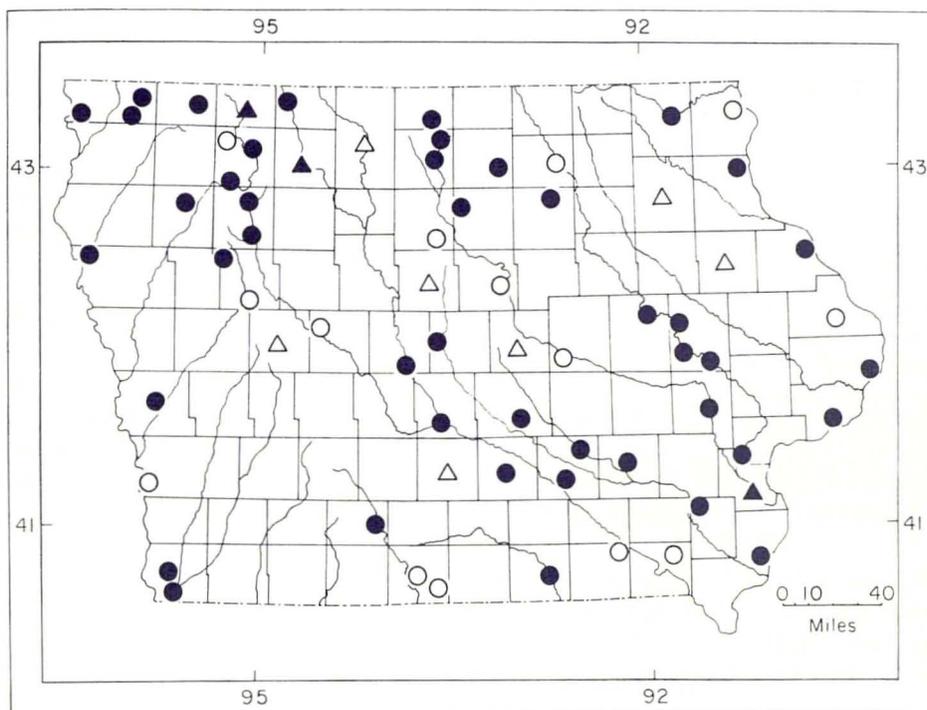


FIG. 18.—Distribution of *Sylvilagus floridanus mearnsii* in Iowa. For explanation of symbols see Fig. 3.

1 (DPM). STORY COUNTY: Ames, 3 (ISU); *SE 1/4 of SE 1/4 of sec. 31, T. 83 N, R. 24 W*, 1 (KU). UNION COUNTY: Thayer, 4 (SUI). WINNEBAGO COUNTY: 1 mi. N, 3 mi. W Forest City, 1 (UMMZ); *Forest City*, 8 (UMMZ). WINNESHIEK COUNTY: 5 mi. NE Decorah, 6 (UMMZ); *Decorah*, 1 (UMMZ). WOODBURY COUNTY: Sioux City, 1 (USNM).

Additional records.—ALLAMAKEE COUNTY: Lansing (record on file, U.S. Biological Survey). BOONE COUNTY: *Moingona Fox Range, about 5 mi. S Boone* (Scott, 1947:450). CARROLL COUNTY: no specific locality (Scott, 1938:539). CLAY COUNTY (Scott, 1940:588): sec. 19, Summitt Twp.; sec. 22, *Waterford Twp.* DAVIS COUNTY: Eldon Fox Area [1 mi. N, 5 mi. E Floris] (Scott and Klimstra, 1955:41). DECATUR COUNTY: Leon (Scott, 1937:82); sec. 13, Woodland Twp. (Hendrickson, 1954:25). DELAWARE COUNTY: no specific locality (Scott, 1938:539). DICKINSON COUNTY: no specific locality (Stephens, 1922:57). DUBUQUE COUNTY: vicinity *Durango* (Giles, 1940:573). FAYETTE COUNTY: no specific locality (Scott, 1938:539). FLOYD COUNTY: Charles City (Webster, 1900:7); no specific locality (Brown, 1917:27). GREENE COUNTY: Churdan (record on file, U.S. Biological Survey). HAMILTON COUNTY: no specific locality (Scott, 1938:539). HARDIN COUNTY: 3/4 mi. E Eldora (Bowles, field notes). JACKSON COUNTY: Michel's Cave, 2 mi. S Springbrook (Trosky and Polder, 1960:608). KOSSUTH COUNTY: no specific locality (Scott, 1938:539). MARSHALL COUNTY: no specific locality (Gabrielson, 1921:148). POLK COUNTY: *Fort Des Moines* (Baird, 1858:601). POTTAWATTAMIE COUNTY: Council Bluffs (record on file, U.S. Biological Survey); no specific locality (Scott, 1937:82). SAC COUNTY: Wall Lake (Spurrell, 1917:281). STORY COUNTY: 2 mi. N Ames (Hendrickson, 1930:399); Ames (Hendrickson, 1947:63); 1 1/2 mi. S Ames (Eakins, 1949:13). TAMA COUNTY: Tama (Joyce and Eddy, 1944:21). VAN BUREN COUNTY: Stockport (Wiseman and Hendrickson, 1950:331); no specific locality (Nelson, 1909:172). WARREN COUNTY: no specific locality (Scott, 1938:539). WRIGHT COUNTY: Wall Lake (Scott, 1947:450).

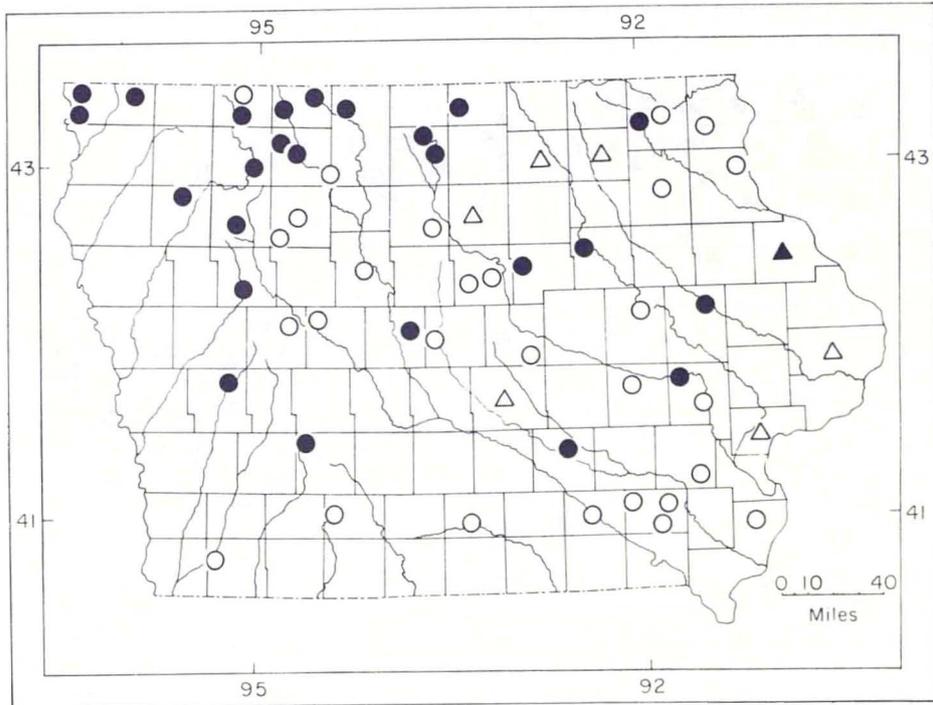


FIG. 19.—Distribution of *Lepus townsendii campanius* in Iowa. For explanation of symbols see Fig. 3.

***Lepus townsendii campanius* Hollister**
White-tailed Jack Rabbit

1837. *Lepus campestris* Bachman. J. Acad. Nat. Sci. Philadelphia, 7:349 (type locality, plains of Saskatchewan, probably near Carlton House), not Meyer, 1790.
1915. *Lepus townsendii campanius* Hollister, Proc. Biol. Soc. Washington, 28:70, 12 March, a renaming of *L. campestris* Bachman.

Distribution in Iowa.—Probably statewide; commonest in the northern part of the state (see Fig. 19).

The white-tailed jack rabbit evidently was uncommon in Iowa and probably restricted to the northwestern part of the state prior to settling and subsequent cultivation of the tall-grass prairie (Allen, 1870:194; Stoner, 1918:131; Scott, 1937:81). The earliest published record that I have found was for Sac County (western Iowa) in about 1868 (Spurrell, 1917:280). Subsequent records suggest that *L. townsendii* rapidly expanded its range as far east as Muscatine County by the late 1890's (Nutting, 1893:40) and south to Shelby County by 1885 (White, 1915:77). Stoner (1918:132) cited records of this species from additional southern Iowa counties of Page, Union, Lucas, and Wapello.

At present, the white-tailed jack rabbit probably is found throughout Iowa, although it is commonest in the north-central and northwestern parts of the state. There are relatively few recent records of this species from southern counties (Polder, 1958:564; Schlitter and Bowles, 1968:528), and there is considerable

local variation in abundance throughout the state (Kline, 1963). In adjacent states, this species was reported from northwestern Illinois (Hoffmeister and Grebner, 1948), and listed as occurring in Missouri, although no specific records were cited (Schwartz and Schwartz, 1959:88). Cockrum (1955:97) and Jones (1964:111) reported a northward shift in the southern limit of the geographic range in Kansas and Nebraska, respectively. Presently this jack rabbit is found primarily north of the Platte River in Nebraska, replaced to the south by the black-tailed jack rabbit, *Lepus californicus* (Jones, *loc. cit.*).

Several authors have discussed the various possible factors influencing the change in the range of *L. townsendii* (see especially Jones, *loc. cit.*, and Jackson, 1961:105). In Iowa, the rapid spread of the white-tailed jack rabbit correlates with the time of drainage and cultivation of the tall-grass prairie (Ross, 1946:22), and Kline (1963) reported particularly high populations of these rabbits in intensively cultivated areas. It seems possible that this species may originally have been restricted by high soil moisture content and tall-grass cover. Kline (1963), for example, noted a decline in local populations of *L. townsendii* during relatively wet growing seasons.

The earliest-taken Iowan specimen that I have examined was collected in December of 1892 by a Mr. Wolf in Madison Township, Johnson County. This specimen (SUI 9153) is a skin (without skull) in winter pelage. Nutting (1895:43) reported that "the first record of Johnson County is based on a specimen killed in January, 1893, by Mr. Wolf. The skull only was kept as a basis for the record." These two records may represent the same specimen; I was unable to locate the mentioned skull.

Specimens examined (56).—ADAIR COUNTY: Adair, 1 (Univ. of Missouri at Kansas City). BLACK HAWK COUNTY: Cedar Falls, 3 (UNI). BOONE COUNTY: SE 1/4 of NE 1/4 of sec. 26, T. 84 N, R. 25 W, 1 (ISU). BUENA VISTA COUNTY: 1 mi. N, 2 mi. E Storm Lake, 1 (BV). CLAY COUNTY: Webb, 11 (AMNH); *no specific locality*, 3 (UMMZ). DICKINSON COUNTY: 3/4 mi. W Lakeside Laboratory [West Okoboji Lake], 1 (DPM). DUBUQUE COUNTY: Peru Bottoms [not precisely located], 1 (ISU). EMMET COUNTY: junction Iowa hwy. 9 and U.S. 17 [Estherville], 1 (ISU); NW 1/4 of SW 1/4 of sec. 9, T. 100 N, R. 31 W, 1 (ISU). GRUNDY COUNTY: Wellsburg, 1 (CC). HANCOCK COUNTY: 3/4 mi. S, 3 1/2 mi. W Forest City, 1 (UMMZ); 1 1/2 mi. S, 6 mi. W Forest City, 1 (UMMZ); 2 1/4 mi. S, 1 1/8 mi. W Forest City, 1 (UMMZ); 1 1/2 mi. N Hayfield, 1 (UMMZ); 1 1/4 mi. N, 3 2/10 mi. W Hayfield, 1 (UMMZ). JOHNSON COUNTY: Madison Twp., 1 (SUI); *no specific locality*, 3 (SUI). KOSSUTH COUNTY: 1/2 mi. N Swea City, 1 (ISU); *no specific locality*, 1 (ISU). LINN COUNTY: 5 mi. S Coggon, 1 (ISU). LYON COUNTY: sec. 35, Elgin Twp., 1 (ISU); sec. 2, Centennial Twp., 1 (ISU); sec. 26, Lyon Twp., 1 (ISU). MAHASKA COUNTY: 1/2 mi. S, 2 mi. E New Sharon, 1 (KU); 2 mi. S, 4 mi. W New Sharon, 1 (KU). PALO ALTO COUNTY: 2 mi. N, 2 3/4 mi. E Ruthven, 1 (ISU); Ruthven, 2 (UMMZ); Emmetsburg, 1 (UMMZ); *no specific locality*, 6 (UMMZ). SAC COUNTY: Wall Lake, 1 (SUI). SHELBY COUNTY: SE 1/4 of sec. 4, T. 80 N, R. 37 W, 1 (ISU). WINNESHIEK COUNTY: 3 mi. S Ridgeway, 1 (UMMZ). WORTH COUNTY: Elk Creek Marsh [3 mi. N Joice], 1 (ISU).

Additional records (Kline, 1963:198-204, unless otherwise indicated).—ALLAMAKEE COUNTY: Waukon (Stoner, 1917:354). BENTON COUNTY: Vinton ("Mount Tom." Forest and Stream, 1899, 52:90). BOONE COUNTY: *Moingona Fox Area, about 5 mi. S Boone* (Scott, 1947:444). BUENA VISTA COUNTY: *near Storm Lake*. CARROLL COUNTY: *near Lidderdale*. CHICKASAW COUNTY: *no specific locality*. CLAYTON COUNTY: McGregor (Stoner, 1918:132). CLINTON COUNTY: *no specific locality* (Spurrell, 1917:281). DES MOINES COUNTY: *Mediapolis* (Polder, 1958:564). DICKINSON COUNTY: *near Spirit Lake; Lakeside Laboratory, [West]*

Lake Okoboji (Stephens, 1922:57). EMMET COUNTY: *Estherville* (Stoner, 1918:133). FAYETTE COUNTY: Fayette (Seton, 1929, 4(2):651). FLOYD COUNTY: no specific locality (Brown, 1917:27). FRANKLIN COUNTY: no specific locality. GREENE COUNTY: Churdan (record on file, U.S. Biological Survey). HARDIN COUNTY: 1 1/2 mi. S, 1/2 mi. W Eldora (Bowles, field notes); 3 1/2 mi. N, 1 mi. W Hubbard (Bowles, field notes). IOWA COUNTY: Marengo (Stoner, 1918:133). JASPER COUNTY: no specific locality (Stoner, 1918:133). JEFFERSON COUNTY: Packwood (Polder, 1958:564); Beckwith (Pammel, 1930:415); Glasgow (Pammel, 1930:415). JOHNSON COUNTY: Iowa City (Stoner, 1918:132). KOSSUTH COUNTY: West Bend (Stoner, 1918:133). LUCAS COUNTY: Chariton (Stoner, 1918:132). MARSHALL COUNTY: 1/2 mi. S, 1/2 mi. E Gilman (Bowles, field notes); *no specific locality* (Gabrielson, 1921:148). MUSCATINE COUNTY: no specific locality (Nutting, 1893:40). PAGE COUNTY: Shenandoah (Stoner, 1918:132). POCAHONTAS COUNTY (Flickinger, 1904:276): W of Pocahontas; W of Fonda. SAC COUNTY (Spurrell, 1917:281): *Sac City*; *Lake View*. SHELBY COUNTY: *near Irwin* (White, 1915:77). STORY COUNTY: *sec. 10, Franklin Twp.* (Henry, 1942:5); 2 mi. N Ames (Hendrickson, 1930:398); Ames (Osborn, 1890:43); *no specific locality* (Weller and Blagen, 1970:288). UNION COUNTY: Creston (Stoner, 1918:132). WAPELLO COUNTY: Ottumwa airport (Polder, 1958:564). WEBSTER COUNTY: Fort Dodge (Stoner, 1918:133). WINNESHIEK COUNTY: Decorah (Stoner, 1918:132). WRIGHT COUNTY: Wall Lake (Scott, 1947:444).

ORDER RODENTIA—Rodents

Twenty-three native species of rodents belonging to seven families occur in Iowa. Four additional species belonging to three families were introduced into the state; of these families, Sciuridae naturally occurs in the United States, whereas Muridae and Capromyidae are not native to North America.

Key to Families of Iowan Rodents

1. Modified for aquatic life; hind feet webbed; lower incisor more than 6.0 in width at alveolus 2
- 1'. Not especially modified for aquatic life (except *Ondatra*); hind feet not webbed; lower incisor less than 5.5 (less than 4.0 in all except Erethizontidae) in width at alveolus 3
- 2.(1) Tail broad, flattened dorsoventrally; infraorbital canal smaller than foramen magnum Castoridae, p. 82
- 2'. Tail not broad or flattened dorsoventrally; infraorbital canal larger than foramen magnum Capromyidae, p. 152
- 3.(1') Dorsal aspect of body and tail quilled; infraorbital canal larger than foramen magnum Erethizontidae, p. 107
- 3'. Body and tail lacking quills; infraorbital canal smaller than foramen magnum 4
- 4.(3') Pelage of tail usually distichous; skull having postorbital process Sciuridae, p. 61
- 4'. Pelage of tail nondistichous; skull lacking postorbital process 5
- 5.(4') Cheekteeth 4/4; external fur-lined cheek pouches present 6
- 5'. Cheekteeth 3/3 or 4/3; no external fur-lined cheek pouches 7
- 6.(5) Tail more than three-fourths length of head and body; hind feet larger than forefeet; tympanic bullae exposed in dorsal view of skull Heteromyidae, p. 81
- 6'. Tail less than three-fourths length of head and body; hind feet smaller than forefeet; tympanic bullae not exposed in dorsal view of skull Geomyidae, p. 77
- 7.(5') Tail much longer than head and body; cheek teeth 4/3 Zapodidae, p. 105
- 7'. Tail equal to or less than the length of head and body; cheekteeth 3/3 8
- 8.(7') Annulations of scales on tail nearly or completely concealed by pelage (excepting *Ondatra zibethicus*, which has a laterally flattened tail); cheekteeth with two longitudinal rows of cusps or prismatic in occlusal view Cricetidae, p. 84

- 8'. Annulations of scales on tail apparent due to sparse hair; cheekteeth with three longitudinal rows of cusps Muridae, p. 149

Family SCIURIDAE—Squirrels and Allies

Key to Iowan Sciurids

1. Total length more than 540; greatest length of skull more than 80; postorbital process at right angle to long axis of skull *Marmota monax*, p. 63
- 1'. Total length less than 540; greatest length of skull less than 70; postorbital process projecting downward and backward 2
- 2.(1') Total length more than 375; condylobasal length of skull more than 50 3
- 2'. Total length less than 375; condylobasal length of skull less than 50 6
- 3.(2) Dorsal pelage yellowish brown; tail with distinct black tip; maxillary toothrows strongly divergent anteriorly, length more than 15 *Cynomys ludovicianus*, p. 153
- 3'. Dorsal pelage other than yellowish brown; tail without distinct black tip; maxillary toothrows more or less parallel, length less than 12 4
- 4.(3') Tail less than 40 per cent of total length; P3 well developed; postorbital breadth less than 15 *Spermophilus franklinii*, p. 65
- 4'. Tail more than 40 per cent of total length; P3 small and peglike, or absent; postorbital breadth more than 15 5
- 5.(4') Lateral hairs of tail tipped with white; P3 usually present *Sciurus carolinensis*, p. 69
- 5'. Lateral hairs of tail tipped with yellowish to reddish orange; P3 absent *Sciurus niger*, p. 71
- 6.(2') Total length more than 300; hind foot more than 40; condylobasal length of skull more than 42 *Tamiasciurus hudsonicus*, p. 73
- 6'. Total length less than 300; hind foot less than 40; condylobasal length of skull less than 42 7
- 7.(6') Upper parts striped but lacking spots; infraorbital canal lacking; P3 absent *Tamias striatus*, p. 61
- 7'. Upper parts lacking stripes, or if striped also with spots; infraorbital canal present; P3 present 8
- 8.(7') Membrane for gliding present between foreleg and hind leg; skull highly arched, highest over braincase; nasals less than 11 *Glaucomys volans*, p. 76
- 8'. Membrane for gliding absent; skull moderately arched, highest over orbits; nasals more than 11 *Spermophilus tridecemlineatus*, p. 67

***Tamias striatus griseus* Mearns**

Eastern Chipmunk

1891. *Tamias striatus griseus* Mearns, Bull. Amer. Mus. Nat. Hist., 3:231, 5 June (type locality, Fort Snelling, Hennepin Co., Minnesota).

Distribution in Iowa.—Common in eastern Iowa; absent or of local occurrence in western part of the state (see Fig. 20).

The eastern chipmunk is common throughout the wooded parts of eastern Iowa. In central and western Iowa, this species is found locally in suitable habitat along tributaries of the Mississippi River as far to the northwest as Lake Okobojo, Dickinson County. Recent populations have been reported from Crawford and Sac counties (Polder, 1958:563) and along the Little Sioux River near Cherokee. I know of no records of *Tamias* from extreme northwestern Iowa or adjacent parts of South Dakota and Minnesota. This chipmunk evidently is

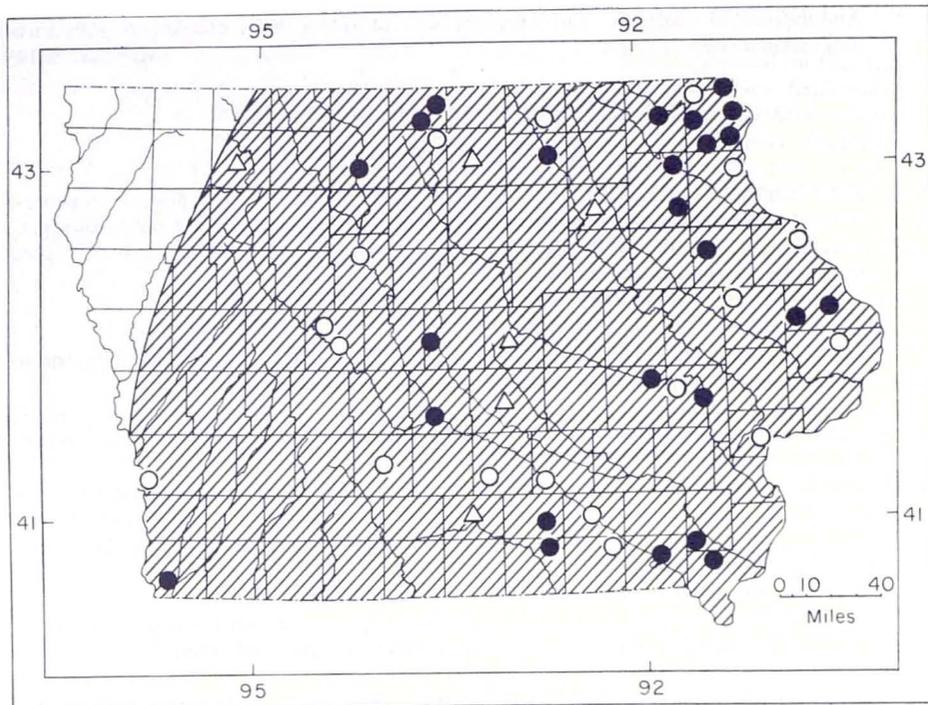


FIG. 20.—Distribution of *Tamias striatus griseus* in Iowa. For explanation of symbols see Fig. 3.

rare or absent in the southwestern part of the state, although it may occur in certain areas along the Missouri River, because Jones (1964:117) reported its recent occurrence as far north as Sarpy County, Nebraska, on the west side of the river.

Evidently, *Tamias* formerly was more abundant in much of southwestern Iowa and eastern Nebraska but was severely restricted as a result of removal of timber by early settlers, and now is limited primarily to suitable areas along major water courses and in areas of wooded bluffs (Jones, 1964:117; Scott, 1937:70; Spurrell, 1917:283). This species was indicated as common in timbered areas, for example, in faunal lists included in histories of Fremont County (Anonymous, 1881a:366) and Montgomery County (Anonymous, 1891:407), although the authors are not identified and the species included are not authenticated.

Specimens examined (99).—ALLAMAKEE COUNTY: N 1/2 of sec. 30, T. 97 N, R. 3 W, 1 (ISU); *Yellow River State Forest*, 1 (ISU); 4 mi. N, 3 mi. E Monona, 1 (KU). APPANOOSE COUNTY: 5 1/2 mi. E Moravia, 1 (KU). BENTON COUNTY: NE 1/4 of NE 1/4 of sec. 29, T. 82 N, R. 11 W, 1 (ISU). BOONE COUNTY: 2 1/2 mi. S Ogden, 3 (ISU). CHEROKEE COUNTY: *Martin's Access* [*Little Sioux River*, 5 mi. NE *Cherokee*], 2 (BV); 3 mi. N *Cherokee*, 1 (BV). CLAYTON COUNTY: NE 1/4 of sec. 35, T. 95 N, R. 6 W, 1 (ISU). DELAWARE COUNTY: *Backbone State Park*, 1 (CC). DES MOINES COUNTY: *Burlington*, 30 (USNM). DICKINSON COUNTY: 1/2 mi. W *Spirit Lake*, 1 (ISU); *Arrowhead Beach*, [*West*] *Lake Okoboji*, 4 (TTU); *Spooky Hollow*, *Little Sioux River*, 2 6/10 mi. W hwy. 32, 1 (TTU); DUBUQUE COUNTY: *Julien*, 1 (ISU); 6 mi. E *Cascade*, 1 (CC). EMMET COUNTY: *Fort Defiance State Park*, 1 (ISU); *Esther-*

ville, 1 (ISU); 4 mi. S Estherville, 1 (ISU). FAYETTE COUNTY: 1 mi. N, 1 mi. E Sumner, 1 (UNI); Fayette, 1 (ISU). FLOYD COUNTY: Charles City, 1 (SUI). HANCOCK COUNTY: Pilot Knob State Park, 2 (ISU). HENRY COUNTY: Hillsboro, 2 (USNM). JACKSON COUNTY: NE 1/4 of SW 1/4 of sec. 13, T. 85 N, R. 3 E, 1 (ISU). JOHNSON COUNTY: NW 1/4 of NE 1/4 of sec. 26, T. 81 N, R. 8 W, 1 (ISU); Iowa City, 2 (1 IHM, 1 SUI). KEOKUK COUNTY: 6 1/2 mi. S, 1 mi. W Sigourney, 2 (KU). LINN COUNTY: 4 mi. E Central City, 1 (ISU); Cedar Rapids, 4 (3 CC, 1 FMNH); no specific locality, 1 (CC). MAHASKA COUNTY: Oskaloosa, 7 (KU). MARION COUNTY: 4 1/4 mi. S Pella, 1 (KU); Tracy, 8 (AMNH). MITCHELL COUNTY: NW 1/4 of NW 1/4 of sec. 35, T. 100 N, R. 17 W, 1 (ISU). SCOTT COUNTY: Pleasant Valley Twp., 1 (DPM). STORY COUNTY: Ames, 3 (2 ISU, 1 USNM). UNION COUNTY: Thayer, 1 (SUI). WINNEBAGO COUNTY: Lake Mills, 1 (ISU). WINNESHIEK COUNTY: Canoe Creek, 1 (UMMZ); Lower Dam [near mouth Coon Creek], 1 (UMMZ); Walnut Creek [about 4 mi. N Ridgeway], 1 (UMMZ).

Additional records (Stoner, 1918:27, unless otherwise indicated).—BLACK HAWK COUNTY: near Finchford (Sloan, 1964:521). BOONE COUNTY: McHose Park, Boone (Bowles, field notes); Moingona Fox Area, about 5 mi. S Boone (Scott, 1947:474). CLAYTON COUNTY: McGregor. CRAWFORD COUNTY: Boyer River, near Denison (Polder, 1958:563). DES MOINES COUNTY: Burlington (Bowles, field notes). DICKINSON COUNTY: Lakeside Laboratory, West Lake Okoboji (Miller, 1954:558). FLOYD COUNTY: no specific locality (Brown, 1917:24). HARDIN COUNTY: 3/4 mi. E Eldora (Bowles, field notes). HENRY COUNTY: Wayland. JEFFERSON COUNTY: 1 mi. N Fairfield (Bowles, field notes). JOHNSON COUNTY: Iowa City. MAHASKA COUNTY: 1 mi. S, 8 mi. W Oskaloosa (Bowles, field notes). MARSHALL COUNTY: no specific locality (Gabrielson, 1921:147). POLK COUNTY: Des Moines. SAC COUNTY: Sac City (Polder, 1958:563); no specific locality (Spurrell, 1917:283). TAMA COUNTY: Traer. WEBSTER COUNTY: Dolliver Memorial State Park (Damon, 1941:326).

***Marmota monax monax* (Linnaeus)**

Woodchuck

1758. [*Mus*] *monax* Linnaeus, *Systema naturae*, ed. 10, 1:60 (type locality, Maryland).

1904. *Marmota monax*. Trouessart, *Catalogus mammalium* . . . Suppl., p. 344.

Distribution in Iowa.—Statewide, but uncommon in northwestern part (see Fig. 21).

The woodchuck is common to abundant throughout eastern Iowa, but uncommon in the northwestern part of the state, where it probably is restricted to the vicinity of woodlots and riparian habitats. Scott (1937:68) thought that *M. monax* was "formerly south of Iowa" and that the "northward extension of its range was most rapid along the larger streams of the Missouri and Mississippi River systems." However, early records suggest that at the time of settlement (mid-1800's) the woodchuck was common in the deciduous forests of eastern Iowa and present, though uncommon, throughout much of the remainder of the state (Allen, 1870:190; Galland, 1921:501; Spurrell, 1917:283).

By the early 1900's, the distributional pattern of this species probably was similar to that found presently (Scott, 1937:68; Stoner, 1918:46), but the relative abundance may have increased in Iowa, as was noted in Nebraska by Swenk (1938:350). Jones (1964:121) found the woodchuck to be restricted to eastern Nebraska. Although there are no published records of this species from South Dakota, specimens from the eastern part of the state are housed in the Museum of Natural History at The University of Kansas.

Howell (1915) referred all *Marmota monax* from the southwestern part of the range of the species to *M. m. monax*, but noted the larger size of Kansan speci-

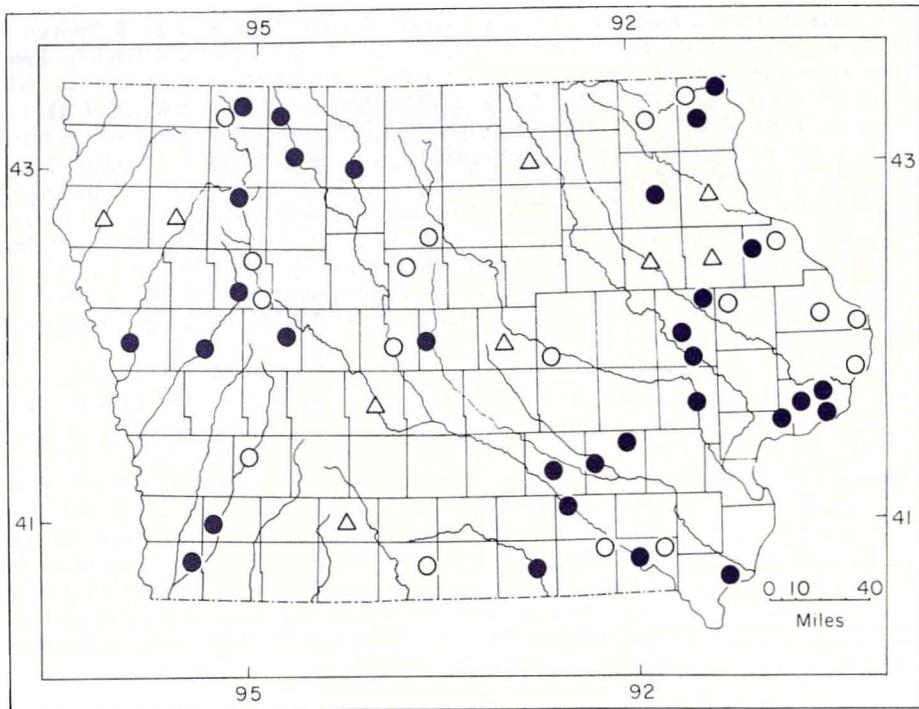


FIG. 21.—Distribution of *Marmota monax monax* in Iowa. For explanation of symbols see Fig. 3.

mens. Black (1938) described the latter as a distinct subspecies, *M. m. bunkerii*; later, Jones (1964:123) “tentatively” referred Nebraskan woodchucks to *bunkerii*. Unfortunately, there are no large series available from Iowa, but a male (KU 109708) from Mahaska County (south-central Iowa) has external and cranial measurements as large as those claimed for *M. m. bunkerii* and does not differ obviously in coloration from typical specimens of *bunkerii*. It seems best to continue to regard all Iowan woodchucks as *M. m. monax* until the systematic relationships of Kansan and Nebraskan populations can be reexamined. It is possible that there is an east-west cline in size within this species, with western individuals averaging slightly larger both externally and cranially. I was unable to detect any intergradation in Iowa between *M. m. monax* and the smaller *M. m. rufescens* from Minnesota.

Specimens examined (34).—ALLAMAKEE COUNTY: 8 mi. SW New Albin, 1 (WSU); 2 mi. NW Waukon, 1 (SUI). APPANOOSE COUNTY: Sharon Bluffs State Park, 1 (ISU). BUENA VISTA COUNTY: 1 mi. N Sioux Rapids, 1 (BV). CARROLL COUNTY: Grant Twp., 1 (ISU). CRAWFORD COUNTY: sec. 13, Denison Twp., 1 (ISU). DICKINSON COUNTY: East Okoboji Lake, 1 (ISU). DUBUQUE COUNTY: Dyersville, 1 (USNM). EMMET COUNTY: 2 mi. S Estherville, 1 (ISU). FAYETTE COUNTY: Fayette, 1 (ISU). FREMONT COUNTY: Walnut Twp., 1 (ISU). JOHNSON COUNTY: Iowa City, 2 (1 SUI, 1 USNM). KEOKUK COUNTY: sec. 16, South English River Twp., 1 (ISU); 3 1/2 mi. S What Cheer, 1 (KU). KOSSUTH COUNTY: Algona, 1 (ISU). LEE COUNTY: sec. 25, Washington Twp., 1 (ISU). LINN COUNTY: Coggin, 1 (CC); 2 mi. N Marion, 1 (ISU); Palisades [-Kepler] State Park, 1 (ISU). MAHASKA COUNTY: 1/2 mi. W

Oskaloosa, 1 (KU). MONONA COUNTY: sec. 6, Belvidere Twp., 1 (ISU). MONTGOMERY COUNTY: Red Oak, 1 (ISU). MUSCATINE COUNTY: vicinity Stockton, 1 (DPM). PALO ALTO COUNTY: Emmetsburg, 1 (SM). SAC COUNTY: Wall Lake, 1 (USNM). SCOTT COUNTY: Long Grove, 1 (DPM); 1 mi. E Long Grove, 1 (DPM); Maysville, 1 (DPM); Bettendorf, 1 (DPM). STORY COUNTY: 2 mi. N Ames, 1 (ISU); Ames, 1 (ISU). VAN BUREN COUNTY: Des Moines River, sec. 24, Van Buren Twp., 1 (ISU). WAPELLO COUNTY: 3 mi. S, 5 mi. E Eddyville, 1 (KU).

Additional records.—ALLAMAKEE COUNTY: *Canoe Creek [near mouth]* (Hoslett, 1965:366). BOONE COUNTY: Moingona Fox Range, about 5 mi. S Boone (Scott, 1947:444). CASS COUNTY: Atlantic (Scott, 1937:68). CHEROKEE COUNTY: no specific locality (Polder, 1958:562). CLINTON COUNTY: Clinton (record on file, U.S. Biological Survey). DAVIS COUNTY: Eldon Fox Range [1 mi. N, 5 mi. E Floris] (Scott and Klimstra, 1955:31); *no specific locality* (Allen, 1870:190). DALLAS COUNTY: no specific locality (Scott, 1938:537). DECATUR COUNTY: sec. 13, Woodland Twp. (Hendrickson, 1954:25). DICKINSON COUNTY (Stephens, 1922:53): Little Sioux River, Okoboji Twp.; *Lakeside Laboratory [West Okoboji Lake]*. DUBUQUE COUNTY: Raccoon Management Area [northeastern corner] (Giles, 1940:381). EMMET COUNTY: *no specific locality* (Polder, 1958:563). FLOYD COUNTY: no specific locality (Brown, 1917:25). HAMILTON COUNTY: Webster City (Aldrich, 1881:737). JACKSON COUNTY: Michel's Cave, 2 mi. S Springbrook (Trosky and Polder, 1960:608); Sabula (record on file, U.S. Biological Survey). JONES COUNTY: Monticello (record on file, U.S. Biological Survey). MARSHALL COUNTY: no specific locality (Gabrielson, 1921:148). PALO ALTO COUNTY: *Emmetsburg* (Stoner, 1918:46). PLYMOUTH COUNTY: no specific locality (Polder, 1958:562). SAC COUNTY: (Spurrell, 1917:283): Lee Grove [8 mi. N Sac City]; *Sac City; Wall Lake; Grant Grove [=City]*. STORY COUNTY: *vicinity Ames* (Crouch and Becker, 1931). TAMA COUNTY: Tama (Joyce and Eddy, 1944:214). VAN BUREN COUNTY: vicinity Stockport (Crabb, 1948:205); *Lacey-Keosauqua State Park* (Trump, 1943:2); *1 mi. S Keosauqua* (Trump, 1943:2). WINNESHIEK COUNTY: Decorah (Hoslett, 1965:366). WRIGHT COUNTY: Wall Lake (Scott, 1947:444).

***Spermophilus franklinii* (Sabine)** Franklin's Ground Squirrel

1822. *Arctomys franklinii* Sabine, Trans. Linn. Soc. London, 13:587 (type locality, Carlton House, Saskatchewan—see Preble, N. Amer. Fauna, 27:165-166, 26 October 1908).
1827. *Spermophilus Franklini*, Lesson, Manuel de Mammalogie . . . p. 244.

Distribution in Iowa.—Statewide in suitable habitats (see Fig. 22).

Prior to the settlement of Iowa, the Franklin's ground squirrel probably was common only in the tall-grass prairie of the central and western parts of the state (Stoner, 1918:36). Clearing of forested areas in southern Iowa and the planting of hay crops undoubtedly increased available habitat (Scott, 1937:69; Spurrell, 1917:283). However, widespread attempts by farmers to eradicate this ground squirrel, along with drainage and cultivation of the prairie, probably have decreased local populations, perhaps extirpating the species in some areas (Scott, 1937:69; Stoner, 1918:39). At present, *Spermophilus franklinii* seems to be found locally throughout the state, especially where there is some tall grass cover.

Franklin's ground squirrel hibernates in the cold months in Iowa; the earliest and latest seasonal records from the state known to me are 16 April and 14 September, respectively.

Specimens examined (73).—BENTON COUNTY: Garrison, 2 (SUI). BLACK HAWK COUNTY: Cedar Falls, 1 (UNI). BOONE COUNTY: sec. 24, Marcy Twp., 1 (ISU). BUENA VISTA COUNTY: 12 mi. N Storm Lake, 1 (BV); Storm Lake and 6 mi. radius thereof, 9 (BV); 3 mi. E

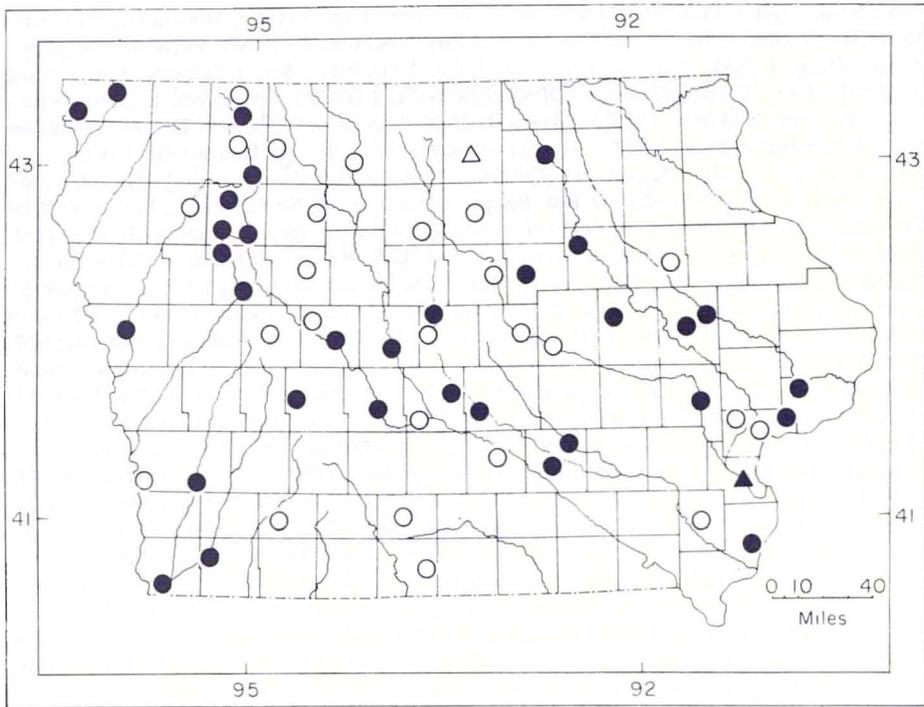


FIG. 22.—Distribution of *Spermophilus franklinii* in Iowa. For explanation of symbols see Fig. 3.

Newell, 1 (BV); no specific locality, 2 (BV). CLAY COUNTY: Webb, 4 (AMNH); no specific locality, 9 (UMMZ). DALLAS COUNTY: Adel, 1 (BV); no specific locality, 1 (BV). DES MOINES COUNTY: Burlington, 1 (USNM). DICKINSON COUNTY: Milford, 1 (UMMZ). FLOYD COUNTY: Charles City, 1 (SUI). FREMONT COUNTY: Hamburg, 1 (ISU). GREENE COUNTY: Jefferson, 2 (SUI). GRUNDY COUNTY: 5 mi. W Grundy Center, 1 (CUI). GUTHRIE COUNTY: sec. 33, T. 80 N., R. 33 W., 1 (ISU). JASPER COUNTY: 1 mi. N Prairie City, 1 (KU). JOHNSON COUNTY: Iowa City, 2 (1 AMNH, 1 IHM); SE of Iowa City, 1 (CC). LINN COUNTY: Waubeek, 1 (CC); 2 mi. S Wapsipinicon River [probably Waubeek], 1 (ISU); 7 mi. N Marion, 1 (ISU). LOUISA COUNTY: no specific locality, 1 (SUI). LYON COUNTY: sec. 26, Riverside Twp., 2 (ISU); sec. 33, Riverside Twp., 1 (ISU); sec. 33, Lyon Twp., 1 (ISU); sec. 34, Lyon Twp., 2 (ISU). MAHASKA COUNTY: 1 1/2 mi. S, 2 mi. E New Sharon, 2 (KU); Oskaloosa and 7 mi. radius thereof, 4 (KU). MONONA COUNTY: sec. 7, Franklin Twp., 1 (ISU). MUSCATINE COUNTY: vicinity Stockton, 1 (DPM). PAGE COUNTY: Shenandoah, 1 (ISH); Grant Twp., 1 (ISU). POLK COUNTY: 2 mi. NE Bondurant, 1 (ISU). POTTAWATTOMIE COUNTY: 1/2 mi. S, 1 mi. E Macedonia, 1 (KU). SAC COUNTY: 2 mi. N Schaller, 2 (BV); Wall Lake, 3 (SUI). SCOTT COUNTY: Dixon, 1 (DPM). STORY COUNTY: 7 mi. N Gilbert, 1 (ISU).

Additional records (Stoner, 1918:38, unless otherwise indicated).—ADAMS COUNTY: Corning. BLACK HAWK COUNTY: no specific locality (Sloan, 1964:521). BOONE COUNTY: Moingona Fox Area, about 5 mi. S Boone (Scott, 1947:445). BUCHANAN COUNTY: Quasqueton (Baird, 1858:377). CALHOUN COUNTY: Rockwell City. CARROLL COUNTY: Carroll. CHEROKEE COUNTY: Cherokee. CERRO GORDO COUNTY: no specific locality (Scott, 1938:537). CLARK COUNTY: Osceola. CLAY COUNTY: Spencer. DECATUR COUNTY: sec. 13, Woodland Twp. (Hendrickson, 1954:25). DICKINSON COUNTY: Lake Okoboji. FLOYD COUNTY: no specific locality (Brown, 1917:25). FRANKLIN COUNTY: Hampton. FREMONT COUNTY: 1 mi. N, 3 mi. W Hamburg (Bowles, field notes). GREENE COUNTY: Churdan (record on file, U.S. Biological Survey).

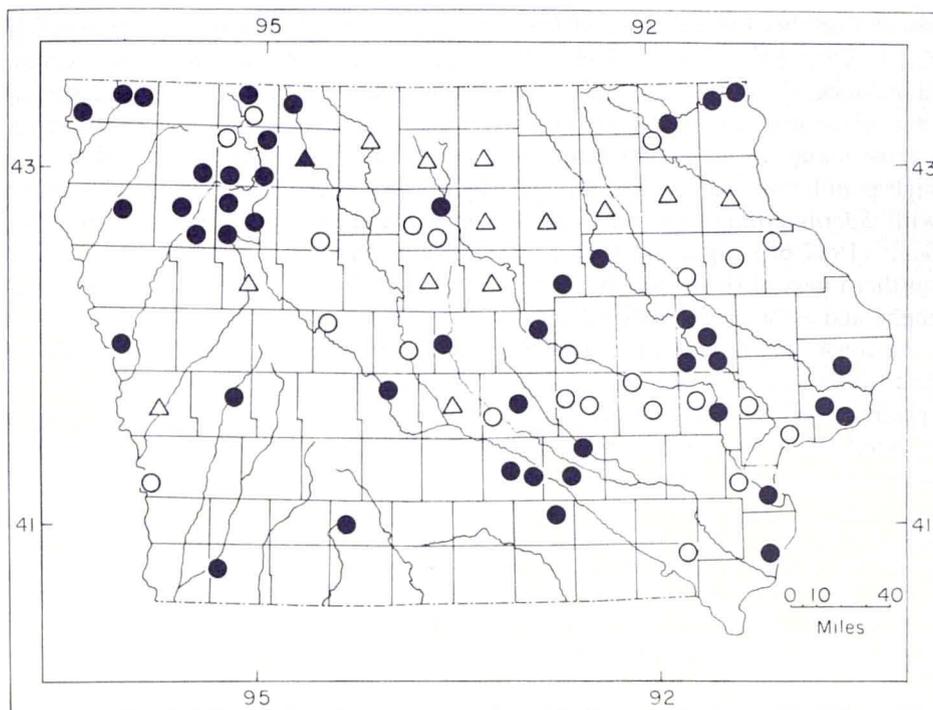


FIG. 23.—Distribution of *Spermophilus tridecemlineatus tridecemlineatus* in Iowa. For explanation of symbols see Fig. 3.

HARDIN COUNTY: Eldora. HENRY COUNTY: Mount Pleasant. KOSSUTH COUNTY: Algona. LYON COUNTY: *Rock Rapids*. MARION COUNTY: 4 1/2 mi. N Knoxville (Bowles, field notes). MARSHALL COUNTY: Marshalltown (Gabrielson, 1921:147). MUSCATINE COUNTY: West Liberty; Muscatine. PALO ALTO COUNTY: Ruthven. POCAHONTAS COUNTY: Gilmore [City]. POLK COUNTY: Des Moines. POTTAWATTAMIE COUNTY: Council Bluffs (record on file, U.S. Biological Survey). SAC COUNTY: *no specific locality* (Spurrell, 1917:283). STORY COUNTY: *near Ames* (Becker and Roudabush, 1934:529); 2 mi. N Ames (Hendrickson, 1930:398). TAMA COUNTY: Tama (Joyce and Eddy, 1944:214). WRIGHT COUNTY: Wall Lake (Scott, 1947:445).

***Spermophilus tridecemlineatus tridecemlineatus* (Mitchill)**

Thirteen-lined Ground Squirrel

1821. *Sciurus tridecem-lineatus* Mitchill, Med. Repos. (n.s.), 6(21):248 (type locality, "region bordering the sources of the river Mississippi"; restricted to central Minnesota by J. A. Allen, Bull. Amer. Mus. Nat. Hist., 7:338, November 1895).

1849. *Spermophilus tridecem lineatus*, Audubon and Bachman, The viviparous quadrupeds of North America, 1:294.

Distribution in Iowa.—Statewide (see Fig. 23).

The thirteen-lined ground squirrel is common to abundant in grassy areas throughout Iowa. Although this species undoubtedly occurred in tall-grass prairie prior to cultivation, it evidently has become much more abundant with the increase in short grass habitat—heavily grazed pastures, golf courses, mowed highway borders (see especially Bush, 1939:432). Spurrell (1917:283), for example,

noted that this ground squirrel was "not as common in early days as now" in Sac County. Early historical records, however, frequently allude to the extreme abundance of "striped gophers" associated with agricultural practices, suggesting that this sciurid was numerous locally even during the period of early settlement. I have found no indication from these records of any general eastward shift of high population centers, and attempts by settlers to eradicate this species, along with *Spermophilus franklinii* and *Geomys bursarius*, have been unsuccessful. Scott (1937:68) suggested that *S. tridecemlineatus* was "most abundant in the northern part of the state," but if this is so, it probably is due to rougher topography and associated woodland habitat in the southern counties.

In Iowa, the thirteen-lined ground squirrel hibernates from early autumn until mid-March (Fitzpatrick, 1927). The earliest spring record known to me is of a specimen taken in Linn County on 25 March, whereas 25 October was reported by Scott (1938:537) as the last day in autumn that any individuals of this species were found dead on Iowa roads.

Specimens examined (231).—ALLAMAKEE COUNTY: 2 mi. S New Albin, 1 (WSU); English Bench [3 mi. S, 2 mi. E Dorchester], 1 (UMMZ). BLACK HAWK COUNTY: Cedar Falls, 1 (UNI). BUENA VISTA COUNTY: 12 mi. N Storm Lake, 1 (BV); 10 mi. N Storm Lake, 1 (BV); 5 mi. SE Albert City, 1 (BV); Storm Lake and 8 mi. radius thereof, 53 (BV); no specific locality, 10 (BV). CHEROKEE COUNTY: 3 mi. N, 1/4 mi. W Cherokee, 1 (SM); 8 1/2 mi. S Cherokee, 1 (BV); no specific locality, 1 (BV). CLAY COUNTY: Dewey's Pasture, 1 (ISU); Webb, 17 (AMNH); 1 mi. N Linn Grove, 1 (BV); no specific locality, 15 (UMMZ). CLINTON COUNTY: 3 mi. NE Dewitt, 1 (ISU); 5 mi. NE Dewitt, 1 (ISU). DALLAS COUNTY: NW 1/4 of sec. 6, T. 80 N, R. 28 W, 2 (ISU). DES MOINES COUNTY: Burlington, 20 (USNM). DICKINSON COUNTY: Spirit Lake, 1 (ISU); 1/4 mi. W Emerson Bay, [West] Lake Okoboji, on hwy. 32, 1 (TTU); 1/8 mi. W Little Emerson Bay, [West] Lake Okoboji, 2 (TTU); E side Garlock Slough, 2 (TTU). EMMET COUNTY: 2 mi. N, 1 mi. E Estherville, 1 (ISU); 1 1/2 mi. S, 2 mi. E Estherville, 1 (ISU). GRUNDY COUNTY: 1 1/2 mi. E Grundy Center, 1 (KU). JASPER COUNTY: Newton, 1 (UMMZ). JOHNSON COUNTY: Iowa City, 14 (SUI). LINN COUNTY: E of Center Point, 1 (CC); 5 mi. N, 3 mi. E Marion, 1 (CC); Otter Creek, Toddville, 1 (CC); Hawkeye Downs [probably Cedar Rapids], 1 (CC); 2 mi. W Fairfax, 1 (KU); 5 mi. SE Cedar Rapids, 1 (ISU). LOUISA COUNTY: NE 1/4 of sec. 35, T. 74 N, R. 3 W, 1 (ISU). LYON COUNTY: sec. 29, Riverside Twp., 1 (ISU); sec. 33, Riverside Twp., 1 (ISU); sec. 35, Elgin Twp., 1 (ISU); sec. 23, Lyon Twp., 1 (ISU). MAHASKA COUNTY: 1 1/2 mi. S, 2 1/2 mi. E New Sharon, 2 (KU); Oskaloosa and 6 mi. radius thereof, 12 (KU). MARION COUNTY: Knoxville, 14 (USNM); Tracy, 1 (AMNH). MARSHALL COUNTY: 1/2 mi. S Green Mountain, 1 (KU). MONONA COUNTY: Blue Lake, 1 (SUI). MONROE COUNTY: 5 1/2 mi. N, 2 1/2 mi. E Albia, 1 (KU). O'BRIEN COUNTY: 1 mi. N, 3 mi. E Sutherland, 1 (BV). PAGE COUNTY: Grant Twp., 1 (ISU). PALO ALTO COUNTY: no specific locality, 14 (UMMZ). PLYMOUTH COUNTY: 1/2 mi. N Le Mars, 1 (BV). SCOTT COUNTY: Maysville, 1 (ISU); Davenport, 3 (DPM); no specific locality, 1 (DPM). SHELBY COUNTY: 4 mi. SE Irwin, 1 (ISU). STORY COUNTY: Ames and 6 mi. radius thereof, 5 (ISU). UNION COUNTY: 1 1/2 mi. S, 1 mi. W Creston, 1 (KU). WINNESHIEK COUNTY: Canoe Creek, 1 (UMMZ); Decorah, 3 (UMMZ). WRIGHT COUNTY: 1 1/2 mi. S Belmond, 1 (KU).

Additional records (Scott, 1938:537, unless otherwise indicated).—ALLAMAKEE COUNTY: New Albin (Hoslett, 1965:367). BLACK HAWK COUNTY: near Finchford (Sloan, 1964:521). BOONE COUNTY: Moingona Fox Area, about 5 mi. S Boone (Scott, 1947:445); no specific locality (Weller and Blagen, 1970:289). BREMER COUNTY: no specific locality. BUCHANAN COUNTY: Quasqueton (Baird, 1858:318). BUTLER COUNTY: no specific locality. CEDAR COUNTY: West Branch (Fitzpatrick, 1927:32); no specific locality (Weller and Blagen, 1970:289).

CERRO GORDO COUNTY: no specific locality. CLAY COUNTY: Waterford Twp. (Scott, 1940:588); *Spencer* (Fitzpatrick, 1927:32). CLAYTON COUNTY: no specific locality. DALLAS COUNTY: *no specific locality* (Coues and Allen, 1877:879). DELAWARE COUNTY: Oneida (record on file, U.S. Biological Survey). DES MOINES COUNTY: *Burlington* (Coues and Allen, 1877:879). DICKINSON COUNTY: "*Lake Region*" (Stephens, 1922:52); *Lake Okoboji* (Fitzpatrick, 1927:31-32); *Milford* (Fitzpatrick, 1927:32). DUBUQUE COUNTY: *Luxemburg* (Howell, 1938:109). FAYETTE COUNTY: no specific locality. FRANKLIN COUNTY: no specific locality. GREENE COUNTY: *Churdan* (record on file, U.S. Biological Survey). HAMILTON COUNTY: no specific locality. HANCOCK COUNTY: no specific locality (Weller and Blagen, 1970:289). HARDIN COUNTY: no specific locality. HARRISON COUNTY: no specific locality. IOWA COUNTY (Fitzpatrick, 1927:28-33): *Marengo*; *Victor*; *Williamsburg*; *Millersburg*. JASPER COUNTY: *Colfax* (Fitzpatrick, 1927:34). JOHNSON COUNTY: *North Liberty* (Fitzpatrick, 1927:29); *Iowa City* (Bush, 1939; Fitzpatrick, 1927:28-34). KOSSUTH COUNTY: no specific locality. LOUISA COUNTY: *Columbus Junction* (Fitzpatrick, 1927:33). MAHASKA COUNTY: *3 mi. S, 4 mi. W Oskaloosa* (Bowles, field notes). MARSHALL COUNTY: *no specific locality* (Gabrielson, 1921:147). MUSCATINE COUNTY: *Fairport* (Scott, 1937:69). POCAHONTAS COUNTY: *Kalso Prairie, 4 1/2 mi. NW Manson* (Brennan, 1969:27). POLK COUNTY: no specific locality. POTTAWATTAMIE COUNTY: *Council Bluffs* (record on file, U.S. Biological Survey). POWESHIEK COUNTY: *Brooklyn* (Fitzpatrick, 1927:33); *Grinnell* (Seton, 1929, 4(1):231). SAC COUNTY: no specific locality (Spurrell, 1917:283). STORY COUNTY: *2 mi. N Ames* (Hendrickson, 1930:398); *Ames* (Becker and Roudabush, 1934:529). TAMA COUNTY: *Tama* (Joyce and Eddy, 1944:214). VAN BUREN COUNTY: *vicinity Stockport* (Crabb, 1948:206). WINNESHIEK COUNTY: *near Conover* (Hoslett, 1965:367). WRIGHT COUNTY: *Eagle Grove* (Fitzpatrick, 1927:29); *Wall Lake* (Scott, 1947:445).

***Sciurus carolinensis pennsylvanicus* Ord**

Gray Squirrel

1815. *Sciurus Pennsylvanica* Ord, in Guthrie. A new geographical, historical, and commercial grammar . . . , ed. 2, 2:292 (type locality, "those parts of Pennsylvania which lie to the westward of the Alleghany ridge").
1894. *Sciurus carolinensis pennsylvanicus*, Rhoads, Amer. Nat., 28:525, June.

Distribution in Iowa.—Statewide, except northwestern part, but usually restricted locally to dense oak-hickory woods, most abundant in eastern Iowa (see Fig. 24).

The gray squirrel probably was commoner in Iowa in the mid-1800's than today, because clearing of timber has decreased available habitat for this species throughout much of the state. Historical literature (see especially Galland, 1921:500; Spurrell, 1917:283) as well as historical documents (representing Audubon, Fremont, Lucas, Mills, and Taylor counties) suggest that the gray squirrel previously was abundant across southern Iowa and specimens from Ames (USNM 193796-98, taken in 1881) and Fort Des Moines (USNM 1126 and 1129, taken in 1855) document its presence in central Iowa before the turn of the century. *Sciurus carolinensis* presently is common to abundant in hardwood forests and many city parks in eastern Iowa, but also occurs in scattered stands of oak-hickory throughout the remainder of the state, with the exception of the extreme northwestern part (Kline, 1964:217; Polder, 1953:723). Present abundance in some areas of eastern Iowa, however, may represent a recent reinvasion of parts of the former range. Jack W. Musgrove (personal communication), for example, noted that prior to the 1930's, the gray squirrel was not present west of the Cedar

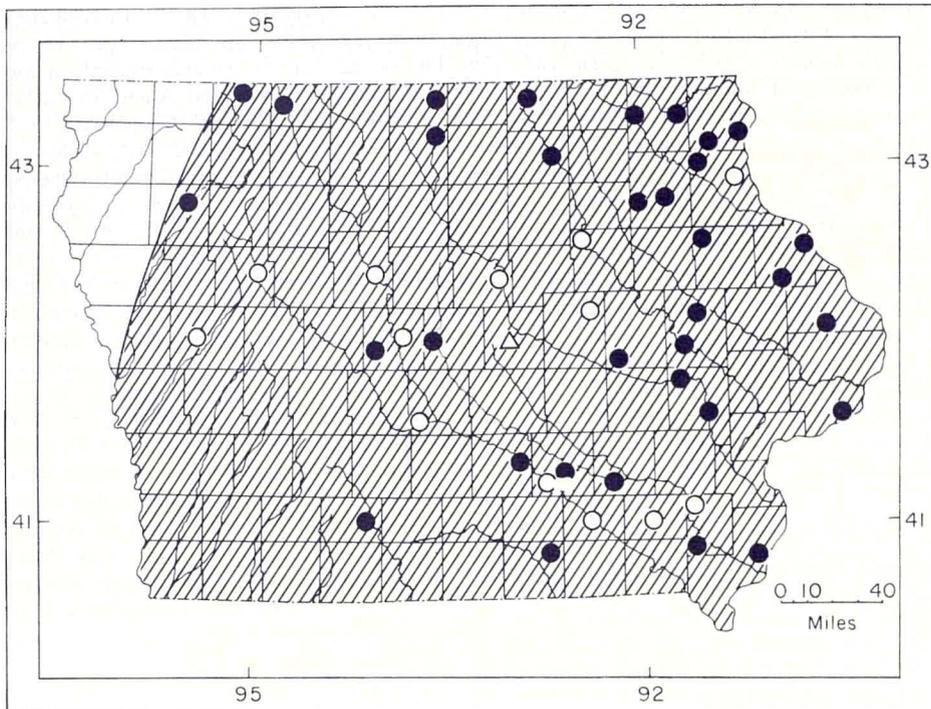


FIG. 24.—Distribution of *Sciurus carolinensis pennsylvanicus* in Iowa. For explanation of symbols see Fig. 3.

River in the vicinity of Iowa City. On the other hand, I know of no recent records of *S. carolinensis* from any localities of southwestern Iowa with the exception of Fremont County where it is quite common in Waubonsie State Park and in other dense stands of oak elsewhere in the county. The species reaches the western limit of its geographic range in extreme eastern Nebraska (Jones, 1964:141).

Specimens of *Sciurus carolinensis* from southeastern Iowa (Appanoose, Monroe, and Van Buren counties) are similar to *S. c. pennsylvanicus* from Kansas and Nebraska (see Jones and Cortner, 1961:287) and herein are assigned to that subspecies (see Table 3 for external and cranial measurements). The zone of intergradation between *S. c. pennsylvanicus* and *S. c. carolinensis* undoubtedly lies in central Missouri as was postulated by Jones and Cortner (1961:286).

Specimens examined (58).—ALLAMAKEE COUNTY: New Albin, 1 (UMMZ); *English Bench*, 2 (UMMZ); *Elon* [probably Eldon], 2 (ISU); Lansing, 1 (UNI); N of Waukon, 2 (CC); *Waterloo Creek* [not specifically located], 1 (UMMZ); 6 mi. S, 3 mi. E Waterville, 2 (KU); 4 mi. N, 3 mi. E Monona, 2 (KU); *no specific locality*, 2 (CC). APPANOOSE COUNTY: 5 1/2 mi. E Moravia, 2 (KU). DELAWARE COUNTY: Manchester, 1 (CC). FAYETTE COUNTY: Clermont, 2 (1 ISU, 1 IHM); sec. 25, T. 92 N, R. 7 W, 1 (ISU). FLOYD COUNTY: Charles City, 1 (SUI). FREMONT COUNTY: 1 1/2 mi. N, 1/2 mi. W Hamburg, 2 (KU). HENRY COUNTY: Hillsboro, 2 (USNM). IOWA COUNTY: Amana, 1 (CC). JACKSON COUNTY: NE 1/4 of NW 1/4 of sec. 13, T. 85 N, R. 3 E, 1 (ISU); Maquoketa State Park, 1 (ISU). JOHNSON COUNTY: Iowa City, 2 (KU); *no specific locality*, 1 (CC). KEOKUK COUNTY: 1/2 mi. S Sigourney, 1 (KU). KOSKUTH COUNTY: 1 mi. W Ambrose A. Call State Park, 1 (ISU). LEE COUNTY: St. Paul, 2 (ISU).

MONROE COUNTY: 2 mi. S, 1/2 mi. E Albia, 1 (KU); 4 mi. S, 1/2 mi. E Albia, 1 (KU). POLK COUNTY: Des Moines, 3 (USNM). STORY COUNTY: Ames, 3 (USNM). VAN BUREN COUNTY: 3 mi. N, 1/2 mi. E Keosauqua, 5 (KU); Lacey-Keosauqua State Park, 3 (ISU). WINNEBAGO COUNTY: Lake Mills, 1 (ISU); Forest City, 1 (UMMZ); 4 mi. E Forest City, 1 (UMMZ). WINNESHIEK COUNTY: 1 mi. N Decorah, 1 (UMMZ); Decorah, 2 (1 CC, 1 UMMZ).

Additional records (Stoner, 1918:24-25, unless otherwise indicated).—ALLAMAKEE COUNTY: 1 mi. E Quandah (Bowles, field notes); *Lansing* (Bowles, field notes); *Waukon*. BREMER COUNTY: no specific locality (Polder, 1953:723). CERRO GORDO COUNTY: no specific locality (Polder, 1953:723). CLAY COUNTY: no specific locality (Polder, 1953:723). CLAYTON COUNTY: McGregor. CLINTON COUNTY: Charlotte (Spurrell, 1917:283). DAVIS COUNTY: Eldon Fox Range [1 mi. N, 5 mi. E Floris] (Scott and Klimstra, 1955:35). DUBUQUE COUNTY: Dubuque. FLOYD COUNTY: *Charles City* (Webster, 1900:7). FREMONT COUNTY: *Waubonsie State Park*, 5 mi. S, 2 mi. W Sidney (Findley *et al.*, 1954:212). GREENE COUNTY: 1 1/2 mi. SW Churdan (record on file, U.S. Biological Survey); Jefferson (Spurrell, 1917:283). HANCOCK COUNTY: Pilot Knob State Park (Blagen, 1967:208). JASPER COUNTY: no specific locality (Polder, 1953:723). JOHNSON COUNTY: Oxford; *Iowa City* (Keegan, 1943:54). JONES COUNTY: Monticello; *no specific locality* (Weller and Blagen, 1970:289). LUCAS COUNTY: no specific locality (Polder, 1953:723). MADISON COUNTY: Winterset (Polder, 1958:563). MAHASKA COUNTY: 1 mi. S, 8 mi. W Oskaloosa (Bowles, field notes). MARSHALL COUNTY: no specific locality (Polder, 1953:723). MITCHELL COUNTY: Osage. MONROE COUNTY: *Albia*. MUSCATINE COUNTY: Muscatine. POTTAWATTAMIE COUNTY: Council Bluffs (record on file, U.S. Biological Survey). WAPELLO COUNTY: Ottumwa. WEBSTER COUNTY: Fort Dodge. WINNEBAGO COUNTY: *no specific locality* (Polder, 1953:723).

***Sciurus niger rufiventer* É. Geoffroy St.-Hilaire**
Fox Squirrel

1803. *Sciurus rufiventer* É. Geoffroy St.-Hilaire, Catalogue des mammifères de Museum National d'Histoire Naturelle, Paris, p. 176 (type locality, somewhere in the Mississippi Valley, probably between southern Illinois and central Tennessee according to Osgood, Proc. Biol. Soc. Washington, 20:44, 18 April 1907).
1907. *Sciurus niger rufiventer*, Osgood, Proc. Biol. Soc. Washington, 20:44, 18 April.

Distribution in Iowa.—Statewide (see Fig. 25).

The fox squirrel is found in wooded and timbered habitats throughout Iowa, although it is probably somewhat less common, and more locally restricted, in the extreme northwestern part of the state than elsewhere (Hicks and Hendrickson, 1940:132; Stoner, 1918:20). Evidently, the species once occurred only along wooded borders of lakes and water courses in the tall-grass prairie region in the western part of the state, but increased in abundance and occupied new areas after early settlers established farm woodlots and planted trees in settlements. Spurrell (1917:283), for example, noted that this species "first appeared at Wall Lake [Sac County] about 1904 and [is] now [1917] common." Furthermore, he noted (*loc. cit.*) the relative scarcity of the fox squirrel in Clinton County until about 1915, suggesting that clearing of some forested areas and perhaps thinning of others, may have enabled this species to occupy more territory in eastern Iowa. In Nebraska (Jones, 1964:144) and South Dakota (Findley, 1954:31), the fox squirrel has expanded its range westward along major drainages since settlement of these areas in the late 1800's.

Sciurus niger is frequently referred to as the "red squirrel" in Iowa and thus confusion exists in the literature regarding the distributional status of this species

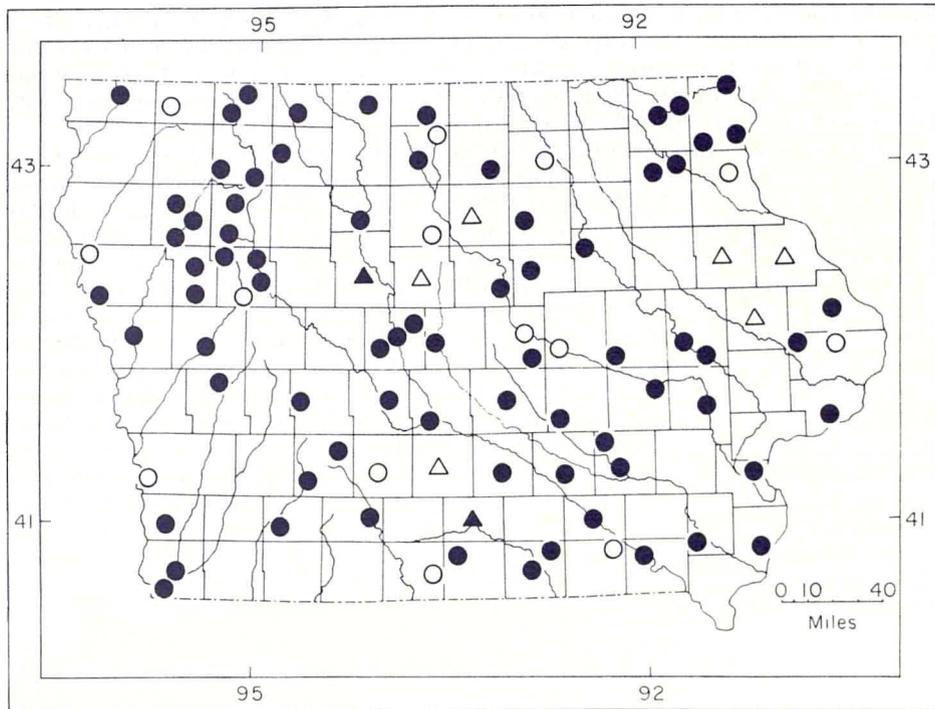


FIG. 25.—Distribution of *Sciurus niger rufiventer* in Iowa. For explanation of symbols see Fig. 3.

and the red squirrel, *Tamiasciurus hudsonicus*. Mosher (1882), for example, referred to “red and striped and the gray ground squirrel” in the vicinity of Spirit Lake, and Polder (1958:563) mentioned a letter from Andrew Walker of Winterset, Madison County, that indicated the presence of “both grey and red squirrels” in Pammel State Park. These and many other records of “red squirrels” probably refer to *Sciurus niger*.

Specimens examined (165).—ADAIR COUNTY: SE 1/4 of sec. 13, T. 77 N, R. 31 W, 1 (ISU); SE 1/4 of NW 1/4 of sec. 6, Richland Twp., 1 (KU). ADAMS COUNTY: Corning, 2 (SUI). ALLAMAKEE COUNTY: New Albin, 1 (UMMZ); 1 1/2 mi. SW New Albin, 1 (WSU); 6 mi. S, 3 mi. E Waterville, 3 (KU); 4 mi. N, 3 mi. E Monona, 4 (KU). APPANOOSE COUNTY: 5 1/2 mi. E Moravia, 1 (KU); Centerville, 1 (IHM). BENTON COUNTY: NW 1/4 of NE 1/4 of sec. 16, T. 82 N, R. 12 W, 1 (ISU). BLACK HAWK COUNTY: Cedar Falls, 1 (UNI). BOONE COUNTY: NW 1/4 of NW 1/4 of sec. 12, T. 84 N, R. 25 W, 1 (ISU); 3 mi. W Boone, 1 (KU); McHose Park, Boone, 1 (KU); 4 mi. S, 2 mi. E Ogden, 1 (ISU). BUENA VISTA COUNTY: 12 mi. N, 1/2 mi. E Storm Lake, 1 (BV); Storm Lake and 10 mi. radius thereof, 12 (BV). BUTLER COUNTY: sec. 36, T. 91 N, R. 18 W, 1 (ISU). CERRO GORDO COUNTY: SE 1/4 of SE 1/4 of sec. 33, T. 95 N, R. 19 W, 1 (ISU). CHEROKEE COUNTY: near Cleghorn, 2 (SM); 1 mi. S. Cherokee, 1 (BV); near Washta, 1 (BV); no specific locality, 1 (SM). CLAY COUNTY: 20 mi. N Alta [4 mi. N, 2 mi. E Peterson], 1 (BV); Webb, 2 (AMNH); 1 mi. N Linn Grove, 1 (BV). CLINTON COUNTY: Sharon Twp., 1 (ISU). CRAWFORD COUNTY: sec. 13, Denison Twp., 1 (ISU). DALLAS COUNTY: Dallas Center, 1 (KU). DES MOINES COUNTY: Burlington, 7 (USNM). DICKINSON COUNTY: Spirit Lake, 1 (ISU); West Okoboji Lake, 1 1/2 mi. N, 1 mi. W Milford, 1 (KU). EMMET COUNTY: 3 1/2 mi. S Gruver, 1 (ISU); Mud Lake, 4 1/2 mi. E Wallingford,

1 (ISU). FAYETTE COUNTY: Clermont, 1 (SUI); 3 mi. W West Union, 1 (KU). FREMONT COUNTY: 2 mi. N, 2 mi. W Riverton, 1 (KU); Hamburg, 2 (ISU). GRUNDY COUNTY: 2 mi. S Wellsburg, 1 (ISU); 9 1/2 mi. W Grundy Center, 1 (KU). GUTHRIE COUNTY: sec. 31, T. 80 N, R. 33 W, 1 (ISU). HANCOCK COUNTY: Duncan, 1 (USNM). HARDIN COUNTY: 1 1/2 mi. N, 1 mi. E New Providence, 1 (KU). HENRY COUNTY: Hillsboro, 1 (USNM). HUMBOLDT COUNTY: 1 1/2 mi. S Dakota City, 1 (ISU). IDA COUNTY: 3 1/2 mi. E Holstein, 1 (BV); 2 1/2 mi. S Ida Grove, 1 (BV). IOWA COUNTY: *Amana colonies* [Lenox Twp.], 1 (ISU); Homestead, 1 (UMMZ). JACKSON COUNTY: NE 1/4 of NW 1/4 of sec. 13, T. 85 N, R. 3 E, 1 (ISU). JASPER COUNTY: Newton, 1 (UMMZ). JOHNSON COUNTY: 4 mi. N Iowa City, 1 (ISU); Iowa City, 1 (AMNH); 5 mi. S Iowa City, 1 (CC); no specific locality, 3 (SUI). KEOKUK COUNTY: 2 mi. S Ledyard, 1 (KU); 6 1/2 mi. S, 1 mi. W Sigourney, 1 (KU). LINN COUNTY: Marion, 1 (ISU); *Cedar Rapids*, 9 (CC); Palisades [-Kepler] State Park, 2 (ISU). LOUISA COUNTY: NE 1/4 of sec. 26, T. 75 N, R. 3 W, 1 (ISU). LUCAS COUNTY: no specific locality, 1 (IHM). LYON COUNTY: sec. 20, Riverside Twp., 1 (ISU); sec. 34, Riverside Twp., 1 (ISU). MAHASKA COUNTY: 1 mi. N, 2 mi. W Oskaloosa, 1 (KU); Oskaloosa, 2 (KU). MARION COUNTY: Knoxville, 8 (5 FMNH, 3 USNM). MARSHALL COUNTY: 1 mi. N Gilman, 1 (KU). MILLS COUNTY: Pacific Junction, 2 (USNM). MONONA COUNTY: sec. 6, Belvidere Twp., 1 (ISU). PALO ALTO COUNTY: Ruthven, 4 (UMMZ); *Virgin Lake*, 1 (UMMZ). POLK COUNTY: Des Moines, 6 (1 ISU, 5 USNM). POWESHIEK COUNTY: 6 mi. S, 1/2 mi. W Searsboro, 1 (KU). SAC COUNTY: 4 1/2 mi. S Newell, 1 (BV); 2 1/2 mi. N, 2 1/2 mi. E Nemaha, 1 (BV); 3 mi. N Schaller, 1 (BV); 2 mi. S, 3 mi. W Sac City, 1 (BV). SCOTT COUNTY: Davenport, 10 (DPM). SHELBY COUNTY: 2 mi. N, 3 mi. E Defiance, 1 (BV). STORY COUNTY: Ames and 6 mi. radius thereof, 7 (3 ISU, 1 KU, 3 USNM). UNION COUNTY: 4 mi. E Afton, 1 (ISU). VAN BUREN COUNTY: Van Buren Twp., 1 (ISU). WAPELLO COUNTY: Ottumwa, 4 (SUI). WAYNE COUNTY: 1 mi. S, 1 mi. W Cambia, 1 (ISU); SW 1/4 of NW 1/4 of sec. 32, T. 70 N, R. 22 W, 1 (KU). WEBSTER COUNTY: no specific locality, 1 (DPM). WINNEBAGO COUNTY: Leland, 1 (KU); 2 mi. W Forest City, 1 (UMMZ); 4 mi. E Forest City, 2 (UMMZ). WINNESHIEK COUNTY: Decorah, 2 (UMMZ); Lower Dam [near mouth Coon River], 1 (UMMZ). WOODBURY COUNTY: NW 1/4 of sec. 33, T. 87 N, R. 47 W, 1 (ISU).

Additional records (Scott, 1938:537, unless otherwise indicated).—BOONE COUNTY: *Moingona Fox Range*, about 5 mi. S Boone (Scott, 1947:445). CLAYTON COUNTY: National (Sherman, 1926:332). CLINTON COUNTY: Charlotte (Spurrell, 1917:283). DAVIS COUNTY: Eldon Fox Range [1 mi. N, 5 mi. E Floris] (Scott and Klimstra, 1955:35). DECATUR COUNTY: sec. 13, Woodland Twp. (Hendrickson, 1954:25). DELAWARE COUNTY: no specific locality (Weller and Blagen, 1970:289). DICKINSON COUNTY: "*Lake Region*" (Stephens, 1922:52). FLOYD COUNTY: Charles City (Brown, 1917:24). FRANKLIN COUNTY: no specific locality. HAMILTON COUNTY: no specific locality. HANCOCK COUNTY: Pilot Knob State Park (Blagen, 1967:208); no specific locality (Weller and Blagen, 1970:289). HARDIN COUNTY: no specific locality (Weller and Blagen, 1970:289). JOHNSON COUNTY: *Iowa City* (Keegan, 1943:54). JONES COUNTY: no specific locality (Weller and Blagen, 1970:289). MADISON COUNTY: Pammel State Park (Polder, 1958:563). MARSHALL COUNTY: Marshalltown (Gabrielson, 1921:147). OSCEOLA COUNTY: Sibley (Stoner, 1918:22). POTTAWATTAMIE COUNTY: Council Bluffs (record on file, U.S. Biological Survey). POWESHIEK COUNTY: no specific locality (Weller and Blagen, 1970:289). SAC COUNTY: Wall Lake (Spurrell, 1917:283); *Sac City* (Spurrell, 1917:283). STORY COUNTY: near Ames (Cabalka *et al.*, 1953:617); Ames (Scott, 1937:71); *Franklin Twp.* (Hicks, 1949:287). TAMA COUNTY: Tama (Joyce and Eddy, 1944:214). WARREN COUNTY: no specific locality. WINNEBAGO COUNTY: no specific locality (O. T. Kalin, University of Minnesota, personal correspondence; Weller and Blagen, 1970:289). WOODBURY COUNTY: Sioux City (Bangs, 1896:150). WRIGHT COUNTY: Wall Lake (Scott, 1947:445).

***Tamiasciurus hudsonicus minnesota* (J. A. Allen)**

Red Squirrel

1899. *Sciurus hudsonicus minnesota* J. A. Allen, Amer. Nat., 33:640, August (type locality, Fort Snelling, Hennepin Co., Minnesota).

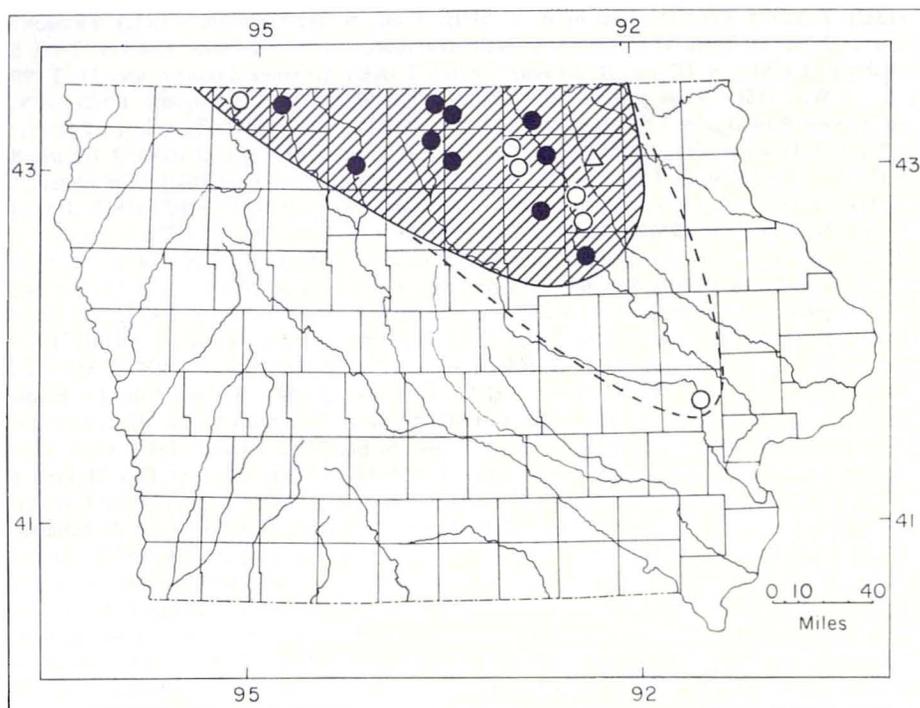


FIG. 26.—Distribution of *Tamiasciurus hudsonicus minnesota* in Iowa. For explanation of symbols see Fig. 3. Present distribution is shaded; probable former range of this species in Iowa is indicated by dashed line.

1940. *Tamiasciurus hudsonicus minnesota*. Hayman and Holt, in Ellerman, The families and genera of living rodents. British Mus.; volume 1. Rodents other than Muridae, p. 346. 8 June.

Distribution in Iowa.—Known with certainty only from north-central Iowa (see Fig. 26).

The red squirrel is definitely known only from north-central Iowa, where it is locally abundant in deciduous woods, principally along water courses. Several authors (Scott, 1937:70; Polder, 1958:563; Lynch and Folk, 1968:465) have assumed a more extensive former distribution of this species in Iowa. Although it may have occurred sporadically in formerly timbered areas of south-central Iowa, I am unconvinced that *Tamiasciurus* existed in the deciduous forests in the eastern or extreme southwestern parts of the state in historical times; and I know of no recent records south of Cedar Falls. Although *Tamiasciurus* was listed as "common" in historical accounts of Fremont (Anonymous, 1881a:366), Mills (Anonymous, 1881b:370), and Taylor (Anonymous, 1881c:376) counties, the authors of these faunal lists are unknown and the records, though possibly valid, cannot be authenticated. Additionally, *Tamiasciurus* was reported from Atlantic, Cass County, by Stoner (1918:26) but he cited no specimen to verify the existence there of the species. Furthermore, Allen (1870:188) did not see a single red squirrel during his trip to central and western Iowa in 1867, and stated that "although I made extended inquiries respecting it, could not learn that it had

ever been seen here." Both Scott (1937:70) and Stoner (1918:26) followed Cory (1912:124) in assuming that a specimen in the Field Museum of Natural History, reportedly collected by G. K. Cherrie, was from Knoxville, Marion County, which apparently led Polder (1958:563) to give credence to reports of "red squirrels" in Madison County (see account of *Sciurus niger*). However, Cherrie (undated letter on file, U.S. Biological Survey) stated that the record from Knoxville was an error and that he had "certainly never collected a red squirrel in Iowa." The label of a specimen (FMNH 5560) in the Field Museum of Natural History gives the locality of Knoxville but the catalogue entry for that specimen simply says "Iowa." Preceding entries in the catalog are from South Dakota and it seems likely that this specimen was collected by Cherrie in that state. Neither Hoslett (1965:375) nor Lynch and Folk (1968) reported any evidence of the presence of this species in the hardwood forests of eastern Iowa, where suitable habitat seemingly exists. Hoffmeister and Mohr (1957:143), however, reported that *Tamiasciurus* formerly was found locally in northern Illinois, but "almost certainly no longer" occurs there. I know of no records of this species from Nebraska or Missouri.

The red squirrel is generally found in coniferous forests in the northern parts of its geographic range, but is known to inhabit deciduous woods in Wisconsin (Jackson, 1961:171), Indiana (Lyon, 1936), and New York (Layne, 1954). In central New York, Layne (*op. cit.*, 236) found that *Tamiasciurus* is more adaptable than the gray squirrel, and when the two species are in direct competition the latter occupied the more densely forested areas. Competitive exclusion between these two species may account for the apparent lack of red squirrels in the hardwood forests of eastern Iowa.

Scott (1937:70) assumed the presence of eastern and northern races of red squirrels in Iowa—*loquax* and *minnesota*, respectively. Because of the large external and cranial measurements (see Table 3) and the distributional pattern within the state, it seems best to refer all red squirrels from Iowa to *T. h. minnesota*. It should be noted, however, that Allen (1899:640) apparently described as *minnesota* the larger squirrels from Minnesota and Wisconsin without being sufficiently convinced that they differed subspecifically from *loquax*. Subsequent systematic studies may show that separation of red squirrels along the southern edge of the range in the central United States into three subspecies cannot be justified.

Specimens examined (25).—BLACK HAWK COUNTY: *Finchford*, 1 (ISU); Cedar Falls, 3 (2 UNI, 1 CUI); *Beaver Creek*, 1 (UNI). BUTLER COUNTY: *Clarksville*, 3 (ISU). CERRO GORDO COUNTY: SW 1/4 of SE 1/4 of sec. 20, T. 96 N, R. 22 W, 2 (1 ISU 1 KU); *Clear Lake*, 3 (CC). EMMET COUNTY: *Fort Defiance State Park*, 2 (ISU); *Mud Lake, 4 1/2 mi. E Wallingford*, 1 (ISU). FLOYD COUNTY: *Charles City*, 2 (SUI); *no specific locality*, 1 (SUI). HANCOCK COUNTY: *Pilot Knob State Park*, 1 (ISU); *5 mi. E [ESE] Forest City*, 2 (ISU). MITCHELL COUNTY: *Osage*, 1 (IHM). WINNEBAGO COUNTY: *Rice Lake State Park*, 1 (ISU). WORTH COUNTY: *1/2 mi. S Elk Creek Marsh [2 1/2 mi. N Joice]*, 1 (ISU).

Additional records (Lynch and Folk, 1968:264-265, unless otherwise indicated).—BLACK HAWK COUNTY: *West Fork Cedar River, 2 mi. E Finchford*. BREMER COUNTY: *Waverly (Van Hynning, 1913:312); 4 mi. NE Janesville; Cedar River, 1 mi. E Plainville [probably Plainfield]*. BUTLER COUNTY: *Norton's corner [not precisely located]* (Polder, 1953:722);

TABLE 3.—Selected external and cranial measurements of red and gray squirrels from Iowa.

Number of specimens averaged	Total length	Length of tail	Length of hind foot	Condylbasal length	Zygomatic breadth	Least interorbital constriction	Length of nasals	Length of maxillary toothrow
<i>Tamiasciurus hudsonicus minnesota</i> , north-central Iowa								
Average 12 (5♂, 7♀)	338.6	134.5	50.7	44.8	26.2	14.6	14.9	8.4
Minimum	303.0	124.0	45.0	43.2	26.8	13.8	13.2	7.8
Maximum	355.0	150.0	55.0	46.1	28.6	15.4	16.2	9.2
SD ±	16.15	9.55	2.50	1.04	0.53	0.49	0.85	0.39
<i>Sciurus carolinensis pennsylvanicus</i> Appanoose, Monroe, and Van Buren counties								
Average 8 (3♂, 5♀)	477.8	219.7	68.1	56.9	34.7	17.7	20.7	11.3
Minimum	460.0	190.0	64.0	55.2	33.5	16.5	19.4	10.9
Maximum	502.0	238.0	71.0	58.5	35.8	18.9	21.7	11.9
SD ±	15.31	16.85	2.67	1.09	0.73	0.79	0.67	0.35

Heery Woods State Park. CHICKASAW COUNTY: no specific locality (Osborn, 1892:5). DICKINSON COUNTY: "Lake Region" (Stephens, 1922:52). EMMET COUNTY: no specific locality (Polder, 1953:722). FLOYD COUNTY: Nora Springs (Brown, 1917:24); Rockford (Van Hyning, 1913:312). JOHNSON COUNTY: Iowa City (Stoner, 1918:26). MITCHELL COUNTY: *Osage* (Van Hyning, 1913:312).

***Glaucomys volans volans* (Linnaeus)**

Southern Flying Squirrel

1758. [*Mus*] *volans* Linnaeus, *Systema naturae*, ed. 10, 1:63 (type locality restricted to Virginia by Elliot, *Field Columb. Mus., Zool. Ser.*, 2:109, 1901).

1915. [*Glaucomys*] *volans*. A. H. Howell, *Proc. Biol. Soc. Washington*, 28:109, 27 May.

Distribution in Iowa.—Common in forests of eastern Iowa and occurs locally in wooded areas in southern counties; absent in northwestern part of state (see Fig. 27).

The flying squirrel is common in the hardwood forests and along major river systems in eastern Iowa. In the southern part of the state, *Glaucomys* is probably confined to dense local stands of oak-hickory timber, but may have been more widely distributed (especially in southwestern counties) prior to clearing of forested areas by early settlers (Spurrell, 1917:284; Stoner, 1918:17).

This species reaches the western limits of its geographic range in extreme eastern Nebraska (Jones, 1964:149) and southeastern Minnesota (Gunderson and Beer, 1953:90). I know of no records of the southern flying squirrel from northwestern Iowa or from adjacent South Dakota.

Specimens examined (46).—ALLAMAKEE COUNTY: New Albin, 1 (UMMZ). BLACK HAWK COUNTY: Cedar Falls, 3 (UNI). DUBUQUE COUNTY: Luxemburg, 3 (ISU); Dubuque, 1 (ISU); sec. 20, Mosalem Twp., 1 (ISU). HENRY COUNTY: Wayland, 1 (SUI); Hillsboro, 2 (USNM). JACKSON COUNTY: NE 1/4 of SW 1/4 of sec. 13, T. 85 N, R. 3 E, 1 (ISU). JOHNSON COUNTY: Iowa City, 5 (2 USNM; 3 SUI). KEOKUK COUNTY: 6 1/2 mi. S, 1 mi. W Sigourney, 1 (Dept. of Biology, William Penn College, Oskaloosa, Iowa). LEE COUNTY: Washington Twp., 2 (ISU). LINN COUNTY: near *Urbana* [not precisely located], 1 (CC); no specific locality, 4

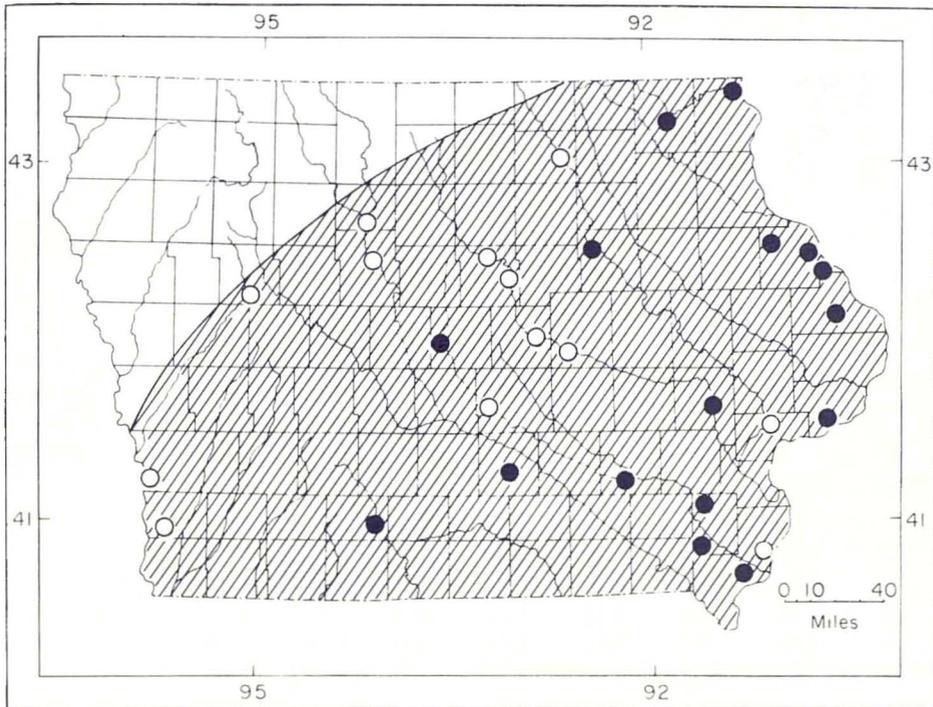


FIG. 27.—Distribution of *Glaucomys volans volans* in Iowa. For explanation of symbols see Fig. 3.

(CC). MARION COUNTY: Knoxville, 3 (1 FMNH, 2 USNM). SCOTT COUNTY: Davenport, 14 (DPM). STORY COUNTY: Ames, 1 (ISU). UNION COUNTY: Thayer, 2 (SUI). WINNESHIEK COUNTY: Decorah, 2 (UMMZ).

Additional records (Stoner, 1918:18, unless otherwise indicated).—DES MOINES COUNTY: Burlington (Coues and Allen, 1877:663). DUBUQUE COUNTY: *Dubuque*. FLOYD COUNTY (Brown, 1917:25): Charles City; 6 mi. E Charles City. HARDIN COUNTY: Iowa Falls; Steam Boat Rock. HUMBOLDT COUNTY: Humboldt. JASPER COUNTY: Colfax. JOHNSON COUNTY: Iowa City (Fryxwell, 1926:133). LINN COUNTY: Cedar Rapids; *no specific locality* (Weller and Blagen, 1970:289). MARSHALL COUNTY: near Marshalltown (Gabrielson, 1921:147). MILLS COUNTY: Pacific Junction (Velich, MS). MUSCATINE COUNTY: Moscow. SAC COUNTY: Wall Lake. POTTAWATTAMIE COUNTY: Council Bluffs (Velich, MS). SCOTT COUNTY: *Davenport* (Fryxell, 1926:133). TAMA COUNTY: Tama (Joyce and Eddy, 1944:214). WEBSTER COUNTY: Fort Dodge.

Family GEOMYIDAE—Pocket Gophers

***Geomys bursarius majusculus* Swenk** Plains Pocket Gopher

1939. *Geomys bursarius majusculus* Swenk, Missouri Valley Fauna, 1:6, 5 December (type locality, Lincoln, Lancaster Co., Nebraska).

Distribution in Iowa.—Statewide in suitable habitats (see Fig. 28).

This pocket gopher is common to abundant in suitable habitats throughout Iowa. Although a typical grassland species, *G. bursarius* may have been less

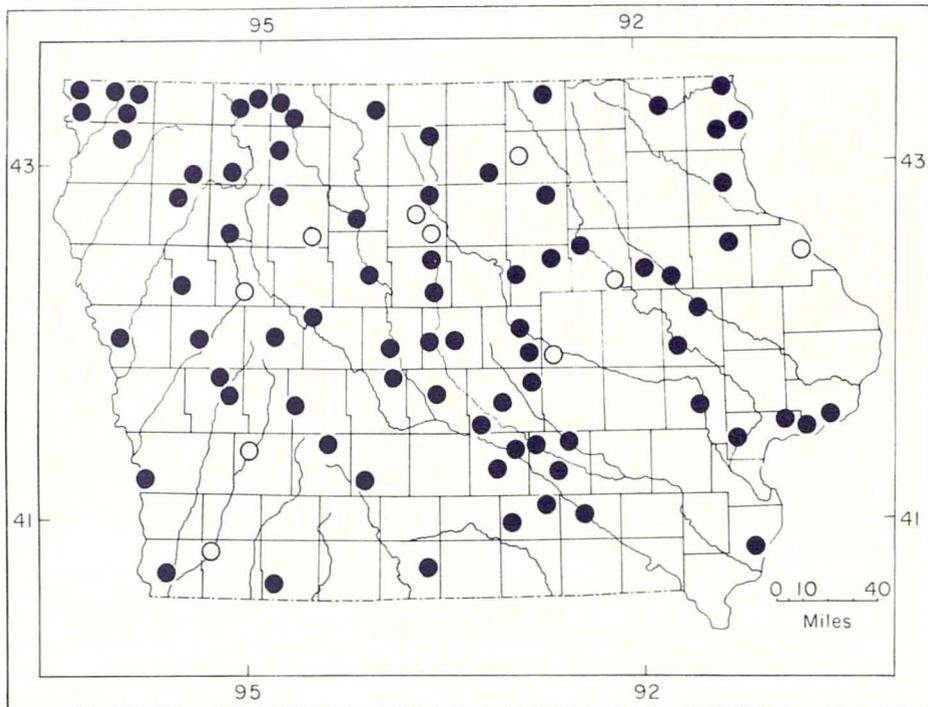


FIG. 28.—Distribution of *Geomys bursarius majusculus* in Iowa. For explanation of symbols see Fig. 3.

abundant than now in the tall-grass prairie region prior to settlement of the state. Spurrell (1917:281) found the species most abundant in disturbed or cultivated areas in Sac County and Stoner (1918:111) reported it "throughout the state, but . . . rather more abundant in the central, north-central, and eastern counties" (the parts of Iowa that had been intensively cultivated by the early 1900's). Because of extensive damage to crops, considerable effort was made by agriculturists to eradicate pocket gophers in certain parts of the state (see especially Stoner, 1918:112-122). However, increase in suitable habitat and food supply through agricultural activities, and a decreasing number of predators have more than counteracted the efforts to control this rodent.

Although *Geomys* is evidently common along the Mississippi River in eastern Iowa and adjacent parts of Minnesota (Gunderson and Beer, 1953:94) and Wisconsin (Jackson, 1961:186), I know of no records from northwestern Illinois between the Illinois and Mississippi rivers.

On the basis of specimens reported by Merriam (1895), Swenk (1939:3) considered the range of *G. b. majusculus* to extend as far east as Marion County in south-central Iowa. Swenk (*loc. cit.*) further indicated that four unsexed specimens from eastern Iowa reported by Baird (1858:377) were smaller than those from eastern Nebraska, thus implying a different subspecies in that part of Iowa although he did not specify a name for this race. The four specimens in question (USNM 1235-36, 1384, 2539) evidently have been exchanged or destroyed and,

TABLE 4.—*External and cranial measurements of Geomys bursarius majusculus from Iowa. Superscript numbers indicate sample size when less than listed in left-hand column.*

Number of specimens averaged or catalogue number	Total length	Length of tail	Length of hind foot	Condylbasal length	Zygomatic breadth	Interorbital constriction	Mastoid breadth	Length of maxillary toothrow
Mahaska and Marion counties								
Average (12♂)	307.3 ³	87.4 ⁴	35.8 ⁴	56.6 ¹¹	35.2 ¹⁰	7.0	31.9 ¹¹	10.0
Minimum	300.0	80.0	30.0	53.4	32.4	6.5	29.0	8.8
Maximum	322.0	100.0	39.0	59.4	37.6	7.8	34.0	11.0
SD ±	12.70	9.67	4.03	2.20	1.86	0.37	1.81	0.65
Average (13♀)	263.3 ⁸	79.8 ⁸	33.7 ⁸	47.6 ¹²	28.5 ¹²	6.5	27.2	9.1
Minimum	242.0	71.0	30.0	44.8	27.4	6.0	25.5	8.3
Maximum	292.0	85.0	36.0	51.8	30.3	7.0	29.6	10.0
SD ±	17.47	4.72	1.98	1.90	0.93	0.30	1.25	0.58
Lyon County								
ISU 556, ♂	325.0	90.0	34.0	60.9	38.3	7.0	33.6	10.2
Average (6♀)	278.7	79.8	35.0	48.5	29.9	6.9	27.7	9.0
Minimum	269.0	75.0	34.0	46.2	27.7	6.8	25.3	8.5
Maximum	300.0	87.0	36.0	53.1	33.0	7.0	30.2	9.7
SD ±	11.43	5.60	0.63	2.90	1.76	0.08	1.83	0.50
Winneshiek County								
UMMZ 83442, ♂	317.0	84.0	42.0	58.2	36.2	7.2	31.8	9.2
UMMZ 83541, ♀	278.0	80.0	35.0	50.2	27.8	7.1	27.5	9.6

therefore, were not examined by me. Scott (1937:72) did not discuss the taxonomic relationship of *Geomys bursarius* in Iowa and did not use a subspecific name. Hall and Kelson (1959:451), however, recognized the subspecies *majusculus* and *bursarius* as occurring in western and eastern parts of the state, respectively.

Specimens from the northeastern part of Iowa (Winneshiek County) and those from the northwestern part of the state (Lyon County) are as large as those from south-central Iowa (see Table 4 for external and cranial measurements) and agree with measurements given by Swenk (1939) for typical *G. b. majusculus*. Thus, all pocket gophers from Iowa are herein assigned to that subspecies. Specimens that I have examined from central Minnesota (housed in the Museum of Natural History, The University of Kansas) are somewhat smaller than those from Iowa and the zone of intergradation between *G. b. bursarius* and *G. b. majusculus* probably occurs in southern Minnesota.

Specimens examined (304).—ADAIR COUNTY: 5 mi. SW Stuart, 1 (ISU). ALLAMAKEE COUNTY: New Albin, 2 (WSU); 1 1/2 mi. S New Albin, 3 (WSU); 2 mi. SW New Albin, 2 (WSU); sec. 19, T. 97 N, R. 3 W, 1 (ISU); SE 1/4 of sec. 19, T. 97 N, R. 4 W, 1 (ISU); near Yellow River Forest, 1 (ISU). BLACK HAWK COUNTY: Cedar Falls, 1 (SM); no specific locality, 1 (SM). BOONE COUNTY: sec. 24, Marcy Twp., 1 (ISU). BUCHANAN COUNTY: SW 1/4 of NW 1/4 of sec. 23, T. 88 N, R. 9 W, 1 (ISU); Quasqueton, 1 (USNM). BUENA VISTA COUNTY: Storm Lake and 5 mi. radius thereof, 5 (BV); no specific locality, 2 (BV). BUTLER COUNTY:

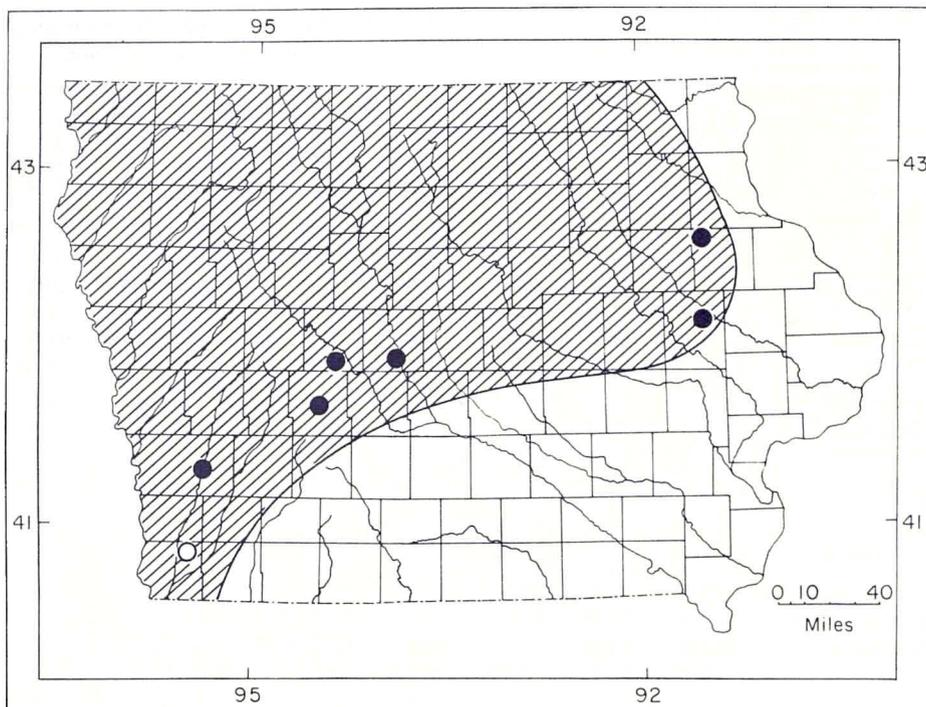


FIG. 29.—Distribution of *Perognathus flavescens penniger* in Iowa. For explanation of symbols see Fig. 3.

1/2 mi. S, 3 mi. E Greene, 1 (KU). CARROLL COUNTY: sec. 32, Grant Twp., 2 (ISU). CERRO GORDO COUNTY: SE 1/4 of SE 1/4 of sec. 33, T. 95 N, R. 19 W, 1 (ISU). CHEROKEE COUNTY: sec. 29, T. 93 N, R. 40 W, 1 (SM); N 1/2 of NE 1/4 of sec. 9, T. 92 N, R. 40 W, 1 (SM). CLAY COUNTY: 5 mi. N, 2 mi. E Linn Grove, 2 (BV); no specific locality, 3 (UMMZ). CLAYTON COUNTY: 2 1/2 mi. W Garnavillo, 3 (UMMZ). CRAWFORD COUNTY: sec. 9, Denison Twp., 1 (ISU). DALLAS COUNTY: 1/4 mi. NE Woodward, 1 (ISU). DECATUR COUNTY: Woodland, 1 (ISU). DELAWARE COUNTY: Greeley, 1 (AMNH). DES MOINES COUNTY: Burlington, 1 (USNM). DICKINSON COUNTY: S 1/2 of sec. 13, T. 99 N, R. 36 W, 2 (1 KU, 1 ISU); 7 mi. SE Spirit Lake, 1 (ISU); Lakeside Laboratory, [West Okoboji Lake], 1 (DPM); 1/4 mi. W Emerson Bay, [West] Lake Okoboji, on hwy. 32, 5 (TTU); EMMET COUNTY: 3 mi. W Estherville, 1 (ISU); Fort Defiance State Park, 3 (ISU); Estherville, 2 (ISU); West Des Moines River, 3 1/2 mi. S, 2 3/4 mi. E Wallingford, 1 (KU). FREMONT COUNTY: 3 1/2 mi. S Sidney, 1 (KU). GREENE COUNTY: near Churdan, 1 (ISU). GRUNDY COUNTY: Greeley, 1 (USNM); 4 1/2 mi. S, 2 1/2 mi. W Wellsburg, 1 (KU); precise locality unknown [listed as "E Steamboat Rock," which is in Hardin Co.], 1 (ISU). GUTHRIE COUNTY: sec. 31, T. 80 N, R. 33 W, 1 (ISU). HAMILTON COUNTY: 10 mi. N Ellsworth, 1 (NWM); Jewell, 1 (ISU); 9 mi. N Gilbert, 1 (ISU). HANCOCK COUNTY: Pilot Knob State Park, 1 (ISU). HUMBOLDT COUNTY: 1 1/2 mi. S Dakota City, 1 (ISU). IDA COUNTY: Battle Creek, 1 (CC). JASPER COUNTY: SE 1/4 of SW 1/4 of sec. 25, T. 81 N, R. 17 W, 1 (ISU); Newton, 2 (UMMZ); 5 1/2 mi. S Prairie City, 1 (NWM). JOHNSON COUNTY: Iowa City, 85 (22 AMNH, 63 SUI); no specific locality, 44 (SUI). KOSSUTH COUNTY: sec. 28, T. 98 N, R. 27 W, 1 (ISU). LINN COUNTY: W of Central City, 1 (IHM); Marion, 1 (ISU); Cedar Rapids, 1 (CC). LYON COUNTY: 1 1/2 mi. S, 1 1/2 mi. E Granite, 1 (KU); sec. 29, Riverside Twp., 1 (ISU); sec. 33, Riverside Twp., 1 (ISU); sec. 35, Elgin Twp., 3 (ISU); sec. 23, Lyon Twp., 5 (ISU); sec. 26, Lyon Twp., 1 (ISU); sec. 28, Wheeler Twp., 1 (ISU). MADISON COUNTY: 10 mi. SW Winterset,

1 (ISU). MAHASKA COUNTY: New Sharon and 5 mi. radius thereof, 10 (KU); NE 1/4 of sec. 33, T. 77 N, R. 17 W, 1 (ISU); Oskaloosa and 5 mi. radius thereof, 4 (KU). MARION COUNTY: 1 mi. S Pella, 1 (KU); Knoxville, 16 (USNM). MARSHALL COUNTY: 3 mi. W Green Mountain, 3 (KU); NW 1/4 of sec. 2, T. 82 N, R. 17 W, 1 (ISU). MITCHELL COUNTY: 1 1/2 mi. N, 2 mi. E Stacyville, 1 (ISU); SW 1/4 of NW 1/4 of sec. 6, T. 99 N, R. 16 W, 1 (ISU). MONONA COUNTY: sec. 6, Franklin Twp., 1 (ISU). MONROE COUNTY: 5 1/2 mi. N, 3 1/2 mi. E Albia, 2 (KU); 1 1/2 mi. N Melrose, 1 (KU). MUSCATINE COUNTY: Sutherland, 1 (ISU); 1/2 mi. E Sutherland, 3 (BV). PALO ALTO COUNTY: Ruthven, 2 (UMMZ). POCAHONTAS COUNTY: 1 mi. E Laurens, 1 (BV). POLK COUNTY: 1 1/2 mi. NE Ankeny, 1 (ISU). POTTAWATTAMIE COUNTY: Council Bluffs, 1 (USNM). SCOTT COUNTY: Davenport, 3 (DPM); Buffalo Twp., 1 (DPM). SHELBY COUNTY: 2 mi. N, 3 mi. E Defiance, 1 (BV); 4 mi. SE Irwin, 1 (ISU). SIOUX COUNTY: 2 1/2 mi. E Hull, 1 (ISU); 4 mi. E Hull, 2 (ISU). STORY COUNTY: Ames and 5 mi. radius thereof, 6 (3 ISU, 3 KU); 1 mi. SW Nevada, 1 (KU). TAYLOR COUNTY: 5 mi. W Bedford, 1 (NWM). WAPELLO COUNTY: Ottumwa, 1 (KU). WEBSTER COUNTY: Otho, 1 (ISU). WINNESHIEK COUNTY: Decorah, 7 (3 FMNH, 4 UMMZ). WRIGHT COUNTY: sec. 16, T. 93 N, R. 24 W, 1 (ISU); SW 1/4 of sec. 16, T. 92 N, R. 24 W, 1 (ISU); 3 mi. N, 3 1/2 mi. E Clarion, 1 (ISU).

Additional records.—BLACK HAWK COUNTY: La Port City (Bailey, 1918:100). BUENA VISTA COUNTY: *Storm Lake* (Fisher, 1888:456). CASS COUNTY: Atlantic (Stoner, 1918:111). DICKINSON COUNTY: "*Lake Region*" (Stephens, 1922:56). DUBUQUE COUNTY: Dubuque (Stoner, 1918:115). FLOYD COUNTY: Rockford (Webster, 1897:116). PAGE COUNTY: Shenandoah (Stoner, 1918:114). POCAHONTAS COUNTY: Kalsow Prairie, 4 1/2 mi. NW Manson (Brennan, 1969:27). SAC COUNTY: *no specific locality* (Spurrell, 1917:281). TAMA COUNTY: Tama (Joyce and Eddy, 1944:214). WINNESHIEK COUNTY: *Iowa River, W of Decorah* (Hoslett, 1965:369). WRIGHT COUNTY: Clarion (Stoner, 1918:114); Wall Lake (Scott, 1947:444).

Family HETEROMYIDAE—Pocket Mice and Kangaroo Rats

***Perognathus flavescens perniger* Osgood**

Plains Pocket Mouse

1904. *Perognathus flavescens perniger* Osgood, Proc. Biol. Soc. Washington, 17: 127, 9 June (type locality, Vermillion, Clay Co., South Dakota).

Distribution in Iowa.—Formerly northern and western parts of the state; may occur locally at present in restricted suitable habitats, particularly on the loess bluffs adjacent to the Missouri River (see Fig. 29).

The plains pocket mouse probably occurred in suitable habitats throughout much of the northern and western parts of Iowa prior to extensive agricultural activities by white settlers. It is possible that a few local populations still exist in this region, although I know of no specimens taken in the state since 1957 (CC 3564, 3581). Jones (1964:167) indicated that *P. flavescens* probably does not now occur in eastern Nebraska. This species has been reported from southwestern Minnesota (Gunderson and Beer, 1953:95). Recent records from relatively ungrazed, grassy slopes of loess bluffs in northwestern Missouri (Easterla, 1967) suggest that *flavescens* likely will be found in similar situations in western Iowa.

Although the first published record of the plains pocket mouse in Iowa was that of Polderboer (1937), the earliest-taken specimen known to me is a female (USNM 210538) that was obtained on 21 August 1914 by J. E. Guthrie in Greene County.

Specimens examined (10).—BOONE COUNTY: sec. 19, Cass Twp., 1 (ISU). DELAWARE COUNTY: vicinity Backbone State Park [Lamont, which is in northeastern Buchanan County,

also recorded on specimen label], 2 (USNM). GREENE COUNTY: Cooper, 1 (USNM). GUTHRIE COUNTY: Guthrie Center, 1 (ISU). LINN COUNTY: 2 mi. W Center Point, 1 (CC); *W of Center Point*, 2 (CC); *S of Center Point*, 1 (CC). POTTAWATTAMIE COUNTY: Oakland, 1 (ISU).

Additional records.—BLACK HAWK COUNTY: Union Twp. (Polderboer, 1937:199). FREMONT COUNTY: Randolph (Fichter, 1939:377).

Family CASTORIDAE—Beavers

***Castor canadensis missouriensis* V. Bailey**

Beaver

1919. *Castor canadensis missouriensis* V. Bailey, J. Mamm., 1:32, 28 November (type locality, Apple Creek, 7 mi. E Bismarck, Burleigh Co., North Dakota).

Distribution in Iowa.—Statewide in suitable habitat (see Fig. 30).

The beaver was abundant along river systems throughout Iowa in the early 1800's. Extensive trapping reduced the numbers, and, by 1840, this species was considered by Galland (1921:500) to be "nearly extinct."

A few local populations continued to exist in the extreme northwestern part of the state (Aitken, 1937; Bowles, 1971), and, aided by legislative protection in 1872, *C. canadensis* reinvaded most of the Missouri River drainage in Iowa by the 1930's (Sanderson, 1953:746). Between 1937 and 1943, beaver populations increased to the extent that a program of "nuisance trapping" was established in western Iowa by the Iowa Conservation Commission and trapped individuals were released in central and eastern counties of the state (Sanderson, *loc. cit.*). Pietsch (1956:195), for example, reported releases of beaver in the eastern Iowa counties of Jackson (in 1940), Muscatine (in 1940-41), and Lee (in 1941). By the late 1940's, the species was found throughout much of the state and Sanderson (1953:747) reported that "in the fall of 1949, there was an open season on beaver in Iowa for the first time in many decades." High population densities in the years 1946 to 1948 probably contributed to rapid dispersal and reestablishment of this species throughout the state (Sanderson, *loc. cit.*).

In northern Missouri, populations of beaver were restocked with animals from Minnesota in 1928 (Bennitt and Nagel, 1937:138) and descendents of these transplanted individuals subsequently may have moved north into southern Iowa. Beaver were nearly extirpated in southern Minnesota (Gunderson and Beer, 1953:98) and populations have probably only recently regained contact with those in adjacent northern Iowa.

Because of the paucity of specimens of adult beaver from Iowa and the nature of restoration of this species within the state, it seems best tentatively to consider all individuals from Iowa as belonging to the subspecies *C. c. missouriensis*. Considering the reintroduction of this species in parts of Iowa and adjacent states, however, there is a definite need to review the systematic relationships of *Castor canadensis* from throughout the Missouri Valley region.

Specimens examined (18).—ALLAMAKEE COUNTY: 3 1/2 mi. E New Albin, 2 (WSU); 1 1/2 mi. SE New Albin, 1 (WSU). APPANOOSE COUNTY: near Centerville, 1 (ISU). CHEROKEE COUNTY: Little Sioux River, 1 (SM). CLAY COUNTY: 2 mi. N, 4 mi. E Sioux River, 1 (BV). DAVIS COUNTY: no specific locality, 1 (ISU). EMMET COUNTY: Des Moines River, 1 mi. E

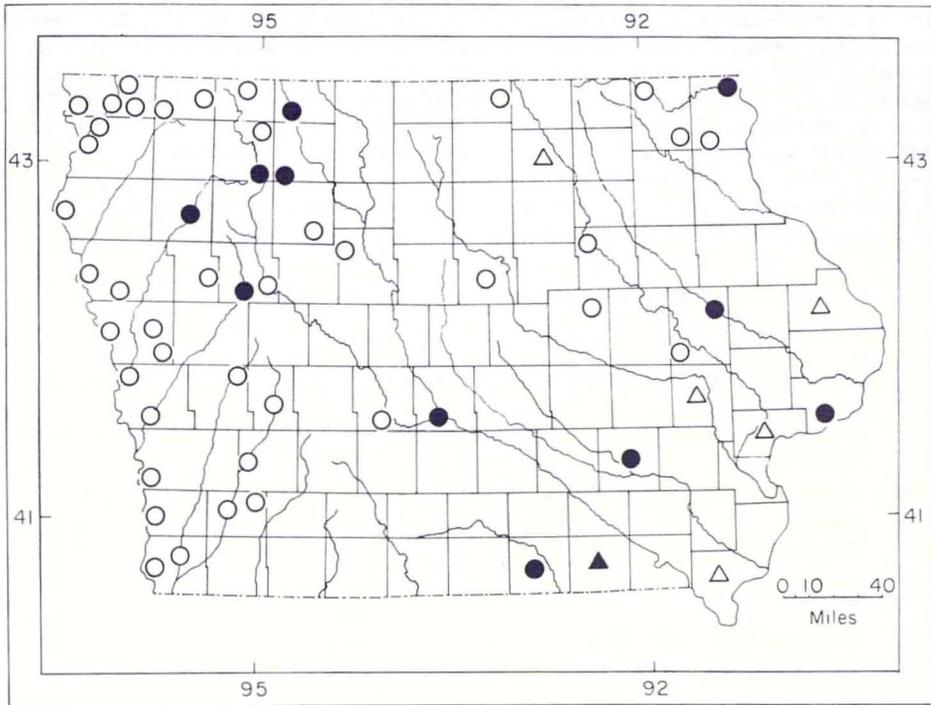


FIG. 30.—Distribution of *Castor canadensis missouriensis* in Iowa. For explanation of symbols see Fig. 3.

Wallingford, 1 (ISU). KEOKUK COUNTY: 3/4 mi. N, 1 mi. W Sigourney, 1 (KU); 1 mi. S Sigourney, 1 (KU). LINN COUNTY: Wapsipinicon River, Waubeek, 2 (CC). PALO ALTO COUNTY: Rush Lake, 1 (ISU). POLK COUNTY: Des Moines, 1 (IHM). SAC COUNTY: Lakeview, 1 (ISU). SCOTT COUNTY: Davenport, 1 (DPM); no specific locality, 2 (DPM).

Additional records (Bowles, 1971:420, unless otherwise indicated). —ALLAMAKEE COUNTY: Yellow River, Franklin Twp. AUDUBON COUNTY: Botna [Nishnabotna River], "above" Exira (Andrews, 1915:42). BLACK HAWK COUNTY: Red Cedar River, Cedar Falls. CASS COUNTY: 1 mi. S Lewis (Bowles, field notes). CLAY COUNTY: inlet to Turnbull Lake (Aitken, 1937:181). CHEROKEE COUNTY: *Little Sioux River* (Aitken, 1937:181); no specific locality (Scott, 1937:73). DALLAS COUNTY: "southern part" (Allen, 1870:190). DICKINSON COUNTY: Spirit Lake. FLOYD COUNTY: no specific locality. FREMONT COUNTY: Nishnabotna River; Missouri River (Aitken, 1937:181). HARDIN COUNTY: 6 mi. W Eldora (Bowles, field notes). HARRISON COUNTY: mouth Little Sioux River (Aitken, 1937:181); near Missouri Valley. IDA COUNTY: Odebolt Creek [tributary of Maple River] (Aitken, 1937:181); *Maple River* (Spurrell, 1917:282). JACKSON COUNTY: no specific locality (Pietsch, 1956:195). JOHNSON COUNTY: no specific locality. LEE COUNTY: no specific locality (Pietsch, 1956:195). LINN COUNTY: near Fairfax (Osborn, 1905:567). LYON COUNTY (Aitken, 1937:181-182): Tom Creek, 4 mi. NE Rock Rapids; *Rock River*, 4 mi. N Rock Rapids; *Rock River*, 5 mi. S Rock Rapids; *Rock River*, 7 mi. S Rock Rapids; *Sioux River*, 1/2 mi. N hwy. 18 [listed as in Sioux County]; *Otter Creek*, 3 mi. N [NW] Matlock [listed as in Sioux County]. MILLS COUNTY: *Missouri River* (Aitken, 1937:182). MONONA COUNTY (Aitken, 1937:182): *Missouri River*; *Little Sioux River*; *Soldier*. MONTGOMERY COUNTY: Nodaway River, 1 mi. N Grant; *Nishnabotna River*, N of Red Oak. MUSCATINE COUNTY: no specific locality (Pietsch, 1956:195). OSCEOLA COUNTY: *Ocheyedan River*; *Otter Creek*, 5 mi. N Sheldon (Aitken, 1937:182). PLYMOUTH COUNTY: *Big Sioux River* (Aitken, 1937:182). POCAHONTAS COUNTY: south branch

Lizard Creek (Flickinger, 1904:276). POTTAWATTAMIE COUNTY (Aitken, 1937:182): Council Bluffs; *mouth Pidgeon Creek*. SAC COUNTY (Spurrell, 1917:282): Raccoon River, E of Lake View; *Boyer River, W of Wall Lake*. SHELBY COUNTY: Elk Creek, 1 1/2 mi. N Irwin. SIOUX COUNTY (Aitken, 1937:182): Rock River; [Big] Sioux River, 1 mi. N Hudson. TAMA COUNTY: near Dysart; *Big Creek* (Nutting, 1893:40). WEBSTER COUNTY: Lizard Creek, 5 mi. NW Fort Dodge (Stoner, 1918:51). WINNESHIEK COUNTY: near Kendallville (Hoslett, 1965:369); Yellow River, Franklin [Frankville] Twp. (Alexander, 1882:344). WOODBURY COUNTY: Missouri River, S of Sioux City (Aitken, 1937:182); Little Sioux River (Aitken, 1937:182); *near Crooked Lake*. WORTH COUNTY: Deer Creek, W of Carpenter (Aitken, 1937:182).

Family CRICETIDAE—Native Rats and Mice

Key to Iowan Cricetids

1. Cheekteeth cusped, occlusal surface lacking lakes of dentine surrounded by enamel 2
- 1'. Cheekteeth lacking cusps, occlusal surface composed of lakes of dentine surrounded by enamel 6
- 2.(1) Pelage coarse, relatively hispid; hind foot more than 24; maxillary tooththrow more than 5.0 *Sigmodon hispidus*, p. 94
- 2'. Pelage relatively smooth; hind foot less than 24; maxillary tooththrow less than 5.0 . . . 3
- 3.(2') Length of head and body less than 80; upper incisors grooved on anterior surface *Reithrodontomys megalotis*, p. 85
- 3'. Length of head and body usually more than 80; upper incisors not grooved 4
- 4.(3') Tail less than 60 per cent of length of head and body; coronoid process of mandible long, extending higher than articular process *Onychomys leucogaster*, p. 93
- 4'. Tail more than 60 per cent of length of head and body; coronoid process of mandible short, not extending higher than articular process 5
- 5.(4') Tail sharply bicolored; hind foot 20 or less (usually less than 18) braincase flattened and roughly parallel sided *Peromyscus maniculatus*, p. 90
- 5'. Tail not sharply bicolored (except occasionally in winter); hind foot 20 or more; braincase rounded, not flattened or parallel sided *Peromyscus leucopus*, p. 87
- 6.(1') Tail more than 100; greatest length of skull more than 35 *Ondatra zibethicus*, p. 103
- 6'. Tail less than 100; greatest length of skull less than 35 7
- 7.(6') Tail about the same length as hind foot; zygomatic breadth usually more than 17.5; upper incisors grooved on anterior surface *Synaptomys cooperi*, p. 96
- 7'. Tail longer than hind foot; zygomatic breadth usually less than 17.5; upper incisors smooth 8
- 8.(7') Dorsum with broad, chestnut-colored stripe running from forehead to base of tail; posterior border of bony palate a straight edge (no median posterior projection) *Clethrionomys gapperi*, p. 95
- 8'. Dorsum without chestnut-colored stripe; posterior border of bony palate having median posterior projection 9
- 9.(8') Dorsum blackish or brownish black, venter grayish or whitish; fourth triangle of M2 with prominent heel that often appears as a distinct fifth triangle *Microtus pennsylvanicus*, p. 100
- 9'. Dorsum brownish or reddish, venter usually washed with buff; fourth triangle of M2 lacking heel 10
- 10.(9') Tail 29 or more; pelage relatively coarse, brownish or brownish gray dorsally; six mammae *Microtus ochrogaster*, p. 98

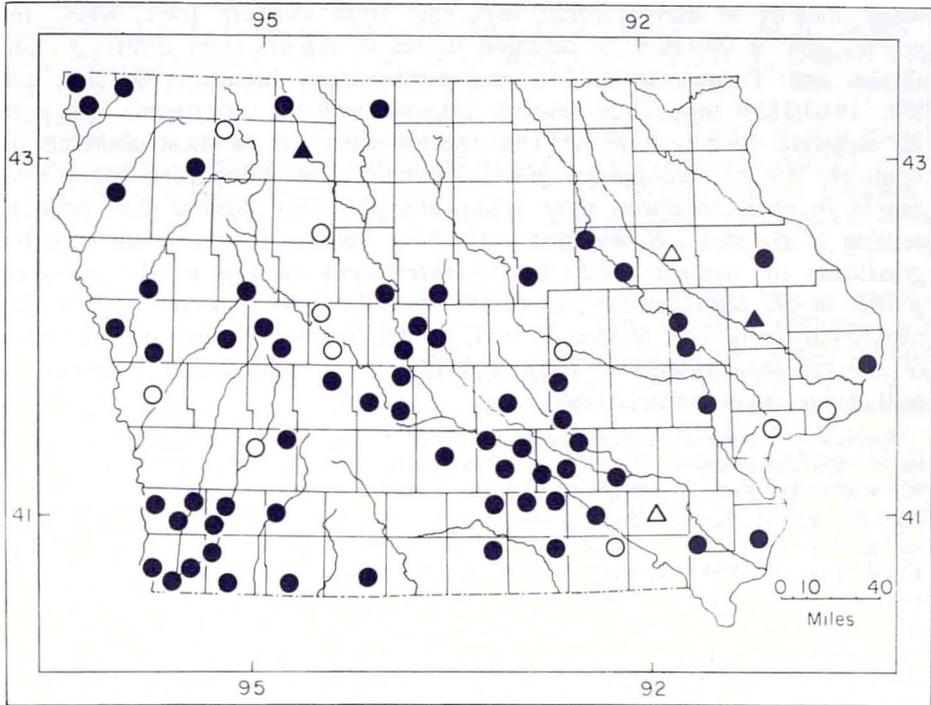


FIG. 31.—Distribution of *Reithrodontomys megalotis dychei* in Iowa. For explanation of symbols see Fig. 3.

- 10'. Tail less than 29 (usually less than 25); pelage soft and smooth, chestnut dorsally; four mammae *Microtus pinetorum*, p. 102

***Reithrodontomys megalotis dychei* J. A. Allen**
Western Harvest Mouse

1895. *Reithrodontomys dychei* J. A. Allen, Bull. Amer. Mus. Nat. Hist., 7:120, 21 May (type locality, Lawrence, Douglas Co., Kansas).

1914. *Reithrodontomys megalotis dychei*, A. H. Howell, N. Amer. Fauna, 36:30, 5 June.

Distribution in Iowa.—Probably statewide in suitable habitats (see Fig. 31).

The western harvest mouse is common to abundant in grassy habitats throughout much of Iowa; there are no authentic records from the extreme northeastern counties, but the species may occur there locally as it has been reported from adjacent parts of Illinois (Hoffmeister and Warnock, 1955), Minnesota (Gunderson and Beer, 1953:99), and Wisconsin (Jackson, 1961:207). Variation in local abundance of harvest mice was evident in the late summer of 1968, when I took specimens easily in southern and western counties, but trapped none in apparently suitable habitat to the east of Plymouth County.

Stoner (1918:78) reported this species as uncommon in the state in the early 1900's and suggested that it probably was extending its range east-

ward. Paucity of early records, especially from southern Iowa, where the species now is common, in addition to recent reports from central Illinois (Stains and Turner, 1963:274), and northwestern Indiana (Whitaker and Sly, 1970:381) suggest an eastern extension of the geographic range of *R. megalotis* in recent years. This species seems to be most abundant in relatively dry or well-drained grassy habitats; most individuals that I have caught in other situations were young animals. This suggests that prior to settling of the state, *R. megalotis* may have been relatively common in the grasslands of western Iowa, but occurred only locally in the tall-grass prairie in the north-central part of the state. Such an eastward shift in distributional limits may, at least in part, be due to the drainage and cultivation of the tall-grass prairie in Iowa and Illinois for agricultural purposes, as well as clearing of timbered land.

Specimens examined (225).—ADAMS COUNTY: 4 mi. N, 3/4 mi. W Nodaway, 1 (KU). APPANOOSE COUNTY: 5 1/2 mi. E Moravia, 3 (KU). BLACK HAWK COUNTY: 4 mi. NW Cedar Falls, 1 (ISU); *North Cedar*, 1 (UNI); 6 mi. SW Jesup, 1 (ISU). BOONE COUNTY: sec. 31, Jackson Twp., 1 (ISU); *NW 1/4 of sec. 8, Marcy Twp.*, 1 (ISU); *7 mi. E, 4 mi. S Ogden*, 1 (ISU); 3 1/2 mi. S, 1/2 mi. W Courthouse, Boone, 1 (KU); *Worth Twp.*, 1 (ISU). CARROLL COUNTY: sec. 22, Maple River Twp., 2 (ISU); *Pleasant [Valley] Twp.*, 1 (ISU). CASS COUNTY: 1 mi. N Anita, 1 (NWM). CLINTON COUNTY: 1/2 mi. S Clinton, 4 (KU). CRAWFORD COUNTY: sec. 8, Denison Twp., 2 (ISU); *sec. 13, Denison Twp.*, 1 (ISU). DALLAS COUNTY: NE 1/4 of sec. 5, T. 81 N, R. 26 W, 1 (ISU); 3 mi. W Panther, 1 (ISU); 2 1/2 mi. N, 1 mi. E Waukee, 1 (KU). DES MOINES COUNTY: 5 1/2 mi. N Burlington, 1 (KU). DUBUQUE COUNTY: Dyersville, 3 (1 ISU, 2 USNM). EMMET COUNTY: Four-mile Lake, 3 1/2 mi. W Estherville, 1 (ISU); *3 mi. W Estherville*, 1 (ISU); *5 mi. W Wallingford*, 1 (ISU). FREMONT COUNTY: *3 1/2 mi. S Sidney*, 2 (KU); 4 mi. S, 9 mi. W Sidney, 1 (KU); *6 mi. N, 3 mi. W Hamburg*, 4 (KU); SW 1/4 of sec. 27, T. 68 N, R. 41 W, 1 (ISU); *1 1/2 mi. N Hamburg*, 1 (KU); *Hamburg*, 2 (ISU); *4 mi. E Hamburg*, 9 (KU); *13 mi. E. Hamburg*, 3 (KU). GRUNDY COUNTY: 5 mi. S, 1/2 mi. E Wellsburg, 2 (KU). GUTHRIE COUNTY: near Springbrook State Park, 1 (ISU), *1/2 mi. E Springbrook State Park*, 1 (KU). HAMILTON COUNTY: Little Wall Lake, 1 (ISU). HENRY COUNTY: Hillsboro, 2 (ISU). JASPER COUNTY: Cherry Creek, Newton, 1 (KU). JOHNSON COUNTY: Iowa City, 1 (SUI). JONES COUNTY: no specific locality, 1 (CC). KEOKUK COUNTY: 6 1/2 mi. S, 1 mi. W Sigourney, 1 (KU). KOSSUTH COUNTY: SE 1/4 of sec. 26, T. 98 N, R. 28 W, 1 (ISU). LINN COUNTY: 2 mi. W Center Point, 1 (CC); *W of Center Point*, 2 (CC); *E of Center Point*, 1 (CC); Cedar Rapids, 2 (CC); *no specific locality*, 4 (CC). LUCAS COUNTY: 2 1/2 mi. N, 2 1/2 mi. E Russell, 3 (KU); *SE 1/4 of NW 1/4 of sec. 11, T. 71 N, R. 21 W*, 1 (ISU). LYON COUNTY: Granite, 2 (ISU); *sec. 29, Riverside Twp.*, 1 (ISU); sec. 33, Riverside Twp., 1 (ISU); sec. 26, Lyon Twp., 3 (ISU). MAHASKA COUNTY: 1/2 mi. S, 5 mi. E New Sharon, 1 (KU); *2 mi. S, 5 mi. E New Sharon*, 2 (KU); 11 1/2 mi. W Oskaloosa, 2 (KU); Oskaloosa and 7 mi. radius thereof, 13 (KU); *2 mi. S, 10 mi. W Oskaloosa*, 1 (KU); *3 mi. S, 9 mi. W Oskaloosa*, 1 (KU). MARION COUNTY: 1 mi. W Percy, 1 (ISU); 2 mi. S, 4 mi. W Pella, 2 (KU); Knoxville and 6 mi. radius thereof, 5 (KU); *1/2 mi. W Tracy*, 2 (KU). MILLS COUNTY: 1/2 mi. S, 3 mi. W Henderson, 2 (KU); sec. 13, Glenwood Twp., 4 (ISU); 1 mi. S Malvern, 1 (KU). MONONA COUNTY: 1/2 mi. S, 2 mi. W Moorhead, 3 (KU); *1 mi. S, 3 1/2 mi. W Moorhead*, 3 (KU); Blue Lake, Franklin Twp., 2 (ISU); *sec. 7, Franklin Twp.*, 1 (KU). MONROE COUNTY: 6 1/2 mi. W Lovilia, 1 (KU); 5 1/2 mi. N, 3 1/2 mi. E Albia, 1 (KU); *1 1/2 mi. N Melrose*, 2 (KU). MONTGOMERY COUNTY: 1 mi. S Red Oak, 2 (ISU); 4 mi. S, 3/4 mi. W Hawthorne, 8 (KU). O'BRIEN COUNTY: Sutherland, 1 (WSU). PAGE COUNTY: Shenan-

doah, 1 (ISU); 7/10 mi. S Coin, 15 (KU); 1 mi. S, 1 mi. W Northboro, 1 (KU); 1 mi. S, 3 mi. E Northboro, 20 (KU). PALO ALTO COUNTY: no specific locality, 1 (UMMZ). PLYMOUTH COUNTY: 2 mi. N Le Mars, 1 (KU). POWESHIEK COUNTY: 1 mi. S, 2 mi. W Grinnell, 1 (KU); 2 1/2 mi. S, 1 mi. E Searsboro, 1 (KU). RINGGOLD COUNTY: 1/2 mi. N, 2 mi. E Mount Ayer, 2 (KU). SAC COUNTY: Wall Lake, 1 (SUI). STORY COUNTY: Ames and 5 mi. radius thereof, 14 (10 ISU, 4 KU). TAYLOR COUNTY: 2 mi. S, 1/2 mi. W Bedford, 1 (KU). WAPELLO COUNTY: Ottumwa, 1 (SUI); 2 1/2 mi. E Ottumwa, 6 (KU); sec. 35, Agency Twp., 2 (ISU). WARREN COUNTY: Indianola, 1 (ISU); 3 mi. S, 1 mi. W Indianola, 2 (KU); Ahquabi State Park, 1 (ISU). WAYNE COUNTY: 1 1/2 mi. S Confidence, 1 (KU). WEBSTER COUNTY: 2 1/2 mi. S, 3 1/2 mi. E Dayton, 1 (KU). WOODBURY COUNTY: 2 mi. NE Oto, 1 (ISU).

Additional records.—BLACK HAWK COUNTY: no specific locality (Sloan, 1964:521). BOONE COUNTY: Moingona Fox Area, about 5 mi. S Boone (Scott, 1947:446). BUCHANAN COUNTY: no specific locality (Coues and Allen, 1877:126). CASS COUNTY: Atlantic (Scott, 1937:74). CLAY COUNTY (Scott, 1940:590): sec. 22, Waterford Twp.; sec. 19, Summit Twp. CRAWFORD COUNTY: Dennison (O. T. Kalin, University of Minnesota, personal communication). DAVIS COUNTY: Eldon Fox Range [1/2 mi. N, 4 mi. E Floris] (Scott and Klimstra, 1955:35). GREENE COUNTY: Churdan (record on file, U.S. Biological Survey); Jefferson (Stoner, 1918:78). HARRISON COUNTY: Logan (Stoner, 1918:78). JEFFERSON COUNTY: no specific locality (Miller, 1954:558). MUSCATINE COUNTY: Fairport (Scott, 1937:74). POCAHONTAS COUNTY: Kalsow Prairie, 4 1/2 mi. NW Manson (Brennan, 1969:19). SCOTT COUNTY: near Davenport (Miller, 1954:558). STORY COUNTY: Ames (Elwell, 1962a:5). TAMA COUNTY: Tama (Joyce and Eddy, 1944:214). WRIGHT COUNTY: Wall Lake (Scott, 1947:446).

***Peromyscus leucopus noveboracensis* (Fisher)**

White-footed Mouse

1829. [*Mus. sylvaticus*] *δ noveboracensis* Fisher, Synopsis mammalium, p. 318 (type locality, New York).

1897. *Peromyscus leucopus noveboracensis*, Miller, Proc. Boston Nat. Hist., 28:22. 30 April.

Distribution in Iowa.—Statewide in suitable habitats (see Fig. 32).

The white-footed mouse is one of the most abundant and widespread mammals in the state. This species occupies a wide variety of habitats—particularly timbered areas, woodlots, overgrown fencerows, bushy or rocky hillsides, and wooded river banks. In grassy pastures, fields, or roadside ditches, habitats in which *P. maniculatus* ordinarily is abundant, I have taken white-footed mice only in the proximity of some kind of heavy cover, clumps of brush, piles of rocks or logs, or tall weeds, for example.

Because of its habitat preferences, it seems likely that the abundance and distribution of the white-footed mouse, *P. leucopus*, has varied locally according to land use since settlement of the state. For example, *P. leucopus*, may have become more widely distributed subsequent to cultivation of the tall-grass prairie and planting of woodlots by settlers. Suitable habitat for *P. leucopus* probably also increased along stream borders and scarps in the tall-grass prairie as a consequence of the decline of prairie fires.

I found no significant variation in size among samples of this species from north-central and southwestern counties (see Table 5).

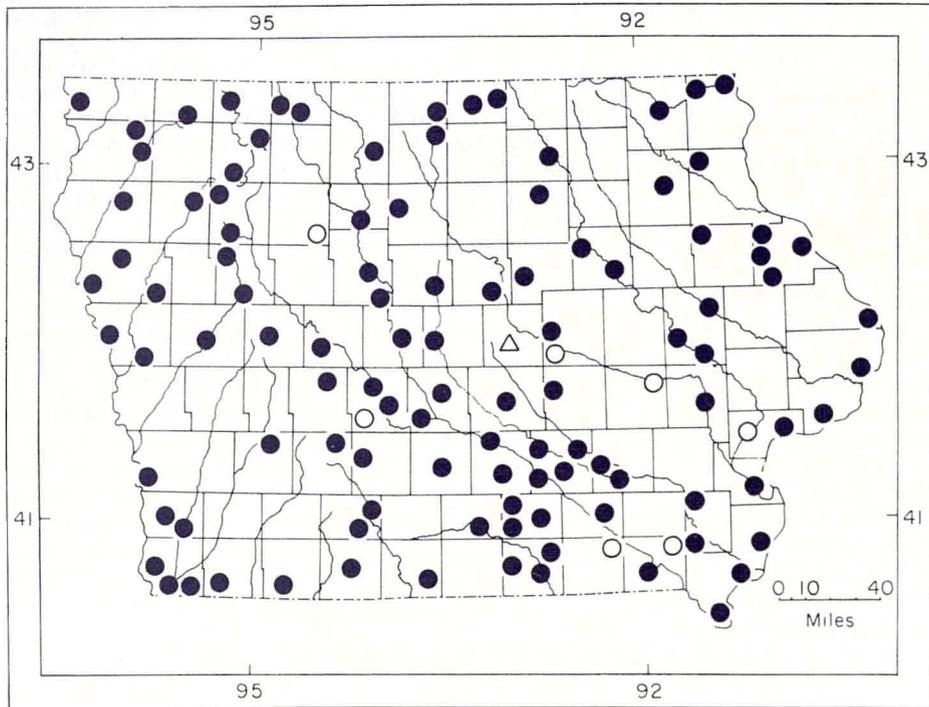


FIG. 32.—Distribution of *Peromyscus leucopus noveboracensis* in Iowa. For explanation of symbols see Fig. 3.

Specimens examined (700).—ADAIR COUNTY: 5 mi. SW Stuart, 1 (ISU). ALLAMAKEE COUNTY: 2 mi. SW New Albin, 1 (WSU); Bear Creek, 1/2 mi. S, 1 1/4 mi. E Quandah, 5 (KU); 4 mi. SW New Albin, 7 (UMMZ); 4 mi. NW Lansing, 1 (ISU). APPANOOSE COUNTY: 5 1/2 mi. E Moravia, 3 (KU); 11 mi. W Centerville, 2 (KU); Sharon Bluffs State Park, 2 (ISU). BLACK HAWK COUNTY: sec. 29, T. 90 N, R. 13 W, 1 (AMNH); Cedar Falls, 1 (UNI); 6 mi. SW Jesup, 2 (ISU). BOONE COUNTY: Honey Creek, McHose Park, Boone, 2 (KU); SE 1/4 of SE 1/4 of sec. 36, T. 84 N, R. 25 W, 1 (ISU); sec. 18, Marcy Twp., 3 (ISU); 3 1/2 mi. S, 1/2 mi. W Courthouse, Boone, 2 (KU); 3 1/2 mi. S Courthouse, Boone, 5 (KU); no specific locality, 1 (ISU). BUENA VISTA COUNTY: 10 mi. N, 3 mi. W Alta, 1 (BV); Storm Lake and 5 mi. radius thereof, 8 (BV). BUTLER COUNTY: 1/2 mi. S, 3 mi. E Greene, 1 (KU). CARROLL COUNTY: sec. 22, Maple River Twp., 2 (ISU). CASS COUNTY: 7 mi. NW Anita, 4 (NWM). CHEROKEE COUNTY: 5 mi. N Cherokee, 1 (BV); 2 mi. NE Cherokee, 2 (BV). CLAY COUNTY: Lost Island Lake, 1 (ISU); 5 mi. N, 2 mi. E Linn Grove, 1 (BV). CLAYTON COUNTY: NE 1/4 of sec. 35, T. 95 N, R. 6 W, 2 (ISU). CLINTON COUNTY: 1/2 mi. S, 1/2 mi. W Clinton, 1 (KU); 1/2 mi. S Clinton, 2 (KU); 1 mi. S, 1/2 mi. W Clinton, 1 (KU). CRAWFORD COUNTY: sec. 13, Denison Twp., 1 (ISU). DALLAS COUNTY: NW 1/4 of sec. 6, T. 80 N, R. 28 W, 1 (ISU); Dallas Center, 1 (ISU). DECATUR COUNTY: High Point, 4 (ISU); Woodland, 2 (ISU). DELAWARE COUNTY: Backbone State Park, 2 (ISU). DES MOINES COUNTY: 5 1/2 mi. N Burlington, 3 (KU); Burlington, 57 (56 USNM, 1 SU). DICKINSON COUNTY: Lakeside Laboratory [West Okoboji Lake], 2 (DPM); Spooky Hollow, Little Sioux River, 2 6/10 mi. W hwy. 32, 7 (TTU); East Lake Okoboji, 5 (ISU); Gull Point State Park, 1 (DPM). DUBUQUE COUNTY: SW 1/4 of SW 1/4 of sec. 9, T. 90 N, R. 2 W, 1 (ISU); Dubuque, 26 (6 ISU, 20 USNM); Dyersville, 4 (1 ISU, 3 USNM); Cascade, 1 (ISU); Green Island [not precisely located], 1 (ISU). EMMET COUNTY: Four-mile Lake, 3 mi. W Estherville, 2 (ISU); Fort

TABLE 5.—External and cranial measurements of white-footed mice and deer mice from Iowa.

Number of specimens averaged	Total length	Length of tail	Length of hind foot	Condylobasal length	Zygomatic breadth	Interorbital constriction	Length of rostrum	Depth of skull	Length of maxillary toothrow
<i>Peromyscus leucopus noveboracensis</i>									
Hardin, Grundy, and Tama counties									
Average 8 (5♂, 3♀)	169.3	74.4	21.8	26.4	13.4	4.1	10.1	9.6	4.0
Minimum	150.0	66.0	21.0	25.3	12.7	3.7	9.3	9.3	3.7
Maximum	184.0	83.0	22.0	27.4	14.1	4.4	11.2	9.9	4.2
SD ±	11.68	6.70	0.46	0.66	0.50	0.21	0.56	0.19	0.20
Fremont and Page counties									
Average 15 (8♂, 7♀)	177.4	76.3	21.3	27.0	13.8	4.2	10.5	9.7	4.1
Minimum	167.0	71.0	19.0	25.0	13.0	3.8	9.6	9.1	3.3
Maximum	193.0	82.0	23.0	28.1	14.4	4.6	11.3	10.0	4.3
SD ±	9.47	5.58	1.05	0.82	0.23	0.21	0.50	0.26	0.23
<i>Peromyscus maniculatus bairdii</i>									
Butler County									
Average 8 (7♂, 1♀)	135.5	56.7	18.1	23.5	12.2	3.8	9.2	8.7	3.4
Minimum	123.0	50.0	17.0	21.8	11.5	3.6	8.1	8.5	3.3
Maximum	144.0	63.0	19.0	25.1	13.2	4.1	10.2	9.0	3.7
SD ±	8.86	5.09	0.64	1.09	0.49	0.17	0.72	2.21	0.12
Marion and Mahaska counties									
Average 12 (4♂, 8♀)	143.0	56.0	17.9	23.4	12.3	3.8	9.3	8.9	3.4
Minimum	132.0	48.0	17.0	22.0	11.6	3.6	8.3	8.6	3.1
Maximum	152.0	62.0	19.0	24.7	12.8	4.0	9.9	9.5	3.6
SD ±	7.33	5.51	0.51	0.74	0.41	0.15	0.49	0.29	0.16
Fremont County									
Average 14 (8♂, 6♀)	146.0	57.7	18.4	23.8	12.2	3.7	9.5	8.5	3.4
Minimum	130.0	54.0	17.0	22.4	11.3	3.5	8.3	8.3	3.1
Maximum	157.0	64.0	19.0	25.1	12.9	4.0	10.2	9.2	3.7
SD ±	7.66	3.00	0.85	0.78	0.52	0.15	0.58	0.27	0.16

Defiance [State Park] 4 (ISU); 1 mi. SW Estherville, 1 (ISU); Ryan Lake, 3 mi. S, 4 mi. E Estherville, 1 (ISU). FAYETTE COUNTY: Fayette, 1 (ISU). FLOYD COUNTY: Charles City, 2 (SUI). FREMONT COUNTY: 5 mi. S, 2 mi. W Sidney, 2 (KU); *Waubonsie State Park*, 2 (ISU); 6 mi. N, 3 mi. W Hamburg, 5 (KU); 1 1/2 mi. N Hamburg, 3 (KU); 13 mi. E Hamburg, 1 (KU); 1 mi. S Hamburg, 1 (KU). GREENE COUNTY: sec. 34, Jackson Twp., 1 (ISU). GRUNDY COUNTY: 4 mi. S, 1 1/2 mi. W Wellsburg, 1 (KU); 5 mi. S, 1/2 mi. E Wellsburg, 1 (KU); 5 1/4 mi. W Grundy Center, 2 (KU). GUTHRIE COUNTY: Springbrook [State Park], 1 (ISU). HAMILTON COUNTY: sec. 27, Lyon Twp., 6 (ISU); Little Wall Lake, 1 (ISU). HANCOCK COUNTY: 4 mi. E [ESE] Forest City, 22 (UMMZ); 5 mi. E [ESE] Forest City, 9 (UMMZ); NE 1/4 of sec. 4, T. 97 N, R. 23 W, 1 (ISU); Pilot Knob State Park, 1 (ISU). HARDIN COUNTY: 3/4 mi. E Eldora, 3 (KU); 1 1/2 mi. N, 1 mi. E New Providence, 4 (KU); 1 mi. N, 1 1/2 mi. E New Providence, 2 (KU). HENRY COUNTY: Wayland, 2 (SUI); Hillsboro, 2 (USNM). HUMBOLDT COUNTY: 1/2 mi. S Dakota City, 1 (ISU). JACKSON COUNTY: Sabula, 2 (1 ISU, 1 USNM). JASPER COUNTY: Newton and 5 mi. radius thereof, 4 (UMMZ). JOHN-

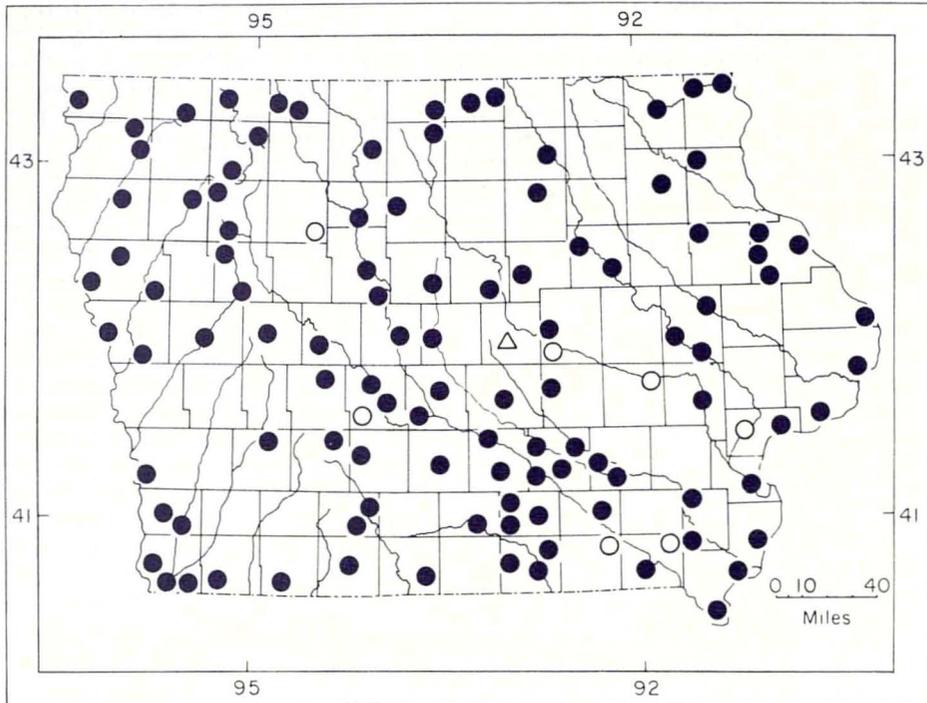


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SD ±	7.66	3.00	0.85	0.78	0.52	0.15	0.58	0.27	0.16

Defiance [State Park] 4 (ISU); 1 mi. SW Estherville, 1 (ISU); Ryan Lake, 3 mi. S, 4 mi. E Estherville, 1 (ISU). FAYETTE COUNTY: Fayette, 1 (ISU). FLOYD COUNTY: Charles City, 2 (SUI). FREMONT COUNTY: 5 mi. S, 2 mi. W Sidney, 2 (KU); *Waubonsie State Park*, 2 (ISU); 6 mi. N, 3 mi. W Hamburg, 5 (KU); 1 1/2 mi. N Hamburg, 3 (KU); 13 mi. E Hamburg, 1 (KU); 1 mi. S Hamburg, 1 (KU). GREENE COUNTY: sec. 34, Jackson Twp., 1 (ISU). GRUNDY COUNTY: 4 mi. S, 1 1/2 mi. W Wellsburg, 1 (KU); 5 mi. S, 1/2 mi. E Wellsburg, 1 (KU); 5 1/4 mi. W Grundy Center, 2 (KU). GUTHRIE COUNTY: Springbrook [State Park], 1 (ISU). HAMILTON COUNTY: sec. 27, Lyon Twp., 6 (ISU); Little Wall Lake, 1 (ISU). HANCOCK COUNTY: 4 mi. E [ESE] Forest City, 22 (UMMZ); 5 mi. E [ESE] Forest City, 9 (UMMZ); NE 1/4 of sec. 4, T. 97 N, R. 23 W, 1 (ISU); Pilot Knob State Park, 1 (ISU). HARDIN COUNTY: 3/4 mi. E Eldora, 3 (KU); 1 1/2 mi. N, 1 mi. E New Providence, 4 (KU); 1 mi. N, 1 1/2 mi. E New Providence, 2 (KU). HENRY COUNTY: Wayland, 2 (SUI); Hillsboro, 2 (USNM). HUMBOLDT COUNTY: 1/2 mi. S Dakota City, 1 (ISU). JACKSON COUNTY: Sabula, 2 (1 ISU, 1 USNM). JASPER COUNTY: Newton and 5 mi. radius thereof, 4 (UMMZ). JOHN-

SON COUNTY: Iowa City, 17 (3 FMNH, 1 IHM, 9 KU, 2 SUI, 2 USNM). KEOKUK COUNTY: 2 mi. W Delta, 1 (KU); 6 1/2 mi. S, 1 mi. W Sigourney, 3 (KU). KOSSUTH COUNTY: sec. 14, T. 96 N, R. 28 W, 1 (ISU). LEE COUNTY: sec. 33, Washington Twp., 1 (ISU); 4 1/2 mi. N Keokuk, 2 (KU). LINN COUNTY: sec. 14, Maine Twp., 1 (ISU); 7 mi. N Marion, 1 (ISU); Cedar Rapids, 44 (CC); Putnam Twp., 1 (USNM); Palisades [—Kepler] State Park, 5 (ISU); Jordan's Grove near Wapsipinicon River, 2 (ISU); no specific locality, 2 (1 CC, 1 USNM). LOUISA COUNTY: NE 1/4 of sec. 35, T. 74 N, R. 3 W, 1 (ISU). LUCAS COUNTY: 2 1/2 mi. E Chariton, 4 (KU). LYON COUNTY: sec. 22, Centennial Twp., 1 (ISU). MADISON COUNTY: SE 1/4 of sec. 14, T. 76 W, R. 29 W, 2 (ISU). MAHASKA COUNTY: 6 mi. S, 5 mi. W Searsboro, 1 (KU); 6 mi. S, 1/2 mi. W Searsboro, 1 (KU); 6 mi. S, 4 mi. E Searsboro, 2 (KU); NE 1/4 of sec. 33, T. 77 N, R. 17 W, 1 (ISU); 1/2 mi. S, 5 mi. E New Sharon, 3 (KU); 11 1/2 mi. W Oskaloosa, 13 (KU); Oskaloosa and 8 mi. radius thereof, 16 (KU). MARION COUNTY: 7 mi. NE Pella, 1 (ISU); 2 mi. E Percy, 2 (KU); 5 1/2 mi. N, 1/2 mi. E Knoxville, 3 (KU); 4 1/2 mi. N, 1/2 mi. E Knoxville, 1 (KU); Knoxville, 9 (1 FMNH, 8 USNM); 4 1/2 mi. S Pella, 2 (KU). MILLS COUNTY: sec. 13, Glenwood Twp., 1 (ISU); 1 mi. S Malvern, 1 (KU). MONONA COUNTY: 6 mi. W Onawa, 1 (BV); 1/2 mi. S, 2 mi. W Moorhead, 3 (KU); 1 mi. S, 3 1/2 mi. W Moorhead, 2 (KU). MONROE COUNTY: 6 1/2 mi. W Lovilia, 1 (KU); Albia and 7 mi. radius thereof, 7 (KU); 1 1/2 mi. N Melrose, 2 (KU). MUSCATINE COUNTY: Wildcat Den State Park, Muscatine, 1 (ISU); Fairport, 3 (USNM). OSCEOLA COUNTY: Melvin, 1 (SUI). PAGE COUNTY: 7/10 mi. S Coin, 24 (KU); 1 mi. W Northboro, 6 (KU); 1 mi. S, 3 mi. E Northboro, 15 (KU). PLYMOUTH COUNTY: 2 mi. N Le Mars, 1 (KU). POLK COUNTY: 1 1/2 mi. NE Ankeny, 1 (ISU); Des Moines, 13 (5 WSU, 8 IHM). POTTAWATTAMIE COUNTY: Council Bluffs, 5 (USNM). POWESHIEK COUNTY: 1 mi. S, 2 mi. W Grinnell, 5 (KU). RINGGOLD COUNTY: 1/2 mi. N, 2 mi. E Mount Ayr, 5 (KU). SAC COUNTY: 4 mi. S, 1/2 mi. W Storm Lake Airport, 1 (BV); Wall Lake, 4 (2 KU, 2 SUI). SCOTT COUNTY: Davenport, 2 (DPM). SIOUX COUNTY: 4 mi. N Boyden, 2 (ISU); 1/4 mi. NW Hospers, 1 (ISU). STORY COUNTY: Ames and 6 mi. radius thereof, 28 (1 DPM, 4 KU, 23 ISU). TAMA COUNTY: 2 1/2 mi. S, 2 1/2 mi. W Garwin, 1 (KU). TAYLOR COUNTY: 2 mi. S, 3/4 mi. W Bedford, 2 (KU). UNION COUNTY: 1 3/4 mi. N, 1/2 mi. E Thayer, 2 (KU); Thayer, 3 (SUI); 3 mi. S Afton, 1 (ISU). VAN BUREN COUNTY: Lacey-Keosauqua State Park, 1 (ISU). WAPELLO COUNTY: 2 1/2 mi. E Ottumwa, 2 (KU); sec. 35, Agency Twp., 2 (ISU). WARREN COUNTY: 3 mi. S, 1 mi. W Indianola, 1 (KU). WEBSTER COUNTY: near Coleville [Coalville], 1 (ISU); 2 1/2 mi. S, 3 1/2 mi. E Dayton, 5 (KU). WINNEBAGO COUNTY: 5 mi. ENE Forest City, 1 (ISU); 1 1/4 mi. N Forest City, 1 (ISU); 1/2 mi. N Forest City, 1 (ISU); 4 mi. E Forest City, 25 (UMMZ); 5 mi. E Forest City, 9 (UMMZ). WINNESHIEK COUNTY: Decorah, 72 (4 FMNH, 68 UMMZ). WOODBURY COUNTY: Moville, 3 (UMMZ); NW 1/4 of sec. 33, T. 87 N, R. 47 W, 2 (ISU); NW 1/4 of sec. 1, T. 86 N, R. 42 W, 2 (ISU). WORTH COUNTY: 1 mi. W Carpenter, 1 (ISU); SE 1/4 of NW 1/4 of sec. 12, T. 99 N, R. 21 W, 1 (ISU). WRIGHT COUNTY: SE 1/4 of NW 1/4 of sec. 34, T. 92 N, R. 26 W, 1 (ISU); SE 1/4 of SW 1/4 of sec. 7, T. 91 N, R. 26 W, 1 (ISU).

Additional records.—BOONE COUNTY: Moingona Fox Area, about 5 mi. S Boone (Scott and Snead, 1942:94). DALLAS COUNTY: Redfield (Osgood, 1909:120). DAVIS COUNTY: Eldon Fox Range [1 mi. N, 4 mi. E Floris] (Scott and Klimstra, 1955:36). HANCOCK COUNTY: Pilot Knob State Park (Miller, 1954:122). IOWA COUNTY: Homestead (Stoner, 1918:71). MARSHALL COUNTY: no specific locality (Gabrielson, 1921:148). MUSCATINE COUNTY: Bayfield (Stoner, 1918:71). POCAHONTAS COUNTY: Kalsow Prairie, 4 1/2 mi. NW Manson (Brennan, 1969:17). TAMA COUNTY: Tama (Joyce and Eddy, 1944:214). VAN BUREN COUNTY: vicinity Stockport (Crabb, 1948:206).

***Peromyscus maniculatus bairdii* (Hoy and Kennicott)**

Deer Mouse

1857. *Mus bairdii* Hoy and Kennicott, Exec. Doc., House of Representatives, 3rd Session, 34th Congress (Rept. Comm. Patents for 1856), 65:92 (type locality restricted to Bloomington, McLean Co., Illinois, by Osgood, N. Amer. Fauna, 28:79, 17 April, 1909).

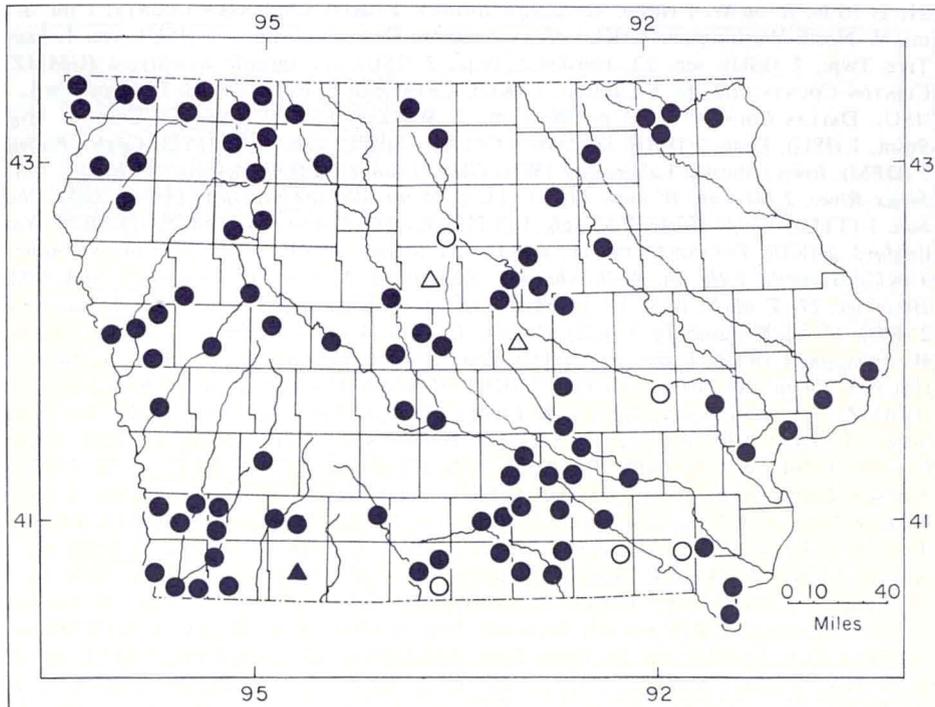


FIG. 33.—Distribution of *Peromyscus maniculatus bairdii* in Iowa. For explanation of symbols see Fig. 3.

1909. *Peromyscus maniculatus bairdii*, Osgood, N. Amer. Fauna, 28:79, 17 April.

Distribution in Iowa.—Statewide in suitable habitats (see Fig. 33).

The deer mouse is common to abundant in open grassy or weedy habitats throughout the state. A paucity of records from east-central Iowa probably reflects simply a lack of sufficient collecting in that area.

Prior to turning of the tall-grass prairie for agricultural purposes, the deer mouse may have been more abundant in much of Iowa than was *P. leucopus*. As the habitat was altered for agricultural purposes, *P. maniculatus* may have been replaced locally by the white-footed mouse in some parts of Iowa (see account of *P. leucopus*).

Population samples from northern (Butler), central (Marion and Mahaska), and western (Fremont) counties reveal no statistically significant differences in standard external and cranial measurements (see Table 5).

Specimens examined (334).—ADAMS COUNTY: 4 mi. N. 3/4 mi. W Nodaway, 2 (KU); Corning, 2 (SUI). ALLAMAKEE COUNTY: Waukon, 1 (SUI). APPANOOSE COUNTY: 5 1/2 mi. E Moravia, 2 (KU); 11 mi. W Centerville, 2 (KU); sec. 3, Sharon Twp., 1 (ISU); sec. 7, Sharon Twp., 1 (ISU). BLACK HAWK COUNTY: Goose Lake [not precisely located] 1 (UNI); sec. 28, T. 90 N, R. 13 W, 1 (AMNH). BOONE COUNTY: Jordan, 1 (ISU); SE 1/4 of SE 1/4 of sec. 36, T. 84 N, R. 25 W, 1 (ISU); Ledges State Park, 2 (KU); 4 mi. S, 2 mi. E Ogden, 1 (ISU). BUENA VISTA COUNTY: 3 mi. N, 9 mi. E Storm Lake, 2 (BV); Storm Lake and 5 mi. radius thereof, 5 (BV). BUTLER COUNTY: 1/2 mi. S, 3 mi. E Greene, 8 (KU). CARROLL COUNTY: sec. 22, Maple River Twp., 2 (ISU); sec. 5, Pleasant Twp., 1 (ISU). CASS COUNTY: NW 1/4 of sec.

21, T. 76 N, R. 36 W, 1 (ISU); *no specific locality*, 1 (SUI). CHICKASAW COUNTY: 1 mi. S, 1 mi. W North Washington, 1 (KU). CLAY COUNTY: Dewey's Pasture, 2 (ISU); sec. 1, Lone Tree Twp., 2 (ISU); sec. 22, Herdland Twp., 2 (ISU); *no specific locality*, 4 (UMMZ). CLINTON COUNTY: 1/2 mi. S Clinton, 1 (KU). CRAWFORD COUNTY: sec. 8, Denison Twp., 1 (ISU). DALLAS COUNTY: 2 1/2 mi. N, 1 mi. E Waukee, 1 (KU). DECATUR COUNTY: High Point, 1 (ISU); Leon, 2 (ISU). DICKINSON COUNTY: Spirit Lake, 1 (UMMZ); *Cayler Prairie*, 1 (DPM); Iowa Lakeside Laboratory [West Okobojo Lake], 2 (DPM); *Spooky Hollow, Little Sioux River*, 2 6/10 mi. W hwy. 32, 4 (TTU); 1/8 mi. W Emerson Bay, [West] Lake Okobojo, 1 (TTU); *E side Garlock Slough*, 3 (TTU). EMMET COUNTY: 1/2 mi. S, 1/4 mi. E Wallingford, 2 (KU). FREMONT COUNTY: 3 1/2 mi. S Sidney, 4 (KU), 4 mi. S, 9 mi. W Sidney, 3 (KU); 6 mi. N, 4 1/2 mi. W Hamburg, 1 (KU); 6 mi. N, 3 mi. W Hamburg, 3 (KU); SW 1/4 of sec. 27, T. 68 N, R. 41 W, 1 (ISU); 1 1/2 mi. N Hamburg, 5 (KU); 4 mi. E Hamburg, 2 (KU); 13 mi. E Hamburg, 1 (KU). GREENE COUNTY: 4 mi. W Jefferson, 4 (KU); 3 1/2 mi. W Jefferson, 1 (KU); *Jefferson*, 2 (SUI). GRUNDY COUNTY: sec. 26, T. 89 N, R. 18 W, 1 (ISU); 5 1/4 mi. W Grundy Center, 2 (KU). HANCOCK COUNTY: 1 mi. S Forest City, 16 (UMMZ). HARDIN COUNTY: 1/2 mi. W Eldora, 2 (KU); 1 mi. N, 1 1/2 mi. E *New Providence*, 1 (KU); *New Providence*, 1 (ISU). HARRISON COUNTY: Logan, 1 (SUI). HENRY COUNTY: Hillsboro, 2 (USNM). IDA COUNTY: N 1/2 of sec. 7, T. 86 N, R. 41 W, 1 (ISU). JOHNSON COUNTY: Iowa City, 22 (20 AMNH, 2 USNM); 3 mi. E Iowa City, 1 (KU). KEOKUK COUNTY: 6 1/2 mi. S, 1 mi. W Sigourney, 2 (KU). LEE COUNTY: sec. 12, Jefferson Twp., 4 (ISU); 4 1/2 mi. N Keokuk, 1 (KU). LUCAS COUNTY: 2 1/2 mi. N, 2 1/2 mi. E Russell, 1 (KU); 2 1/2 mi. E Chariton, 1 (KU); SE 1/4 of NW 1/4 of sec. 11, T. 71 N, R. 21 W, 1 (ISU). LYON COUNTY: Gitchie Manitou State Park, 1 1/2 mi. N, 1 mi. W Granite, 1 (KU); *Granite*, 2 (ISU); sec. 33, *Riverside Twp.*, 2 (ISU); *Rock Rapids*, 5 (UMMZ); sec. 26, *Elgin Twp.*, 2 (ISU); sec. 35, *Elgin Twp.*, 3 (ISU); sec. 23, *Lyon Twp.*, 2 (ISU); sec. 26, *Lyon Twp.*, 1 (ISU). MAHASKA COUNTY: 1/2 mi. S, 1/2 mi. E New Sharon, 4 (KU); 11 1/2 mi. W Oskaloosa, 4 (KU); Oskaloosa and 6 mi. radius thereof, 11 (KU). MARION COUNTY: 2 mi. S, 4 mi. W Pella, 1 (KU); Knoxville and 6 mi. radius thereof, 16 (1 FMNH, 3 KU, 12 USNM); 1/2 mi. W Tracy, 2 (KU). MILLS COUNTY: 1/2 mi. S, 3 mi. W Henderson, 3 (KU); sec. 13, *Glenwood Twp.*, 1 (KU); 1 mi. S Malvern, 2 (KU). MONONA COUNTY: 2 mi. NW Mapleton, 1 (BV); sec. 4, *Kennebeck Twp.*, 2 (ISU); sec. 33, *Kennebeck Twp.*, 1 (ISU); sec. 7, *Franklin Twp.*, 2 (ISU); 6 mi. W Onawa, 2 (BV); 1/2 mi. S, 2 mi. W Moorhead, 2 (KU); 1 mi. S, 3 1/2 mi. W Moorhead, 3 (KU). MONROE COUNTY: 6 1/2 mi. W Lovilia, 1 (KU); 5 1/2 mi. N, 3 1/2 mi. E Albia, 1 (KU). MONTGOMERY COUNTY: 1 1/2 mi. S, 2 mi. E Wales, 1 (KU); 4 mi. S, 3/4 mi. W Hawthorne, 5 (KU). MUSCATINE COUNTY: Fairport, 1 (USNM); *Conesville*, 2 (USNM). OSCEOLA COUNTY: *Ocheyedon*, 2 (SUI); *Melvin*, 2 (SUI). PAGE COUNTY: *Shenandoah*, 3 (ISU); 7/10 mi. S *Coin*, 4 (KU); 1 mi. S, 3 mi. E Northboro, 3 (KU). PALO ALTO COUNTY: *Redman*, 2 (SUI); *no specific locality*, 4 (UMMZ). PLYMOUTH COUNTY: 2 mi. N Le Mars, 1 (KU). POLK COUNTY: *Des Moines*, 1 (IHM). POWESHIEK COUNTY: 1 mi. S, 2 mi. W Grinnell, 1 (KU); 2 1/2 mi. S, 1 mi. E Searsboro, 1 (KU). SAC COUNTY: *Wall Lake*, 5 (SUI). SCOTT COUNTY: *Maysville*, 2 (KU). SIOUX COUNTY: 1/4 mi. S, 1 mi. E Orange City, 1 (KU); *Ireton*, 1 (UMMZ). STORY COUNTY: *Ames* and 5 mi. radius thereof, 8 (3 ISU, 5 KU); *no specific locality*, 1 (ISU). TAMA COUNTY: 1 mi. N, 1 1/2 mi. W Lincoln, 4 (KU). TAYLOR COUNTY: *no specific locality*, 3 (KU). UNION COUNTY: 1 3/4 mi. N, 1/2 mi. E Thayer, 2 (KU). WAPELLO COUNTY: *Ottumwa*, 4 (SUI); 2 1/2 mi. E *Ottumwa*, 1 (KU). WAYNE COUNTY: 1 1/2 mi. S Confidence, 1 (KU). WEBSTER COUNTY: 2 1/2 mi. S, 3 1/2 mi. E Dayton, 2 (KU). WINNEBAGO COUNTY: 1/2 mi. N, 3 1/2 mi. W Thompson, 5 (KU); 1 mi. N, 3 mi. W *Forest City*, 12 (UMMZ). WINNESHIEK COUNTY: *Decorah*, 11 (2 FMNH, 9 UMMZ); *Ridgeway*, 3 (UMMZ); *Conover*, 2 (UMMZ).

Additional records.—DAVIS COUNTY: *Eldon Fox Range*, 1 mi. N, 4 mi. E Floris (Scott and Klimstra, 1955:36). DECATUR COUNTY: sec. 13, *Woodland Twp.* (Hendrickson, 1954:25). HAMILTON COUNTY: *no specific locality* (Scott, 1938:537). IOWA COUNTY: *Homestead* (Stoner, 1918:76). MARSHALL COUNTY: *no specific locality* (Gabrielson, 1921:148). MUSCATINE COUNTY: *Fairport* (O. T. Kalin, University of Minnesota, personal communication). VAN

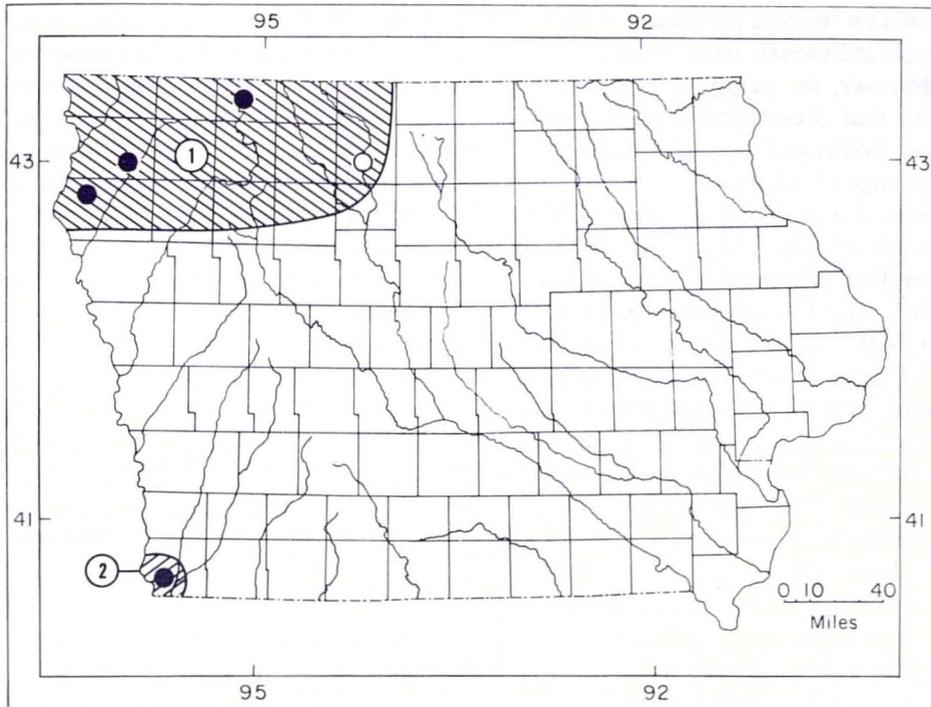


FIG. 34.—Distribution of two species of cricetines in Iowa: 1, *Onychomys leucogaster leucogaster*; 2, *Sigmodon hispidus texianus*. For explanation of symbols see Fig. 3.

BUREN COUNTY: vicinity Stockport (Crabb, 1948:206). WRIGHT COUNTY: Wall Lake (Scott, 1947:446).

***Onychomys leucogaster leucogaster* (Wied-Neuwied)**
Grasshopper Mouse

1841. *Hypudaeus leucogaster* Wied-Neuwied, *Reise in das innere Nord-America . . .*, 2:99 (type locality, Mandan Indian village, near Fort Clark, Oliver Co., North Dakota).

1858. *Onychomys leucogaster*, Baird, *Mammals, in Reports of explorations and surveys . . . from the Mississippi River to the Pacific Ocean . . .*, 8(1):459, 14 July.

Distribution in Iowa.—Extreme northwestern part of the state (see Fig. 34).

The first record of the grasshopper mouse from Iowa was a specimen from Dickinson County reported by Dice (1924:66) as taken "just north of the Iowa Lakeside Laboratory . . . in a large pasture field largely covered by short grass and two species of ragweed." Subsequently, specimens have been taken both in prairie areas (Miller, 1954:122) and in blue-grass cover adjacent to roadways in the extreme northwestern counties.

Dice (*loc. cit.*) referred his specimen (UMMZ 55595) to *O. l. breviauritus*, "the description of which subspecies it seems most closely to approximate." Hollister earlier (1914:432) had used the color of ear tufts as a diagnostic feature in distinguishing *breviauritus* from the geographically adjacent northern race, *leucogaster*, the tuft being cinnamon-brown in the former and whitish in the latter.

Tufts on the ears are clearly evident only in winter-taken specimens; unfortunately all individuals from Iowa that I have examined were trapped in late summer. However, the pelage of both adults and subadults from Iowa is clearly darker than that of comparable summer-taken specimens of *O. l. breviauritus* from Kansas. Additionally, external and cranial measurements of individuals from Iowa (average of 13 adults, six males and seven females), which follow, approximate those of *leucogaster* (Hollister, 1914:452): total length, 150.5 (140-171) \pm 9.68; length of tail, 43.5 (36-55) \pm 4.43; length of hind foot, 22.0 (20-23) \pm 0.83; condylobasal length, 26.5 (25.4-27.9) \pm 0.82; zygomatic breadth, 15.6 (14.7-16.8) \pm 0.81; interorbital constriction, 4.7 (4.5-4.8) \pm 0.10; depth of skull, 10.3 (9.9-10.6) \pm 0.22; length of maxillary tooththrow, 4.9 (4.5-5.3) \pm 0.22.

The grasshopper mouse is not known to occur in extreme eastern Nebraska and Jones (1964:212) suggested that riparian vegetation along the Missouri River has acted as a barrier to dispersal of this species. Findley (1956:33) assigned specimens from Clay County, South Dakota, to the subspecies *leucogaster*, primarily because of the dark coloration of the pelage. On zoogeographic grounds, the population in northwestern Iowa would seem to be derived from the northern subspecies and I feel justified, therefore, in applying the subspecific name *leucogaster* to Iowan mice as suggested by Jones (1964:212).

Specimens examined (15).—DICKINSON COUNTY: West Okoboji Lake, 1 (UMMZ). LYON COUNTY: Granite, 10 (ISU); sec. 26, Lyon Twp., 2 (ISU). PLYMOUTH COUNTY: S 1/2 of SE 1/4 of sec. 2, Preston Twp., 1 (ISU). SIOUX COUNTY: 1 1/2 mi. S Alton, 1 (ISU).

Additional record.—KOSSUTH COUNTY: Stinson Prairie, Algona (N. A. Wilson, University of Northern Iowa, personal communication).

***Sigmodon hispidus texianus* (Audubon and Bachman)**

Cotton Rat

1853. *Arvicola texiana* Audubon and Bachman, The viviparous quadrupeds of North America, 3:229 (type locality, Brazos River, Texas).

1891. *Sigmodon hispidus texianus*, J. A. Allen, Bull. Amer. Mus. Nat. Hist., 3:287, 30 June.

Distribution in Iowa.—Known only from owl pellets obtained at Waubonsie State Park, Fremont County (see Fig. 34).

The northward dispersal in recent years of the hispid cotton rat into southern Nebraska and north of the Missouri River in Missouri was summarized by Genoways and Schlitter (1967). In 1964, W. N. Berg found owl pellets containing crania and lower jaws of three *Sigmodon* in Waubonsie State Park, Fremont County, Iowa, located in hills bordering the Missouri River approximately five miles north of the Missouri state-line.

Genoways and Schlitter (*op. cit.*) suggested that the Missouri River has acted as a barrier to northward and eastward dispersal of the cotton rat but that individuals probably have crossed occasionally during periods of flooding. I know of no records of *Sigmodon* from extreme northwestern Missouri, although it seems likely that the species has invaded southwestern Iowa from that area. It is possible, however, that cotton rats crossed the Missouri River into Iowa from southeastern Nebraska, because Jones (1964:214) reported *Sigmodon* from a locality

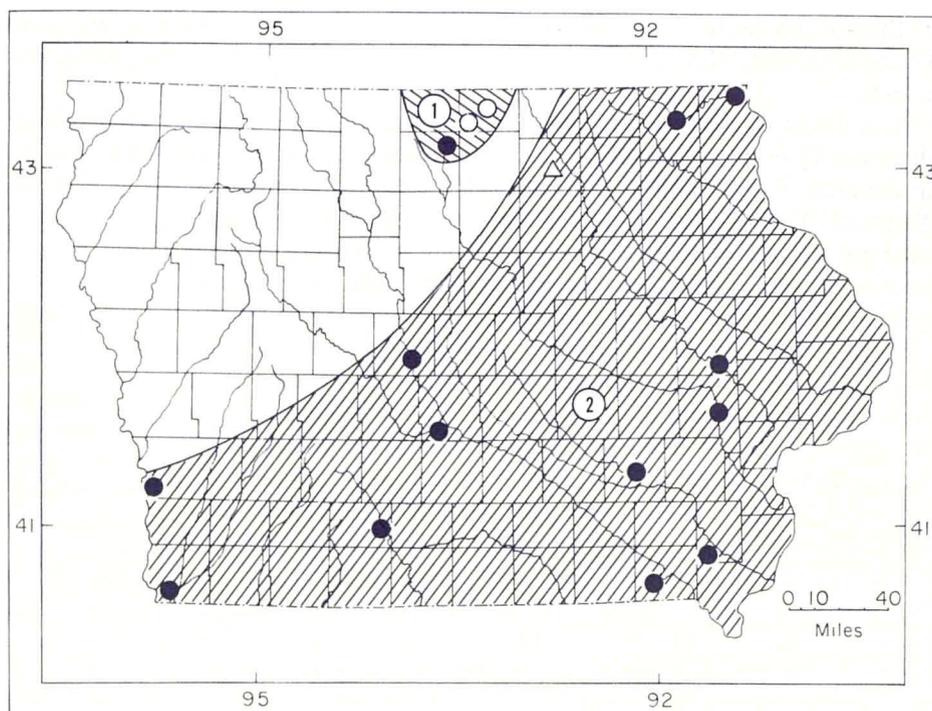


FIG. 35.—Distribution of two species of microtines in Iowa: 1, *Clethrionomys gapperi loringi*; 2, *Microtus pinetorum nemoralis*. For explanation of symbols see Fig. 3.

3 1/2 mi. S and 1 mi. W Dawson, Richardson County, Nebraska (approximately 40 miles southwest of Waubonsie State Park).

Specimens examined (3).—FREMONT COUNTY: Waubonsie State Park, 6 mi. N, 2 mi. W Hamburg, 3 (KU).

Clethrionomys gapperi loringi (V. Bailey)
Southern Red-backed Vole

1897. *Evotomys gapperi loringi* V. Bailey, Proc. Biol. Soc. Washington, 11:125, 13 May (type locality, Portland, Traill Co., North Dakota).

1929. *Clethrionomys gapperi loringi*, B. Bailey, J. Mamm., 10:162, 9 May.

Distribution in Iowa.—Known only from restricted area in north-central part of the state (see Fig. 35).

The southern red-backed vole evidently occurs only in a few scattered forest stands along Cary moraines in Winnebago, Worth, and Hancock counties (Blagen, 1967:166). The first two specimens of this species taken in Iowa were obtained by I. J. Cantrall in 1937 and 1940; the localities given on the specimen labels were 4 mi. E Forest City, Winnebago County, and 5 mi. E Forest City, Hancock County, respectively. Blagen (1967:163) concluded "that the two specimens taken by Dr. Cantrall were associated with the vegetation and topography within the park [Pilot Knob State Park], as he described it, and properly referred only to Hancock County." Subsequently, Miller (1954:122) collected 21 *Clethrionomys*

in Pilot Knob State Park. Fifteen of these specimens are housed at Brigham Young University (Blagen, 1967:8), but the location of the remaining six is unknown.

Remains of *C. gapperi* have been found in Indian shelter caves near Edgewood, Delaware County, and Rochester, Cedar County, in eastern Iowa that may be approximately 2000 BP (H. L. Semken, Jr., personal communication). However, Blagen (1967:167-169) postulated that the present distributional pattern of isolated populations of *Clethrionomys* in south-central Minnesota and north-central Iowa was established when contiguous postglacial populations were separated by prairie expansions during "xeric periods, from 8,000-3,000 BP."

I was unable to detect any difference in color between specimens of *C. gapperi* from Pilot Knob State Park and those in a series from Elk River, Sherburne County, Minnesota; cranial measurements, likewise, did not differ significantly. Moreover, fossils of this species in Arkansas are dated as 2000 to 3000 BP (Semken, 1969). It seems likely that at least local populations of *C. gapperi* were present in favorable habitats in much of eastern Iowa considerably later than the time suggested by Blagen, although Ehrlich and Raven (1969:1228) pointed out that "populations that have been completely isolated for long periods often show little differentiation." Suitable habitat for *Clethrionomys* in north-central Iowa almost certainly was reduced by post-settlement agricultural activities and such activities probably contributed to isolation of populations in southern Minnesota and northern Iowa (see Blagen, 1967, for details of *Clethrionomys* habitat in north-central Iowa).

Specimens examined (16).—HANCOCK COUNTY: 4 mi. E [ESE] Forest City, 1 (UMMZ); 5 mi. E [ESE] Forest City, 1 (UMMZ); Pilot Knob State Park, 14 (12 BYU, 2 ISU).

Additional records (Blagen, 1967:166).—WORTH COUNTY: NW 1/4 of sec. 12, T. 99 N, R. 21 W; NE 1/4 of sec. 29, T. 98 N, R. 22 W; SW 1/4 of sec. 26, T. 98 N, R. 22 W. WINNEBAGO COUNTY: SW 1/4 of sec. 22, T. 98 N, R. 23 W; SW 1/4 of sec. 33, T. 98 N, R. 23 W; SW 1/4 of sec. 34, T. 98 N, R. 23 W. HANCOCK COUNTY: NW 1/4 of sec. 4, T. 97 N, R. 23 W; NW 1/4 of sec. 3, T. 97 N, R. 23 W.

***Synaptomys cooperi gossii* (Coues)**

Southern Bog Lemming

1877. *Arvicola (Synaptomys) gossii* Coues, in Coues and Allen, Bull. U.S. Geol. Surv. Territories, 11:235, August—published as synonym of *Synaptomys cooperi*, but name stated to apply to Kansan specimens, description and measurements of which are on p. 236 (type locality, Neosho Falls, Woodson Co., Kansas).
1897. *Synaptomys cooperi gossi*, Rhoads, in Rhoads and Young, Proc. Acad. Nat. Sci. Philadelphia, 49:307, June.

Distribution in Iowa.—Probably statewide (see Fig. 36).

The bog lemming is generally distributed throughout southern Iowa, although I have found it nowhere common and generally restricted to moist bluegrass habitat, especially along fence rows (see also Miller, 1954:122). Polder (1953:723), however, took specimens "on a dry sandstone hilltop under a clump of white pines" in northeastern Iowa. In the north-central part of the state, the

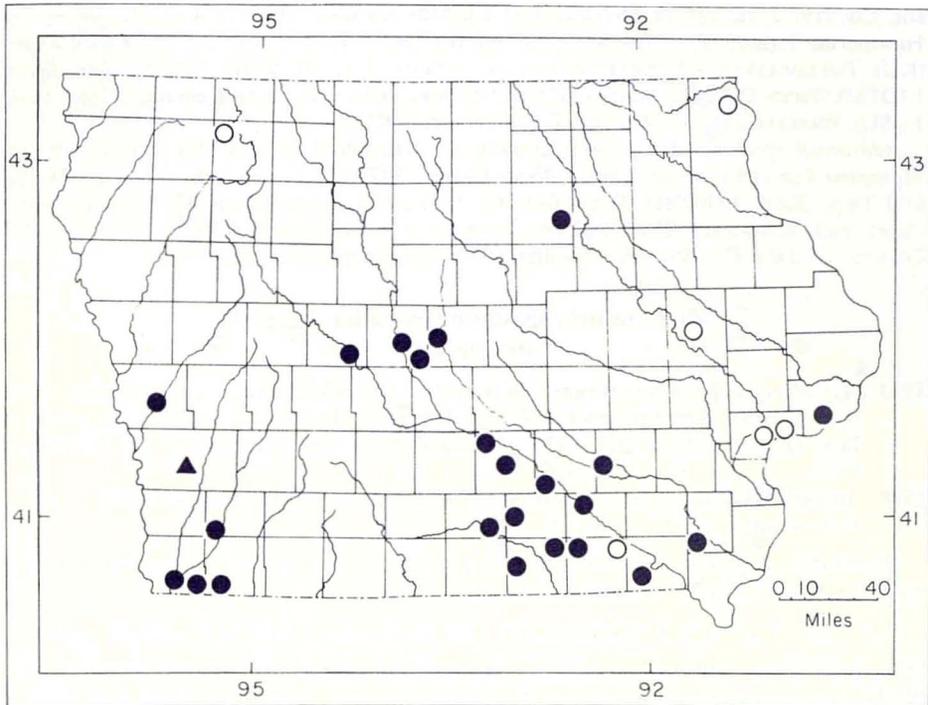


FIG. 36.—Distribution of *Synaptomys cooperi gossii* in Iowa. For explanation of symbols see Fig. 3.

species probably occurs locally in suitable habitats, but I know of no records from that region, where poorly drained tall-grass prairie once occurred. Undoubtedly, drainage and cultivation of the land by early settlers greatly restricted the distribution of *S. cooperi*. In the northwestern part of the state the species is known only from burrowing owl pellets taken in Clay County (Scott, 1940:590). Both Scott (1937:77) and Wetzel (1955:16) mistakenly reported *Synaptomys* from Spirit Lake—evidently misinterpreting the comments of Stephens (1922:56), who stated that “very few specimens have been taken in Iowa, and none in Dickinson County” (see also Fichter and Hansen, 1947).

This species reaches the western limits of its geographic range in Nebraska (Jones, 1964:220) and Kansas (Hall, 1955:144). I know of no published records of the occurrence of the southern bog lemming in South Dakota or southwestern Minnesota.

Specimens examined (35).—APPANOOSE COUNTY: 4 1/2 mi. N, 1/2 mi. E Unionville, 1 (KU); 11 mi. W Centerville, 2 (KU). BOONE COUNTY: Moingona, 1 (ISU); sec. 19, Marcy Twp., 1 (ISU); sec. 25 Garden Twp., 2 (ISU). BUTLER COUNTY: Shellrock, 1 (ISU). DAVIS COUNTY: 3 3/4 mi. W Ashgrove, 1 (KU). FREMONT COUNTY: 6 mi. N, 4 1/2 mi. E Hamburg, 3 (KU); 4 mi. E Hamburg, 1 (KU); 13 mi. E Hamburg, 3 (KU). GREENE COUNTY: sec. 6, Franklin Twp., 1 (ISU). HARRISON COUNTY: Logan, 1 (SU1). HENRY COUNTY: Hillsboro, 1 (USNM). KEOKUK COUNTY: 1/2 mi. S, 2 1/2 mi. W Delta, 1 (KU). LUCAS COUNTY: SE 1/4 of NW 1/4 of sec. 11, T. 71 N, R. 21 W, 1 (ISU). MAHASKA COUNTY: 3 mi. S, 9 mi. W Oskaloosa, 2 (KU). MARION COUNTY: 1 mi. W Percy, 1 (ISU); Knoxville, 1 (USNM). MON-

ROE COUNTY: 1 1/2 mi. N Melrose, 1 (KU). MONTGOMERY COUNTY: 4 mi. S, 3/4 mi. W Hawthorne, 1 (KU). PAGE COUNTY: 7/10 mi. S Coin, 1 (KU); 1 mi. S, 3 mi. E Northboro, (KU). POTTAWATTAMIE COUNTY: no specific locality, 1 (ISU). SCOTT COUNTY: Davenport, 1 (DPM). STORY COUNTY: Ames, 1 (ISU). VAN BUREN COUNTY: Lacey-Keosauqua State Park, 1 (ISU). WAPELLO COUNTY: 4 1/4 mi. E Chillicothe, 1 (KU).

Additional records.—ALLAMAKEE COUNTY: Lansing (Polder, 1953:723). BOONE COUNTY: *Moingona Fox Area, about 5 mi. S Boone* (Scott, 1947:443). CLAY COUNTY: sec. 22, Waterford Twp. (Scott, 1940:586). DAVIS COUNTY: Eldon Fox Range [1 mi. N, 5 mi. E Floris] (Scott and Klimstra, 1955:37). LINN COUNTY: Marion (Howell, 1927:19). MUSCATINE COUNTY: Wild Cat Den State Park (Miller, 1954:122); Fairport (Scott, 1937:76).

***Microtus ochrogaster ochrogaster* (Wagner)**

Prairie Vole

1842. *Hypudaeus ochrogaster* Wagner, in Schreber, *Die Säugthiere . . .*, Supplement, 3:592 (type locality, America; probably New Harmony, Posey Co., Indiana, according to Bole and Moulthrop, *Sci. Publ. Cleveland Mus. Nat. Hist.*, 5:157, 11 September 1942).
1898. *Microtus (Pedomys) ochrogaster*, J. A. Allen, *Bull. Amer. Mus. Nat. Hist.*, 10:459, 10 November.

Distribution in Iowa.—Statewide; abundant in southern Iowa, locally distributed in central and northern parts of the state (see Fig. 37).

Microtus ochrogaster is abundant in southern Iowa where it is found in a variety of habitats. In the central part of the state, its geographic range overlaps that of *Microtus pennsylvanicus* and the prairie vole evidently is locally restricted in this area. I know of no records of the species from extreme north-central Iowa, although some local populations undoubtedly occur there. A single individual was reported from Wright County in red fox fecal material by Scott (1947:448). In Webster County, I have taken *M. ochrogaster* and *M. pennsylvanicus* in the same trap line, but the only records of *ochrogaster* from Marshall County are from long-eared owl pellets (Gabrielson, 1921:148). In Black Hawk County, Sloan (1964:523) obtained but a single prairie vole which, according to the specimen label, was taken in a "marshy area." During the same study, Sloan collected 33 meadow voles. Hoslett (1965:376) trapped 130 microtines (but no *ochrogaster*) in moist lowlands and upland prairie in northeastern Iowa. It is of interest to note that the only individual of this species that I have trapped in a nongrassy habitat was a young female (KU 116208) that was taken on a hillside covered with oak-hickory forest in Allamakee County.

In Minnesota (Gunderson and Beer, 1953:115) and Wisconsin (Jackson, 1961:237), this species is evidently less abundant locally at present than it was in the 1880's and 1890's. This apparent change evidently is correlated with the turning of the tall-grass prairie for agricultural purposes. It seems likely that the prairie vole also was relatively more abundant in north-central Iowa in the late 1800's than now. It is noteworthy that at Knoxville, Marion County, for example, where the most abundant microtine at present is *M. pennsylvanicus*, representatives of the U.S. Biological Survey trapped 99 specimens of *Microtus* in the period 1894 to 1896, of which 95 were *ochrogaster* but only four were *pennsylvanicus*. In Floyd County, Brown (1917:26) noted that this species was "formerly quite common, but [is] now rarely seen."

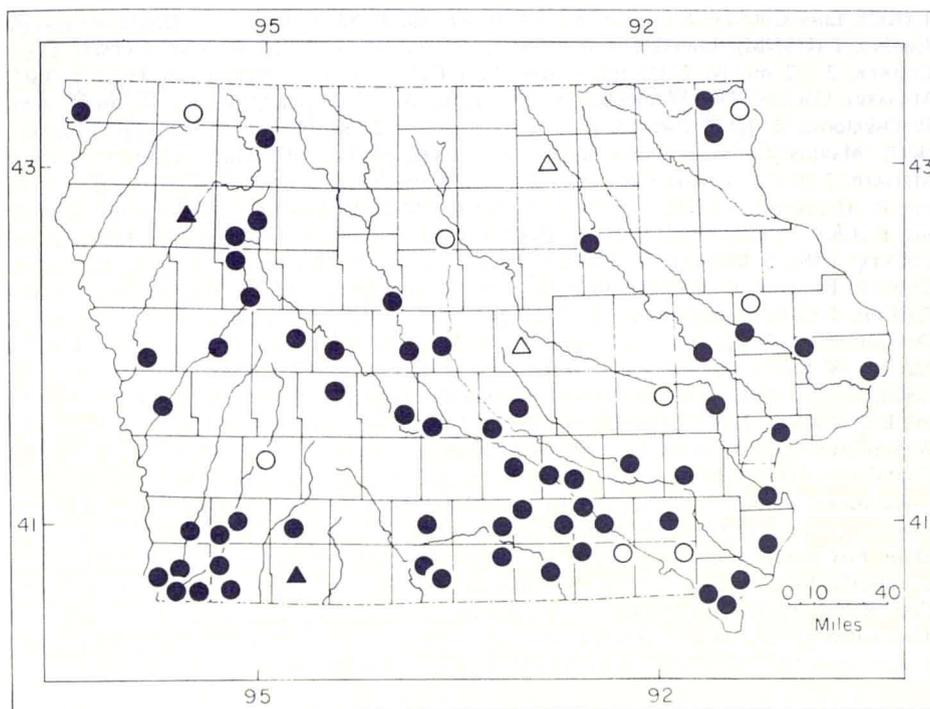


FIG. 37.—Distribution of *Microtus ochrogaster ochrogaster* in Iowa. For explanation of symbols see Fig. 3.

All specimens of *M. ochrogaster* that I have examined from Iowa are large. The zone of intergradation between *M. o. ochrogaster* and the smaller *M. o. minor*, geographically adjacent to the north, evidently occurs in southern Minnesota.

Specimens examined (284).—ADAMS COUNTY: Corning, 2 (SUI). ALLAMAKEE COUNTY: Bear Creek, 1/2 mi. S, 1 1/4 mi. E Quandah, 1 (KU); Waukon, 1 (SUI). APPANOOSE COUNTY: 4 1/2 mi. N, 1/2 mi. E Unionville, 1 (KU); 5 1/2 mi. N, 1 mi. W Plano, 1 (KU); Sharon Bluff State Park, 3 (ISU). BLACK HAWK COUNTY: sec. 28, T. 90 N, R. 14 W, 1 (UNI). BOONE COUNTY: sec. 18, Worth Twp., 2 (ISU); sec. 19, Worth Twp., 1 (ISU). BUENA VISTA COUNTY: 3 mi. E Storm Lake, 1 (BV); Storm Lake, 1 (BV); 1/2 mi. S, 3 mi. W Storm Lake, 1 (BV); no specific locality, 1 (BV). CARROLL COUNTY: sec. 32, Grant Twp., 1 (ISU). CHEROKEE COUNTY: no specific locality, 1 (SM). CLARKE COUNTY: Osceola, 4 (USNM). CLAY COUNTY: Dewey's Pasture, 5 mi. N, 1 mi. W Ruthven, 1 (ISU). CLINTON COUNTY: 1/2 mi. S Clinton, 1 (KU); Sharon Twp., 1 (ISU). CRAWFORD COUNTY: sec. 13, Denison Twp., 1 (ISU). DALLAS COUNTY: 2 1/2 mi. N, 1 mi. E Waukee, 1 (KU). DAVIS COUNTY: 3 3/4 mi. W Ashgrove, 1 (KU). DECATUR COUNTY: Leon, 2 (ISU); Woodland, 3 (ISU). DES MOINES COUNTY: 1 mi. N, 2 mi. W West Burlington, 1 (KU). FREMONT COUNTY: 3 1/2 mi. S Sidney, 3 (KU); 4 mi. S, 9 mi. W Sidney, 4 (KU); Hamburg and 6 mi. radius thereof, 18 (KU); 13 mi. E Hamburg, 4 (KU). GREENE COUNTY: Jackson Twp., 1 (ISU). GUTHRIE COUNTY: Springbrook State Park, 2 (1 ISU, 1 KU). HARRISON COUNTY: Logan, 1 (SUI). JASPER COUNTY: 1/2 mi. S Newton, 1 (UMMZ); 2 mi. S, 4 mi. W Prairie City, 1 (ISU). JEFFERSON COUNTY: Fairfield, 1 (USNM). JOHNSON COUNTY: Iowa City, 20 (AMNH). JONES COUNTY: 1 mi. SE Anamosa, 1 (ISU). KEOKUK COUNTY: SE 1/4 of sec. 1, T. 75 N, R. 12 W, 1 (ISU); 6 1/2 mi. S, 1 mi. W Sigourney, 3 (KU). LEE COUNTY: sec. 25, Washington Twp., 1 (ISU); 5 mi. E Farmington, 1 (KU); sec. 10, Montrose Twp., 2 (ISU); sec. 28, Montrose Twp., 3 (ISU); 4 1/2 mi. N Keokuk,

1 (KU). LINN COUNTY: SE 1/4 of SE 1/4 of sec. 30, T. 83 N, R. 6 W, 1 (ISU); *no specific locality*, 1 (USNM). LOUISA COUNTY: NE 1/4 of sec. 35, T. 74 N, R. 3 W, 1 (ISU). LUCAS COUNTY: 2 1/2 mi. N, 2 1/2 mi. E Russell, 1 (KU). LYON COUNTY: Lyon Twp., 3 (ISU). MAHASKA COUNTY: Des Moines River, 10 3/4 mi. W Oskaloosa, 1 (KU); 2 1/2 mi. S, 4 mi. W Oskaloosa, 2 (KU); 3 mi. S, 4 mi. W Oskaloosa, 2 (KU); 3 mi. S, 4 mi. W Beacon, 2 (KU). MARION COUNTY: Knoxville, 98 (3 FMNH, 95 USNM). MILLS COUNTY: 1 mi. S Malvern, 2 (KU). MONONA COUNTY: 1/2 mi. S, 2 mi. W Moorhead, 3 (KU); 1 mi. S, 3 1/2 mi. W Moorhead, 4 (KU). MONROE COUNTY: 6 1/2 mi. W Lovilia, 1 (KU); 1 mi. N, 6 1/2 mi. E Albia, 1 (KU); 6 mi. E Albia, 1 (KU); 3 mi. S, 5 mi. E Albia, 1 (KU). MONTGOMERY COUNTY: 1 mi. S Red Oak, 1 (ISU); 4 mi. S, 3/4 mi. W Hawthorne, 1 (KU). MUSCATINE COUNTY: Fairport, 6 (USNM). PAGE COUNTY: Shenandoah, 5 (ISU); *Grant Twp.*, 1 (ISU); 7/10 mi. S Coin, 1 (KU); 1 mi. S, 3 mi. E Northboro, 14 (KU). POLK COUNTY: 1/2 mi. W Des Moines, 1 (KU); *Riverview Park, T. 79 N, R. 24 W*, 1 (ISU). SAC COUNTY: 4 mi. S, 1/2 mi. W Storm Lake Airport, 1 (BV); Wall Lake, 1 (SUI). STORY COUNTY: Ames, 9 (ISU); *Kelly*, 1 (ISU). TAYLOR COUNTY: *no specific locality*, 1 (KU). WAPELLO COUNTY: 4 1/4 mi. E Chillicothe, 2 (KU); Ottumwa, 1 (SUI); 1/2 mi. SW Agency, 1 (ISU); T. 71 N, 1 (ISU). WASHINGTON COUNTY: 1 mi. N, 3 mi. W Washington, 1 (ISU). WAYNE COUNTY: 1 1/2 mi. S Confidence, 4 (KU). WEBSTER COUNTY: 2 1/2 mi. S, 3 1/2 mi. E Dayton, 2 (KU).

Additional records (Stoner, 1918:91, unless otherwise indicated).—ALLAMAKEE COUNTY: Lansing (record on file, U.S. Biological Survey). CASS COUNTY: Atlantic. DAVIS COUNTY: Eldon Fox Range [1 mi. N, 5 mi. E Floris] (Scott and Klimstra, 1955:37). FLOYD COUNTY: *no specific locality* (Brown, 1917:26). IOWA COUNTY: Homestead. JOHNSON COUNTY: *Iowa City* (Bailey, 1918:101). JONES COUNTY: Monticello. MARSHALL COUNTY: *no specific locality* (Gabrielson, 1921:148). OSCEOLA COUNTY: Melvin. VAN BUREN COUNTY: near Stockport (Crabb, 1948:206). WRIGHT COUNTY: Wall Lake (Scott, 1947:448).

***Microtus pennsylvanicus pennsylvanicus* (Ord)**

Meadow Vole

1815. *Mus Pennsylvanica* Ord, in Guthrie, A new geographical, historical and commercial grammar . . . , ed. 2, 2:292 (type locality, meadows below Philadelphia, Philadelphia Co., Pennsylvania).

1895. *M[icrotus]. pennsylvanicus*, Rhoads, Amer. Nat., 29:940, October.

Distribution in Iowa.—Abundant throughout much of the state; probably only of local occurrence in southern counties (see Fig. 38).

Throughout most of northern and central Iowa, the meadow vole is common in most types of grassy or other open habitats. As far south as Marion and Mahaska counties, this species is considerably more abundant and widespread than is *M. ochrogaster*. In the southern two tiers of counties in Iowa, however, the prairie vole is the commoner of the two species.

Prior to the 1900's, the meadow vole may have been less abundant than the prairie vole in much of central Iowa (see account of *Microtus ochrogaster*). It seems likely that in much of the state *M. pennsylvanicus* is the more successful of the two species in highly agricultured areas.

The geographic range of *Microtus pennsylvanicus* probably extends into northern Missouri, although previous records of the species from that state were considered doubtful by Schwartz and Schwartz (1959:336). The meadow vole is common in northern Nebraska (Jones, 1964:227) and has been reported along the Blue River drainage in southern Nebraska (Choate and Genoways, 1967:240) and northern Kansas (Flehart and Andersen, 1964). In Illinois, *Microtus*

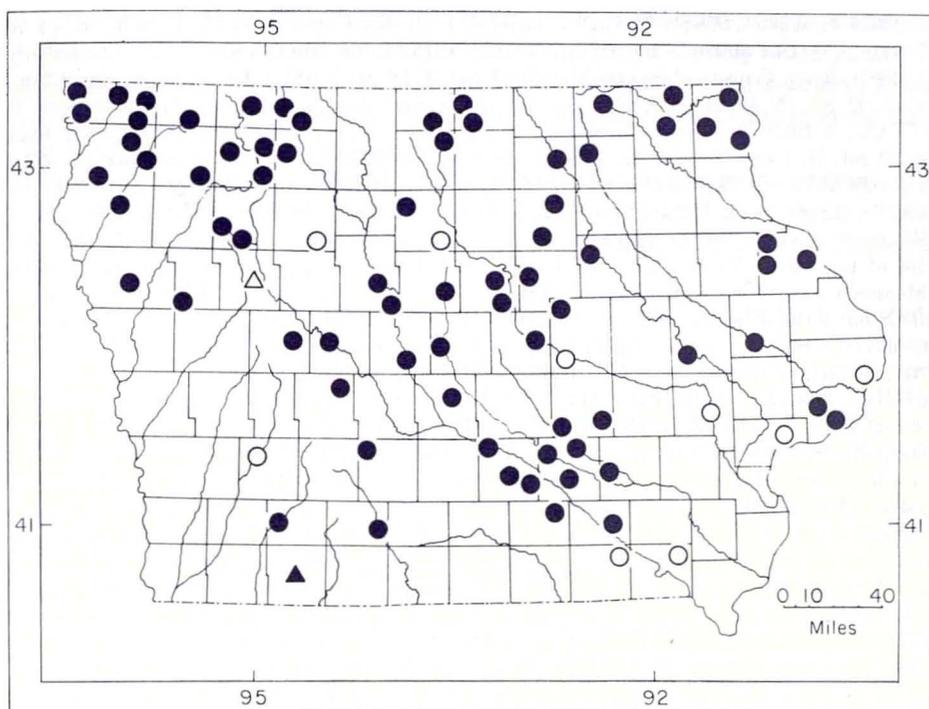


FIG. 38.—Distribution of *Microtus pennsylvanicus pennsylvanicus* in Iowa. For explanation of symbols see Fig. 3.

pennsylvanicus occurs "as far south as an imaginary line drawn between Kankakee and Havana" (Hoffmeister and Mohr, 1957:175), and Mumford (1969:75) noted its scarcity in southern Indiana.

Specimens examined (320).—ADAMS COUNTY: 4 mi. N, 3/4 mi. W Nodaway, 2 (KU). ALLAMAKEE COUNTY: 1/2 mi. W New Albin, 1 (WSU); 2 mi. S, New Albin, 1 (WSU); Waukon, 4 (SUI); sec. 31, T. 97 N, R. 3 W, 3 (ISU). BLACK HAWK COUNTY: Cedar Falls and 6 mi. radius thereof, 11 (1 AMNH, 1 ISU, 9 UNI). BOONE COUNTY: 3 1/2 mi. S Boone, 1 (KU), 4 mi. S Boone, 1 (ISU). BUENA VISTA COUNTY: 1/4 mi. N, 2 mi. W Alta, 2 (KU); Storm Lake and 5 mi. radius thereof, 7 (BV). BUTLER COUNTY: 1/2 mi. S, 3 mi. E Greene, 9 (KU); Big Marsh [5 mi. N Parkersburg], 1 (UNI). CARROLL COUNTY: sec. 32, Grant Twp., 5 (ISU). CHICKASAW COUNTY: 1 mi. S, 1 mi. W North Washington, 6 (KU). CLAY COUNTY: Dewey's Pasture [5 mi. N, 1 mi. W Ruthven], 10 (ISU); sec. 1, Lone Tree Twp., 1 (ISU); Webb, 3 (AMNH). CLINTON COUNTY: 1/2 mi. S Clinton, 1 (KU). DICKINSON COUNTY: *Caylor Prairie*, 1 (DPM); Okoboji and 5 mi. radius thereof; 10 (2 DPM, 4 ISU, 4 TTU); 3/4 mi. NW *Bendix* [not precisely located], 1 (DPM). DUBUQUE COUNTY: Luxemburg, 3 (FMNH); Dyersville, 3 (ISU); Dubuque, 1 (ISU). EMMET COUNTY: Four-mile Lake, 3 mi. W Estherville, 2 (ISU); *Fort Defiance State Park*, 1 (ISU); 2 1/2 mi. S, 1/4 mi. E Wallingford, 2 (KU). FLOYD COUNTY: Charles City, 1 (SUI). GREENE COUNTY: 4 mi. W Jefferson, 9 (KU); 3 1/2 mi. W Jefferson, 1 (KU). GRUNDY COUNTY: 4 mi. S, 1 1/2 mi. W Wellsburg, 2 (KU); 5 mi. S, 3 1/2 mi. W Wellsburg, 2 (KU); 5 mi. S, 1/2 mi. E Wellsburg, 8 (KU); 5 1/4 mi. *Grundy Center*, 3 (KU). GUTHRIE COUNTY: 1/2 mi. E Springbrook State Park, 1 (KU). HAMILTON COUNTY: Goose Lake [Jewell], 1 (ISU); *Little Wall Lake* [2 mi. S Jewell], 1 (ISU). HANCOCK COUNTY: 5 mi. ESE Forest City, 3 (2 ISU, 1 UMMZ). HARDIN COUNTY: 1/2 mi. W Eldora, 2 (KU); 1 1/2 mi. N, 1 mi. E New Providence, 1 (KU); 1 mi. S New Providence,

1 (ISU). HOWARD COUNTY: Hayden Prairie, 4 (ISU). IDA COUNTY: sec. 7, T. 86 N, R. 41 W, 2 (ISU). JASPER COUNTY: 3 mi. W Prairie City, 1 (ISU). JOHNSON COUNTY: *no specific locality*, 2 (SUI). JONES COUNTY: Muskrat Slough [3 mi. W Olin], 2 (ISU). KEOKUK COUNTY: 1/2 mi. S, 2 1/2 mi. W Delta, 1 (KU). LINN COUNTY: Cedar Rapids and 7 mi. radius thereof, 16 (12 CC, 4 ISU); *no specific locality*, 2 (CC). LYON COUNTY: Gitche Manitou State Park, 1 1/2 mi. N, 1 mi. W Granite, 2 (KU); *Granite*, 2 (ISU); sec. 29, Riverside Twp., 2 (ISU); *sec. 33, Riverside Twp.*, 4 (ISU); *sec. 33, Elgin Twp.*, 1 (ISU); sec. 35, Elgin Twp., 5 (ISU); sec. 26, Lyon Twp., 1 (ISU); sec. 20, Dale Twp., 2 (ISU). MADISON COUNTY: 10 mi. NW Winterset, 1 (ISU). MAHASKA COUNTY: New Sharon and 5 mi. radius thereof, 7 (KU); NE 1/4 of sec. 33, T. 77 N, R. 17 W, 1 (ISU); Oskaloosa and 6 mi. radius thereof, 11 (KU). MARION COUNTY: 1 mi. W Percy, 1 (ISU); 5 1/2 mi. N Knoxville, 4 (KU); 4 mi. S, 4 mi. W Pella, 1 (KU); Knoxville, 6 (2 FMNH, 4 USNM); 1/2 mi. W Tracy, 2 (KU). MARSHALL COUNTY: 3 mi. W Green Mountain, 2 (KU). MONROE COUNTY: 5 1/2 mi. N, 3 1/2 mi. E Albia, 1 (KU). O'BRIEN COUNTY: Sutherland, 1 (WSU); *no specific locality*, 1 (WSU). OSCEOLA COUNTY: Melvin, 1 (SUI). PALO ALTO COUNTY: Ruthven, 1 (ISU). PLYMOUTH COUNTY: 2 mi. N Le Mars, 2 (KU). POLK COUNTY: 1 1/2 mi. NE Ankeny, 1 (ISU). POWESHIEK COUNTY: Deep River, 1 (ISU); 2 1/2 mi. S, 1 mi. E Searsboro, 2 (KU). SCOTT COUNTY: Maysville, 2 (1 ISU, 1 KU); Davenport, 4 (DPM). SIOUX COUNTY: sec. 31, T. 97 N, R. 44 W, 1 (ISU); 1/4 mi. NW Hospers, 1 (ISU); Ireton, 1 (UMMZ). STORY COUNTY: Ames and 6 mi. radius thereof, 13 (9 ISU, 4 KU). TAMA COUNTY: 1 mi. N, 1 1/2 mi. W Lincoln, 2 (KU). TAYLOR COUNTY: *no specific locality*, 1 (KU). UNION COUNTY: Thayer, 1 (SUI). WAPELLO COUNTY: 2 1/2 mi. E Ottumwa, 3 (KU); 1/2 mi. SW Agency, 1 (ISU). WEBSTER COUNTY: Otho, 1 (ISU); 2 1/2 mi. S, 3 1/2 mi. E Dayton, 4 (KU); *no specific locality*, 1 (ISU). WINNEBAGO COUNTY: 1 mi. N, 3 mi. W Forest City, 8 (UMMZ). WINNESHIEK COUNTY: Hesper, 2 (KU); Decorah, 42 (6 FMNH, 36 UMMZ). WOODBURY COUNTY: NE 1/4 of sec. 2, T. 87 N, R. 45 W, 1 (ISU). WORTH COUNTY: sec. 20, T. 99 N, R. 22 W, 1 (ISU); 1/2 mi. N Fertile, 1 (ISU). WRIGHT COUNTY: NW 1/4 of SE 1/4 of sec. 3, T. 92 N, R. 26 W, 1 (ISU).

Additional records (Stoner, 1918:81, unless otherwise indicated).—BLACK HAWK COUNTY: *near Finchford* (Sloan, 1964:523). CASS COUNTY: Atlantic. CLAY COUNTY: *no specific locality* (Ruthven and Wood, 1912:204). DAVIS COUNTY: Eldon Fox Range [1 mi. N, 5 mi. E Floris] (Scott and Klimstra, 1955:37). GREENE COUNTY: *Jefferson*. JOHNSON COUNTY: Iowa City. MARSHALL COUNTY: *no specific locality* (Gabrielson, 1921:148). MUSCATINE COUNTY: Fairport (Scott, 1937:77). POCAHONTAS COUNTY: Kalsow Prairie, 4 1/2 mi. NW Manson (Brennan, 1969:28). SAC COUNTY: *no specific locality* (Spurrell, 1917:282). TAMA COUNTY: Tama (Joyce and Eddy, 1944:214). VAN BUREN COUNTY: Stockport (Crabb, 1948:206). WRIGHT COUNTY: Wall Lake (Scott, 1947:448).

***Microtus pinetorum nemoralis* V. Bailey**

Woodland Vole

1898. *Microtus pinetorum nemoralis* V. Bailey, Proc. Biol. Soc. Washington, 12:89, 30 April (type locality, Stilwell, Adair Co., Oklahoma).

Distribution in Iowa.—Locally distributed in suitable habitats in southern and eastern parts of state (see Fig. 35).

The woodland vole is known only from widely separated localities in Iowa and probably is restricted locally to deciduous forests or other woodland habitats in the southern and eastern parts of the state. The range of this species may have extended some distance northwestward into the eastern part of the tall-grass prairie (along the oak-hickory forests bordering major tributaries of the Mississippi River) at the time of settlement, although I know of no authentic records from north-central Iowa or adjacent Minnesota. Brown (1917:26) reported that in Floyd County, the "wood or red-backed mouse . . . is quite common, though

not so common as in early times." This reference is probably to *M. pinetorum* because at the time of settlement, the forests in Floyd County were primarily along rivers and thus unlike the wooded habitat in extreme north-central Iowa, the only known locality of occurrence of the southern red-backed vole in the state (see account of *Clethrionomys gapperi*).

Microtus pinetorum reaches the western limit of its geographic distribution in eastern Nebraska, where it was taken in deciduous riparian forests (Jones, 1964: 231). The species also is known from the extreme southeastern part of Minnesota (Gunderson and Beer, 1953:115).

Specimens examined (24).—ALLAMAKEE COUNTY: 4 mi. SW New Albin, 1 (UMMZ). BOONE COUNTY: sec. 19, Worth Twp., 2 (ISU). FREMONT COUNTY: 5 mi. S, 2 mi. W Sidney, 5 (KU). HENRY COUNTY: Hillsboro, 1 (USNM). JOHNSON COUNTY: Iowa City, 1 (SUI). LINN COUNTY: Palisades [-Kepler] State Park, 1 (ISU). POLK COUNTY: Des Moines, 1 (IHM). POTTAWATTAMIE COUNTY: Council Bluffs, 2 (USNM). UNION COUNTY: Thayer, 1 (SUI). VAN BUREN COUNTY: Lacey-Keosauqua State Park, 2 (ISU). WAPELLO COUNTY: Ottumwa, 1 (SUI). WINNESHIEK COUNTY: Decorah, 6 (UMMZ).

Additional record.—FLOYD COUNTY: no specific locality (Brown, 1917:26).

***Ondatra zibethicus zibethicus* (Linnaeus)**

Muskrat

1766. [*Castor*] *zibethicus* Linnaeus, Systema naturae, ed. 12, 1:79 (type locality, eastern Canada).

1795. [*Ondatra*] *zibethicus*, Link, Beiträge zur Naturgeschichte, 1(2):76.

Distribution in Iowa.—Statewide in suitable habitats (see Fig. 39).

The muskrat is common in streams and rivers, and around marshes and lakes throughout Iowa. Population fluctuations due to natural causes (Errington, 1954) or trapping pressure (Brown, 1917:25) have been reported, but *Ondatra* never has been in danger of extirpation from the state.

Although the biology of the muskrat has been investigated thoroughly in north-central Iowa (see Errington, 1963), Jones (1964:237) pointed out the need for study of "geographic variation in *Ondatra zibethicus* on the Great Plains and adjacent regions." Hollister (1911:30) considered central Iowa as the eastern limit of the range of *O. z. cinamominus*, principally on the basis of a single adult male (USNM 191599) from Knoxville, Marion County, which is considerably paler than most individuals I have examined from Marion and Mahaska counties. Polder (1953:724) found that eight of 72 individuals from New Hartford, Butler County, were the "typical bright" color of *cinamominus* and that reddish individuals were found "as far east as Cedar Falls in Black Hawk County." On the other hand, most of the specimens examined by me from Lyon and Clay counties in northwestern Iowa are darker than many from Nebraska and more nearly resemble typical individuals of the subspecies *zibethicus*. Jones (1964: 236) referred Nebraskan muskrats to *O. z. cinamominus*, but noted variation in color in specimens from the eastern part of that state and, in addition, found that there was little, if any, difference in external and cranial size between the "sub-species" recognized by Hollister. There are few adult muskrat skulls of known sex from Iowa in museum collections seen by me and thus no meaningful

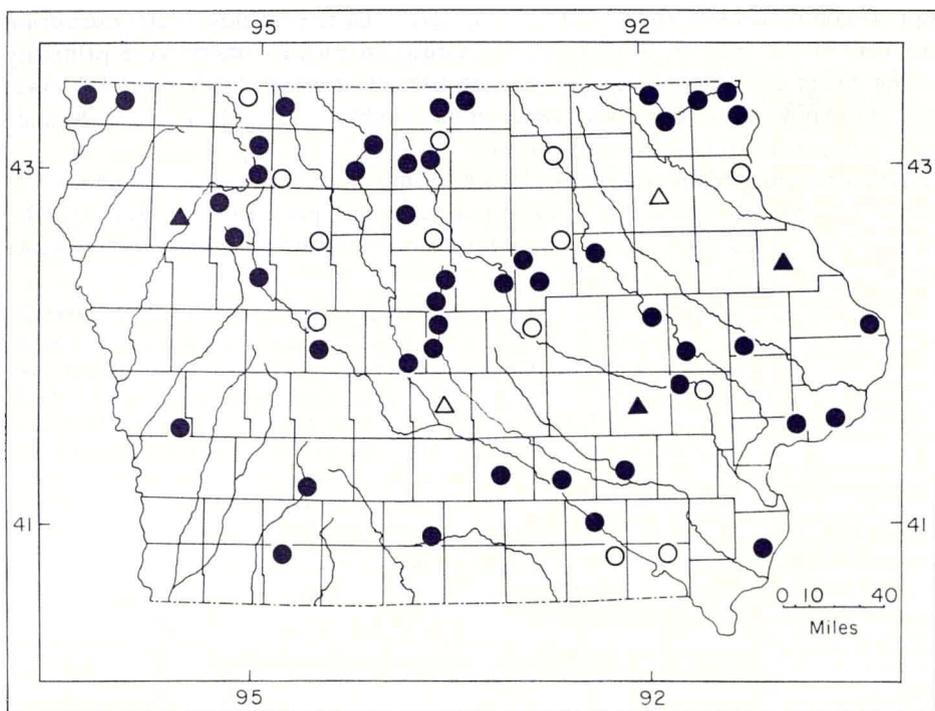


FIG. 39.—Distribution of *Ondatra zibethicus zibethicus* in Iowa. For explanation of symbols see Fig. 3.

statement yet can be made regarding variation in size or possible trends in variation within the state.

Because there is considerable color variation in muskrats in Iowa and a paucity of adequate skeletal material, it seems best for the present to consider all as belonging to the same subspecies—*O. z. zibethicus*. This is done primarily on the basis of the relatively dark coloration, on the average, of specimens from throughout the state, as compared to the typically paler coloration of *O. z. cinamominus*. Thus the Missouri River is considered as a “boundary of convenience” between the two subspecies until further work clarifies the systematic relationships of *Ondatra* in the central United States.

Specimens examined (123).—ADAIR COUNTY: sec. 5, Richland Twp., 1 (KU). ALLAMAKEE COUNTY: New Albin and 3 mi. radius thereof, 3 (1 UMMZ, 2 WSU); Hanover Twp., 1 (UMMZ); Lansing, 1 (ISU). BENTON COUNTY: Vinton, 2 (CC). BLACK HAWK COUNTY: Waterloo, 1 (UMMZ). BOONE COUNTY: Madrid, 1 (ISU). BUENA VISTA COUNTY: Elk Twp., 1 (BV); Storm Lake and 5 mi. radius thereof, 7 (BV); *no specific locality*, 1 (BV). CHEROKEE COUNTY: *no specific locality*, 1 (SM). CLARKE COUNTY: 3 mi. N, 1 mi. W Le Roy, 1 (ISU). CLAY COUNTY: Round Lake, 11 (10 ISU, 1 USNM); Webb, 12 (AMNH); *no specific locality*, 1 (UMMZ). DES MOINES COUNTY: Burlington, 1 (USNM). DUBUQUE COUNTY: Green’s Island [not precisely located], 4 (ISU). EMMET COUNTY: Estherville, 2 (ISU). GREENE COUNTY: Raccoon River, sec. 2, Jackson Twp., 1 (ISU). GRUNDY COUNTY: sec. 26, T. 89 N, R. 18 W, 1 (ISU); 2 1/2 mi. W Grundy Center, 1 (KU). HAMILTON COUNTY: 4 1/2 mi. E Ellsworth, 6 (KU); Little Wall Lake, 6 (4 ISU, 2 USNM); 1 1/3 mi. SW Little Wall Lake, 1 (USNM). HANCOCK COUNTY: Hayfield, 6 (FMNH); Britt, 1 (CC). HARDIN COUNTY: Pine

Lake State Park, 1 mi. E Eldora, 1 (KU). HARRISON COUNTY: 1/2 mi. S Persia, 1 (NWM). IOWA COUNTY: West Ashby [not precisely located], 1 (ISU); *no specific locality*, 2 (CC). JACKSON COUNTY: Sabula, 1 (SUI). JOHNSON COUNTY: SE 1/4 of SE 1/4 of sec. 21, T. 81 N, R. 8 W, 1 (ISU); *no specific locality*, 1 (SUI). JONES COUNTY: Muskrat Slough, 1 (ISU). KEOKUK COUNTY: Sigourney, 1 (KU); 2 1/2 mi. S, 2 1/2 mi. W Sigourney, 1 (KU). KOSSUTH COUNTY: Union Slough, 1 (ISU); Algona, 2 (ISU). LINN COUNTY: Cedar Rapids, 2 (CC). LYON COUNTY: Granite, 1 (ISU); sec. 28, Riverside Twp., 1 (ISU). MAHASKA COUNTY: Oskaloosa, 2 (KU). MARION COUNTY: Knoxville, 1 (USNM). MUSCATINE COUNTY: vicinity Stockton, 2 (DPM). PALO ALTO COUNTY: *no specific locality*, 1 (UMMZ). SAC COUNTY: Sac City, 1 (BV). SCOTT COUNTY: Davenport, 2 (DPM); *no specific locality*, 9 (DPM). STORY COUNTY: Story City, 2 (USNM); Ames, 3 (ISU). TAYLOR COUNTY: 8 mi. S, 3 mi. W Corning, 1 (NWM). WAPELLO COUNTY: Ottumwa, 1 (KU). WINNEBAGO COUNTY: Rice Lake, Lake Mills, 1 (ISU). WINNESHIEK COUNTY: Bluffton, 1 (ISU); Decorah, 1 (CC). WORTH COUNTY: Northwood, 1 (ISU). WRIGHT COUNTY: 4 mi. E Goldfield, 1 (BV).

Additional records (Errington, 1963, unless otherwise indicated).—BLACK HAWK COUNTY: Cedar Falls (Polder, 1953:724). BUTLER COUNTY: New Hartford (Polder, 1953:724). CLAY COUNTY: *Dewey's Pasture; Mud Lake*. CLAYTON COUNTY: Bergman Island, Mississippi River, near McGregor (Stoner, 1918:101). DAVIS COUNTY: Eldon Fox Range [1 mi. N, 5 mi. E Floris] (Scott and Klimstra, 1955:41). DICKINSON COUNTY: Spirit Lake (Mosher, 1882:66). EMMET COUNTY: *Four-mile Lake; Cheever Lake*. FAYETTE COUNTY: *no specific locality* (Scott, 1938:537). FLOYD COUNTY: Cedar River, 1/2 mi. NW Charles City (Brown, 1917:25). GREENE COUNTY: Churdan (record on file, U.S. Biological Survey). HANCOCK COUNTY: Pilot Knob State Park (Blagen, 1967:208). JOHNSON COUNTY: Swan Lake, 11 mi. NW Iowa City (Stoner, 1918:99). MARSHALL COUNTY: Iowa River (Gabrielson, 1921:148). PALO ALTO COUNTY: Rush Lake (Neal, 1968:194). POCAHONTAS COUNTY: Kalsow Prairie, 4 1/2 mi. NW Manson (Brennan, 1969:28). POLK COUNTY: *no specific locality* (Scott, 1938:537). SAC COUNTY (Spurrell, 1917:282): *Boyer River; Raccoon River*. STORY COUNTY: *Skunk River; Onion Creek*. VAN BUREN COUNTY: near Stockport (Crabb, 1948:205). WRIGHT COUNTY: Wall Lake.

Family ZAPODIDAE—Jumping Mice

Zapus hudsonius intermedius Krutzsch

Meadow Jumping Mouse

1954. *Zapus hudsonius intermedius* Krutzsch, Univ. Kansas Publ., Mus. Nat. Hist., 7:447, 21 April (type locality, Ridgeway, Winneshiek Co., Iowa).

Distribution in Iowa.—Common to abundant in northern counties; locally common in suitable habitats in south-central part of state (see Fig. 40).

The meadow jumping mouse is locally common to abundant in prairie or bluegrass cover in northern Iowa, although Miller (1955:558) collected *Zapus* in a wide variety of habitats in Dickinson County. In the south-central part of the state, this species evidently is restricted locally to lush bluegrass and other moist grassy habitats.

Krutzsch (1954:447) named the subspecies *Z. h. intermedius* from a series of specimens collected at Ridgeway, Winneshiek County, and suggested that individuals from Lyon County in northwestern Iowa probably were intergrades with *Z. h. pallidus* from adjacent areas of Nebraska (see also Jones, 1964:239). Cranial measurements of specimens from the type locality are slightly greater than those of specimens from the northwestern counties of Dickinson, Lyon, and Sioux, but I was unable to detect differences in coloration (see Table 6 for cranial measurements).

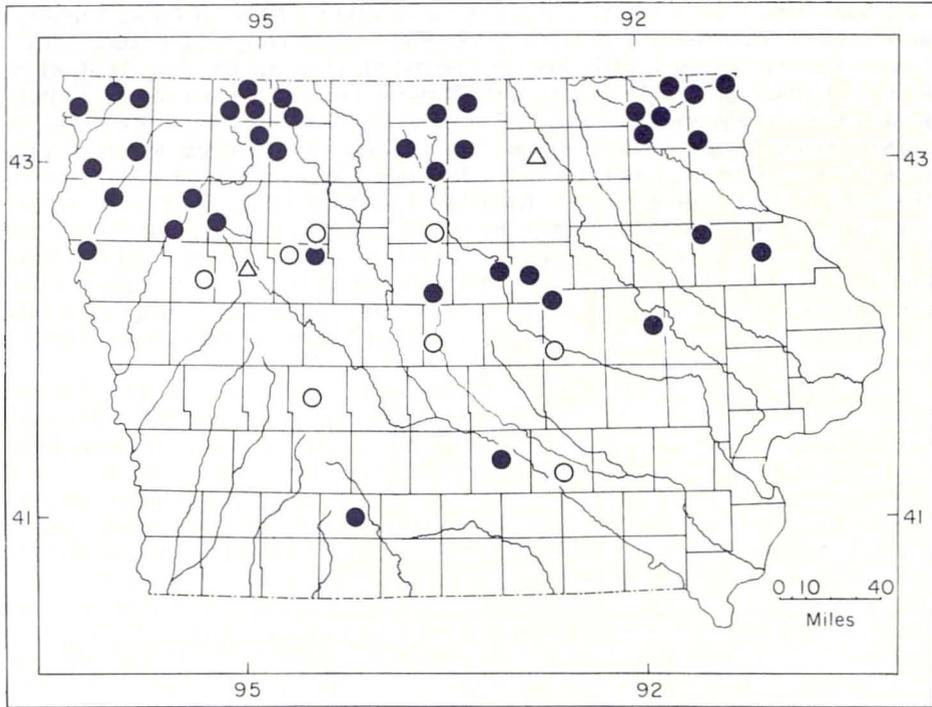


FIG. 40.—Distribution of *Zapus hudsonius intermedius* in Iowa. For explanation of symbols see Fig. 3.

Jones (1964:239) reported *Z. h. pallidus* from the Missouri River floodplain in extreme southeastern Nebraska. I know of no records of *Zapus* from either southwestern Iowa or northern Missouri (north of the Missouri River), although it is doubtful that the Missouri acts as a barrier to dispersal of the jumping mouse.

Specimens examined (86).—ALLAMAKEE COUNTY: 1 mi. S New Albin, 2 (WSU); NE 1/4 of NE 1/4 of sec. 18, T. 99 N, R. 6 W, 1 (ISU); Postville, 1 (ISU). BENTON COUNTY: Shellsburg, 1 (CC). BUENA VISTA COUNTY: 1/4 mi. N, 2 mi. W Alta, 2 (KU). CALHOUN COUNTY: Manson, 2 (ISU). CERRO GORDO COUNTY: 2 mi. N, 3 mi. W, Mason City, 1 (ISU). CHEROKEE COUNTY: 2 mi. NE Cherokee, 1 (BV); Quimby, 1 (SM). CLAY COUNTY: Dewey's Pasture, 5 mi. N, 1 mi. W Ruthven, 2 (ISU); *Smith's Slough*, 5 mi. N, 1 mi. W Ruthven, 5 (ISU). DELAWARE COUNTY: Backbone State Park, 2 (1 CC, 1 ISU); *Dundee, Richland Twp.*, 1 (USNM). DICKINSON COUNTY: Spirit Lake, 1 (UMMZ); Camp Foster, East Okoboji Lake, 3 (ISU); Iowa Lakeside Laboratory [West Okoboji Lake], 5 (DPM). DUBUQUE COUNTY: Dyersville, 1 (USNM). EMMET COUNTY: Fort Defiance State Park, 1 (ISU); *Ryan Lake*, 3 mi. S, 4 mi. E Estherville, 3 (ISU); 2 1/2 mi. S, 1/4 mi. E Wallingford, 1 (KU). GRUNDY COUNTY: 5 mi. S, 1/2 mi. E Wellsburg, 1 (KU). HAMILTON COUNTY: Little Wall Lake, 6 (ISU). HANCOCK COUNTY: *Pilot Knob State Park*, 1 (ISU); NE 1/4 of SW 1/4 of sec. 9, T. 94 N, R. 23 W, 1 (ISU); Britt, 2 (1 SUI, 1 USNM). HARDIN COUNTY: Pine Lake State Park, 1 (UNI). LYON COUNTY: sec. 17, Riverside Twp., 1 (ISU); sec. 28, Riverside Twp., 1 (ISU); sec. 26, Elgin Twp., 1 (ISU); sec. 35, Elgin Twp., 2 (ISU); sec. 26, Lyon Twp., 2 (ISU). MARION COUNTY: 4 1/2 mi. N Knoxville, 1 (KU). PALO ALTO COUNTY: 5 mi. N Ruthven, 1 (ISU); Ruthven [label incorrectly records Clay County], 1 (ISU). PLYMOUTH COUNTY: 2 mi.

TABLE 6.—Cranial measurements of adult *Zapus hudsonius intermedius* from Iowa. Super-script numbers indicate sample size when less than listed in left-hand column.

Number of specimens averaged	Occipitonasal length	Condylobasal length	Zygomatic breadth	Interorbital breadth	Length of maxillary toothrow
Winneshiek County					
Average 10 (5♂, 5♀)	22.5 ⁶	20.0 ⁸	10.9	4.2	3.9
Minimum	21.7	18.9	10.2	3.9	3.7
Maximum	23.2	21.0	11.4	4.6	4.2
SD ±	0.56	0.75	0.38	0.14	0.17
Dickinson County					
Average 5 (2♂, 3♀)	21.6	19.5	10.9	4.1	3.6
Minimum	21.0	19.0	10.7	4.0	3.6
Maximum	22.3	20.2	11.2	4.3	3.7
SD ±	0.48	0.52	0.20	0.11	0.05
Lyon and Sioux counties					
Average 6 (4♂, 2♀)	21.8 ⁴	18.7 ⁴	10.8 ⁴	4.3	3.6
Minimum	20.9	17.0	10.3	4.1	3.4
Maximum	22.9	20.4	11.4	4.5	3.8
SD ±	0.71	0.48	0.46	0.14	0.16

N Le Mars, 1 (KU). SIOUX COUNTY: NE 1/4 of sec. 3, T. 95 N, R. 43 W, 1 (ISU); Ireton, 2 (UMMZ). TAMA COUNTY: 1 mi. N, 1 1/2 mi. W Lincoln, 1 (KU). UNION COUNTY: 3 mi. E Afton, 1 (ISU). WINNEBAGO COUNTY: NW 1/4 of SW 1/4 of sec. 22, T. 98 N, R. 23 W, 1 (ISU). WINNESHIEK COUNTY: 1 3/4 mi. E Hesper, 1 (KU); Ridgeway, 11 (UMMZ); Decorah, 3 (UMMZ); Conover, 3 (UMMZ). WOODBURY COUNTY: Sioux City, 1 (UMMZ). WORTH COUNTY: SE 1/4 of sec. 10, T. 99 N, R. 21 W, 1 (ISU).

Additional records.—CALHOUN COUNTY: near Pomeroy (Stoner, 1918:124). DICKINSON COUNTY: "west shore Lake Okoboji" (Stephens, 1922:56). FLOYD COUNTY: no specific locality (Brown, 1917:26). GUTHRIE COUNTY: Sheeder Prairie, 1/2 mi. N, 3 1/2 mi. W Guthrie Center (Bowles, field notes). HANCOCK COUNTY: *Pilot Knob State Park* (Miller, 1955:558). IDA COUNTY: Arthur (Krutzsch, 1954:449). MAHASKA COUNTY: Oskaloosa (Stoner, 1918:124). POCAHONTAS COUNTY: Kalsow Prairie, 4 1/2 mi. NW Manson (Brennan, 1969:19); *no specific locality* (Weller and Blagen, 1970:293). SAC COUNTY: no specific locality (Spurrell, 1917:281). STORY COUNTY: 2 mi. N Ames (Hendrickson, 1930:399); Ames (Krutzsch, 1954:449). TAMA COUNTY: Tama (Eddy and Joyce, 1944:320). WRIGHT COUNTY: Wall Lake (Scott, 1947:473).

Family ERETHIZONTIDAE—Porcupines

Erethizon dorsatum dorsatum (Linnaeus)

Porcupine

1758. [*Hystrix*] *dorsata* Linnaeus, *Systema naturae*, ed. 10, 1:57 (type locality, eastern Canada).

1822. *E[rethizon]. dorsatum*, F. Cuvier, *Mém. Mus. Hist. Nat.*, Paris, 9:432.

Distribution in Iowa.—Probably occurred formerly in northeastern hardwood forests and irregularly in wooded areas elsewhere in the state; evidently disappeared from Iowa during the early period of settlement (not mapped).

The porcupine may have ranged into many wooded parts of Iowa, especially the area of hardwood forests in the northeast, prior to the coming of European man. Although early writers such as Galland (1921:500) and Newhall (1841:29) mentioned the presence of this species in Iowa, the only specific early record reported in the literature, insofar as I know, was of an individual from Grant City, Sac County, taken in 1857 (Spurrell, 1917:280). Scott (1937:90) considered that more recent records from Allamakee, Clarke, and Lucas counties "must be . . . accidental, probably escaped pets." It is also of interest to note that in about 1965, nine adult porcupines were killed in the autumn and winter in Hardin County. One of the animals was killed by a car in section seven of Clay Township and the others by hunters or farmers but there is no satisfactory explanation that would indicate their source and none was seen before or after that time (D. A. Wilson, Iowa Conservation Commission, personal communication).

An undated *Erethizon* lower jaw found in Michel's Cave, Jackson County (Trosky and Polder, 1960:608), seems to verify the former presence of this species, at least along the Mississippi River, even though no museum specimens are available either from Iowa or northwestern Illinois (see Cory, 1912:255). Parmalee *et al.* (1969:24), however, reported fossil records from Jefferson County, Missouri, and suggested that the species disappeared from that area prior to the coming of white man.

The subspecific name *dorsatum* has been applied to porcupines east of the Missouri River (see map, Hall and Kelson, 1959:782) and is used here for the sake of convenience. Jones (1964:242) referred porcupines from Nebraska to the subspecies *E. d. bunkerii*. Although not aware of any specific records from extreme eastern Nebraska, he assumed (p. 242) that it "may have been statewide in distribution." It is unlikely that the Missouri River would have been a barrier to dispersal of the porcupine and two subspecific names for *Erethizon dorsatum* in this part of its geographic range doubtfully are justified.

Specimens examined.—None.

Additional records.—ALLAMAKEE COUNTY: French Creek (Van Hynning, 1913:311). CLARKE COUNTY: Murray (Scott, 1937:90). HARDIN COUNTY: sec. 7, Clay Twp. (see text). JACKSON COUNTY: Michel's Cave, 2 mi. S Springbrook (Trosky and Polder, 1960:608). LUCAS COUNTY: Chariton (Scott, 1937:90). SAC COUNTY: Grant City (Spurrell, 1917:90).

ORDER CARNIVORA—Carnivores

Twenty species of carnivores belonging to seven families are known to have occurred in Iowa in historic times and several others probably were eliminated before their presence was documented. The gray wolf, fisher, and mountain lion were extirpated prior to 1900 and have not been reported in Iowa since then. Recent occurrences of the black bear, wolverine, and lynx suggest that some of the larger carnivores, earlier eliminated from the state by European man, may be reinvading parts of their previous range; the otter has returned to the Mississippi and Missouri rivers bordering Iowa.

Key to Families of Iowan Carnivores

1. Five toes on hind foot; 34 to 42 teeth; longitudinal septa lacking in auditory bullae 2
- 1'. Four toes on hind foot; 28, 30, or 42 teeth; longitudinal septa present in auditory bullae 4
- 2.(1) Total length more than 1200; tail shorter than hind foot; alisphenoid canal present; 42 teeth Ursidae, p. 117
- 2'. Total length less than 1200; tail longer than hind foot; alisphenoid canal absent; 34 to 40 teeth 3
- 3.(2') Tail with conspicuous rings; 40 teeth (molars 2/2); carnassials flattened Procyonidae, p. 119
- 3'. Tail lacking rings; 34 to 38 teeth (molars 1/2); carnassials not flattened Mustelidae, p. 120
- 4.(1') Muzzle elongate; 42 teeth; claws nonretractile Canidae, p. 109
- 4'. Muzzle rounded; 28 or 30 teeth; claws retractile Felidae, p. 137

Family CANIDAE—Coyote, Wolves, and Foxes

Key to Iowan Canids

1. Total length more than 1050; condylobasal length more than 155; postorbital processes thickened and convex dorsally 2
- 1'. Total length less than 1050; condylobasal length less than 155; postorbital process thin and concave dorsally 3
- 2.(1) Total length usually more than 1400; width of rhinarium more than 25; upper canines, when viewed from the front, not extending below line drawn through anterior mental foramina of rami *Canis lupus*, p. 111
- 2'. Total length usually less than 1400; width of rhinarium less than 25; upper canines, when viewed from the front, extending below line drawn through anterior mental foramina of rami *Canis latrans*, p. 109
- 3.(1') Upper parts reddish; condylobasal length more than 125; length of maxillary tooththrow more than 55; temporal ridges reduced, not lyre-shaped *Vulpes vulpes*, p. 113
- 3'. Upper parts grizzled grayish; condylobasal length less than 125; length of maxillary tooththrow less than 55; temporal ridges prominent, lyre-shaped *Urocyon cinereoargenteus*, p. 115

***Canis latrans thamnus* Jackson**

Coyote

1949. *Canis latrans thamnus* Jackson, Proc. Biol. Soc. Washington, 62:31, 17 March (type locality, Basswood Island, Apostle Islands, Ashland Co., Wisconsin).

Distribution in Iowa.—Statewide, but commonest in western and southern parts of state (see Fig. 41).

In the early 1800's, the coyote was abundant throughout most of Iowa, but by 1870 it was greatly reduced in numbers, primarily due to measures taken by early settlers to exterminate this and other canids (Allen, 1870:81). Osborn (1905: 566) commented that "within ten years [after settlement] the animal had practically disappeared." Individuals continued to be killed throughout the state, however, as bounties were (and still are) maintained in many counties. In the early part of the present century, circular "wolf" hunts were not uncommon in south-

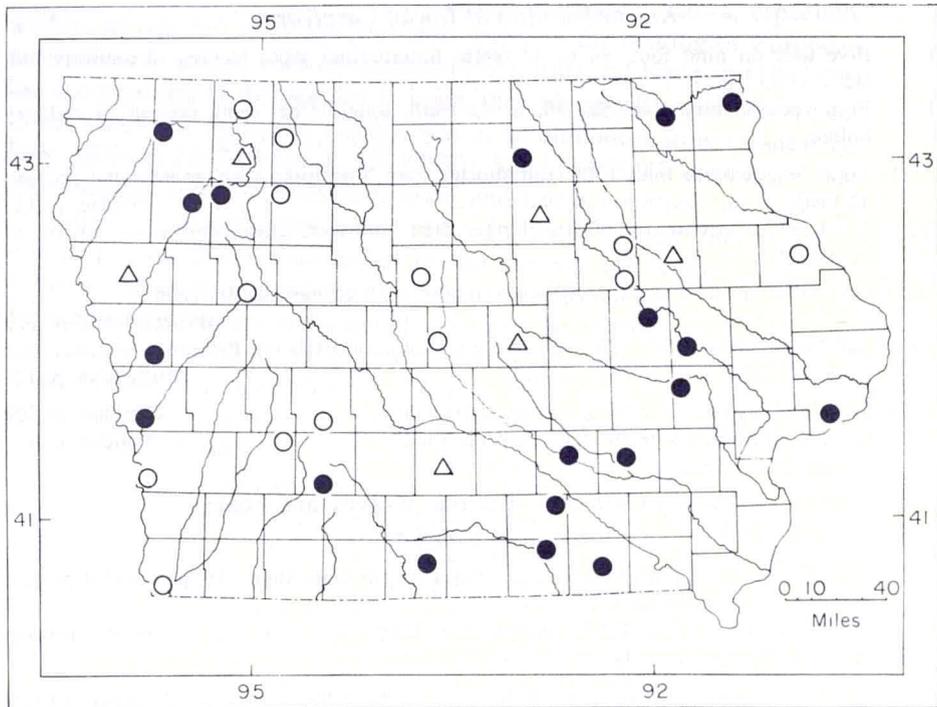


FIG. 41.—Distribution of *Canis latrans thamnoides* in Iowa. For explanation of symbols see Fig. 3.

eastern Iowa (Peterson, 1940). According to Hicks and Henderson (1940:117), “numbers probably reached a low point in the 1920’s.”

At present, *C. latrans* is fairly abundant in areas of rough terrain, especially in western and southern Iowa, but was reported from every county in the state during a 1953 census by the Iowa Conservation Commission (Glen C. Sanderson, personal communication). Young (1944:26) suggested that the coyote now may be somewhat more widespread in Iowa than during presettlement times as it may have replaced the gray wolf (*Canis lupus*) in northeastern Iowa.

The coyote was often called the “prairie wolf” by early settlers and at present, the term “wolf” is frequently applied to this species by residents in the state. Historical records of the coyote are listed below only if they clearly refer to *Canis latrans* and not to the gray wolf.

Jackson (1951) referred coyotes from Iowa to the subspecies *C. l. thamnoides*. Few specimens of adult animals from the state are available, particularly from localities along the Missouri River, and it thus seems appropriate tentatively to follow Jackson. However, Jones (1964:248), while designating all Nebraskan coyotes as *C. l. latrans*, pointed out that individuals from eastern Nebraska would be expected to resemble those from the upper Mississippi Valley “rather than those from the Great Plains.” He further commented that “the Missouri River is not an absolute barrier to the dispersal of the species.” Certainly further work regarding the systematics of coyotes in the upper Mississippi Valley is needed,

and if Jones' suspicions prove to be correct, the subspecific name *latrans*, rather than *thamnos*, may apply to some or all of the coyotes of Iowa.

Specimens examined (30).—ADAIR COUNTY: Richland Twp., 2 (KU). ALLAMAKEE COUNTY: Lansing, 1 (CC). APPANOOSE COUNTY: Moravia, 2 (KU); 5 1/2 mi. E Moravia, 1 (KU). BENTON COUNTY: Vinton, 2 (CC). BUENA VISTA COUNTY: 8 mi. N, 3 mi. W Alta, 1 (BV). CHEROKEE COUNTY: near Cherokee, 1 (ISU). DAVIS COUNTY: N of Bloomfield, 1 (ISU). DECATUR COUNTY: Leon, 1 (ISU). FLOYD COUNTY: Rockford, 1 (USNM). HARRISON COUNTY: Missouri Valley, 1 (ISU). JOHNSON COUNTY: Oxford, 1 (SUI). KEOKUK COUNTY: 1 1/2 mi. N Sigourney, 1 (KU). LINN COUNTY: Toddville, 1 (CC); Cedar Rapids, 1 (CC); no specific locality, 2 (CC). MAHASKA COUNTY: 5 mi. N Oskaloosa, 1 (KU); 3 1/2 mi. N, 1/2 mi. E Oskaloosa, 1 (KU). MONONA COUNTY: 3 mi. SE Soldier, 1 (BV). MONROE COUNTY: 2 mi. N Avery, 3 (KU). O'BRIEN COUNTY: NW of Sheldon, 1 (SM). SCOTT COUNTY: W of Davenport, 1 (DPM); no specific locality, 1 (DPM). WINNESHIEK COUNTY: Decorah, 1 (CC).

Additional records.—BLACK HAWK COUNTY: Barclay Twp. (Hartman, 1915:89); LaPort City (Peterson, 1940:68). BUCHANAN COUNTY: no specific locality (Church and Chappell, 1914:36). BUTLER COUNTY: no specific locality (Hart, 1914:43). CASS COUNTY: Anita (Peterson, 1940:63). CLAY COUNTY: no specific locality (Ruthven and Wood, 1912:204). DICKINSON COUNTY: 6 mi. W Milford (Stephens, 1922:59). DUBUQUE COUNTY: Peosta (Jackson, 1951:269). FLOYD COUNTY: no specific locality (Brown, 1917:29). FREMONT COUNTY: vicinity Hamburg (Bowles, field notes). GUTHRIE COUNTY: southern part (Allen, 1870:181). HAMILTON COUNTY: near Kamrar (Peterson, 1940:61). MARSHALL COUNTY: no specific locality (Gabrielson, 1921:148). PALO ALTO COUNTY: near Lost Island Lake (Ruthven and Wood, 1912:204). POCAHONTAS COUNTY: Swan Lake Twp. (Flickinger, 1904:273). POTTAWATTAMIE COUNTY: Council Bluffs (Pellett, 1911:452). SAC COUNTY: near Wall Lake (Spurrell, 1917:279). STORY COUNTY: vicinity Ames (Osborn, 1905:566). WARREN COUNTY: no specific locality (Peterson, 1940:70). WOODBURY COUNTY: near Crooked Lake [not precisely located] (Coues, 1893:73).

***Canis lupus nubilus* Say**

Gray Wolf

1823. *Canis nubilus* Say, in James, Account of an expedition from Pittsburgh to the Rocky Mountains . . . , 1:169 (footnote) (type locality, Engineer Cantonment [= approximately 2 mi. E Ft. Calhoun], Washington Co., Nebraska).
1829. [*Canis*] Var. D *Lupus nubilus*, Richardson, Fauna Boreali-Americana, p. 69.

Distribution in Iowa.—Formerly common in western and probably northern Iowa but evidently rare or absent in the southeastern part of the state; extirpated by late 1800's (see Fig. 42).

The former distribution, relative abundance, and time of extermination of the gray wolf in Iowa are difficult to assess. To my knowledge, there are no specimens preserved in museums from the state and, in addition, authors of historical literature usually did not distinguish between the gray (or timber) wolf (*Canis lupus*) and the coyote (*Canis latrans*)—often called the "prairie wolf." The last record of *C. lupus* in Iowa that I regard as valid was from Butler County in the winter of 1884-85 (Bowles, 1971:421).

The gray wolf probably was relatively abundant in western Iowa and, perhaps, also numerous in the northern part of the state. I have found no published record of this species from southern Minnesota, but Gunderson and Beer (1953:163) noted that *C. lupus* originally was found over the entire state. There seems to be no evidence that the gray wolf occurred in extreme southeastern Iowa. Spurrell (1917:280) reported a "black [gray] wolf killed in Clinton county in

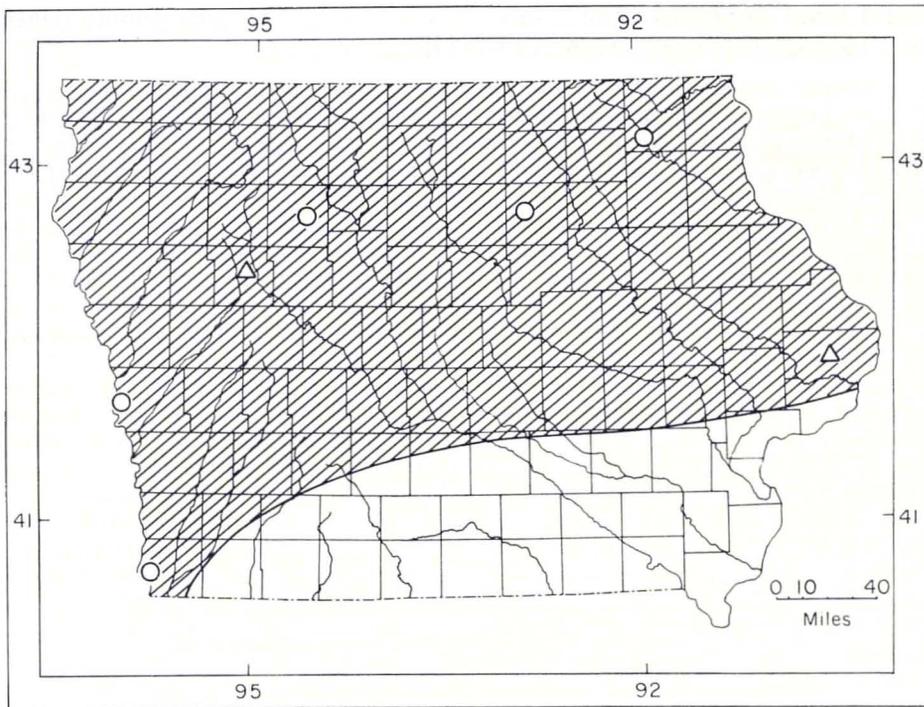


FIG. 42.—Probable former distribution of *Canis lupus nubilus* in Iowa. For explanation of symbols see Fig. 3.

[the] early days or along in the 1860's," and this is the southernmost record from the eastern part of the state that clearly refers to this species. Cory (1912: 316-317) summarized records of wolves from western Illinois, none of which were clearly authenticated.

The red wolf (*Canis niger*) was reported by Goldman (1944:484) to have ranged up the Mississippi River as far as Warsaw, Hancock County, Illinois. If true, this species could well have occurred in the adjacent southeastern corner of Iowa.

The type locality of *C. l. nubilus* is in Washington County, Nebraska, opposite northwestern Pottawattamie County, Iowa—thus not in Iowa as was formerly supposed. This species was reported by Jones (1964:249) to have been abundant in Nebraska, "especially in association with vast herds of bison." He suggested (p. 250) that the primary cause of extirpation of this species from Nebraska probably was the disappearance of the bison, the primary food source, although trapping and poisoning also may have been factors. It seems likely that extirpation of this wolf in Iowa resulted from similar causes.

Specimens examined.—None.

Additional records (Bowles, 1971:421).—BUTLER COUNTY: West Point Twp. CLINTON COUNTY: no specific locality. FREMONT COUNTY: Missouri River. HARRISON COUNTY: mouth Soldier River. POCAHONTAS COUNTY: north branch Lizard Creek. SAC COUNTY: no specific locality. WINNESHIEK COUNTY: Turkey River, southern part.

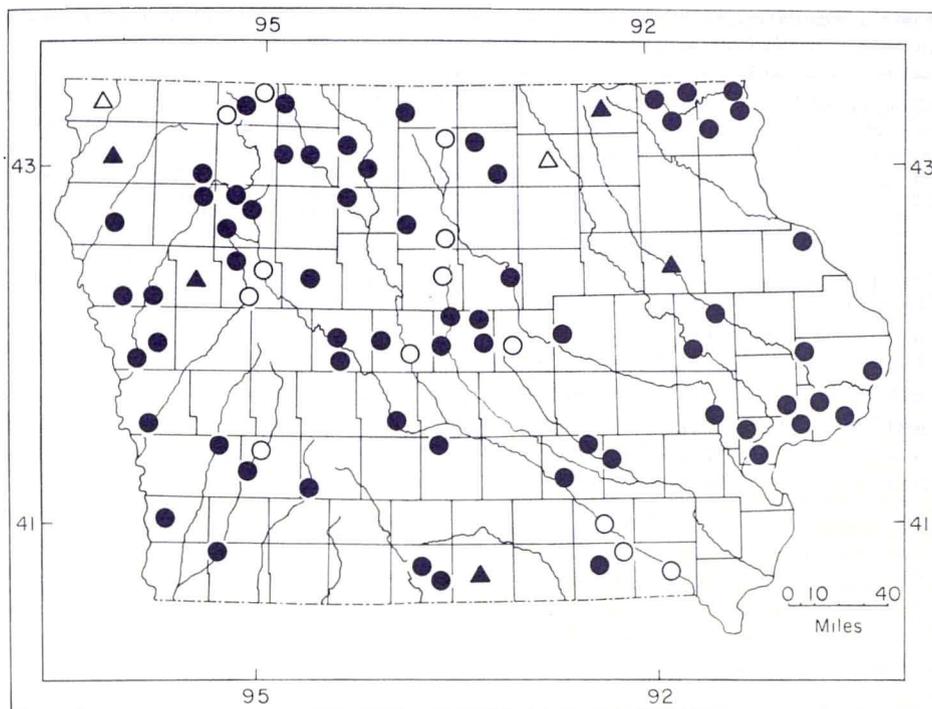


FIG. 43.—Distribution of *Vulpes vulpes regalis* in Iowa. For explanation of symbols see Fig. 3.

***Vulpes vulpes regalis* Merriam**
Red Fox

1900. *Vulpes regalis* Merriam, Proc. Washington Acad. Sci., 2:672, 28 December (type locality, Elk River, Sherburne Co., Minnesota).
1964. *Vulpes vulpes regalis*, Jones, Univ. Kansas Publ., Mus. Nat. Hist., 16:256, October.

Distribution in Iowa.—Statewide; common to abundant locally (see Fig. 43).

In early 1800's, the red fox occurred in wooded areas along the Missouri River (see Jones, 1964:254) and probably in similar habitat in eastern Iowa along the Mississippi and its tributaries, but I have found few early records that indicate the exact nature of its distribution. Evidently, the species was neither common nor widespread prior to settlement and it is of interest to note that Galland (1921:500) did not mention its presence in Iowa in 1840. Reports in the literature dating from the late 1800's suggest that *V. vulpes* expanded its range in the state during the early period of settlement and this expansion was correlated with activities of white man (see also Churcher, 1959:514). Allen (1870:182) found the red fox uncommon or absent in southern Iowa during his visit in 1867, and Scott (1937:64) reported evidence that the species "first appeared at Atlantic, Cass County, during the 1900's." Nutting (1895:43) indicated that *V. vulpes* was increasing in numbers in the 1890's in the southeastern part of the state and reported that the first individual known from Johnson County was taken in 1894.

TABLE 7.—Cranial measurements of *Vulpes vulpes regalis* from Iowa. Superscript numbers indicate sample size when less than listed in left-hand column.

Number of specimens averaged or catalogue number	Condylobasilar length	Zygomatic breadth	Interorbital breadth	Postorbital breadth	Palatal length	Length of maxillary toothrow
Hardin County (north-central Iowa)						
Average 6 (unsexed)	136.7 ⁵	73.4 ⁵	26.3	23.8	69.8	62.3
Minimum	129.0	70.9	23.4	22.8	66.3	59.1
Maximum	142.9	74.9	28.2	26.2	73.4	64.7
SD ±	5.39	1.69	1.67	1.22	2.49	2.33
Scott County (eastern Iowa)						
DPM 149. ♂	143.2	75.8	25.6	21.6	73.6	66.6
DPM 151. ♂	144.3	77.9	27.4	20.9	73.1	65.8
DPM 150. ♀	144.0	71.6	26.9	25.4	67.4	61.8
Decatur County (south-central Iowa)						
Average 4 (2♂, 2♀)	135.1	71.1	26.1	24.2	67.6	61.5
Minimum	131.1	68.4	24.8	22.8	63.9	59.2
Maximum	140.2	74.6	28.6	26.0	71.6	64.2
SD ±	4.28	2.58	1.73	1.36	3.16	2.33

The red fox was considered as occurring "all over the state" by Van Hyning and Pellett (1910:217).

Occasional local population declines have been recorded, such as the reports by Spurrell (1917:278) and Brown (1917:29) in Sac and Floyd counties, respectively. Scott (1937:64), however, noted that "despite persistent hunting and year round open season, the red fox continues to maintain its population throughout the state."

Cranial measurements of *V. vulpes* from eastern and southeastern counties are as large as those of red foxes from north-central Iowa (see Table 7) and eastern Nebraska (see Jones, 1964:260). All red foxes from Iowa are herein regarded as *V. v. regalis*. I noted no indication of intergradation with the smaller *V. v. fulva* of adjacent regions to the east and south of Iowa.

Specimens examined (282).—ADAIR COUNTY: Washington Twp., 1 (KU). ALLAMAKEE COUNTY: 2 1/2 mi. SW New Albin, 1 (WSU); Lansing, 2 (USNM); Waukon, 5 (USNM). BOONE COUNTY: Beaver, 3 (USNM). BUCHANAN COUNTY: no specific locality, 4 (USNM). BUENA VISTA COUNTY: Linn Grove, 3 (USNM); 2 mi. S Sioux Rapids, 1 (BV); 4 mi. NW Storm Lake, 1 (BV); 3 mi. S, 3 1/2 mi. W Storm Lake, 1 (BV). CALHOUN COUNTY: Rockwell City, 2 (USNM). CASS COUNTY: 3 mi. E Lewis, 1 (USNM); no specific locality, 1 (USNM). CEDAR COUNTY: 3 mi. S Sunbury, 1 (DPM). CERRO GORDO COUNTY: 3 mi. E Mason City, 1 (KU); Rockwell, 1 (ISU). CHEROKEE COUNTY: 8 mi. N, 4 mi. E Cherokee, 1 (BV); 10 mi. N, 1/4 mi. E Aurelia, 1 (BV); no specific locality, 1 (SM). CLINTON COUNTY: 1 1/4 mi. S, 1 1/2 mi. E Lost Nation, 1 (KU); 2 mi. W Clinton, 1 (KU). DALLAS COUNTY: Van Meter, 1 (USNM). DAVIS COUNTY: near Bloomfield, 1 (CC). DECATUR COUNTY: Leon, 1 (ISU); Woodland, 8 (USNM); no specific locality, 20 (USNM). DICKINSON COUNTY: Okoboji, 1 (USNM); Lake Okoboji, 1 (USNM). DUBUQUE COUNTY: Durango, 1 (ISU). EMMET COUNTY: 3 mi. N, 4 mi. E Estherville, 1 (ISU); Estherville, 1 (ISU). GREENE COUNTY: Farlin, 2 (USNM);

Jefferson, 3 (USNM); Cooper, 1 (USNM); *no specific locality*, 3 (USNM). HARDIN COUNTY: 1/4 mi. E Steamboat, 6 (KU); *no specific locality*, 1 (USNM). HARRISON COUNTY: Missouri Valley, 1 (ISU). HOWARD COUNTY: *no specific locality*, 1 (USNM). HUMBOLDT COUNTY: Ottosen, 1 (USNM). IDA COUNTY: *no specific locality*, 2 (USNM). JOHNSON COUNTY: 3 mi. S Iowa City, 1 (KU); *no specific locality*, 7 (SUI). KEOKUK COUNTY: 1 1/2 mi. E What Cheer, 1 (KU). KOSSUTH COUNTY: Lott's Creek, 2 (USNM); Algona, 1 (USNM); *no specific locality*, 1 (USNM). LINN COUNTY: *Wapsipinicon River*, 1 (CC); *Wapsipinicon River*, near Waubeek, 2 (CC); Cedar Rapids, 3 (CC); *no specific locality*, 3 (CC). MAHASKA COUNTY: 1 1/2 mi. S, 1 1/2 mi. W Barnes City, 1 (KU); 3 mi. E New Sharon, 1 (KU); 1 1/2 mi. S New Sharon, 1 (KU); 3 mi. W Oskaloosa, 1 (KU). MILLS COUNTY: Glenwood, 1 (USNM); *no specific locality*, 17 (USNM). MONONA COUNTY: 5 mi. W Soldier, 1 (BV); 2 mi. S, 6 mi. W Moorhead, 1 (KU). MUSCATINE COUNTY: *Wilton Twp.*, 2 (USNM); vicinity Stockton, 1 (DPM); Nichols, 3 (USNM); *Fairport*, 1 (USNM); Cedar Twp., 1 (USNM); *no specific locality*, 7 (USNM). O'BRIEN COUNTY: Sutherland, 2 (USNM). PAGE COUNTY: Essex, 1 (USNM). PALO ALTO COUNTY: Ruthven, 5 (2 UMMZ; 3 USNM); Emmetsburg, 4 (USNM); *no specific locality*, 1 (USNM). PLYMOUTH COUNTY: Stanton Twp., 1 (USNM). POTTAWATTAMIE COUNTY: Avoca, 1 (USNM); *no specific locality*, 19 (USNM). SAC COUNTY: 2 1/2 mi. NW Early, 1 (BV). SCOTT COUNTY: near Maysville, 1 (DPM); Davenport, 3 (DPM); *near Blue Grass*, 2 (DPM); *no specific locality*, 3 (DPM). SIOUX COUNTY: *no specific locality*, 1 (SM). STORY COUNTY: Roland, 3 (USNM); McCallsburg, 7 (USNM); Ames, 1 (ISU); Colo, 3 (USNM). TAMA COUNTY: Garwin, 1 (USNM). WARREN COUNTY: Greenfield Twp., 1 (USNM). WAYNE COUNTY: *no specific locality*, 17 (USNM). WINNEBAGO COUNTY: Buffalo Center, 1 (USNM). WINNESHIEK COUNTY: Highlandville, 28 (USNM); Bluffton, 1 (USNM); Decorah, 1 (CC); *no specific locality*, 9 (2 UMMZ, 7 USNM). WOODBURY COUNTY: Willow Twp., 1 (USNM); Oto Twp., 1 (USNM). WRIGHT COUNTY: Eagle Grove, 3 (USNM); *no specific locality*, 8 (USNM).

Additional records.—BOONE COUNTY: Moingona Fox Area, about 5 mi. S Boone (Scott, 1947:353). BUENA VISTA COUNTY: sec. 26, Grant Twp. (Allen, 1968:147). CASS COUNTY: Atlantic (Scott, 1937:64). DAVIS COUNTY: Eldon Fox Range [1 mi. N, 5 mi. E Floris] (Scott and Klimstra, 1955:5). DICKINSON COUNTY: Spirit Lake (Mosher, 1882:66); 10 mi. W Milford (Stephens, 1922:58). FLOYD COUNTY: *no specific locality* (Brown, 1917:29). HAMILTON COUNTY: 15 mi. N Randall (Mech, 1970:621). HANCOCK COUNTY: Pilot Knob State Park (Blagen, 1967:208). JOHNSON COUNTY: *no specific locality* (Nutting, 1895:43). LYON COUNTY: *no specific locality* (O. T. Kalin, University of Minnesota, personal communication). MARSHALL COUNTY: Linn Creek (Gabrielson, 1921:148). SAC COUNTY (Spurrell, 1917:278): Sac City; Wall Lake. WAPELLO COUNTY: 2 1/2 mi. E Ottumwa (Bowles, field notes). WINNESHIEK COUNTY (Hoslett, 1965:372): *Decorah; Canoe Creek*. WRIGHT COUNTY: Wall Lake (Scott, 1947:353).

***Urocyon cinereoargenteus ocythous* Bangs**

Gray Fox

1899. *Urocyon cinereoargenteus ocythous* Bangs, Proc. New England Zool. Club, 1:43, 5 June (type locality, Platteville, Grant Co., Wisconsin).

Distribution in Iowa.—Statewide, but uncommon in northwestern part of state (see Fig. 44).

The gray fox probably occurred in suitable habitats throughout most of Iowa prior to early settlement of the state. This species was reported as "common in early days" in Floyd County (Brown, 1917:29) and was seen by at least one early resident of Sac County (Spurrell, 1917:29). Allen (1870:182) found the gray fox to be "frequent but not especially numerous" during his travels across southern Iowa in 1867. Evidently, by the early 1900's, *Urocyon* was extirpated from north-

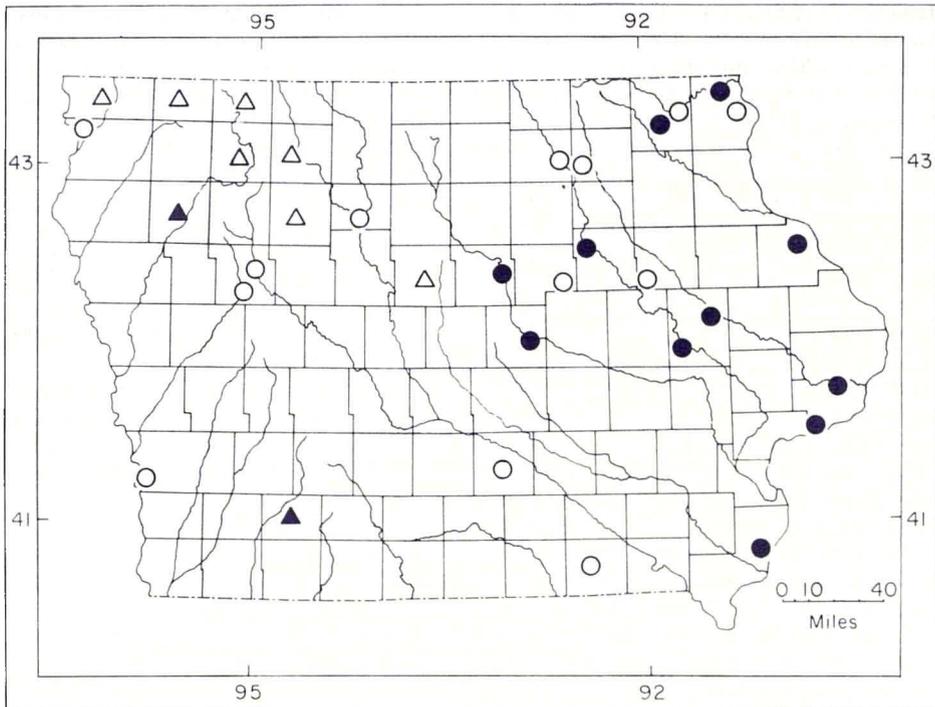


FIG. 44.—Distribution of *Urocyon cinereoargenteus ocythous* in Iowa. For explanation of symbols see Fig. 3.

western Iowa (where it may have been rare initially) and greatly reduced in numbers in the remainder of the state. An individual shot in 1880 near Greeler's Grove, Buchanan County, for example, created great interest because of the rarity of the species (Church and Chappell, 1914:36).

In Nebraska, Jones (1964:259) attributed a similar gray fox decline primarily to poisoning programs to eradicate wolves and coyotes. Polder (1958:561), however, suggested that *Urocyon* was fairly dependent on habitat afforded by beaver dams and thus population reduction was correlated with the disappearance of the beaver.

In the 1940's, the gray fox reappeared in western Iowa and increased in numbers in eastern counties. Polder (1958:560) suggested that this species moved northward along the Missouri River drainage and northwest and along the Des Moines River and its tributaries in western Iowa. During the 1953 census by the Iowa Conservation Commission, *Urocyon* was reported from all counties of the state (Glen C. Sanderson, personal communication). At present, the gray fox is relatively common in eastern Iowa, but is restricted to brushy timber adjacent to streams in the northwestern counties (Polder, 1958:561).

A similar pattern of reappearance of the gray fox was noted in Nebraska by Jones (1964:259). In southeastern South Dakota, occasional individuals have been reported (Findley, 1954:28), and, according to Swanson (1945:70), this species "has extended its range a great deal in Minnesota in recent years."

Specimens examined (20).—ADAMS COUNTY: no specific locality, 1 (ISU). ALLAMAKEE COUNTY: 10 mi. SW New Albin, 1 (WSU). BLACK HAWK COUNTY: "local" [vicinity Cedar Falls], 1 (UNI). CHEROKEE COUNTY: no specific locality, 1 (SM). DES MOINES COUNTY: Burlington, 1 (CC). DUBUQUE COUNTY: Durango, 1 (ISU). HARDIN COUNTY: Pine Lake State Park, 1 mi. E Eldora, 1 (KU). LINN COUNTY: Wapsipinicon River, near Waubeek, 2 (CC); Cedar Rapids, 2 (CC); *no specific locality*, 1 (CC). MARSHALL COUNTY: 1 mi. N Le Grand, 1 (SUI). SCOTT COUNTY: Wapsipinicon River, 1 (DPM); W of Buffalo Center, 1 (DPM). WINNESHIEK COUNTY: Decorah, 5 (CC).

Additional records (Polder, 1958:560-562, unless otherwise indicated).—ALLAMAKEE COUNTY: Lansing (record on file, U.S. Biological Survey). BUCHANAN COUNTY: Greeley's Grove [sec. 19, Jefferson Twp.] (Church and Chappell, 1914:36). CHICKASAW COUNTY: Bassett (Brown, 1917:29). CLAY COUNTY: no specific locality. DAVIS COUNTY: Bloomfield (Polder, 1953:721). DICKINSON COUNTY: no specific locality. FLOYD COUNTY: 6 1/2 mi. SE Charles City (Brown, 1917:29). HANCOCK COUNTY: Pilot Knob State Park (Blagen, 1967:208). HUMBOLDT COUNTY: Dakota City (Polder, 1953:721). LYON COUNTY: no specific locality. MARION COUNTY: Knoxville (record on file, U.S. Biological Survey). OSCEOLA COUNTY: no specific locality. PALO ALTO COUNTY: no specific locality. POCAHONTAS COUNTY: no specific locality. POTTAWATTAMIE COUNTY: Council Bluffs (Polder, 1953:721). SAC COUNTY: Sac City; Wall Lake (Iowa Conservationist, 1957, 16:98); *no specific locality* (Spurrell, 1917:279). SIOUX COUNTY: Settlers Twp. WINNESHIEK COUNTY: Canoe Creek (Hoslett, 1965:372).

Family URSIDAE—Bears and Allies

Ursus americanus americanus Pallas

Black Bear

1780. *Ursus americanus* Pallas, . . . *Spicilegia zoologica* . . . , fasc. 14, p. 5 (type locality, eastern North America).

Distribution in Iowa.—Formerly occurred in wooded areas of Iowa and in riparian communities along the larger rivers in the tall-grass prairie; possibly now becoming re-established in the state (see Fig. 45).

In the early 1800's, the black bear was fairly common in the hardwood forests of eastern Iowa and in wooded river valleys throughout the remainder of the state (Bowles, 1971:421). Probably it was uncommon in the areas of tall-grass prairie, although Captain Allen (1846:18) did record "a fine bear [killed] on a prairie chase" on a ridge between the Raccoon River and Beaver Creek, in what is now eastern Dallas County or western Polk County.

By the mid-1800's, few black bears remained in the state and the last record in the 19th century, insofar as I have been able to determine, was of an individual killed in 1876 in the vicinity of Spirit Lake, Dickinson County (Stephens, 1922:61). Because it was extirpated early, there are no museum specimens of *U. americanus* available from Iowa, although a tooth was found in a cave in Jackson County (Trosky and Polder, 1960:608).

In May 1965, a black bear was trailed from Wapello County to Mahaska County, and on 25 May a bear, presumably the same individual, was shot near Tipton, Cedar County—more than 100 miles from where the tracks were first observed. Although this bear may have been forced south from Minnesota by unusually widespread spring flooding, a more recent sighting of bear tracks in Tama County in early February 1970, suggests the possibility that some bears

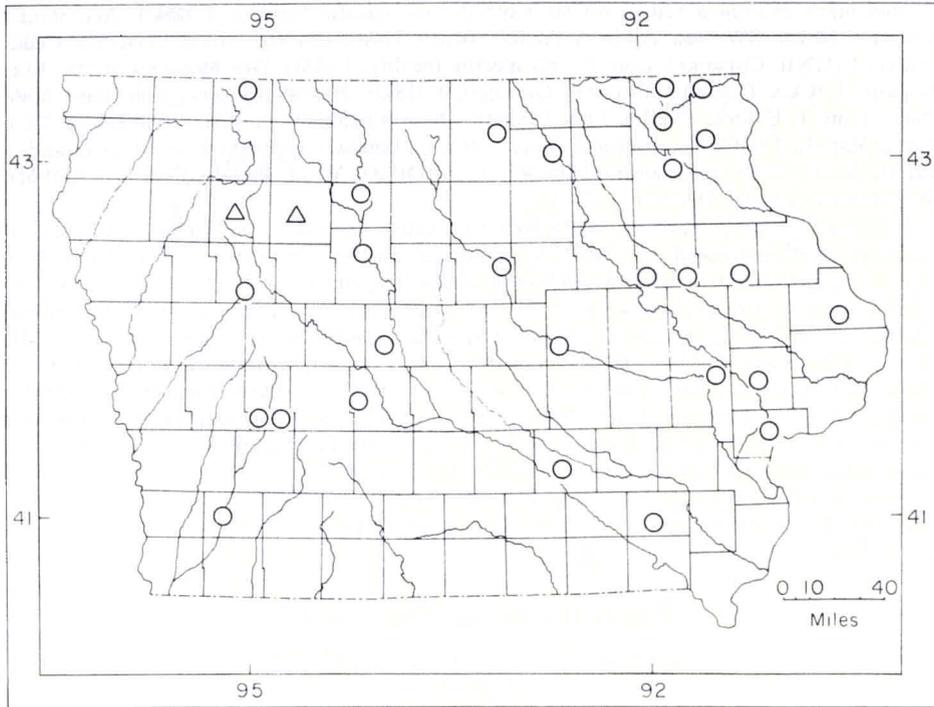


FIG. 45.—Records of occurrence of *Ursus americanus americanus* in Iowa. For explanation of symbols see Fig. 3.

now are moving along some of the more protected river valleys in Iowa. The latter report was from a wooded area near the Iowa River in N 1/2 of sec. 30, Tama Township (Donald Wanatee, Mesquakie Indian Reservation, personal communication). Additionally, a bear was trailed in 1968 in northwestern Allamakee County, and in March and June 1970, individuals—including an adult and cub—were reported from near Decorah and in section 25, Hesper Township, Winneshiek County (Berl Downing, Iowa Conservation Commission, personal communication).

In November 1969, a black bear was observed in northwestern Missouri (Daviness County) and this species reportedly has increased in numbers elsewhere in that state (F. W. Sampson, Missouri Department of Conservation, personal communication). Bears, therefore, now may be expected in any part of the state.

Specimens examined.—None.

Additional records (Bowles, 1971:421-422, unless otherwise indicated).—ALLAMAKEE COUNTY: northwestern corner (see text); near Hardin, Franklin Twp. AUBUDON COUNTY: Buck Creek, Oak Field Twp.; sec. 21, Exira Twp. BOONE COUNTY: Bear Creek, Marcy Twp. BUCHANAN COUNTY: Jefferson Twp.; Newton Twp. BUENA VISTA COUNTY: Pond Grove [not precisely located]. CEDAR COUNTY: near Tipton (*Des Moines Register*, 26 May 1965). CERRO GORDO COUNTY: Shell Rock River, 6 or 7 mi. from Rock Grove [probably Rock Falls]. DELAWARE COUNTY: Plum Creek, South Fork Twp. DICKINSON COUNTY: vicinity Spirit Lake (Stephens, 1922:61). FAYETTE COUNTY: sec. 29, Dover Twp. FLOYD COUNTY: vicinity Charles City. HARDIN COUNTY: Clay Twp. HUMBOLDT COUNTY: northern part. JACKSON

COUNTY: Michel's Cave, 2 mi. S Springbrook (Trosky and Polder, 1960:608). JEFFERSON COUNTY: Cedar Creek, about 4 mi. S Fairfield. JOHNSON COUNTY: sec. 31, Cedar Twp. MAHASKA COUNTY: Painter Creek, Oskaloosa Twp. MONTGOMERY COUNTY: Nishnabotna River. MUSCATINE COUNTY: vicinity Muscatine. POCAHONTAS COUNTY: no specific locality. SAC COUNTY: S of Wall Lake. TAMA COUNTY: Iowa River, N 1/2 of sec. 30, Tama Twp. (see text). WEBSTER COUNTY: vicinity New Castle [Webster City]. WINNESHIEK COUNTY (see text): sec. 25, Hesper Twp.; near Decorah.

Family PROCYONIDAE—Raccoon and Allies

Procyon lotor hirtus Nelson and Goldman
Raccoon

1930. *Procyon lotor hirtus* Nelson and Goldman, J. Mamm., 11:455. 11 November (type locality, Elk River, Sherburne Co., Minnesota).

Distribution in Iowa.—Statewide in suitable habitats (see Fig. 46).

The raccoon is common throughout Iowa and occurs in a wide variety of habitats. Literature regarding the distribution of *Procyon* in the state in the early 1800's, however, suggests that its distribution probably was concentrated at that time in the hardwood forests of eastern Iowa and along heavily wooded waterways in the remainder of the state (Galland, 1921:500; Osborn, 1890:42). The clearing of timber by early settlers may have had an initial negative effect on numbers (Scott, 1937:59), but agricultural practices undoubtedly contributed ultimately to the present widespread distribution of the species. Such activities directly provided both shelter and food in previously unfavorable prairie areas (see Giles, 1940, and elsewhere; Cabalka *et al.*, 1953).

Based on fur records of the Iowa Conservation Commission, Sanderson (1951) reported a significant increase in the numbers of raccoons in both Missouri and Iowa between 1930 and 1950. In Iowa, the population growth curve was sharpest in the 1940's, with a peak in 1946-47 (Sanderson, 1951:528). A similar population increase was noted in Kansas by Stains (1956:26-27), although he pointed out that at least some of the increase was attributable to liberation of raccoons brought from other states. Jones (1964:264) found "no record of the introduction of raccoons into Nebraska" and, to my knowledge, no such releases have occurred in Iowa.

Specimens examined (53).—ADAIR COUNTY: Washington Twp., 1 (KU). ADAMS COUNTY: 6 mi. S, 4 mi. W Corning, 1 (NWM). ALLAMAKEE COUNTY: 4 mi. SW New Albin, 1 (WSU). APPANOOSE COUNTY: 5 1/2 mi. E Moravia, 1 (KU). AUDUBON COUNTY: 5 mi. N Anita, 1 (NWM). BENTON COUNTY: Vinton, 1 (UNI); 8 mi. S Vinton, 1 (CC). BLACK HAWK COUNTY: Cedar Falls, 2 (UNI). BOONE COUNTY: Frasier, 1 (ISU); sec. 19, Worth Twp., 1 (ISU); Berkley, 1 (ISU). BUENA VISTA COUNTY: 1 mi. E Alta, 1 (BV); 1 mi. S, 3 mi. W Storm Lake, 1 (BV). CASS COUNTY: 2 mi. S, 3 mi. E Anita, 1 (NWM). CHEROKEE COUNTY: 5 1/2 mi. N Cherokee, 1 (SM); 10 mi. W Cherokee, 1 (SM); 1 1/2 mi. E Cherokee, 1 (SM); *Mill Creek Bridge*, 1 (SM); *no specific locality*, 1 (SM). CLAY COUNTY: Peterson, 1 (WSU). DICKINSON COUNTY: Spooky Hollow, Little Sioux River, 2 6/10 mi. W hwy. 32, 1 (TTU). DALLAS COUNTY: 1 mi. W Perry, 1 (DPM). FREMONT COUNTY: Hamburg, 1 (CC). HOWARD COUNTY: Cresco, 1 (ISU). JOHNSON COUNTY: Iowa City, 1 (AMNH); *no specific locality*, 1 (SUI). KEOKUK COUNTY: Sigourney, 1 (KU). KOSSUTH COUNTY: *no specific locality*, 1 (DPM). LINN COUNTY: near Coggin, 1 (CC); Cedar Rapids, 2 (CC); *no specific locality*, 1 (CC). MAHASKA

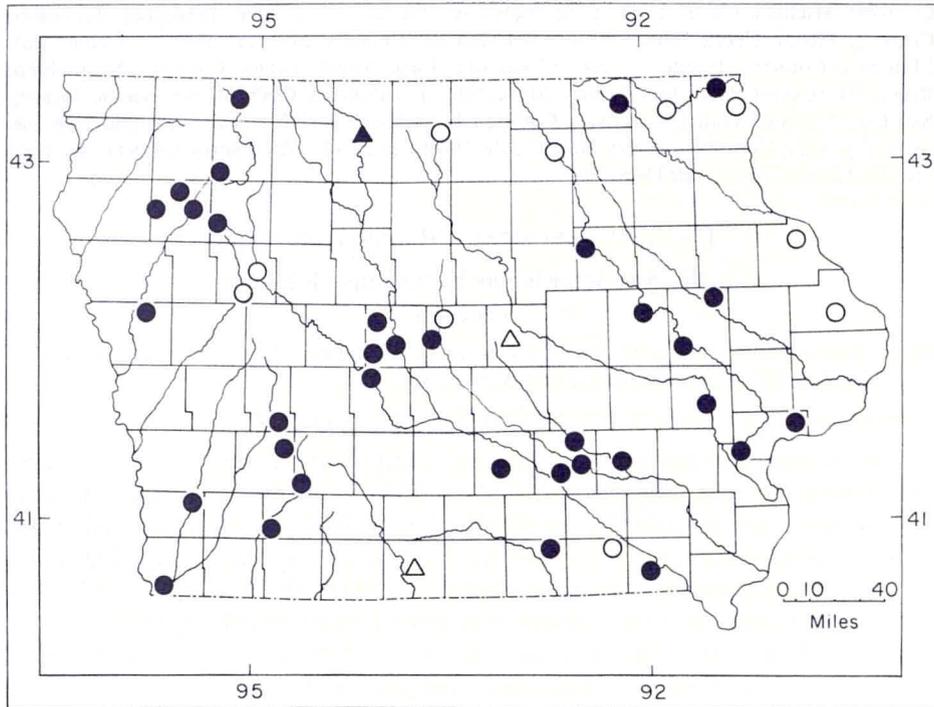


FIG. 46.—Distribution of *Procyon lotor hirtus* in Iowa. For explanation of symbols see Fig. 3.

COUNTY: 2 1/2 mi. N, 4 1/2 mi. E New Sharon, 1 (KU); 2 1/2 mi. E New Sharon, 1 (KU); 5 mi. S, 1 mi. E New Sharon, 2 (KU); 1 1/2 mi. N, 1 1/2 mi. W Rose Hill, 1 (KU); Oskaloosa, 2 (KU); 4 1/2 mi. E Oskaloosa, 2 (KU). MARION COUNTY: Knoxville, 1 (SUI). MILLS COUNTY: 1 mi. N, 2 mi. E Henderson, 1 (KU). MONONA COUNTY: 2 mi. W Mapleton, 1 (BV). MUSCATINE COUNTY: vicinity Stockton, 2 (DPM); Cedar River, 2 mi. E Conesville, 1 (ISU). SAC COUNTY: no specific locality, 3 (DPM). STORY COUNTY: 2 mi. N Ames, 1 (KU). VAN BUREN COUNTY: sec. 3, Des Moines Twp., 1 (ISU).

Additional records.—ALLAMAKEE COUNTY: near New Albin (Hoslett, 1965:372); Lansing (record on file, U.S. Biological Survey). BOONE COUNTY: Moingona Fox Area, about 5 mi. S Boone (Scott, 1947:444). DAVIS COUNTY: Eldon Fox Range [1 mi. N, 5 mi. E Floris] (Scott and Klimstra, 1955:31). DECATUR COUNTY: Quail Research Area [not specifically located] (Mangold, 1951:218). DICKINSON COUNTY (Stephens, 1922:61): west shore Lake Okoboji; loop of Little Sioux River. DUBUQUE COUNTY: vicinity Durango (Giles, 1940:375). FLOYD COUNTY: "some distance" W Charles City (Brown, 1917:30). HANCOCK COUNTY: Pilot Knob State Park (Blagen, 1967:208). JACKSON COUNTY: Michel's Cave, 2 mi. S Springbrook (Trosky and Polder, 1960:607). MARSHALL COUNTY: no specific locality (Gabrielson, 1921:149). SAC COUNTY: (Spurrell, 1917:277); near Sac City; near Wall Lake. STORY COUNTY: Skunk River, N junction Keigley's Creek (Cabalka *et al.*, 1953:616); vicinity Ames (Giles, 1939:68). WINNESHIEK COUNTY: "few miles" N Decorah (Hoslett, 1965:372).

Family MUSTELIDAE—Weasels, Skunks, and Allies

Key to Iowan Mustelids

1. Toes webbed; 36 teeth (premolars 4/3) *Lutra canadensis*, p. 135
- 1'. Toes not webbed or only slightly so; 34 or 38 teeth (premolars 3/3 or 4/4) 2

- 2.(1') Upper parts black and white; bony palate extending only slightly beyond posterior border of M1 3
- 2'. Upper parts brownish, yellowish, or grayish overall; bony palate extending appreciably beyond posterior border of M1 4
- 3.(2) Upper parts having two white stripes; zygomatic breadth more than 40; maxillary tooththrow more than 20 *Mephitis mephitis*, p. 133
- 3'. Upper parts with four or more broken white lines (or spots); zygomatic breadth less than 40; maxillary tooththrow less than 20 *Spilogale putorius*, p. 131
- 4.(2') Weight more than 5 pounds; tail only slightly longer than hind foot; condylobasal length more than 80 5
- 4'. Weight less than 5 pounds; tail more than twice length of hind foot (except in *Mustela nivalis*); condylobasal length less than 80 7
- 5.(4) Upper parts brownish; 38 teeth (premolars 4/4) 6
- 5'. Upper parts yellowish gray to silvery gray; 34 teeth (premolars 3/3) *Taxidea taxus*, p. 129
- 6.(5) Body robust, obscure brownish stripes dorsally; greatest length of skull more than 130; interorbital region not strongly constricted *Gulo gulo*, p. 129
- 6'. Body slender; stripes lacking dorsally; greatest length of skull less than 130; interorbital region strongly constricted *Martes pennanti*, p. 121
- 7.(4') Total length more than 500; condylobasal length more than 55 *Mustela vison*, p. 127
- 7'. Total length less than 500; condylobasal length less than 55 8
- 8.(7') Postglenoid length of skull more than 47 per cent of condylobasal length *Mustela frenata*, p. 123
- 8'. Postglenoid length of skull more than 47 per cent of condylobasal length 9
- 9.(8') Tail without black tip (may have a few black hairs) *Mustela nivalis*, p. 125
- 9'. Tail with conspicuous black tip *Mustela erminea*, p. 122

***Martes pennanti pennanti* (Erxleben)**

Fisher

1777. [*Mustela*] *pennanti* Erxleben, *Systema regni animalis* . . . , p. 470 (type locality, eastern Canada [= Quebec]).

1912. *Martes pennanti pennanti*, Miller, *Bull. U.S. Nat. Mus.*, 79:94, 31 December.

Distribution in Iowa.—Probably occurred irregularly in wooded areas in the northern part of the state; evidently disappeared from Iowa by the early 1800's (not mapped).

On 11 July 1820, Stephen Kearney reported that in the vicinity of Elk Lake [latitude 43° 11' 3"] "our party killed, on the banks of the river, a Fisher, who, however, did not give up his life without a struggle nor without showing much fierceness of disposition" (Kearney, 1912:348). Insofar as I know, this is the only specific record of occurrence of this species in Iowa. Many authors (notably Spurrell, 1917:277 and Van Hynning, 1913:311), however, cited indirect evidence of its former presence. Others, including Osborn (1892:5) included the fisher on species lists with no evidence to authenticate its former presence.

It seems likely that *M. pennanti* was present, although uncommon, in the wooded areas of northern Iowa when white man first arrived there, but disappeared by the early 1800's.

Records of occurrence.—See text.

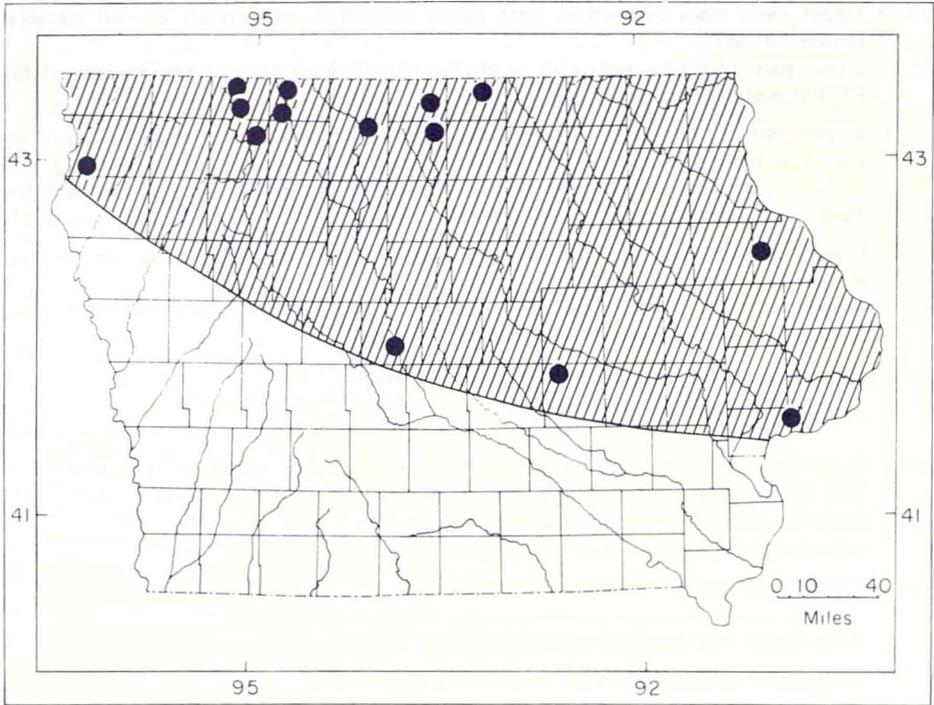


FIG. 47.—Distribution of *Mustela erminea bangsi* in Iowa. For explanation of symbols see Fig. 3.

***Mustela erminea bangsi* Hall**
Ermine

1945. *Mustela erminea bangsi* Hall. J. Mamm., 26:176. 19 July (type locality, Elk River, Sherburne Co., Minnesota).

Distribution in Iowa.—Known certainly only from northern half of state (see Fig. 47).

There are only scattered records of the ermine from Iowa and these are primarily from north-central counties. The southern limit of the geographic range in the state is not well documented. A specimen from Muscatine County (DPM 123), taken in November 1877, lacks precise locality data. Individuals from Boone and Poweshiek counties were collected in 1939 and 1964, respectively, and a specimen from Sioux County was taken in 1925. Based on the state mammal census in 1953 by the Iowa Conservation Commission (Glen C. Sanderson, personal communication) the southern limits of *M. erminea* in the state were recorded as Woodbury, Adair, Wayne, Appanoose, and Des Moines counties, but I have not based my map (Fig. 47) on these data because they are unsubstantiated by specimens.

In Minnesota, *M. erminea* is commonest in the north but is "found throughout the state with the possible exception of the southeastern counties" (Gunderson and Beer, 1953:141). I know of no published records of this species from Illinois, Nebraska, or eastern South Dakota.

Specimens examined (28).—BOONE COUNTY: sec. 24, Marcy Twp., 1 (ISU). CLAY COUNTY: Dewey's Pasture, 1 (ISU); *no specific locality*, 1 (BV). DICKINSON COUNTY: Spirit Lake, 1 (collection of P. D. Kline, Indianola, Iowa); *3/4 mi. E Orleans*, 1 (ISU); Iowa Lakeside Laboratory [West Okoboji Lake], 1 (UMMZ); *Spooky Hollow, Little Sioux River, 2 6/10 mi. W hwy. 32*, 2 (TTU); *1/8 mi. W Little Emerson Bay, [West] Lake Okoboji*, 2 (TTU); *E side Garlock Slough*, 1 (TTU). DUBUQUE COUNTY: Dodge Twp., 1 (KU). EMMET COUNTY: 4 1/2 mi. N, 6 mi. E Estherville, 1 (ISU); 1 mi. S Wallingford, 1 (ISU). HANCOCK COUNTY: Pilot Knob State Park, 1 (ISU). KOSSUTH COUNTY: Union Slough National Wildlife Refuge, 2 (ISU). MUSCATINE COUNTY: vicinity Stockton, 1 (DPM); *no specific locality*, 1 (DPM). POWESHIEK COUNTY: T. 81 N, R. 15 W, 1 (ISU). SIOUX COUNTY: Ireton, 1 (UMMZ). WINNEBAGO COUNTY: Lake Mills, 6 (ISU). WORTH COUNTY: Northwood, 1 (ISU).

Mustela frenata

Long-tailed Weasel

The long-tailed weasel is distributed throughout Iowa and probably is the commonest of the three species of weasels occurring in the state. Hall (1951:51) noted significant differences in coloration in this species in response to climatic variation. Weasels in regions of heavy snowfall have white winter pelage, whereas southern populations are brown in winter pelage. In a narrow geographical zone in between, which includes much of Iowa, winter coat is variable—some individuals being white and others brown.

There are two currently recognized subspecies of *Mustela frenata* in Iowa—*spadix* in the north and *primulina* in the south. Several individuals from along the Iowa side of the Mississippi River are evidently intergrades with *M. f. noveboracensis*, a subspecies found in the adjacent states of Illinois and Wisconsin (Hall, 1951:221). There have been few specimens of this species taken in Iowa that were not previously examined by Hall (1951) and the reader is referred to that work for details of variation not provided here.

***Mustela frenata primulina* Jackson**

1913. *Mustela primulina* Jackson, Proc. Biol. Soc. Washington, 26:123, 21 May (type locality, 5 mi. NE Avilla, Jasper Co., Missouri).
 1936. *Mustela frenata primulina*, Hall, Publ. Carnegie Inst. Washington, 473:104, 20 November.

Distribution in Iowa.—Southeastern half of state (see Fig. 48).

This subspecies evidently is distributed to the south of a line running approximately from south of Council Bluffs through southern Boone and Story counties to Clayton County. Hall (1951:238) considered that individuals from eastern Iowa counties of Henry, Van Buren, Cedar, Linn, and Dubuque were intergrades with *M. f. noveboracensis*, a subspecies found in adjacent Illinois. Specimens from Butler, Hardin, southern Story (Kelley), and southern Boone (Worth Township) counties were considered by Hall to be intergrades with the adjacent northern subspecies, *M. f. spadix*. I know of no specimens from extreme western Iowa, thus the line separating *spadix* from *primulina* (Fig. 48) is drawn south of Council Bluffs to correspond with records of *primulina* from Sarpy County, Nebraska (see Jones, 1964:268).

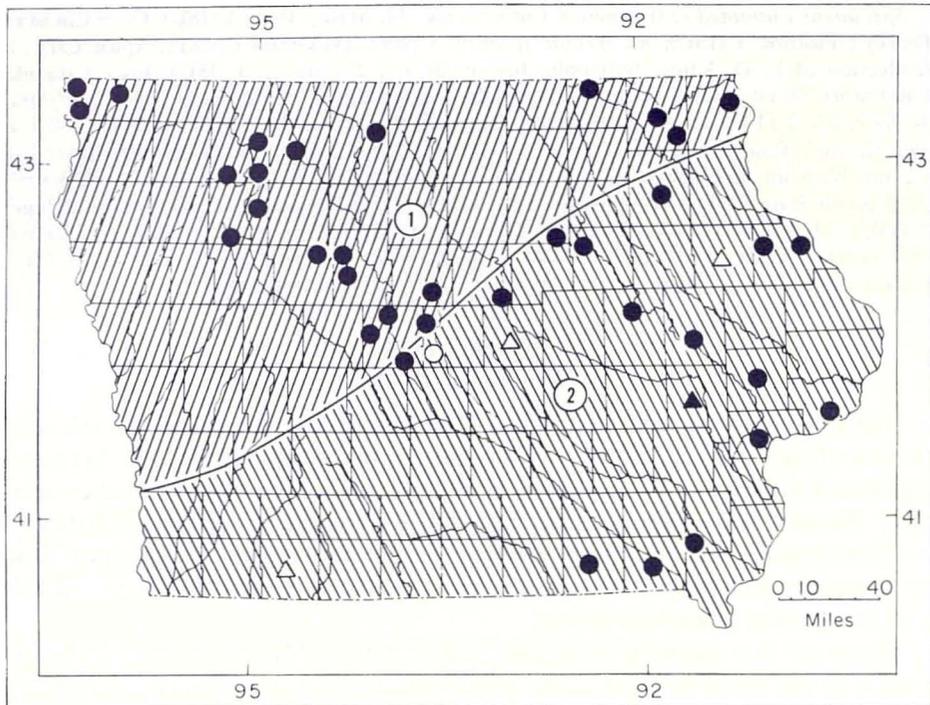


FIG. 48.—Distribution of *Mustela frenata* in Iowa: 1, *M. f. spadix*; 2, *M. f. primulina*. For explanation of symbols see Fig. 3.

According to Hall (1951:238), *primulina* differs from *spadix* in adjacent northern Iowa by having “least width of color of underparts amounting to less than 40 per cent of greatest width of color of upper parts, and by smaller size.”

Specimens examined (39).—BENTON COUNTY: Vinton, 4 (CC). BOONE COUNTY: 3 mi. E Boone, 1 (ISU); Moingona, 1 (ISU); *Ledges State Park*, 1 (ISU); sec. 21, Worth Twp., 1 (ISU). BLACK HAWK COUNTY: Cedar Falls, 1 (UNI). BUTLER COUNTY: New Hartford, 1 (CC). CEDAR COUNTY: Tipton, 3 (CC). DAVIS COUNTY: near Bloomfield, 1 (ISU). DUBUQUE COUNTY: 1 mi. E Dyersville, 2 (KU); 2 1/2 mi. E Dyersville, 1 (KU); 1 mi. S Dyersville, 1 (KU); Dubuque, 1 (CC); *Green's Island*, 1 (ISU). FAYETTE COUNTY: Fayette, 2 (CC). HARDIN COUNTY: Union, 1 (ISU). HENRY COUNTY: Hillsboro, 5 (USNM). JOHNSON COUNTY: Old Man's Creek [not precisely located], 1 (CC). LINN COUNTY: 1 1/2 mi. N Marion, 1 (USNM); Cedar Rapids, 1 (CC); no specific locality, 1 (CC). MUSCATINE COUNTY: Muscatine, 3 (CC). SCOTT COUNTY: Davenport, 2 (CC). TAYLOR COUNTY: no specific locality, 1 (KU). VAN BUREN COUNTY: Keosauqua, 1 (ISU).

Additional records.—DELAWARE COUNTY: no specific locality (Polder, 1953:720). JOHNSON COUNTY: no specific locality (Nutting, 1893:40). LINN COUNTY: Marion (Polderboer, 1948a: 295). MARSHALL COUNTY: no specific locality (Gabrielson, 1921:149). STORY COUNTY: Kelley (Hall, 1951:240).

***Mustela frenata spadix* (Bangs)**

1896. *Putorius longicauda spadix* Bangs, Proc. Biol. Soc. Washington, 10:8, 25 February (type locality, Fort Snelling, Hennepin Co., Minnesota).
1936. *Mustela frenata spadix*, Hall, Publ. Carnegie Inst. Washington, 473:105, 20 November.

Distribution in Iowa.—Northwestern half of state, north of a line from Council Bluffs to Allamakee County (see Fig. 48).

Specimens of *Mustela frenata* from northern and western Iowa were assigned to the subspecies *spadix* by Hall (1951:258), although he noted that this part of the state was in a region of intergradation among the subspecies *noveboracensis*, *primulina*, *spadix*, and perhaps *longicauda*. Thus a great variability of coat color and skull proportions is to be expected. Jones (1964:271), however, noted that in eastern Nebraska, the occurrence of white or brown winter pelage generally parallels the "understood boundary" between the subspecies *spadix* and *primulina*. Such does not seem to be the case, however, in Iowa for brown individuals, as well as those in white pelage have been taken in winter throughout most of the state.

According to Hall (1951:259-260), specimens from Calhoun, Webster, Boone (Amaqua Township), and Story (Ames) counties show many characteristics of the adjacent southern subspecies, *primulina*, and an individual from Lansing, Allamakee County, is an intergrade with *noveboracensis*, a subspecies found to the east of Iowa. Specimens from Clay and Palo Alto counties showed a few characteristics of both *primulina* and *longicauda*, the latter a Great Plains subspecies (Hall, 1951:258).

Specimens examined (36).—ALLAMAKEE COUNTY: Lansing, 2 (CC). BOONE COUNTY: Boxholm, 1 (ISU); Pilot Mound, 3 (CC); sec. 19, Amaqua Twp., 1 (ISU). BUENA VISTA COUNTY: 2 mi. S Albert City, 1 (BV); Hayes Twp., 1 (ISU). CALHOUN COUNTY: Manson, 1 (ISU). CLAY COUNTY: Lost Island [Lake], 1 (UMMZ); Webb, 1 (AMNH); 2 1/2 mi. N Linn Grove, 1 (BV). HAMILTON COUNTY: Wall Lake, 1 (ISU). HOWARD COUNTY: Chester, 6 (CC). KOSKUTH COUNTY: Union Slough Refuge, 1 (ISU). LYON COUNTY: Granite, 1 (ISU); sec. 35, Riverside Twp., 1 (ISU); sec. 23, Lyon Twp., 1 (ISU); sec. 26, Lyon Twp., 1 (ISU). PALO ALTO COUNTY: Ruthven, 1 (UMMZ); Emmetsburg, 1 (SM); no specific locality, 1 (UMMZ). STORY COUNTY: Ames, 3 (ISU). WEBSTER COUNTY: Barnum, 1 (ISU); Moorland, 1 (ISU). WINNESHIEK COUNTY: Decorah, 2 (CC); 8 mi. NE Ossian, 1 (UMMZ).

Additional records.—CLAY COUNTY: near Ruthven (Ruthven and Wood, 1908:205). STORY COUNTY: near Ames (Polderboer *et al.*, 1941:115). WINNESHIEK COUNTY: Upper Iowa River, W of Decorah (Hosleit, 1965:372).

***Mustela nivalis campestris* Jackson**

Least Weasel

1913. *Mustela campestris* Jackson, Proc. Biol. Soc. Washington, 26:124, 21 May (type locality, Beemer, Cuming Co., Nebraska).
 1959. *Mustela nivalis campestris*, Hall and Kelson, The mammals of North America, 2: 1082, 31 March.

Distribution in Iowa.—Probably statewide (see Fig. 49).

The least weasel has been regarded as locally common in northeastern Iowa (Polder, 1968 and elsewhere) and, according to the 1953 mammal census of the Iowa Conservation Commission, occurs in suitable habitat throughout the remainder of the state (Glen C. Sanderson, personal communication). Easterla (1970) reported records of this weasel from extreme southwestern Iowa and northeastern Missouri and concluded (*op. cit.*, 339) that *M. nivalis* presently is commoner in that area than the long-tailed weasel, *Mustela frenata*. The least

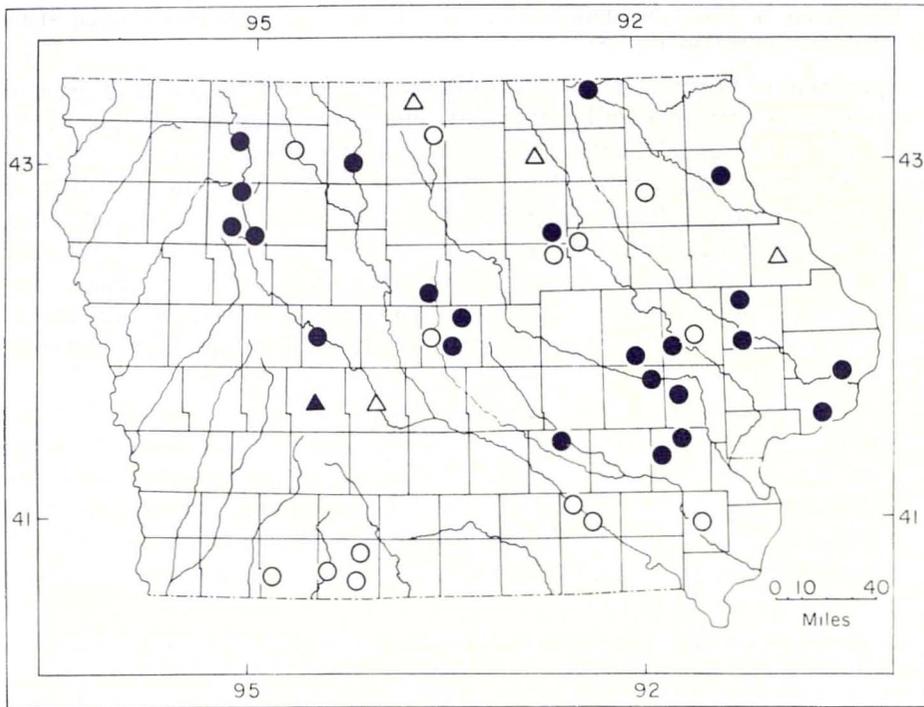


FIG. 49.—Distribution of *Mustela nivalis campestris* in Iowa. For explanation of symbols see Fig. 3.

weasel also occurs in eastern Nebraska (Jones, 1964:278) and northeastern Kansas (Hesket and Fleharty, 1966:582).

Insofar as I know, this weasel has not been recorded from southern Illinois in historic times, but it is of interest to note that remains of this species have been reported from caves in southwestern Illinois and east-central Missouri by Parmalee *et al.* (1969:25). Thus *M. nivalis* evidently ranged farther south, at least along the Mississippi River, during past periods of relative coolness—as, for example, about 3000 BP—when other boreal mammals such as *Clethrionomys gapperi* were known to exist farther south than at present.

Specimens examined (31).—BENTON COUNTY: Watkins, 1 (KU). BUENA VISTA COUNTY: 3 1/2 mi. E Sioux Rapids, 1 (ISU); 4 mi. NE Storm Lake, 1 (BV); 1 mi. E Newell, 1 (BV). BUTLER COUNTY: sec. 20, Beaver Twp., 3 (ISU). CLAY COUNTY: junction U.S. 71 and Iowa 240 [4 mi. S Spencer], 1 (ISU). CLAYTON COUNTY: National, 1 (USNM); *no specific locality*, 1 (SUI). CLINTON COUNTY: near McCausland, 1 (DPM). GREENE COUNTY: 1 1/2 mi. W Jefferson, 1 (KU). GUTHRIE COUNTY: *no specific locality*, 1 (SUI). HAMILTON COUNTY: Little Wall Lake, 2 (ISU). HOWARD COUNTY: Chester, 1 (CC). IOWA COUNTY: Amana, 1 (SUI). JOHNSON COUNTY: Tiffin, 1 (SUI); *no specific locality*, 2 (SUI). JONES COUNTY: Monticello, 1 (IHM); 2 1/2 mi. W Olin, 1 (ISU). KOSSUTH COUNTY: Algona, 1 (ISU). LINN COUNTY: 4 mi. N Cedar Rapids, 1 (CC). MAHASKA COUNTY: New Sharon, 1 (KU). SCOTT COUNTY: Davenport, 2 (ISU). STORY COUNTY: McCallsburg, 1 (ISU); 1 mi. S Nevada, 1 (ISU). WASHINGTON COUNTY: Kalona, 1 (SUI); Wellman, 1 (SUI).

Additional records.—BENTON COUNTY: *no specific locality* (Polder, 1953:719). BLACK HAWK COUNTY: Cedar Falls (Polderboer, 1942:145). DALLAS COUNTY: *no specific locality*

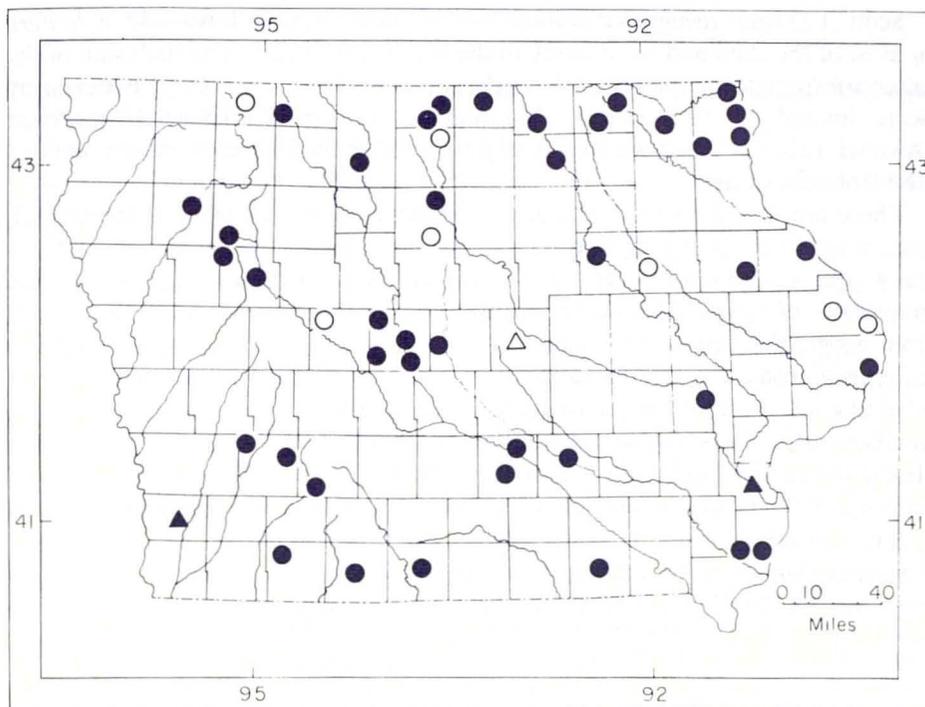


FIG. 50.—Distribution of *Mustela vison letifera* in Iowa. For explanation of symbols see Fig. 3.

(Polder, 1953:719). DUBUQUE COUNTY: no specific locality (Polder, 1953:719). FAYETTE COUNTY: Randalia. (Polderboer, 1942:145). FLOYD COUNTY: no specific locality (Brown, 1917:30). GRUNDY COUNTY: Fairfield Twp. (Polderboer, 1942:145). HANCOCK COUNTY: Pilot Knob State Park (Blagen, 1967:208). HENRY COUNTY: Mount Pleasant (Hall, 1951:192). LINN COUNTY: Marion (Polderboer, 1948b:296). PALO ALTO COUNTY: Emmetsburg (Scott, 1939b:240). RINGGOLD COUNTY (Easterla, 1970:336): 4 mi. E Tingley; near Platte River, 8 mi. W Mount Ayr; 1 mi. W Mount Ayr; 2 mi. S, 2 mi. E Mount Ayr. STORY COUNTY: near Ames (Polderboer *et al.*, 1941:118). TAYLOR COUNTY: 5 mi. W Bedord (Easterla, 1970:336). WAPELLO COUNTY: sec. 28, Highland Twp. (Scott, 1939b:240); Ottumwa (Hall, 1951:192). WINNEBAGO COUNTY: no specific locality (Polderboer, 1942:145).

***Mustela vison letifera* Hollister**
Mink

1913. *Mustela vison letifera* Hollister. Proc. U.S. Nat. Mus., 44:475, 18 April (type locality, Elk River, Sherburne Co., Minnesota).

Distribution in Iowa.—Statewide in suitable habitats (see Fig. 50).

Historical literature indicates that the mink was abundant in Iowa prior to the arrival of the early trappers, but was reduced in numbers shortly thereafter. Although Osborn (1905:567) included this species on his list of "extinct and vanishing mammals," it seems doubtful that it was ever in danger of extirpation in Iowa. At present, *M. vison* is common along water courses throughout the state.

Scott (1937:60) recognized two subspecies as occurring in Iowa—*M. v. letifera* in most of the state and *M. v. mink* in the southeastern part. The inclusion of the latter subspecies was based on a single specimen from Iowa City, not seen by Scott, housed in the American Museum of Natural History. This specimen (AMNH 123861) is a male that is slightly smaller than others I have examined from Johnson County.

There are few skins of Iowa-taken specimens available for color comparison with mink from other geographic areas. Skulls of this species from the southern part of the state do not differ significantly in size from those of specimens from other parts of Iowa, Nebraska, or Kansas. A cursory examination of individuals from geographic areas to the east of Iowa suggests that there may be little size difference between *letifera* and *mink*. It is doubtful that the Mississippi River would be a significant barrier to such a wide ranging species as *M. vison*, and it is clear that the systematic relationships of mink in the central United States should be reviewed. The most recent revision is that of Hollister (1913); until a thorough study is undertaken, it seems best to regard all Iowan mink as belonging to the subspecies *letifera*.

Specimens examined (89).—ADAIR COUNTY: Richland Twp., 1 (KU). ALLAMAKEE COUNTY: 3 mi. radius of New Albin, 1 (WSU); Lansing, 1 (ISU); Harpers Ferry, 1 (ISU); Post Twp., 1 (ISU). BLACK HAWK COUNTY: Waterloo, 1 (UNI). BOONE COUNTY: Boxholm, 1 (ISU); *Pilot Mound*, 1 (ISU); Boone, 1 (ISU); *Ogden*, 1 (ISU); *Luther*, 2 (ISU); Berkley, 1 (ISU); Madrid, 1 (ISU). BUENA VISTA COUNTY: Storm Lake, 1 (USNM); 2 1/2 mi. E Storm Lake, 1 (BV); no specific locality, 1 (BV). CASS COUNTY: 5 mi. NW Atlantic, 1 (NWM); 2 mi. S, 3 mi. E Anita, 1 (NWM). CHEROKEE COUNTY: 3 mi. N, 1/4 mi. W Cherokee, 1 (SM); no specific locality, 1 (SM). CLINTON COUNTY: 3 mi. N Clinton, 2 (KU). DAVIS COUNTY: Bloomfield, 3 (1 CC, 2 ISU). DECATUR COUNTY: Leon, 2 (ISU). DELAWARE COUNTY: 2 mi. W Worthington, 1 (KU). DES MOINES COUNTY: Middletown, 1 (USNM); Burlington, 2 (USNM). DUBUQUE COUNTY: Dubuque, 1 (ISU); *Green's Island*, 1 (ISU); 1 mi. S Dyersville, 1 (USNM); *Worthington*, *Dodge Twp.*, 1 (KU); *Dodge Twp.*, 1 (KU); [S of] *Worthington* [in] *Cascade Twp.*, 1 (KU). EMMET COUNTY: 2 mi. S, 2 mi. W Estherville, 1 (ISU). FLOYD COUNTY: Floyd, 5 (ISU). HOWARD COUNTY: Cresco, 1 (ISU); Lourdes, 3 (ISU). JOHNSON COUNTY: Iowa City, 1 (AMNH); no specific locality, 8 (SUI). KOSSUTH COUNTY: Algona, 1 (ISU). LOUISA COUNTY: no specific locality, 1 (SUI). MAHASKA COUNTY: 4 mi. N Oskaloosa, 1 (KU); 2 1/2 mi. N, 2 mi. E Oskaloosa, 1 (KU). MARION COUNTY: 1 1/2 mi. S, 1 1/2 mi. E Otley, 1 (KU); Knoxville, 1 (USNM). MILLS COUNTY: no specific locality, 1 (ISU). MITCHELL COUNTY: Osage, 3 (ISU). RINGGOLD COUNTY: Mount Ayr, 1 (NWM). SAC COUNTY: 2 mi. N Schaller, 1 (BV); 4 mi. S, 1/2 mi. E Sac City, 1 (BV). STORY COUNTY: Ames, 2 (ISU). TAYLOR COUNTY: 8 mi. S, 3 mi. W Corning, 1 (NWM). WINNEBAGO COUNTY: Rice Lake, Lake Mills, 8 (ISU); Forest City, 3 (ISU). WINNESHIEK COUNTY: Decorah, 3 (CC). WORTH COUNTY: Northwood, 1 (ISU). WRIGHT COUNTY: SW 1/4 of sec. 31, T. 93 N, R. 23 W, 1 (ISU).

Additional records.—BOONE COUNTY: *Moingona Fox Area*, about 5 mi. S Boone (Scott, 1947:445). BUCHANAN COUNTY: Independence (Church and Chappell, 1914:36). DICKINSON COUNTY: Spirit Lake (Mosher, 1882:66); no specific locality (Stephens, 1922:60). FLOYD COUNTY: *Charles City* (Brown, 1917:30). GREENE COUNTY: Churdan (record on file, U.S. Biological Survey). HANCOCK COUNTY: Pilot Knob State Park (Blagen, 1967:208). JACKSON COUNTY: Michel's Cave, 2 mi. S Springbrook (Trosky and Polder, 1960:608); Sabula (Merriam, 1889:490). MARSHALL COUNTY: no specific locality (Gabrielson, 1921:49). MITCHELL COUNTY: *Cedar River*, near Osage (Webster, 1889:176). WRIGHT COUNTY: Wall Lake (Scott, 1947:445).

Gulo gulo luscus (Linnaeus)

Wolverine

1758. [*Ursus luscus*] Linnaeus, *Systema naturae*, ed. 10, 1:47 (type locality, "Hudsonis" [= Hudson Bay], Canada).

1959. *Gulo gulo luscus*, Kurten and Rausch, *Acta Arctica*, fasc. 11, p. 19.

Distribution in Iowa.—Possibly in wooded parts of northeastern Iowa in the early 1800's; one recent record from the state (not mapped).

There is no direct evidence to support the presence of the wolverine in Iowa at the time of early settlement, although Scott (1937:87) suggested that it "probably entered northeastern Iowa." Early records in southern Indiana (Lyon, 1936:113) and northwestern Nebraska (Jones, 1964:282) lend support to Scott's view.

In 1960, a wolverine was captured in Tama County. Haugen (1961) considered it likely that this individual had accidentally entered Iowa, perhaps by truck, and subsequently escaped. The specimen (ISU 1657) was taken in the late spring, however, and more likely reached the state under natural circumstances. A record of this species from Dewey County, South Dakota (Lee, 1962:21), in addition to recent occurrences of bear and lynx (see accounts of those species), certainly would suggest that some of the larger predatory mammals, extirpated in the early period of settlement, may perhaps be reoccupying some of their former range (see also Newby and Wright, 1955, for long distance movements of the wolverine in Montana).

Specimen examined (1).—TAMA COUNTY: sec. 3, T. 86 N [label reads 68], R. 15 W, 1 (ISU).

Taxidea taxus taxus (Schreber)

Badger

1778. *Ursus Taxus* Schreber, *Die Säugthiere . . .*, 3:589, description on pp. 520-521 (type locality, "Labrador und um die Hudsonsbay," but the species is not known to occur at either of these places; "probably southwest of Hudson Bay" according to Miller and Kellogg, *Bull. U.S. Nat. Mus.*, 205:747, 3 March 1955).

1894. *Taxidea taxus*, Rhoads, *Amer. Nat.*, 28:524, June.

Distribution in Iowa.—Statewide in suitable habitats (see Fig. 51).

The badger was relatively common throughout the tall-grass prairie region of Iowa until the late 1800's (Spurrell, 1917:278), but by 1905 it was considered to be rare or extirpated in many parts of the state (Osborn, 1905:567; Van Hyning and Pellett, 1910:217).

Although trapping pressure and agricultural activities of settlers may have influenced negatively the distribution and numbers of this species, the poisoning of burrowing rodents—the major food of badgers—may have been the most significant factor in population decline. Removal of timber from large areas, on the other hand, undoubtedly increased available habitat for the species.

Scott (1937:63) noted an increase of badgers trapped between 1930 and 1936, no doubt reflecting a statewide population change since the early 1900's. Similar changes were reported in the adjacent states of Illinois (Hoffmeister and Mohr, 1957:111), Nebraska (Jones, 1964:284), and Missouri (Schwartz and Schwartz,

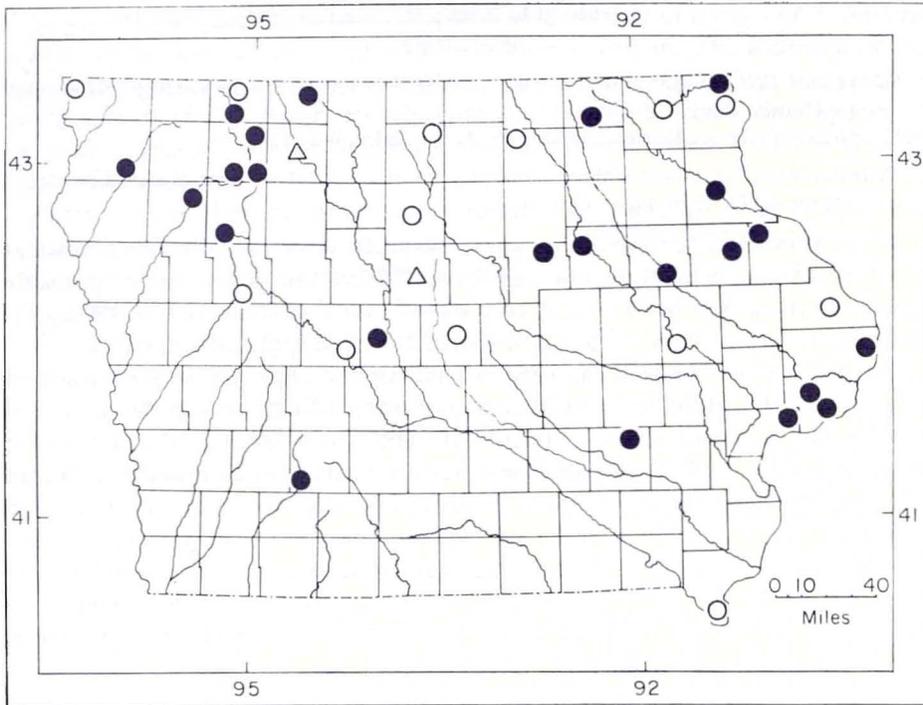


FIG. 51.—Distribution of *Taxidea taxus taxus* in Iowa. For explanation of symbols see Fig. 3.

1959:291). The badger presently is found throughout the state, although probably is least abundant in wooded areas of northeastern Iowa. Also, there are few records from the southern half of the state although I suspect the species is distributed throughout this area (see Fig. 51).

Specimens examined (25).—ADAIR COUNTY: Washington Twp., 1 (KU). ALLAMAKEE COUNTY: 3 mi. radius of New Albin, 1 (WSU). BLACK HAWK COUNTY: Cedar Falls, 2 (UNI). BOONE COUNTY: Ogden, 1 (ISU). BUCHANAN COUNTY: Quasqueton, 1 (USNM). BUENA VISTA COUNTY: 2 mi. S, 1 mi. W Storm Lake, 1 (BV). CHEROKEE COUNTY: SW 1/4 of NW 1/4 of sec. 6, T. 92 N, R. 39 W, 1 (SM). CLAY COUNTY: Dewey's Pasture, 1 (ISU); 4 mi. N Sioux Rapids, 1 (ISU); Webb, 1 (AMNH). CLAYTON COUNTY: Turkey River, 1 (USNM). CLINTON COUNTY: 2 mi. N Clinton, 1 (DPM); *no specific locality*, 1 (SUI). DELAWARE COUNTY: Earlville, 1 (USNM). DICKINSON COUNTY: Milford, 1 (ISU). DUBUQUE COUNTY: Luxemburg, 1 (ISU). EMMET COUNTY: 1 mi. N Dolliver, 1 (ISU). GRUNDY COUNTY: Stout, 1 (USNM). HOWARD COUNTY: Lourdes, 1 (ISU). KEOKUK COUNTY: 1/4 mi. W South English, 1 (KU). MUSCATINE COUNTY: vicinity Stockton, 1 (DPM). SCOTT COUNTY: near Maysville, 1 (DPM); Davenport, 1 (DPM). SIOUX COUNTY: Alton, 1 (USNM).

Additional records.—ALLAMAKEE COUNTY: Lansing (record on file, U.S. Biological Survey). BOONE COUNTY: "northern portion" (Snead and Hendrickson, 1942:380). CLAY COUNTY: *no specific locality* (Ruthven and Wood, 1912:204). DICKINSON COUNTY: near Miller's Bay, Lake Okoboji (Stephens, 1922:60). FLOYD COUNTY: Nora Springs (Brown, 1917:29). GREENE COUNTY: Rippey (Allen, 1870:184). HANCOCK COUNTY: Pilot Knob State Park (Blagen, 1967:208). JACKSON COUNTY: Michel's Cave, 2 mi. S Springbrook (Trosky and Polder, 1960:308). LEE COUNTY: near Keokuk (Bennitt, 1939). LINN COUNTY: Cedar Rapids (Van

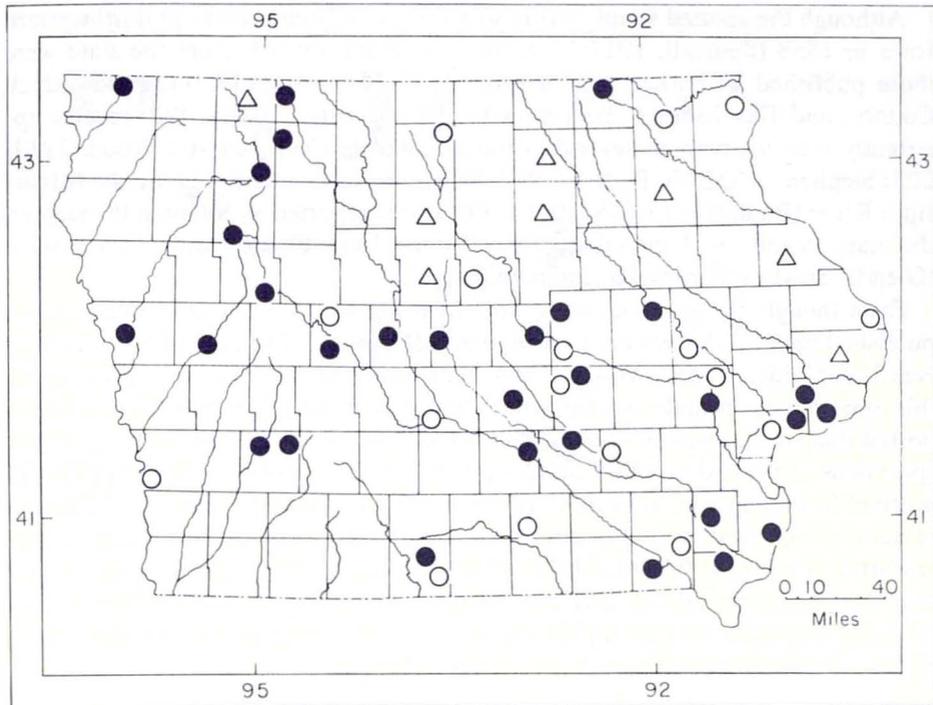


FIG. 52.—Distribution of *Spilogale putorius interrupta* in Iowa. For explanation of symbols see Fig. 3.

Hying, 1913:312). LYON COUNTY: "northwestern corner" (Snead and Hendrickson, 1942:380). PALO ALTO COUNTY: no specific locality (Ruthven and Wood, 1912:204). SAC COUNTY: Wall Lake (Spurrell, 1917:278). STORY COUNTY: "several miles" NE Nevada (Briggs, 1897:6). WINNESHIEK COUNTY: Decorah (Hoslett, 1965:373). WRIGHT COUNTY: near Clarion (Schantz, 1947:288).

***Spilogale putorius interrupta* (Rafinesque)**
Spotted Skunk

1820. *Mephitis interrupta* Rafinesque, Ann. Nat., 1:3 (type locality, "Louisiana"; restricted to upper Missouri River by Lichenstein, Abh. K. Akad. Wiss. Berlin, for 1836, p. 281, 1838.

1952. *Spilogale putorius interrupta*, McCarley, Texas J. Sci., 4:108, 30 March 1952.

Distribution in Iowa.—Statewide (see Fig. 52).

At the time of early settlement of Iowa, the spotted skunk probably occurred in suitable habitats only in the western part of the state in the areas adjacent to the Missouri River and its tributaries. Evidently, it was not then found in the tall-grass prairie areas of north-central Iowa nor in the eastern part of the state. Van Gelder (1959) summarized evidence of a northeastward extension of the geographic range of *Spilogale* in the past century or so, a range extension likely resulting, at least in part, from habitat changes brought about by agricultural activities of the early settlers.

Although the spotted skunk was reported to have been present in northwestern Iowa in 1858 (Spurrell, 1917:278), the first actual records from the state were those published by Parker (1871a:376, 1871b:761)—from Grinnell, Poweshiek County, and Des Moines, Polk County. By the early 1900's, this species apparently was common in several northern counties (Ruthven and Wood, 1912:205; Stephens, 1922:59; Brown, 1917:30) and in Iowa counties along the Mississippi River (Bailey, 1915:355, 1916:290); it was reported as common throughout the state in the 1953 mammal survey by the Iowa Conservation Commission (Glen C. Sanderson, personal communication).

Even though *Spilogale* occurs in eastern Iowa, to my knowledge there are no published records of specimens taken in adjacent parts of Illinois in historic times (see Van Gelder, 1959). Miller (1955:122), however, indicated the presence of this species on "islands in the Mississippi River" and Bailey (1916:290) reported that C. H. Swift of Sabula, Jackson County, had "personally trapped two specimens of the little spotted skunk on the Illinois side of the Mississippi River north of Savannah [= Savanna, Carroll Co., Illinois], twenty years ago." Skeletal remains of *Spilogale* found in southwestern Illinois, radio-carbon dated as representing the period 6500 to 4500 BP (Parmalee, 1967:138), certainly suggest that the Mississippi River was not always a barrier to dispersal. This species probably extended its geographic range eastward during periods of drier post-Wisconsin climatic conditions, possibly several times.

Specimens examined (48).—BENTON COUNTY: Vinton, 1 (CC). BOONE COUNTY: Ogden, 1 (ISU). BUENA VISTA COUNTY: 3 mi. S Storm Lake, 1 (BV). CASS COUNTY: near Atlantic, 1 (NWM); 2 mi. S, 3 mi. E Anita, 1 (NWM). CLAY COUNTY: Webb, 1 (AMNH). CRAWFORD COUNTY: sec. 23, Denison Twp., 1 (ISU). DECATUR COUNTY: Leon, 2 (1 ISU, 1 USNM). DES MOINES COUNTY: 4 mi. N Burlington, 1 (CC). EMMET COUNTY: 3 1/2 mi. N Estherville, 1 (ISU). GREENE COUNTY: sec. 27, Jackson Twp., 1 (ISU); *no specific locality*, 1 (SUI). HENRY COUNTY: Mount Pleasant, 1 (CC). HOWARD COUNTY: Chester, 1 (CC). JASPER COUNTY: Newton, 2 (KU). JOHNSON COUNTY: Iowa City, 7 (AMNH); *no specific locality*, 3 (SUI). LEE COUNTY: sec. 17, Pleasant Ridge Twp., 1 (ISU). LYON COUNTY: sec. 20, Riverside Twp., 1 (ISU). MAHASKA COUNTY: 1 1/2 mi. S New Sharon, 1 (KU); 1 1/2 mi. S, 2 mi. E New Sharon, 1 (KU). MARION COUNTY: 1 mi. S, 1 1/2 mi. E Pella, 1 (KU). MARSHALL COUNTY: Marshalltown, 2 (1 ISU; 1 USNM). MONONA COUNTY: sec. 9, Franklin Twp., 1 (KU). MUSCATINE COUNTY: vicinity Stockton, 1 (DPM). PALO ALTO COUNTY: Ruthven, 3 (UMMZ); *no specific locality*, 1 (UMMZ). POWESHIEK COUNTY: 18 mi. SE Marshalltown, 1 (CC). SAC COUNTY: Wall Lake, 1 (CC). SCOTT COUNTY: Plainview, 1 (DPM); *Walcott*, 1 (DPM); Davenport, 1 (DPM). STORY COUNTY: Ames, 1 (ISU). TAMA COUNTY: Gladbrook, 1 (USNM). VAN BUREN COUNTY: Lacey-Keosauqua State Park, 1 (ISU).

Additional records.—ALLAMAKEE COUNTY: Lansing (record on file, U.S. Biological Survey). BUTLER COUNTY: *no specific locality* (Scott, 1938:537). CLINTON COUNTY: *no specific locality* (Miller, 1955:122). DECATUR COUNTY: sec. 13, Woodland Twp. (Hendrickson, 1954:25). DES MOINES COUNTY: 5 mi. W Burlington (Van Gelder, 1959:273). DICKINSON COUNTY: *no specific locality* (Stephens, 1922:59). DUBUQUE COUNTY: *no specific locality* (Miller, 1955:122). FAYETTE COUNTY: *no specific locality* (Scott, 1938:537). FLOYD COUNTY: *no specific locality* (Brown, 1917:30). GREENE COUNTY: Churdan (record on file, U.S. Biological Survey). HAMILTON COUNTY: *no specific locality* (Scott, 1938:537). HANCOCK COUNTY: Pilot Knob State Park (Blagen, 1967:208). HARDIN COUNTY: 3 mi. N, 1 mi. W Hubbard (Bowles, field notes). JACKSON COUNTY: Sabula (Bailey, 1915:355). JOHNSON COUNTY: Solon (Bailey, 1915:355); *no specific locality* (Nutting, 1895:43). KEOKUK COUNTY: What Cheer

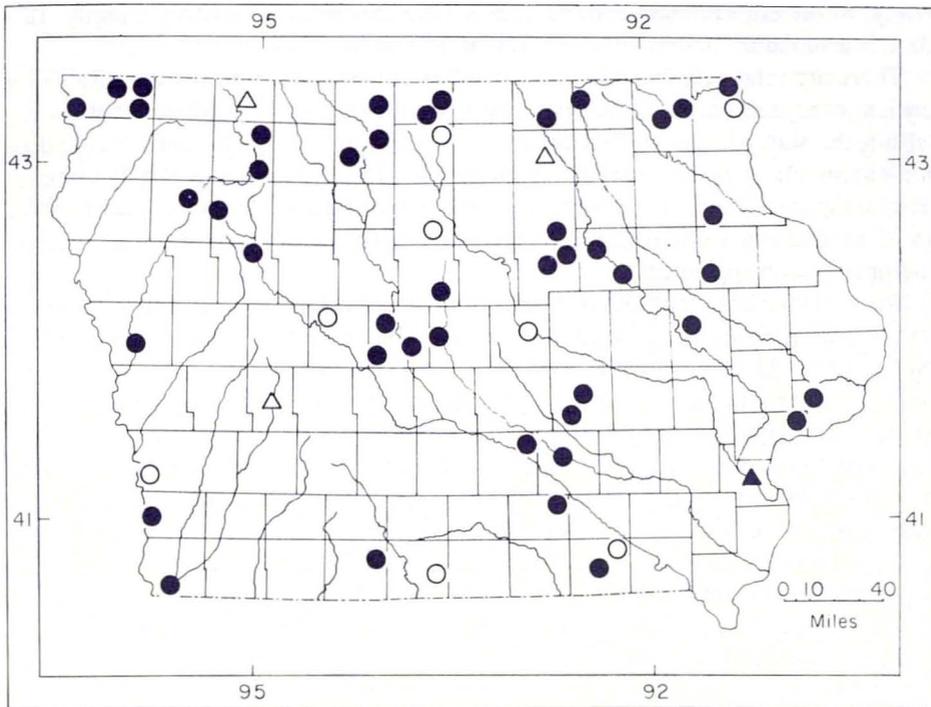


FIG. 53.—Distribution of *Mephitis mephitis hudsonica* in Iowa. For explanation of symbols see Fig. 3.

(Bailey, 1915:355). LINN COUNTY: Cedar Rapids (record on file, U.S. Biological Survey). MARSHALL COUNTY: *no specific locality* (Gabrielson, 1921:149). MONROE COUNTY: sec. 9, Franklin Twp. (Van Gelder, 1959:273). MUSCATINE COUNTY: Muscatine (Bailey, 1915:355). POLK COUNTY: Des Moines (Parker, 1871b:761). POTTAWATTAMIE COUNTY: Council Bluffs (record on file, U.S. Biological Survey). POWESHIEK COUNTY: Grinnell (Van Gelder, 1959:273). SAC COUNTY: *no specific locality* (Spurrell, 1917:278). STORY COUNTY: *Colorado [probably Colo]* (Van Gelder, 1959:273). TAMA COUNTY: Tama (Joyce and Eddy, 1944:214). VAN BUREN COUNTY: vicinity Stockport (Crabb, 1948:201). WINNESHIEK COUNTY: Decorah (Bailey, 1915:355). WRIGHT COUNTY: *no specific locality* (Scott, 1938:537).

***Mephitis mephitis hudsonica* Richardson**
Striped Skunk

1829. *Mephitis americana* var. *hudsonica* Richardson, Fauna Boreali-Americana, 1:55 (type locality, plains of Saskatchewan, Canada).

1934. *Mephitis mephitis hudsonica*, Hall, Univ. California Publ. Zool., 40:368, 5 November.

Distribution in Iowa.—Statewide (see Fig. 53).

The striped skunk is common to abundant throughout Iowa, although continuously trapped as an important furbearer since early settlement of the state. Probably on geographic grounds, Scott (1937:62) assigned specimens from northern Iowa to the subspecies *hudsonica*, but Howell (1901:31) and Scott (*loc. cit.*) assigned individuals from Delaware County and Story County, respec-

tively, to the adjacent southern race, *avia* (the specimen from Story County, ISU 38a, is a subadult male with small cranial measurements).

There are relatively few adult specimens of this species from Iowa available for critical examination; those that have been studied suggest a north-south size cline within the state similar to that found by Jones (1964:294) in Nebraska. Cranial measurements of adults from northern and southern Iowa are generally comparable to those of skunks from Nebraska and eastern Kansas that have been referred to *M. m. hudsonica* and *M. m. avia*, respectively (see Table 8 for cranial measurements of Iowan specimens).

Jones (1964:294) tentatively assigned all striped skunks from Nebraska to the subspecies *hudsonica*, but suggested the possibility that specimens from eastern Nebraska might be intergrades with *avia*. Cockrum (1952:255) considered specimens from northeastern Kansas as assignable to the subspecies *avia*. Striped skunks from north-central Iowa are as large as those I have examined from northern Nebraska and the few males I have seen from south-central Iowa have measurements greater than those of the type specimen of *avia* (Howell, 1901:30). Although I have not examined topotypes of *avia* (type locality, San Jose, Mason County, Illinois), I am inclined at present tentatively to consider the name *M. m. hudsonica* the most applicable for striped skunks throughout Iowa.

The subspecies *avia* is not particularly well defined (see Howell, 1901:30-31) and the name has been applied to individuals from a small geographic area in the center of the range of the species. When the genus *Mephitis* is revised, specimens presently considered as *avia*, may be referable to the subspecies *mesomelas*, a name applicable to striped skunks from the south-central United States.

Specimens examined (79).—ALLAMAKEE COUNTY: within 3 mi. New Albin, 1 (WSU). BLACK HAWK COUNTY: vicinity Cedar Falls, 2 (UNI); Gilbertville, 1 (UNI). BOONE COUNTY: Pilot Mound, 1 (ISU); Luther, 1 (ISU); Berkley, 2 (ISU). BUENA VISTA COUNTY: 5 mi. N, 6 mi. W Storm Lake, 1 (BV). BUTLER COUNTY: New Hartford, 1 (CC). CHEROKEE COUNTY: 3 1/2 mi. N Cherokee, 1 (BV); *no specific locality*, 1 (SM). CLAY COUNTY: Dewey's Pasture, 1 (ISU); Webb, 5 (AMNH); *no specific locality*, 2 (UMMZ). CLAYTON COUNTY: Edgewood, 1 (CC). DAVIS COUNTY: Bloomfield, 2 (ISU). DELAWARE COUNTY: Robinson, 1 (CC). FREMONT COUNTY: Hamburg, 1 (ISU). GRUNDY COUNTY: Fairfield Twp., 1 (ISU); 6 mi. N Grundy Center, 1 (CUI). HAMILTON COUNTY: Jewell, 1 (ISU). HOWARD COUNTY: Riceville, 2 (ISU). KOSSUTH COUNTY: Lakota, 1 (ISU); Titonka, 1 (ISU); Algona, 3 (ISU). LINN COUNTY: Alburnett, 1 (CC). LOUISA COUNTY: *no specific locality*, 1 (SUI). LYON COUNTY: sec. 34, Riverside Twp., 1 (ISU); sec. 35, Elgin Twp., 2 (ISU); sec. 20, Lyon Twp., 1 (ISU); sec. 26, Lyon Twp., 1 (ISU); sec. 20, Dale Twp., 1 (ISU). MAHASKA COUNTY: 3 mi. N Oskaloosa, 1 (KU); 1/4 mi. W Oskaloosa, 1 (KU). MARION COUNTY: 1 mi. N, 2 mi. E Pella, 1 (CUI); 1/2 mi. S, 1 mi. E Pella, 1 (KU). MILLS COUNTY: Missouri River, 1 (ISU). MITCHELL COUNTY: Osage, 5 (ISU). MONONA COUNTY: sec. 27, Belvedere Twp., 1 (ISU). MONROE COUNTY: 3 mi. N, 4 1/2 mi. E Albia, 1 (KU). MUSCATINE COUNTY: vicinity Stockton, 1 (DPM). POWESHIEK COUNTY: 8 mi. N Montezuma, 1 (KU); 3/4 mi. W Montezuma, 1 (KU). RINGGOLD COUNTY: 2 mi. SE Beaconsfield, 1 (ISU). SAC COUNTY: 5 mi. S, 1 3/4 mi. W Newell, 1 (BV). SCOTT COUNTY: near Maysville, 1 (DPM). STORY COUNTY: Ames, 1 (ISU). WINNEBAGO COUNTY: Lake Mills, 1 (ISU); Forest City, 2 (ISU). WINNESHIEK COUNTY: Lower Dam, 1 (UMMZ); Decorah, 13 (CC).

Additional records.—ALLAMAKEE COUNTY: *New Albin* (Hoslett, 1965:375); Lansing (record on file, U.S. Biological Survey). DAVIS COUNTY: Eldon Fox Range [1 mi. N, 5 mi. E Floris] (Scott and Klimstra, 1955:31). DECATUR COUNTY: sec. 13, Woodland Twp. (Hendrickson, 1954:25). DICKINSON COUNTY: *no specific locality* (Stephens, 1922:59). FLOYD COUNTY:

TABLE 8.—Cranial measurements of adult *Mephitis mephitis hudsonica* from Iowa. Super-script numbers indicate sample size when less than listed in left-hand column.

Number of specimens averaged, or catalogue number	Condylobasal length	Zygomatic breadth	Postorbital constriction	Mastoid breadth	Palatal length	Length of maxillary toothrow
Northern Iowa (Boone County and counties north thereof)						
Average 10 (♂)	78.6	50.9 ⁹	19.0	43.2	30.6	22.7
Minimum	76.3	48.8	16.9	40.5	29.7	21.1
Maximum	80.5	53.5	20.0	45.4	31.8	24.6
SD ±	1.81	1.54	0.88	1.38	0.78	1.01
Average 12 (♀)	70.9	44.8	18.3	37.9	28.2	21.9
Minimum	68.6	43.8	16.7	36.5	26.0	20.7
Maximum	72.4	45.9	20.0	39.0	29.6	23.0
SD ±	1.33	0.61	1.78	0.87	1.09	0.66
Southern Iowa (Marion, Poweshiek, and Ringgold counties)						
Average 3 (♂)	72.8	48.1	19.2	41.0	28.3	21.6
Minimum	70.9	45.5	18.7	39.0	27.5	20.6
Maximum	74.2	51.5	20.2	43.2	29.5	22.9
SD ±	1.69	3.08	0.84	2.11	1.04	1.18
Mahaska and Monroe counties, respectively						
KU 109833, ♀	69.7	44.5	20.0	37.0	27.5	20.9
KU 108076, ♀	67.7	42.7	16.6	37.0	27.5	20.9

no specific locality (Brown, 1917:29). GREENE COUNTY: Churdan (record on file, U.S. Biological Survey). HANCOCK COUNTY: Pilot Knob State Park (Blagen, 1967:208). DELAWARE COUNTY: *no specific locality* (Howell, 1901:31). MARSHALL COUNTY: Marshalltown (Gabrielson, 1921:148). POTTAWATTAMIE COUNTY: Council Bluffs (record on file, U.S. Biological Survey). SAC COUNTY: *no specific locality* (Spurrell, 1917:278). WRIGHT COUNTY: "Walled Lake" [Wall Lake] (Aldrich, 1877:687).

Lutra canadensis canadensis (Schreber)

River Otter

1776. *Mustela lutra canadensis* Schreber, Die Säugtiere . . . Theil 3, Heft 18, pl. 126b [type locality, eastern Canada (= Quebec)].

1823. *Lutra canadensis*, Sabine, in Franklin, Narrative of a journey to the shores of the Polar Sea in . . . 1819-22, p. 653.

Distribution in Iowa.—Formerly statewide in suitable habitats; recently recorded only along the Mississippi River and adjacent tributaries south to Scott County and along the Missouri River (see Fig. 54).

Prior to settlement of Iowa, the otter was abundant along major rivers and their tributaries throughout the state. Trapping pressure, pollution of streams, and agricultural activities of early settlers drastically reduced populations of this species. By 1840, Galland (1921:500) considered the otter to be rare in the state, although occasional individuals were reported from the interior of Iowa in the late 1800's and early 1900's (Scott, 1937:61).

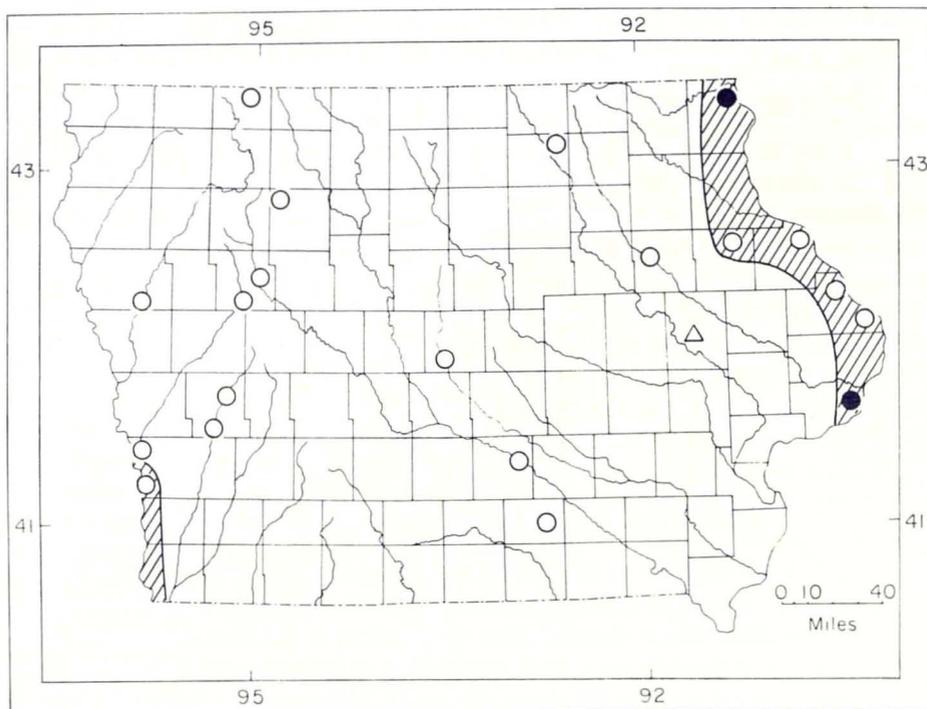


FIG. 54. Records of occurrence of *Lutra canadensis canadensis* in Iowa. For explanation of symbols see Fig. 3. The shaded area represents the present distribution.

Prior to December 1969, when a female otter was taken at Lake Manawa near Council Bluffs, Pottawattamie County, and others were sighted in the same vicinity (D. E. King, Iowa Conservation Commission, personal communication), the last authentic Iowan record of *Lutra* in the Missouri River drainage was from Smithland, Woodbury County, in 1929 (Sanderson, 1954:52).

Evidently the otter never was extirpated in the upper Mississippi River and its tributaries. Through a program of complete protection, *Lutra* increased in numbers in southern Minnesota (Gunderson and Beer, 1953:150), and by the early 1940's there were a number of reports of otters along the Mississippi River in Allamakee County. The species has continued to expand its range southward and periodically individuals are taken accidentally in commercial fishing nets or beaver traps in eastern Iowa counties. The southernmost recent record known to me is a specimen (DPM 494) from Grant's Slough, near Princeton, Scott County, taken on 11 April 1966. On the Illinois side of the Mississippi River, the otter "has been seen or taken in 25 counties" since 1900 (Hoffmeister and Mohr, 1957:106).

Polder (1958:560) reported little recent movement of otters toward the interior of the state from the Mississippi River and the only interior record evidently known to him was from Elk Creek, near Colesburg, Delaware County. Under complete protection, along with continuous efforts to decrease water pollution and improve streamside habitats in the state, this species may increase in num-

bers and perhaps will reach the former limits of its geographic range in the central United States.

All specimens of otter from Iowa that I have examined are from the Mississippi River and, on geographic grounds, are best referred to the northern subspecies, *L. c. canadensis*. The subspecies, *L. c. interior*, which occurs in Nebraska (Jones, 1964:296) also may inhabit western Iowa.

After this report was completed, van Zyll de Jong (1972) revised the river otters and employed the generic name *Lontra* for new world representatives. Inasmuch as I have not had the opportunity to review his findings, I here employ *Lutra*.

Specimens examined (5).—ALLAMAKEE COUNTY: Mississippi River, 5 mi. N Lansing, 1 (ISU); near Lansing, 1 (ISU); no specific locality, 1 (SUI). SCOTT COUNTY: Princeton, 1 (DMP); Grant's Slough, near Princeton, 1 (DPM).

Additional records (Bowles, 1971:422-423, unless otherwise indicated).—BUCHANAN COUNTY: Wapsipinicon River, near Independence. DELAWARE COUNTY: Elk Creek, near Colesburg (Polder, 1958:560). DICKINSON COUNTY: Spirit Lake (Mosher, 1882:66). DUBUQUE COUNTY: Spechts Ferry (Polder, 1958:560). FLOYD COUNTY: Little Cedar River. JACKSON COUNTY (Sanderson, 1954:55): between Bellevue and Gordon's Ferry; Running Slough, Green Island Bottoms. LINN COUNTY: no specific locality (Osborn, 1905:567). MARION COUNTY: Des Moines River, near Harvey (Van Hynning, 1913:311). MONROE COUNTY: Albia (Van Hynning, 1913:12). POCAHONTAS COUNTY: Swan Lake Twp. POTTAWATTAMIE COUNTY: Boyer River; Lake Manawa, near Council Bluffs (see text). SAC COUNTY (Spurrell, 1917:227): Sac City; Wall Lake. SHELBY COUNTY: near Kirkman; *Nishnabotna River, near Harlan*. STORY COUNTY: Cambridge (Scott, 1937:61). WOODBURY COUNTY: near Smithland (Sanderson, 1954:52).

Family FELIDAE

Key to Iowan Felids

1. Tail more than twice length of hind foot; premolars 3/3; zygomatic breadth more than 110 *Felis concolor*, p. 137
- 1'. Tail shorter than hind foot; premolars 2/2; zygomatic breadth less than 110 2
- 2.(1') Tip of tail black all around; jugular foramen separate from anterior condyloid foramen *Lynx canadensis*, p. 139
- 2'. Black at tip of tail restricted to dorsal blotch; jugular foramen and anterior condyloid foramen confluent *Lynx rufus*, p. 139

***Felis concolor schorgeri* Jackson**

Mountain Lion

1955. *Felis concolor schorgeri* Jackson, Proc. Biol. Soc. Washington, 68:149, 31 October (type locality, near Appleton, Outagamie Co., Wisconsin).

Distribution in Iowa.—Formerly probably statewide, now extirpated (see Fig. 55).

The mountain lion undoubtedly occurred in most wooded areas of Iowa during the early period of settlement, although no museum specimens are available to verify the taxonomic status of this felid in the state. I know of no specific instances of occurrence in the southeastern part of Iowa, but there are several records of mountain lions from other parts of the state (Bowles, 1971:423).

To the west, Jones (1964:299) reported two specimens of *F. concolor* from northern Nebraska, as well as literature records from along the Missouri River.

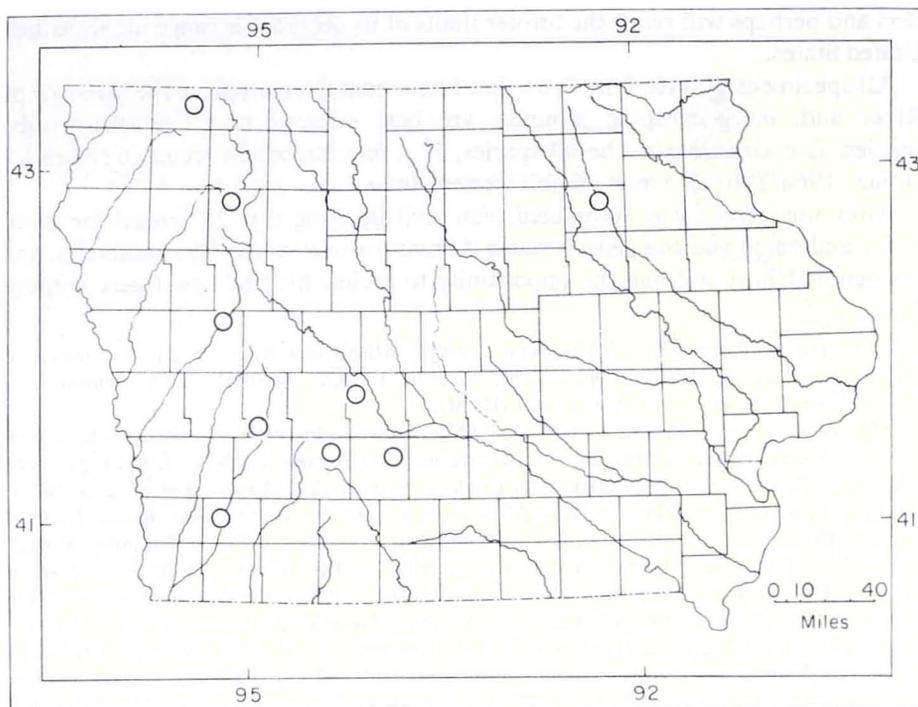


FIG. 55.—Records of occurrence of *Felis concolor schorgeri* in Iowa. For explanation of symbols see Fig. 3.

Cory (1912:280) cited several records from northeastern Illinois but none from the vicinity of the Mississippi River. In addition, Roberts (1945:18) wrote that "five or six panthers" were killed in 1841 by Sioux Indians on the Cedar River in what is now either southern Minnesota or northern Iowa.

It is impossible to know when the last mountain lion was seen or killed within the borders of the state. For example, Van Hyning (1913:312) reported that an individual was shot on an island in Rush Lake, Osceola County, on 13 April 1909. It is doubtful that the incident occurred at that late date, however.

The subspecific name *schorgeri* has been applied to this species in Iowa and adjacent states (see map, Hall and Kelson, 1959:957), and is used herein, although with strong reservations. Jones (1964:300) referred *F. concolor* in Nebraska to the subspecies *hippolestes*. No barriers to dispersal of this species existed in this part of its range and it thus seems unlikely that noteworthy geographic variation existed among populations in Iowa and adjacent states.

Specimens examined.—None.

Additional records (Bowles, 1971:423, unless otherwise indicated).—AUDUBON COUNTY: Buck Creek, Oak Field Twp. BUENA VISTA COUNTY: south bank Inyan Yankey [probably Little Sioux River], near Sioux Rapids. CRAWFORD COUNTY: Boyer River, Boyer Grove. DALLAS COUNTY: outlet Pilot Lake [SW 1/2 of sec. 3, Lincoln Twp.]. FLOYD COUNTY: near Floyd. MADISON COUNTY: Crawford Twp. MONTGOMERY COUNTY: Red Oak Twp. OSCEOLA COUNTY: Rush Lake (Van Hyning, 1913:312).

Lynx canadensis canadensis Kerr

Lynx

1792. *Lynx canadensis* Kerr, The animal kingdom . . . , 1, systematic catalogue inserted between pp. 32-33 and p. 157 (type locality restricted to Province of Quebec, Canada, by Miller and Kellogg, Bull. U.S. Nat. Mus., 205:777, 3 March 1955).

Distribution in Iowa.—Probably occurred irregularly in northern Iowa and southward along forested river valleys prior to settlement of the state; known certainly only by a single recent record (not mapped).

The only specimen of a lynx from Iowa known to me is an individual, probably a young male, that was obtained on 13 July 1963 near a wooded stream in Shelby County (Rasmussen, 1969:371). There are no other indisputable records of this species from the state, although it probably occurred irregularly in northern Iowa in the period of early settlement (Scott, 1937:67) and occasional individuals probably ranged southward along heavily forested river valleys.

Many early historical accounts referred to the "Canada lynx" or "lynx" without additional comments regarding the presence of the bobcat (see account of *L. rufus*). Van Hyning (1913:312), for example, reported that "a hunter on the island south of the city [Muscatine] today [14 January 1906] killed a Canadian lynx," but there is doubt as to the accuracy of identification (see Scott, 1937:67). On the other hand, Spurrell (1917:280) discussed the occurrence of both species of *Lynx* in Sac County and gave reasonably convincing evidence that "three [lynx] were trapped in 1869 and one in 1875."

I know of no specimens of *L. canadensis* from Illinois, but an individual collected in 1890 in northeastern Nebraska was reported by Jones (1964:302). Gunderson and Beer (1953:167) commented that the lynx is "no longer [as] abundant in Minnesota as it was in pioneer days, although a few are taken each year along the northern border of the state."

Some recent authors have employed the specific name *Lynx lynx* for this species.

Specimen examined (1).—SHELBY COUNTY: sec. 4, T. 80 N, R. 37 W, 1 (collection of J. Rasmussen).

Additional record.—SAC COUNTY: no specific locality (Spurrell, 1917:280).

Lynx rufus rufus (Schreber)

Bobcat

1777. *Felis rufa* Schreber, Die Säugthiere . . . , 3, pl. 109b (type locality, New York).

1817. *Lynx rufus*, Rafinesque, Amer. Monthly Mag., 2:46, November.

Distribution in Iowa.—Fairly common in northeastern part of state; rare in suitable habitats throughout remainder of Iowa (see Fig. 56).

The bobcat is relatively common in the hardwood forest region of northeastern Iowa and occurs sparingly in heavily wooded parks and river bottoms throughout the remainder of the state. The species probably was fairly common in Iowa and adjacent states at the time of settlement by white man, but now is rare in northern Missouri (Bennitt and Nagel, 1937:176), northern Illinois (Hoffmeister and Mohr, 1957:123), and eastern Nebraska (Jones, 1964:304). Bobcats still are

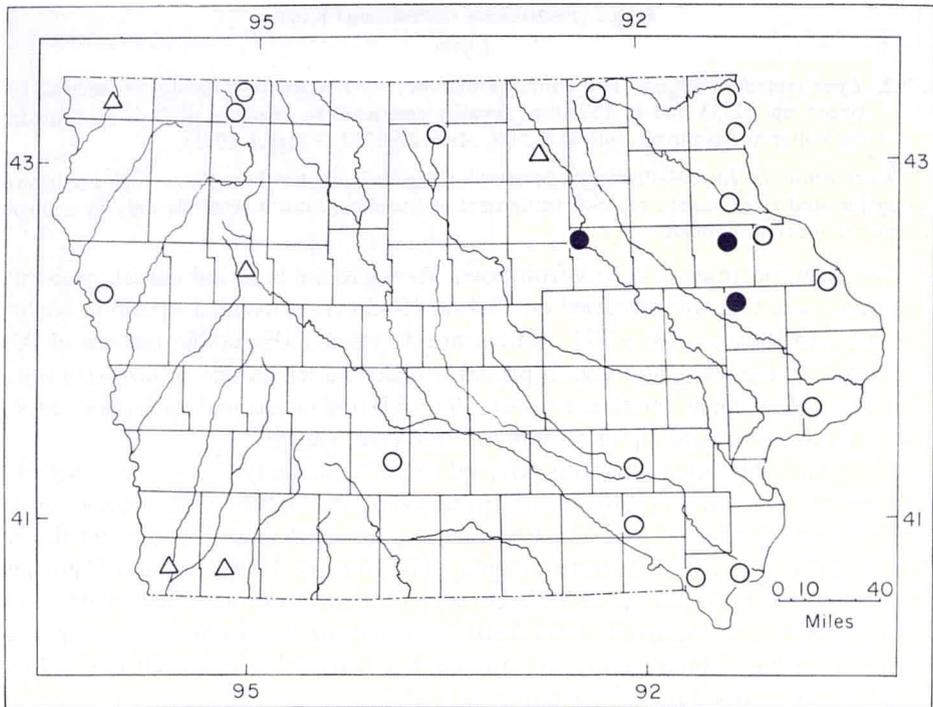


FIG. 56.—Distribution of *Lynx rufus rufus* in Iowa. For explanation of symbols see Fig. 3.

occasionally found in southern Minnesota, but the species is more abundant farther to the north in that state, perhaps owing to removal of coniferous forests and subsequent decline in populations of the lynx (*Lynx canadensis*) (Gunderson and Beer, 1953:167).

This felid often was referred to as “wild cat,” “bay lynx,” or “lynx” by early settlers and it thus is difficult to determine if historical reports refer to *L. rufus* or *L. canadensis*. Mosher (1882:66), for example, reported that four “Canada lynxes” were killed in the vicinity of Spirit Lake, Dickinson County, “since I came,” but because he made no mention of bobcats, I am reasonably certain he was referring to the latter species. In addition, Smith (1902:385), probably in reference to two of the above-mentioned animals, reported that “a lynx, known among the trappers as the ‘bobcat’ . . . was killed in the winter of 1869 or 1870 northwest of Spirit Lake . . . [and] another that winter . . . [was] killed west of West Okoboji.”

There are, to my knowledge, only three Iowan specimens of this species with accurate data in museum collections.

Specimens examined (3).—BLACK HAWK COUNTY: Snag Creek, near Cedar Falls, 1 (UNI). DELAWARE COUNTY: Plum Springs [= Greeley], 1 (USNM). JONES COUNTY: E of Monticello, 1 (ISU).

Additional records (Polder, 1958:562, unless otherwise indicated).—ALLAMAKEE COUNTY: Lansing (record on file, U.S. Biological Survey); Harpers Ferry (Iowa Conservationist,

1955, 14:110). BLACK HAWK COUNTY: *N of Waterloo* (Iowa Conservationist, 1954, 13:70). CLAYTON COUNTY: Turkey River [probably near Garber] (Iowa Conservationist, 1960, 19:10). DICKINSON COUNTY (Smith, 1902:385): NW of Spirit Lake; W of West Okoboji. DUBUQUE COUNTY: White Pine Hollow State Park; *Swiss Valley [not precisely located]*. FLOYD COUNTY: no specific locality (Brown, 1917:28). FREMONT COUNTY: no specific locality. HANCOCK COUNTY: Pilot Knob State Park (Blagen, 1967:208). HOWARD COUNTY: Bear Creek, near Lime Springs (Iowa Conservationist, 1954, 13:70). JACKSON COUNTY: near St. Donatus. JEFFERSON COUNTY: [between] Batavia and Libertyville. JONES COUNTY: *no specific locality* (Polder, 1953:722). KEOKUK COUNTY: North Skunk River, 7 mi. W Talleyrand (Iowa Conservationist, 1955, 14:110). LEE COUNTY: Harrison Twp.; Green Bay Twp. LYON COUNTY: no specific locality. MADISON COUNTY: near Patterson. PAGE COUNTY: no specific locality (Spurrell, 1917:280). SCOTT COUNTY: 2 mi. S Maysville (Des Moines Register, 16 December 1958). WOODBURY COUNTY: Sloan.

ORDER ARTIODACTYLA—Even-toed Ungulates

Probably all five of the species of native ungulates, which represent three families, were either eliminated or nearly so by European man in Iowa. Only the two species of deer now occur in the state—return of the white-tailed deer being a direct result of management by the Iowa Conservation Commission.

Key to Iowan Artiodactyla

1. Horns not deciduous, not branched, present in both sexes; lacrimal bone articulating with nasal bone (family Bovidae) *Bison bison*, p. 147
- 1'. Horns or antlers deciduous, branched, absent in females (except Antilocapridae); lacrimal bone not articulating with nasal bone 2
- 2.(1') Horns composed of fused hairs surrounding bony core, present in both sexes; lateral digits (dew hoofs) absent (family Antilocapridae) *Antilocapra americana*, p. 147
- 2'. Antlers composed of bone, absent in females, lateral digits present (family Cervidae) 3
- 3.(2') Tail straw-colored; maxillary tooththrow more than 110; canines present *Cervus elaphus*, p. 141
- 3'. Tail bicolored (white along with brown or black); maxillary tooththrow less than 110; canines lacking 4
- 4.(3') Tail relatively large, brown above, white below; each antler with one main beam giving rise to a series of tines; lacrimal pit shallow *Odocoileus virginianus*, p. 144
- 4'. Tail relatively small, tipped with black; each antler with main beam branching dichotomously forming two secondary branches, each with tines; lacrimal pit deep *Odocoileus hemionus*, p. 143

Family CERVIDAE—Wapiti, Deer, and Allies

Cervus elaphus canadensis Erxleben

Wapiti

1777. [*Cervus elaphus*] *canadensis* Erxleben, *Systema regni animalis* . . . , p. 305 (type locality, eastern Canada, probably the vicinity of Montreal according to V. Bailey, Proc. Biol. Soc. Washington, 48:187, 15 November 1935).

Distribution in Iowa.—Formerly abundant in prairie habitat throughout the state; extirpated by the late 1800's (see Fig. 57).

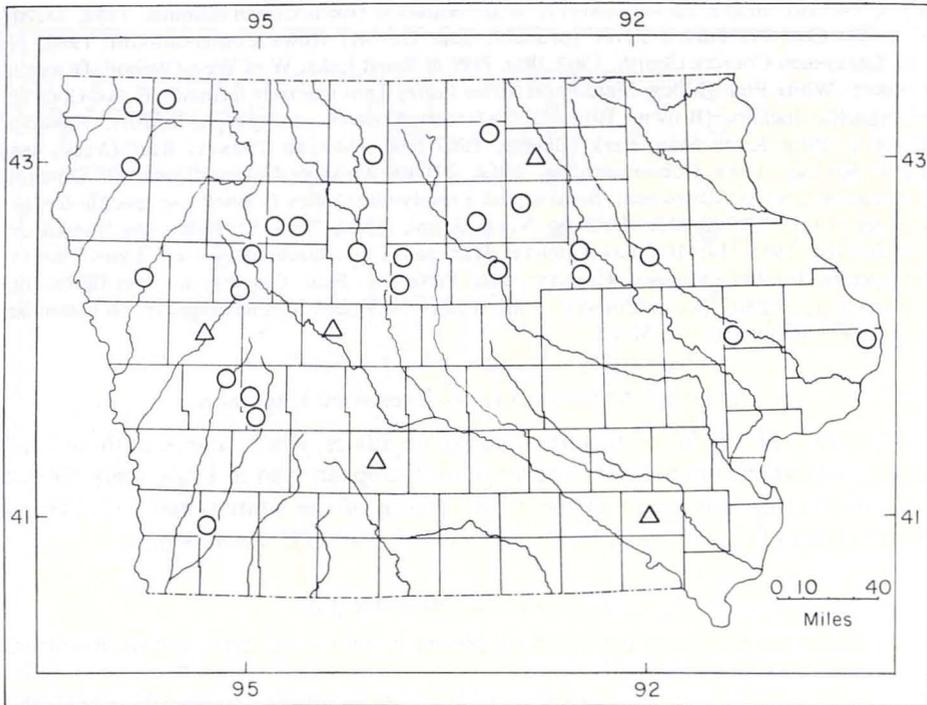


FIG. 57.—Former distribution of *Cervus elaphus canadensis* in Iowa. For explanation of symbols see Fig. 3.

The wapiti, or American elk, was abundant in the tall-grass prairie of western and central Iowa and probably occurred along prairie ridges in the eastern part of the state in the early 1800's. No museum specimens of this species taken in Iowa are available, but antlers and other skeletal remains have been found in scattered localities throughout the state. In addition, the historical literature contains numerous authenticated records of wapiti from many places in Iowa (Bowles, 1971). There are, however, few reports of *C. e. canadensis* from the extreme southeastern part of the state. This suggests that it may have been uncommon in the predominantly forested section of Iowa and, also, disappeared from there early in the period of settlement.

Winter herding behavior of this species made it easy prey for man, especially during heavy blizzards. According to the historical literature, large numbers of wapiti were slaughtered in the severe snow and ice storms of 1855-1857 and only occasional individuals subsequently were seen in central Iowa. A few small herds continued to exist in protected valleys in the northwestern part of the state until they were driven south, and many individuals killed, in the winter of 1871 (Bowles, 1971:424).

Specimens examined.—None.

Selected additional records (Bowles, 1971:424-425, unless otherwise indicated).—AUDUBON COUNTY: Indian Creek [Sharon Twp.]; near West Exira. BLACK HAWK COUNTY: Cedar Falls; near Hudson. BUCHANAN COUNTY: Independence. BUTLER COUNTY: vicinity Bristow.

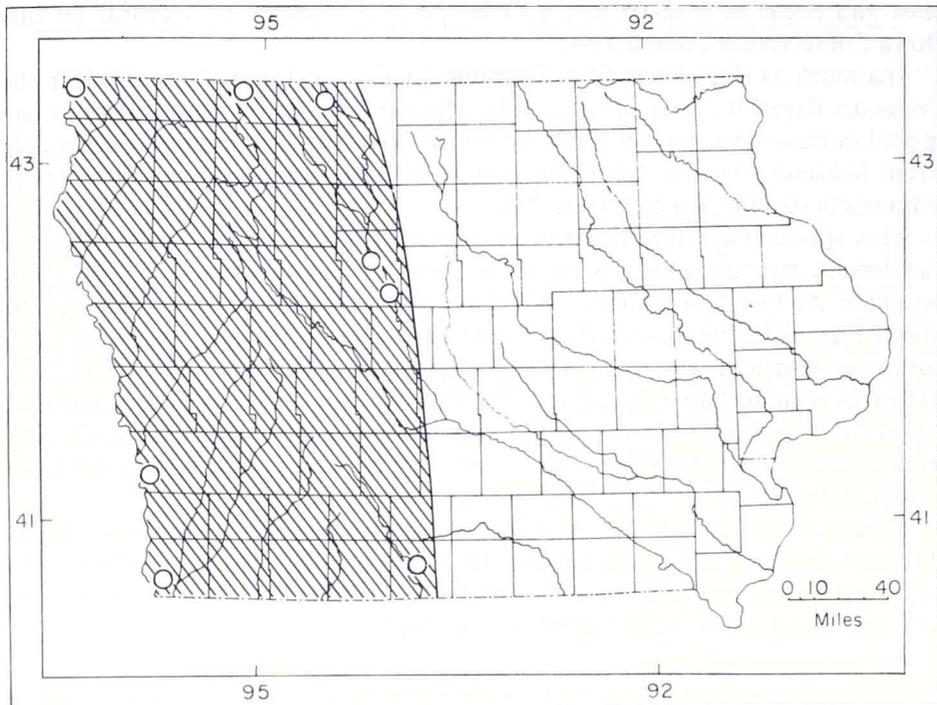


FIG. 58.—Distribution of *Odocoileus hemionus hemionus* in Iowa. For explanation of symbols see Fig. 3.

CERRO GORDO COUNTY: Shell Rock River, near Rock Grove [probably Rock Falls]. CLINTON COUNTY: Elk River Twp. CRAWFORD COUNTY: no specific locality. FLOYD COUNTY: no specific locality. FRANKLIN COUNTY: Reeve Twp. GREENE COUNTY: New Jefferson [not specifically located] (Allen, 1870:185). HAMILTON COUNTY: White Fox Creek, New Castle [=Webster City]; sec. 19, T. 87 N, R. 26 W. HARDIN COUNTY: Clay Twp. JEFFERSON COUNTY: no specific locality. JONES COUNTY: 1/2 mi. NW Fairview. KOSSUTH COUNTY: *W of Riverdale* [not precisely located]; S of Wesley. LYON COUNTY: T. 98 N, R. 44 W. MADISON COUNTY: no specific locality. MONTGOMERY COUNTY: Walnut Creek, West Twp. OSCEOLA COUNTY: Sibley. POCAHONTAS COUNTY: 7 mi. N Fonda (Spurrell, 1917:275); *NW 1/4 of sec. 35, Grant Twp.*; west branch Lizard Creek, Lincoln Twp. SAC COUNTY: Douglas Twp.; Wall Lake. SHELBY COUNTY: 3 mi. SE Irwin. SIOUX COUNTY: Orange City. WEBSTER COUNTY: near mouth Lizard Creek [Fort Dodge]. WOODBURY COUNTY: Little Sioux River.

***Odocoileus hemionus hemionus* (Rafinesque)**

Mule Deer

1817. *Cervus hemionus* Rafinesque. Amer. Monthly Mag., 1:436, October (type locality, mouth of Big Sioux River, Union Co., South Dakota).
 1898. *Odocoileus hemionus*. Merriam, Proc. Biol. Soc. Washington, 12:100, 30 April.

Distribution in Iowa.—Probably occurs irregularly in western third of state (see Fig. 58).

The mule deer probably occurs irregularly in western Iowa. Three Iowa-taken specimens, all males, have been reported in the literature in recent years (see Kline, 1959) but other individuals, including a female, have been taken as far

east and north as Webster and Emmet counties, respectively (records on file, Iowa Conservation Commission).

Inasmuch as a specimen from Fremont County was taken on an island in the Missouri River, it seems likely that the Missouri is only a partial barrier to dispersal of these deer. I know of no records in the scientific literature of mule deer from Missouri, but individuals have been reported from scattered localities in Minnesota (Gunderson and Beer, 1953:176).

This species may have occurred in western Iowa during the early period of settlement, but probably was no more common than at present. In 1843, for example, Audubon (Audubon, 1897:484) wrote: "We passed the river called the Sioux Pictout [Little Sioux River]. . . . On going along the bank bordering a long and wide prairie, thick with willows and small brushwood, we saw four Black-tailed Deer immediately on the bank." Although it is unclear whether Audubon observed these deer in Nebraska or in what is now northwestern Harrison County, it does seem likely that mule deer occurred on both sides of the Missouri River at that time.

There are, to my knowledge, no reports of this deer in eastern Iowa but at least one herd maintained in the late 1800's on a farm in Cerro Gordo County reportedly contained some mule deer (Lincoln, 1909:935) and it is not unlikely that occasional individuals escaped from captivity.

Specimens examined.—None.

Additional records (on file, Iowa Conservation Commission, unless otherwise indicated). —DECATUR COUNTY: near Leon (Sanderson, 1956:457). DICKINSON COUNTY: 5 mi. NW Spirit Lake. EMMET COUNTY: near Armstrong. FREMONT COUNTY: "on an island of the Missouri River," 4 1/2 mi. W, 1 mi. N Hamburg (Kline, 1959:148). LYON COUNTY: near Big Sioux River, NW 1/4 of sec. 25, T. 100 N, R. 49 W (Kline, *loc. cit.*). POTTAWATTAMIE COUNTY: near Council Bluffs. WEBSTER COUNTY: near Fort Dodge; near Stratford.

***Odocoileus virginianus macrourus* (Rafinesque)**

White-tailed Deer

1817. *Corvus* [*sic*] *macrourus* Rafinesque, Amer. Monthly Mag., 1:436, October (type locality, "Plains of the Kangar [= Kansas] River"; restricted to plains near Wakarusa Creek, Douglas Co., Kansas, by Miller and Kellogg, Bull. U.S. Nat. Mus., 205:804, 3 March 1955).
1902. *Odocoileus virginianus macrourus*, Cary, Proc. Nebraska Ornith. Union, 3:69, December.

Distribution in Iowa.—Presently common to locally abundant throughout the state; original populations extirpated prior to 1900 (see Fig. 59).

When European man first settled in Iowa in the early 1800's, the white-tailed deer was common in the hardwood forest of eastern Iowa and in wooded river valleys throughout the rest of the state. Although there may have been some initial increase in numbers as a result of agricultural practices of the early settlers, populations soon were reduced drastically by hunting pressure, particularly during winter. Many white-tailed deer were killed in eastern Iowa, for example, during the severe snow and ice storms in the winter of 1848-49. Similar drastic reductions in numbers took place in central Iowa in 1855-57, and in western counties in 1880-81 (Bowles, 1971:425).

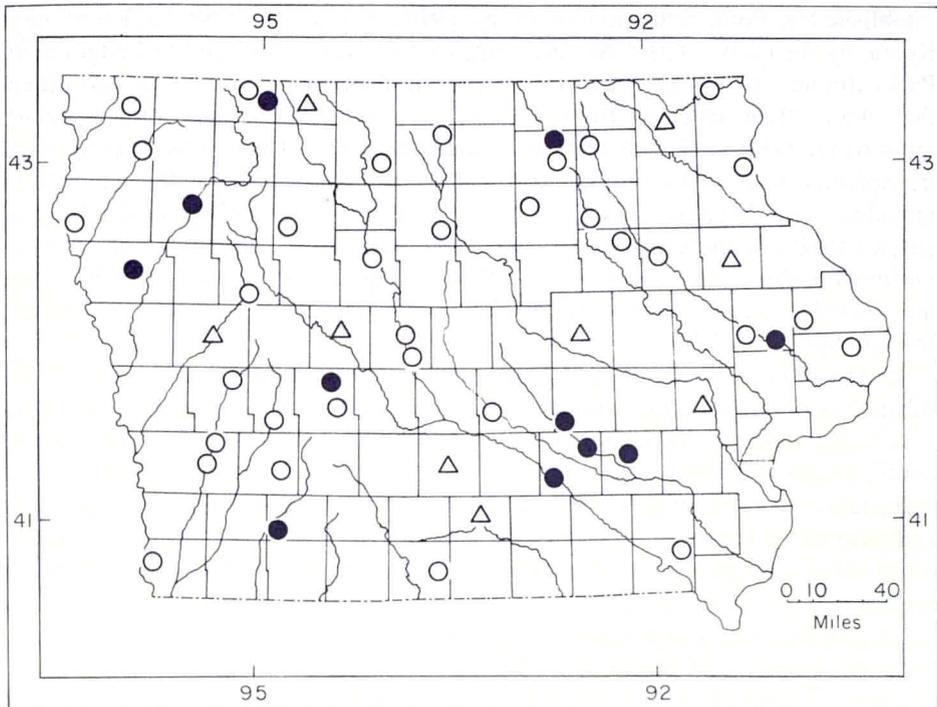


FIG. 59.—Distribution of *Odocoileus virginianus macrourus* in Iowa. For explanation of symbols see Fig. 3.

The last wild individual of which I have record (prior to escape of captives) is from northern Sac County in 1890 (Spurrell, 1917:26), although Nutting (1893:40) wrote: "A specimen of this deer was killed last winter [1891] in Johnson County. There is a strong probability, but not a certainty, that the animal had escaped confinement in another part of the state." A few deer may have continued to exist in the protected valleys of northeastern Iowa because there evidently was an early reestablishment of the species in that part of the state. Presumably, however, individuals also entered Iowa from adjacent parts of Minnesota and Wisconsin following statewide protection of *O. virginianus* in 1898 (see Madson, 1953).

Several captive herds of white-tailed deer were maintained in various parts of the state, at least for a time. In Cerro Gordo County, for example, a herd of white-tailed deer, some of which were obtained from Minnesota and Wisconsin, was established in the late 1800's (Lincoln, 1909:935). It is not unlikely that occasional individuals escaped from this captive herd, as was true elsewhere in the state.

The principal sources for reestablishment of the white-tailed deer in Iowa, however, were the captive herds in Avoca, Pottawattamie County, and Keota, Washington County. Both of these herds were started primarily with individuals captured in Nebraska (Scott, 1937:84; Sanderson and Speaker, 1954:615). As captive populations built up, individuals escaped and this species was again

established in Pottawattamie County by 1914, and along the Skunk River, near Keota, by the early 1920's. Another captive herd was established in Ledges State Park, Boone County, in 1928 with two individuals from Minnesota and others that were "live trapped from the Avoca herd" (Sanderson and Speaker, 1954:615). White-tailed deer from the Ledges State Park subsequently were transplanted to counties throughout the state (see Salinas, 1948, for localities of introductions). Between 1940 and the reopening of a hunting season for this species in 1953, there was a sharp increase in numbers and distribution of *O. virginianus* throughout Iowa. For further details on population growth during this period, the reader is referred to the detailed summary published by Sanderson and Speaker (1954).

Jones (1964:318), although referring all white-tailed deer in Nebraska to the subspecies *O. v. macrourus*, pointed out the difficulty of recognizing geographic races in the central United States. Because Nebraska was the primary source of populations presently occupying Iowa, it seems best to continue to use the sub-specific name *macrourus* for this species in Iowa at least until the systematics of this species is reviewed. It should be mentioned, however, that populations of white-tailed deer in Iowa in the early 1800's may have been primarily of eastern origin.

Specimens examined (22).—ADAMS COUNTY: 1 1/2 mi. S, 6 mi. E Corning, 1 (KU). CHEROKEE COUNTY: E of Cherokee, 1 (SM). CLINTON COUNTY: *no specific locality*, 1 (ISU). DICKINSON COUNTY: N of Superior, 1 (ISU). FLOYD COUNTY: 2 mi. N Floyd [label reads Mitchell County], 1 (ISU); Floyd Twp., 1 (ISU). GUTHRIE COUNTY: 4 1/2 mi. S, 1 mi. E Bayard, 1 (BV). JONES COUNTY: Oxford Junction, 1 (ISU). KEOKUK COUNTY: 2 mi. N, 1 mi. W Sigourney, 2 (KU); 1 1/2 mi. S Sigourney, 2 (KU). MAHASKA COUNTY: 2 mi. N, 1/2 mi. E New Sharon, 1 (KU); 5 1/2 mi. N, 3 1/2 mi. E Oskaloosa, 3 (KU); 3 mi. S, 3 mi. W Oskaloosa, 1 (KU); 4 1/2 mi. S, 2 mi. W Oskaloosa, 2 (KU). POTTAWATTAMIE COUNTY: *no specific locality*, 1 (ISU). POWESHIEK COUNTY: 2 1/2 mi. S, 1/2 mi. W Searsboro, 1 (KU). WOODBURY COUNTY: NW of Anthon, 1 (ISU).

Selected additional records (Bowles, 1971:426, unless otherwise indicated).—ALLAMAKEE COUNTY: [upper] Iowa River valley (Madson, 1953:101). AUDUBON COUNTY: Exira. BLACK HAWK COUNTY: Bennington Twp. BOONE COUNTY: Worth Twp. (Buxton, 1951:7); Colfax Twp.; Douglas Twp. (Buxton, *loc. cit.*). BREMER COUNTY: Janesville. BUCHANAN COUNTY: 2 mi. SE Independence. BUTLER COUNTY: Bristow. CASS COUNTY: Union Twp. CHICKASAW COUNTY: Deerfield Twp. CLAYTON COUNTY: vicinity McGregor (Peterson, 1952:158). CLINTON COUNTY: Waterford Twp. CRAWFORD COUNTY: Mason's Grove [not precisely located] (Spurrell, 1917:276). DECATUR COUNTY: sec. 13, T. 68 N, R. 24 W (Hubbard, 1952:11). DELAWARE COUNTY: *no specific locality* (Sohn, 1967:75). DICKINSON COUNTY: Spirit Lake. EMMET COUNTY: *no specific locality* (Sohn, 1967:75). FLOYD COUNTY: vicinity St. Charles [Charles City]. FREMONT COUNTY: 4 mi. SE McPaul. GREENE COUNTY: *no specific locality* (Sohn, 1967:75). GUTHRIE COUNTY: Highway 64, E of Panora (Swisher, 1940:409). HANCOCK COUNTY: Pilot Knob State Park (Blagen, 1967:208). HARDIN COUNTY: Clay Twp. JACKSON COUNTY: Maquoketa River, vicinity Maquoketa Caves (Swisher, 1940:399). JASPER COUNTY: Skunk River. JOHNSON COUNTY: *no specific locality* (Nutting, 1893:40). JONES COUNTY: 1/2 mi. NW Fairview. KOSSUTH COUNTY: Prairie Twp. LYON COUNTY: T. 98 N, R. 44 W. MAHASKA COUNTY: *Oskaloosa Twp.* MONROE COUNTY: *no specific locality* (Sohn, 1967:75). PLYMOUTH COUNTY: Sioux River, Sioux Twp. POCAHONTAS COUNTY: sec. 24, Dover Twp.; *Grant Twp.* POTTAWATTAMIE COUNTY (Scott, 1937:84): Avoca; N of Hancock. SAC COUNTY: near Lake View. SHELBY COUNTY: vicinity Irwin (Scott, 1937:84); 1/4 mi. S Copenhagen. TAMA COUNTY: *no specific locality* (Sohn, 1967:75). VAN BUREN COUNTY: Cedar Twp. WARREN COUNTY: *no specific locality* (Sohn, 1967:75). WEBSTER COUNTY: near mouth

Lizard Creek [Fort Dodge] (Allen, 1846:8). WINNESHIEK COUNTY: no specific locality (Sohn, 1967:75). WRIGHT COUNTY: Wall Lake (Scott, 1947:443).

Family ANTILOCAPRIDAE—Pronghorn

Antilocapra americana americana (Ord)

Pronghorn

1815. *Antelope Americanus* Ord, in Guthrie, A new geographical, historical, and commercial grammar . . . , ed. 2, 2:292, 308 (type locality, unknown—noted in the original description as found “on the plains and the high-lands of the Missouri”).

1818. *Antilocapra americana*, Ord, J. Phys. Chim. Hist. Nat. et Arts, 87:149.

Distribution in Iowa.—Formerly occurred in western part of state, now extirpated (not mapped).

The former presence of the pronghorn is noted in historical accounts of several western Iowa counties, and one source noted occurrence of this species as far east as Jefferson County (Bowles, 1971:426). The only record of actual sighting of pronghorn in Iowa, however, was reported by Jones (1960:249) from just north of the Little Sioux River in 1850, in what is now “northwestern Harrison County or southwestern Monona County.”

This species evidently was not observed by early explorers along this part of the Missouri River and perhaps dispersal was blocked by adjacent deciduous forests as was suggested by Jones (1964:321). He pointed out, however, that the riparian community was discontinuous to the north of Nebraska, and the pronghorn thus may have entered Iowa from South Dakota. Such may have been the case, for on 11 September 1844 Captain Allen (1846:14) and a party of dragoons were travelling southward along the east side of the Big Sioux River near the present site of Sioux Falls, South Dakota, and reported as follows: “In the afternoon, Jones killed an Antelope, and we saw ten more in a short distance among gentle hills of the prairie; I was surprised to meet them in this country.” Allen’s last comment suggests that although pronghorns occurred in this region—including Minnesota (see Roberts, 1945:16-17)—they were uncommon at that time. This species was also reported from western Missouri prior to settlement (McKinley, 1960:503).

Presumably this species occurred farther to the east at least sometime in the late Pleistocene period and perhaps during eastward expansions of the grasslands in the post-Pleistocene, especially during Atlantic time. It is of interest to note, for instance, that Hay (1924:284) reported part of a radius, presumably of *A. americana*, from a collection made “in the lead region of Wisconsin, Iowa, and Illinois” [= vicinity Dubuque, Iowa].

Records of occurrence.—See text.

Family BOVIDAE—Bovids

Bison bison bison (Linnaeus)

Bison

1758. [*Bos*] *bison* Linnaeus, Systema naturae, ed. 10, 1:72 (type locality restricted to ancient “Quivera,” central Kansas, by Hershkovitz, Proc. Biol. Soc. Washington, 70:31-32, 28 June 1957).

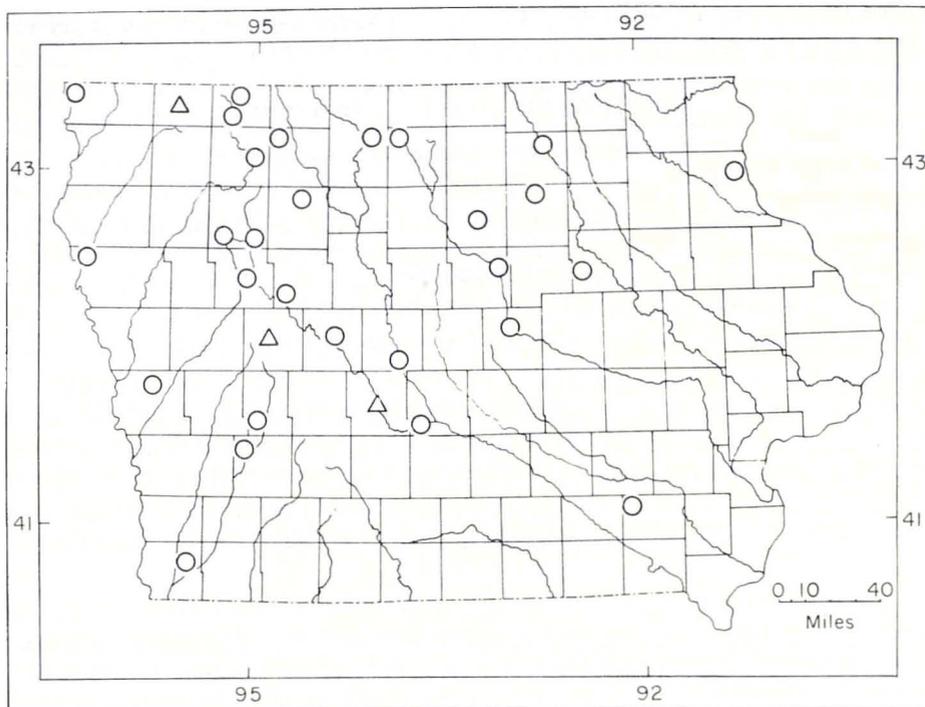


FIG. 60.—Former distribution of *Bison bison bison* in Iowa. For explanation of symbols see Fig. 3.

1888. *B[ison]. bison*, Jordan, Manual of the vertebrate animals . . . ed. 5, p. 337.

Distribution in Iowa.—Formerly common in the tall-grass prairie, and probably occurred locally elsewhere in the state; now extinct (see Fig. 60).

The bison was common in the tall-grass prairie areas in the early 1800's, but it probably was not as numerous in Iowa as in adjacent western states (Bowles, 1971:427). Although I have found no evidence of slaughter of large numbers of bison in Iowa by white man, it undoubtedly was extirpated by early hunters and settlers in the state. I know of no wild-taken museum specimens of this species from Iowa, but skeletal remains are preserved from various localities in the state (see especially Pammel, 1930).

In 1673, Joliet and Marquette reported bison in the vicinity of the present town of McGregor, Clayton County (Peterson, 1952:185), one of the few authenticated sightings of bison in eastern Iowa. There are, however, numerous references to the presence of "buffalo wallows" and trails in that region of the state in the historical literature.

The bison apparently disappeared from eastern Iowa early in the 1800's, and I have found no records of its occurrence in central Iowa after 1854. The last report of this species from the state, so far as I know, was from the Little Sioux River, Dickinson County, in 1870 (Bowles, 1971:427).

Specimens examined.—None.

Selected additional records (Bowles, 1971:427-428, unless otherwise indicated).—AUDUBON COUNTY: Buck Creek, Oak Field Twp. BLACK HAWK COUNTY: near Hudson. BOONE COUNTY: sec. 22, Cass Twp. BUENA VISTA COUNTY: Storm Lake; 1 1/2 mi. S Newell. BUTLER COUNTY: Greene. CALHOUN COUNTY: near Lake City. CARROLL COUNTY: no specific locality. CASS COUNTY: W of Atlantic. CLAYTON COUNTY: vicinity McGregor (Peterson, 1952:185). DALLAS COUNTY: no specific locality. DICKINSON COUNTY: *West Okoboji Lake*; East Okoboji Lake; Little Sioux River, Okoboji Twp. FLOYD COUNTY: NW of Charles City. FRANKLIN COUNTY: Maysville [sec. 27, Reeve Twp.]. FREMONT COUNTY: Manti [between Fisher and Walnut twps.]. GREENE COUNTY: near Jefferson. HANCOCK COUNTY: Buffalo Grove [NW corner]. HARRISON COUNTY: Boyer River, Boyer Twp. JEFFERSON COUNTY: near Packwood. KOSSUTH COUNTY: north branch Buffalo Creek. LYON COUNTY: northwestern corner (Allen, 1846:15). MARSHALL COUNTY: near Marietta. OSCEOLA COUNTY: no specific locality. PALO ALTO COUNTY: Lost Island Lake. POCAHONTAS COUNTY: SW 1/4 of sec. 24, Powhatan Twp. POLK COUNTY: near Des Moines. SAC COUNTY: 1 1/2 mi. S, 3 mi. W Sac City (Spurrell, 1917:275). WOODBURY COUNTY: vicinity Sioux City.

INTRODUCED MAMMALS

Family MURIDAE—Old World Rats and Mice

Mus musculus Linnaeus

House Mouse

1758. [*Mus*] *musculus* Linnaeus, *Systema naturae*, ed. 10, 1:62 (type locality restricted to Upsala, Sweden, by Thomas, *Proc. Zool. Soc. London*, p. 147, 22 March 1911).

Distribution in Iowa.—Common to abundant throughout the state (see Fig. 61).

The house mouse is common to locally abundant throughout the state and is especially numerous wherever man has provided sufficient food and shelter through his various activities. I have trapped few in or near woodlots or wooded borders of waterways.

There is no specific record of introduction of this species to Iowa, although it seems likely that it first occurred along the Missouri and Mississippi rivers and subsequently invaded the interior of the state. The house mouse first may have been brought to eastern Nebraska by Long's expedition up the Missouri River in 1819-20 (Jones, 1964:332) and, perhaps, was introduced into Iowa at about the same time. Spurrell (1917:282) reported that it was present in Sac County prior to 1870. Along the Mississippi River, Jackson (1961:258) suggested that *Mus* may have occurred in Prairie du Chien, Wisconsin, "by the close of the eighteenth century," and Kennicott (1857:109) reported this species "in considerable numbers" in Illinois by the mid-1850's. At least by the turn of the last century, the house mouse evidently was common throughout Iowa (Osborn, 1890:43).

Bailey (1918:211) reported *Mus* from stomach contents of a screech owl taken in Keokuk, Lee County, in 1885. Otherwise, the earliest-taken specimens of this species from Iowa known to me are from Johnson County (SUI 11663) and Burlington, Des Moines County (USNM 85112)—collected in 1894 and 1898, respectively.

Specimens examined (155).—ADAIR COUNTY: 5 mi. SW Stuart, 1 (ISU). ADAMS COUNTY: 6 mi. S, 2 mi. W Corning, 1 (ISU). ALLAMAKEE COUNTY: 1 mi. S New Albin, 1 (WSU); 6 mi.

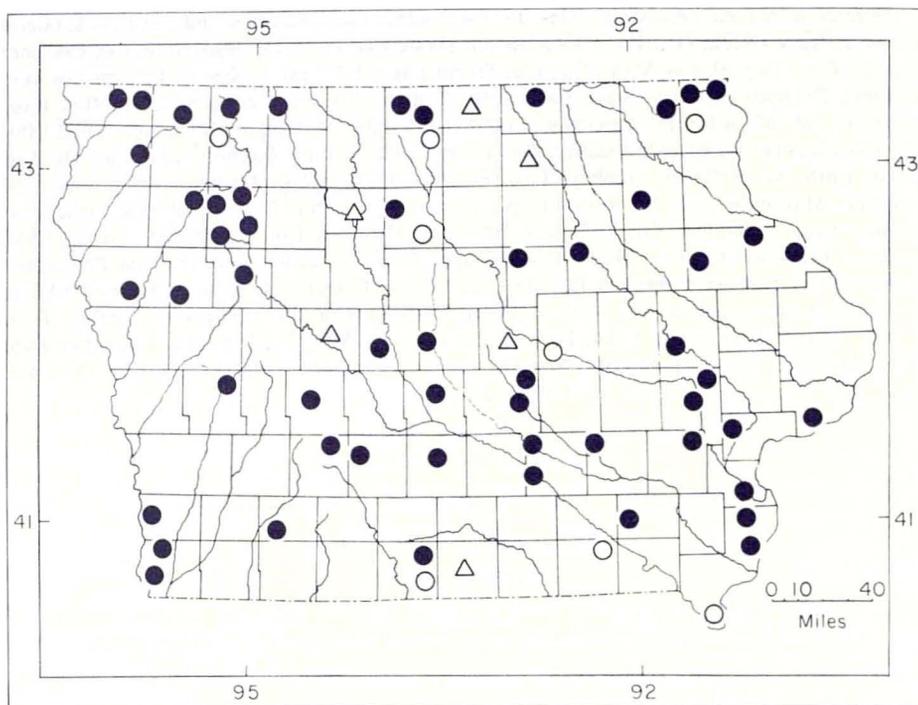


FIG. 61.—Distribution of *Mus musculus* in Iowa. For explanation of symbols see Fig. 3.

SW New Albin, 2 (UMMZ); English Bench, 1 (UMMZ); Upper Iowa River, Hanover Twp., 3 (UMMZ); Waterloo Creek, 1 (UMMZ). BLACK HAWK COUNTY: Cedar Falls and 5 mi. radius thereof, 14 (1 ISU, 13 UNI). BOONE COUNTY: SE 1/4 of SE 1/4 of sec. 1, T. 83 N, R. 25 W, 1 (ISU); 4 mi. S, 2 mi. E Ogden, 1 (ISU). BUENA VISTA COUNTY: 3 1/2 mi. E Sioux Rapids, 1 (ISU); 10 1/4 mi. N, 3 mi. W Alta, 1 (BV); 3 mi. N, 9 mi. E Storm Lake, 6 (BV); Storm Lake, 1 (BV); no specific locality, 2 (BV). CHEROKEE COUNTY: 10 mi. N Aurelia, 1 (BV). CLAY COUNTY: no specific locality, 1 (UMMZ). DECATUR COUNTY: High Point, 1 (ISU). DELAWARE COUNTY: SW 1/4 of NE 1/4 of sec. 5, T. 88 N, R. 6 W, 1 (ISU). DES MOINES COUNTY: Mediapolis, 1 (ISU); Burlington, 3 (USNM). DICKINSON COUNTY: 4 1/2 mi. E Milford, 2 (TTU). DUBUQUE COUNTY: Luxemburg, 1 (FMNH); Dubuque, 1 (ISU). ENMET COUNTY: 3 mi. W Estherville, 1 (ISU); 1 mi. SW Estherville, 1 (ISU). FAYETTE COUNTY: SE 1/4 of NE 1/4 of sec. 35, T. 93 N, R. 9 W, 1 (ISU). FREMONT COUNTY: 1 mi. W Tabor, 1 (NWM); 6 mi. N, 4 1/2 mi. W Hamburg, 1 (KU). GRUNDY COUNTY: sec. 26, T. 89 N, R. 18 W, 1 (ISU). GUTHRIE COUNTY: SE 1/4 of sec. 26, T. 80 N, R. 32 W, 1 (ISU). IDA COUNTY: N 1/2 of sec. 7, T. 86 N, R. 41 W, 1 (ISU). JASPER COUNTY: SE 1/4 of SE 1/4 of sec. 1, T. 81 N, R. 17 W, 1 (ISU); 2 mi. S Kellogg, 1 (ISU). JEFFERSON COUNTY: 4 mi. W Fairfield, 1 (ISU). JOHNSON COUNTY: NE 1/4 of SE 1/4 of sec. 23, T. 81 N, R. 5 W, 1 (ISU); Iowa City, 19 (AMNH); no specific locality, 1 (SU). KEOKUK COUNTY: 2 1/2 mi. NE What Cheer, 1 (ISU). LINN COUNTY: Cedar Rapids, 5 (CC); sec. 28, Bertram Twp., 1 (CC); no specific locality, 1 (ISU). LOUISA COUNTY: NE 1/4 of sec. 35, T. 74 N, R. 3 W, 1 (ISU). LYON COUNTY: sec. 29, Riverside Twp., 1 (ISU); sec. 26, Elgin Twp., 1 (ISU). MADISON COUNTY: SE 1/4 of sec. 14, T. 76 N, R. 29 W, 1 (ISU). MAHASKA COUNTY: NE 1/4 of sec. 33, T. 77 N, R. 17 W, 1 (ISU); 11 1/2 mi. W Oskaloosa, 1 (KU). MILLS COUNTY: 2 mi. NW Glenwood, 1 (NWM); Glenwood Twp., 2 (ISU). MITCHELL COUNTY: 1 1/2 mi. N, 2 mi. E Stacyville, 1 (ISU). MUSCATINE COUNTY: sec. 17, Pike Twp., 1 (ISU). OSCEOLA COUNTY: Melvin, 2 (SUI). POLK COUNTY: 1 1/2 mi. NE Ankeny, 1 (ISU). SAC COUNTY: 2 mi.

S, 3 mi. W Sac City, 1 (BV). SCOTT COUNTY: Davenport, 1 (DPM). SHELBY COUNTY: 4 1/2 mi. SE Irwin, 1 (ISU). SIOUX COUNTY: 1/4 mi. NW Hospers, 1 (ISU). STORY COUNTY: Ames and 6 mi. radius thereof, 13 (ISU). WARREN COUNTY: Indianola, 1 (ISU). WASHINGTON COUNTY: 1 mi. W Riverside, 1 (ISU). WINNEBAGO COUNTY: 1/2 mi. N, 3 1/2 mi. W Thompson, 1 (KU); 1 mi. N, 3 mi. W Forest City, 6 (ISU). WINNESHIEK COUNTY: Canoe Creek, 1 (UMMZ). WOODBURY COUNTY: NW 1/4 of sec. 1, T. 86 N, R. 44 W, 1 (ISU). WRIGHT COUNTY: SE 1/4 of NW 1/4 of sec. 24, T. 92 N, R. 26 W, 1 (ISU).

Additional records.—ALLAMAKEE COUNTY: Waukon (Hoslett, 1965:371). BOONE COUNTY: *Moingona Fox Range, about 5 mi. S Boone* (Scott, 1947:474). CLAY COUNTY: sec. 22, Waterford Twp. (Scott, 1940:590). DAVIS COUNTY: Eldon Fox Range [1 mi. N, 5 mi. E Floris] (Scott and Klimstra, 1955:41). DECATUR COUNTY: sec. 13, Woodland Twp. (Hendrickson, 1954:25). FLOYD COUNTY: no specific locality (Brown, 1917:26). FREMONT COUNTY (Findley *et al.*, 1954:212); 4 mi. S, 9 mi. W Sidney; 5 mi. S, 2 mi. W Sidney. GREENE COUNTY: no specific locality (Weller and Blagen, 1970:293). HANCOCK COUNTY: Pilot Knob State Park (Blagen, 1967:208). HUMBOLDT COUNTY: no specific locality (Weller and Blagen, 1970:293). LEE COUNTY: Keokuk (Bailey, 1918:211). MARSHALL COUNTY: no specific locality (Gabrielson, 1921:148). SAC COUNTY: *no specific locality* (Spurrell, 1917:282). STORY COUNTY: *near Ames* (Polderboer *et al.*, 1941:116). TAMA COUNTY: Tama (Eddy and Joyce, 1944:320). WAYNE COUNTY: no specific locality (Weller and Blagen, 1970:293). WORTH COUNTY: no specific locality (Weller and Blagen, 1970:293). WRIGHT COUNTY: Wall Lake (Scott, 1947:472).

***Rattus norvegicus* (Berkenhout)**

Norway Rat

1769. *Mus norvegicus* Berkenhout, Outlines of the natural history of Great Britain and Ireland, 1:5 (type locality, England, where the species was introduced from Asia, probably via Continental Europe, in the early 1700's).
1916. *Rattus norvegicus*, Hollister, Proc. Biol. Soc. Washington, 29:126, 6 June.

Distribution in Iowa.—Statewide in proximity to human habitations (see Fig. 62).

The Norway rat probably was established in towns along the Mississippi and Missouri rivers prior to the mid-nineteenth century and evidently was transported to the interior of the state during early settlement. Galland (1921:500) noted that in 1840 "rats are continually arriving, with almost every accession to our white population, though it is clear that they are not natives to the country." It is not possible, however, to know if Galland meant the Norway rat rather than the black rat (*Rattus rattus*), which previously may have been established in some parts of Iowa (see accounts of species of unverified occurrence), nor is it clear whether he was referring to the entire state or to a specific county or city. Although *R. norvegicus* was first reported in Iowa by Goding (1883:331), the only specific early record of an introduction was an individual that arrived in a "box of goods from New York" in Sac County in 1858 (Spurrell, 1917:282).

This species probably became established throughout the state by the late 1800's and is now especially common in the vicinity of human habitations.

Specimens examined (56).—ADAIR COUNTY: 5 mi. SE Stuart, 1 (ISU). ADAMS COUNTY: Corning, 1 (NWM). BOONE COUNTY: Napier, 1 (ISU). BUENA VISTA COUNTY: Storm Lake and 5 mi. radius thereof, 7 (BV); *no specific locality*, 1 (BV). CERRO GORDO COUNTY: SE 1/4 of SE 1/4 of sec. 33, T. 95 N, R. 19 W, 1 (ISU). DELAWARE COUNTY: Prairie Twp., 1 (ISU). DES MOINES COUNTY: Burlington, 5 (USNM). DICKINSON COUNTY: Spooky Hollow, Little Sioux River, 2 6/10 mi. W hwy. 32, 1 (TTU). EMMET COUNTY: 1 mi. N, 2 mi. E Estherville, 3

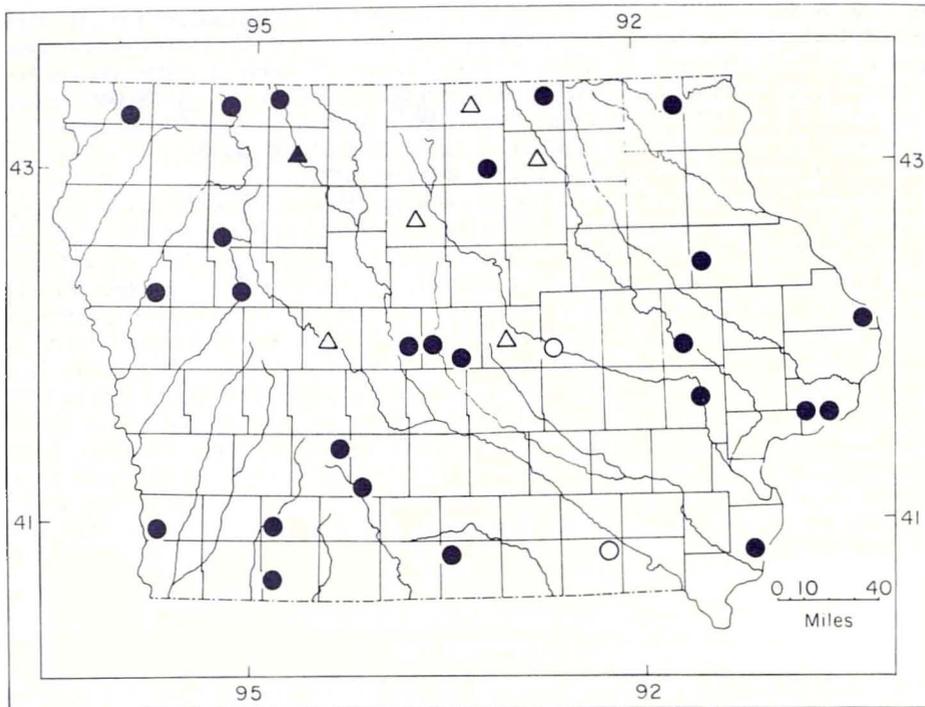


FIG. 62.—Distribution of *Rattus norvegicus* in Iowa. For explanation of symbols see Fig. 3.

(ISU). JACKSON COUNTY: Sabula, 1 (ISU). JOHNSON COUNTY: Iowa City, 1 (AMNH). LINN COUNTY: Cedar Rapids, 4 (CC); Marion, 1 (ISU). LYON COUNTY: sec. 28, Wheeler Twp., 1 (ISU). MADISON COUNTY: SE 1/4 of sec. 14, T. 76 N, R. 29 W, 1 (ISU). MILLS COUNTY: 10 mi. S Glenwood, 1 (NWM). MITCHELL COUNTY: 1 1/2 mi. N, 2 mi. E Staceyville, 1 (ISU). PALO ALTO COUNTY: no specific locality, 1 (BV). SAC COUNTY: 4 mi. W Lake View, 1 (BV). SCOTT COUNTY: Walcott, 4 (DPM); Davenport, 1 (DPM); no specific locality, 7 (DPM). STORY COUNTY: Ames, 2 (ISU); 1/2 mi. E Maxwell, 1 (ISU). TAYLOR COUNTY: 5 mi. W Bedford, 2 (NWM). WAYNE COUNTY: 3 1/2 mi. E Humestown, 1 (ISU). WINNESHIEK COUNTY: Canoe Creek, 1 (UMMZ). WOODBURY COUNTY: NW 1/4 of sec. 1, T. 86 N, R. 42 W, 2 (ISU).

Additional records.—DAVIS COUNTY: Eldon Fox Range [1 mi. N, 5 mi. E Floris] (Scott and Klimstra, 1955:41). FLOYD COUNTY: no specific locality (Brown, 1917:25). GREENE COUNTY: no specific locality (Gunderson, 1944:307). JOHNSON COUNTY: Iowa City (Stoner, 1918:58). MARSHALL COUNTY: no specific locality (Gabrielson, 1921:148). SAC COUNTY: no specific locality (Spurrell, 1917:282). STORY COUNTY: Ames (Becker and Hall, 1931:131). TAMA COUNTY: Tama (Joyce and Eddy, 1944:214). WORTH COUNTY: no specific locality (Weller and Blagen, 1970:293). WRIGHT COUNTY: no specific locality (Scott, 1940:537).

Family CAPROMYIDAE—Nutria and Allies

Myocastor coypus (Molina)

Coypu or Nutria

1782. *Mus coypus* Molina, Saggio sulla storia naturale de Chili, pp. 287-288, 342 (type locality, rivers of Chile).

1792. *Myocastor Coypus*, Kerr, The animal kingdom . . . , p. 225.

Distribution in Iowa.—Several wild-taken individuals reported from the state; current status unknown (not mapped).

The coypu was introduced into the United States from South America and has become established in many localities (see Hall and Kelson, 1959:799). To my knowledge, there have been only three individuals taken in the wild in Iowa, although this species probably was raised on several fur farms in the state.

In December 1942, a coypu (ISU T62) was trapped in Deep Creek, near Charlotte, Clinton County. A comment written on the specimen label indicates that in 1940, six individuals were brought to Princeton, Scott County, from Canada. One of these escaped in 1941 but the "rest were released." In 1942, a number were purchased by a buyer in Spragueville, Jackson County, where they subsequently "escaped or were turned loose."

In 1957, a coypu was taken in the Missouri River adjacent to Fremont County, Iowa, and another was captured a year later in Sarpy County, Nebraska (Velich, 1961:93). The most recent record known to me is from the Cedar River in Bremer County in 1959 (P. D. Kline, personal communication).

Other individuals probably have escaped, or were released, from other fur farms in Iowa, but this species does not seem to have become established anywhere in the state.

Specimen examined (1).—CLINTON COUNTY: Deep Creek, near Charlotte, 1 (ISU).

Additional records.—BREMER COUNTY: Cedar River, Waverly (see text). FREMONT COUNTY: Missouri River (Velich, 1961:93).

Family SCIURIDAE—Squirrels and Allies

***Cynomys ludovicianus ludovicianus* (Ord)**

Black-tailed Prairie Dog

1815. *Arctomys Ludoviciana* Ord, in Guthrie, A new geographical, historical, and commercial grammar . . . , ed. 2, 2:292 (description on p. 302) (type locality restricted by Jones (1964:138) to lower slope of the "Tower," a prominent landmark in sec. 10, T. 34 N, R. 10 W, Boyd Co., Nebraska).

1858. *Cynomys ludovicianus*, Baird, Mammals, in Reports of explorations and surveys from the Mississippi River to the Pacific Ocean . . . , 8(1):331, 14 July.

Distribution in Iowa.—Introduced at several localities in the early 1900's, but did not become established (not mapped).

The black-tailed prairie dog is a short-grass prairie species and probably did not occur naturally in Iowa in Recent times. It was introduced at several localities in the state at the turn of the century but evidently never became established (Stoner, 1918:44-45). No colonies were reported to exist in Iowa during the 1950 census conducted by the Iowa Conservation Commission (Glen C. Sanderson, personal communication).

Only in the case of the small colony near Shenandoah, Fremont County, was there a reference to the source of the introduced animals. That colony was established from a pair brought from Fort Morgan, Colorado (Stoner, 1918:44).

Specimens examined.—None.

Records of introduction (Stoner, 1918:44-45).—CASS COUNTY: no specific locality. DES MOINES COUNTY: Burlington. FREMONT COUNTY: near Shenandoah. HARRISON COUNTY: Logan. PALO ALTO COUNTY: no specific locality. SAC COUNTY: Jackson Twp. SIOUX COUNTY: 5 mi. N Calliope [incorporated in Hawarden].

SPECIES OF UNVERIFIED OCCURRENCE

Species that may occur in Iowa

The geographic distribution of several of the following species may have included parts of Iowa prior to the mid-1800's but direct evidence to support such occurrence is lacking. The remainder have been reported from areas near the borders of Iowa and subsequently may be found within the state. Information concerning the details of the distribution of each species may be found in Hall and Kelson (1959), "The Mammals of North America," or Jones (1964), "Distribution and Taxonomy of Mammals of Nebraska."

Sorex palustris hygrobadistes Jackson, 1926.—The water shrew is known from central Minnesota and possibly may occur in north-central Iowa in the vicinity of Pilot Knob State Park or in the northeastern corner of the state.

Sorex arcticus laricorum Jackson, 1925.—Commentary same as for *S. palustris* above.

Condylura cristata cristata (Linnaeus, 1758).—The star-nosed mole has been reported from southeastern Minnesota and may occur in adjacent parts of Iowa; it was included in early lists of Iowan mammals.

Myotis grisescens A. H. Howell, 1909.—The gray bat is known from the Ozark Plateau in central Missouri and may enter southern Iowa in summer.

Myotis leibii (Audubon and Bachman, 1842).—The small-footed myotis previously was included in lists of Iowan mammals (under the name *M. subulatus*) based on an incorrectly identified specimen (see Kunz and Schlitter, 1968:168). Authenticated records of *M. l. ciliolabrium* (Merriam, 1866) from north-central Nebraska and *M. l. leibii* (Audubon and Bachman, 1842) from southern Missouri suggest that the species could occur in Iowa.

Tadarida brasiliensis mexicana (Saussure, 1860).—The Brazilian free-tailed bat is known from Kansas and southeastern Nebraska, and was recently reported by Walley (1970) from Illinois; it may be expected to occur in Iowa.

Dasyurus novemcinctus mexicanus Peters, 1864.—Recent reports from Iowa of the nine-banded armadillo are probably of animals that escaped from captivity; the species is known from as far north as central Missouri and possibly may be expected to extend its range into southern Iowa.

Lepus americanus phaeonotus J. A. Allen, 1899.—The snowshoe hare is known from as near Iowa as central Minnesota; it was included in early lists of Iowan mammals and may be found in northeastern counties.

Lepus californicus melanotis Mearns, 1890.—A single black-tailed jack rabbit was reported from Johnson County (Stoner, 1918:134), but it probably escaped from captivity. The species is known from eastern Nebraska and northern Missouri and may be found in southern or western parts of Iowa.

Perognathus hispidus spilotus Merriam, 1899.—The hispid pocket mouse occurs in southeastern Nebraska and should be looked for in adjacent parts of Iowa.

Reithrodontomys montanus griseus V. Bailey, 1905.—Situation for this harvest mouse same as for *P. hispidus* above.

Rattus rattus rattus (Linnaeus, 1758) and *Rattus rattus alexandrinus* (É. Geoffroy St.-Hilaire, 1803).—The black rat may have been introduced in towns along the Mississippi and Missouri rivers (see also account of *Rattus norvegicus*) and still may exist in larger river cities.

Canis niger gregoryi Goldman, 1937.—The red wolf may have occurred formerly in extreme southeastern Iowa (see also account of *Canis lupus*).

Vulpes velox velox (Say, 1823).—There are several unverified reports of the swift fox from western counties in the early 1800's. No records exist, however, from adjacent parts of Nebraska and it seems unlikely that this fox occurred in Iowa within historic time.

Martes americana americana (Turton, 1806).—There is no direct evidence of former existence of the marten in Iowa, but it may have occurred in the extreme northeastern part of the state.

Species incorrectly reported from Iowa

Early lists of mammals of Iowa published by Goding (1883) and Osborn (1890, 1892) included mention of *Hesperomys nuttalli*, a species that occurs naturally nowhere near the state of Iowa. Additionally, Osborn (1892) included *Thomomys talpoides* and *Oryzomys palustris* with no supportive evidence and neither occurs in Iowa today. Scott (1937:93) failed to locate the specimen of *Neotoma floridana*, supposedly the basis for inclusion of this species by Osborn. It is not unlikely that the eastern woodrat once occurred in Iowa along the Missouri River, although I know of no recent records from anywhere in that vicinity and this rat does not now occur in southeastern Nebraska. Goding (1883:331) included *Lepus callotis* in his list of Iowan mammals. Because he did not also list *L. townsendii*, it seems likely that he applied an incorrect name to the white-tailed jack rabbit.

BIOGEOGRAPHIC DISCUSSION

Geologically, Iowa consists of two basically different glaciated areas—that of the most recent glaciation (Cary lobe of the Wisconsin), which is similar to the area of southern Minnesota, and that of the older (Nebraskan and Kansan) glaciations, similar geologically to northern Missouri. Climatically, Iowa lies within an eastward-protruding, wedge-shaped zone of relatively dry conditions. According to Wright (1968:78-79), the northeastern limit of this wedge lies in Minnesota “close to the mean position of the Alberta storm track in January, and thus the southern edge of the area of heavy snowfall; or in another analysis, it follows the late-winter position of the Arctic front [as defined by Bryson and Wendland, 1967].” The southeastern border of the wedge passes “through Missouri [and] coincides with the mean position of the winter storm tracks that follow the edge of the moist tropical air mass from the Gulf of Mexico, and thus the northern edge of the area of heavy winter rainfall” (Wright, *loc. cit.*). Dry, continental westerlies, which have lost moisture over the Rocky Mountains before they pass across the western plains, dominate the weather patterns in this wedge. Wright further stated (p. 79) that “in the summer, the wedge of continental air is much contracted into the western plains by the northward movement of the moist Gulf air mass, but when this contraction does not occur, the dry western air dominates even in summer, resulting in droughts and higher temperatures.”

Environmentally, two biomes exist within the state of Iowa (see Shelford, 1963)—the grassland (steppe) and the deciduous forest. Actually, the tall-grass prairie in Iowa was an ecotone between the mixed-grass steppe to the west and the deciduous forest to the east (see especially McComb and Loomis, 1944). Prior to changes wrought by European man, the deciduous forest biome in Iowa included at least three associations: sugar maple-basswood forest in the northeastern corner; the northern flood plain forest of cottonwoods, willows, and elms that formed riparian and gallery forests in north-central and northwestern sections; and oak-hickory forest in major river valleys in other parts of the state.

The native mammalian fauna of Iowa, compared to that of adjacent states, is relatively depauperate (see Table 9). Although having fewer total species of mammals, Iowa is intermediate in numbers of representatives of several orders. For example, from north to south in the central United States, kinds of bats increase and species of insectivores and carnivores decrease (Table 9), whereas the number of species of rodents decreases from west to east. The overall pattern of mammalian distribution in Iowa seems to be due primarily to the location and topography of the state relative to the northern boreal forest, eastern deciduous forest, and Great Plains. Thus, an understanding of the present mammalian fauna of Iowa in relationship to surrounding states requires examination of possible past distributional patterns and their relationship to changing environments.

As was noted by Hoffmann and Jones (1970:356), a biogeographic analysis of any given area may provide evidence relative to the nature of the Pleistocene and early Holocene environments, and, likewise, “data on late glacial and post-glacial environments may assist in interpretation of geographic and ecologic

TABLE 9.—Numerical relationship of the native mammalian fauna of Iowa and adjacent states. Numbers of species from states surrounding Iowa are taken (or modified) from the following sources: Minnesota (Gunderson and Beer, 1953); Wisconsin (Jackson, 1961); Illinois (Hoffmeister and Mohr, 1957; Walley, 1970); Missouri (Easterla, 1967, 1970; Hall and Kelson, 1959; Long, 1961; Schwartz and Schwartz, 1959); Kansas (Birney *et al.*, 1971; Fleharty and Andersen, 1964; Hall, 1955; Heskett and Fleharty, 1966; Jones *et al.*, 1967); Nebraska (Jones, 1964; McDaniel, 1967).

State	Marsupialia	Insectivora	Chiroptera	Edentata	Lagomorpha	Rodentia	Carnivora	Artiodactyla	Total
Minnesota	1	8	7	0	3	30	20	7	76
Wisconsin	1	9	8	0	3	24	20	5	70
Illinois	1	6	13	0	3	23	18	3	67
Iowa	1	5	10	0	2	24	19	5	66
Missouri	1	3	13	1	4	26	16	4	68
Kansas	1	3	15	1	5	34	19	5	83
Nebraska	1	5	12	0	4	34	20	6	82

distributions of Recent mammals." They noted that relict populations of mammals are indicative of broader past distributions and, additionally, suggested that groupings of ecogeographically similar species provide useful zoogeographic evidence in that "occurrence of a species belonging to such an ecogeographic group in another geographic area . . . is evidence that the species dispersed from its original geographic center to the other area at some time in the past" (pp. 356-357). Corroborative evidence from fossil mammals, as well as from paleontologic and pedologic analyses, strengthens assumptions of past distributions.

Until recently, past climatic shifts have been inferred chiefly from biotic or pedologic evidence (see especially, Jones, 1964; Ruhe, 1970; Smith, 1957; Wright, 1968). In order to avoid circular reasoning by use of such evidence, Bryson and Wendland (1967) developed the concept of "climata," which they considered as parallel to biota, and defined (p. 272) as "naturally occurring complexes of meteorological parameters found in the various climatic regions, much as the various biota occupy biotic regions." These authors utilized this concept in revising the more traditional terminology of post-Pleistocene events in North America (see for example, Jones, 1964). Using this newer terminology and chronology, Hoffmann and Jones (1970) summarized the postglacial environmental and mammalian faunal changes on the Northern Great Plains, and this sequence, used in the following discussion, is listed below:

Full-Glacial (to 13,000 BP)	Maximal Wisconsin ice
Late-Glacial (13,000 to 10,500 BP)	Stagnation, retreat of ice
Pre-Boreal (10,500 to 9140 BP)	Cool and moist, maximal boreal forest
Boreal (9140 to 8450 BP)	Continental climate, increase of deciduous forest
Atlantic (8450 to 4680 BP)	Warm and dry, maximal steppe
Sub-Boreal (4680 to 2690 BP)	Cool, retreat of steppe
Sub-Atlantic (2690 to 1690 BP)	Wet, maximal deciduous forest

Scandic (1690 to 1100 BP)	Warm and dry
Neo-Atlantic (1000 to 760 BP)	Warm and moist
Pacific (760 to 410 BP)	Cool and moist
Recent (115 BP to present)	Present climate

LATE WISCONSIN AND HOLOCENE CLIMATIC AND VEGETATIONAL CHANGES

Full-Glacial (to about 13,000 BP).—The exact nature of the conditions immediately south of the glacial border during full-glacial has been argued by many (see especially Hoffmann and Jones, 1970; Jones, 1964; Smith, 1957; Wright, 1968, 1970) and can not be resolved in the present paper. It is worthy of note, however, that the advancing front of the Cary lobe apparently covered previously standing coniferous forests that included fir, hemlock, larch, and spruce (Ruhe, 1970:42). There seems to be no conclusive evidence, therefore, of a tundra or tundralike border adjacent to the subsequently stationary ice front in Iowa, although Walker (1966:873) suggested that vegetative cover near the ice may have been sparse. Boreal forest (taiga), dominated by spruce (*Picea*) and fir (*Abies*), occurred south of the glacial border in Iowa and throughout much of central North America during full glaciation—at least as far south as northeastern Kansas (see Hoffmann and Jones, 1970; Ruhe, 1970; Wright, 1968). The presence of taiga prior to, and during, full glaciation was indicative of a “cooler, relatively more moist climate than at present” (Ruhe, 1970:53). Rainfall probably was fairly evenly distributed throughout the growing season, evaporation rate was relatively low, and “subsurface storage of water relatively high” (Ruhe, *loc. cit.*). Because Wisconsin loess deposition in Iowa occurred on land surface and paleosols of previous periods, drainage and hydrologic patterns probably were similar to those of the present in southern Iowa (Ruhe, *loc. cit.*).

Late-Glacial (13,000 to 10,500 BP).—Climatic conditions probably ameliorated prior to general recession of the continental ice (Bryson and Wendland, 1967:278). Subsequently, except for sporadic cooling, there was a general increase in temperature and decrease in humidity, although the climate may have been somewhat cooler in summer and warmer in winter than at present (Hoffmann and Jones, 1970:360). The four Cary glacial moraines in Iowa attest to some climatic variation as “these systems represent retreatal phases of the ice margin, with ice pausing long enough to build the end moraines” (Ruhe, 1970:58); additionally, at least two major glacial advances (Two Creeks and Valdres) occurred during this period. Although some kind of “tundra-like” situation may have existed adjacent to receding ice (see Wright, 1968:82), the boreal forest in southern Iowa evidently dispersed northward rather rapidly in the wake of glacial retreat (Walker, 1966:873), and taiga dominated by spruce-fir continued to cover Iowa until at least about 11,000 and, perhaps, even to 8000 BP (Ruhe, 1970:187; Wright, 1970:161). There seems to be no conclusive evidence of steppe vegetation in Iowa during this time, although there could have been some openings in the boreal forest from either blow-down or fire in which *Betula* and *Pinus* appeared (see Wright, 1968:83). The latter genus apparently was a new

floristic element in Minnesota, having invaded the boreal forest from the east (Wright, *loc. cit.*); presumably *Pinus* in Iowa during Late-Glacial times was of the same biogeographic affinity. To the west of Iowa, "steppe, or a mosaic of savannah or pine and steppe vegetation was mostly to the south of the Northern Great Plains, though perhaps occupying southwestern Nebraska, north-eastern Colorado, and the Wyoming Basin" (Hoffmann and Jones, 1970:360).

Pre-Boreal (10,500 to 9140 BP) and *Boreal* (9140 to 8450 BP).—Pollen evidence from north-central Iowa (Brush, 1967:103-110; Ruhe, 1970:190) and from adjacent parts of Minnesota and South Dakota (Wright, 1968:83) implies that boreal species were replaced during this period by those of eastern deciduous forest origin—notably *Acer*, *Alnus*, *Ostrya*, *Tilia*, *Ulmus*, and *Quercus*. Wright (1970:167), however, noted that some of the resultant forest cover on the eastern Great Plains may have been parkland with grassy openings. Farther to the west, taiga evidently was replaced directly by steppe, at least as far north as southern Manitoba (Wright, 1970:167). This apparent replacement of taiga by a predominantly deciduous (or mixed) forest in Iowa and Minnesota is worthy of specific comment because numerous authors have argued for steppe (or at least savannah or parkland) expansion eastward immediately following the retreat of the ice (see especially Gleason, 1922; Schmidt, 1938; Guilday *et al.*, 1964; McComb and Loomis, 1944). The widely accepted time of a major climatic shift was about 10,500 BP in central North America and perhaps represented "an abrupt change away from the circulation pattern of the late-glacial" (Hoffmann and Jones, 1970:360). The apparent presence of a steppe corridor at northern latitudes (perhaps even extending far eastward), associated with passage of cold arctic air southward into the plains region and eastward, initiated the Boreal period, and the climate, presumably dominated by strong westerlies, became more continental—warmer summers and colder winters. Thus a wedge of dry air projecting eastward into and beyond Iowa, similar to the present, probably developed at this time (see Hoffmann and Jones, 1970:360).

Atlantic (8450 to 4680 BP).—The steady decrease of continental ice (except for the Cochrane readvance), in addition to strong westerlies, allowed for the maximum eastward projection of warm, dry climatic conditions during the Atlantic period. Boreal coniferous tree species disappeared from Iowa by 8000 BP and there was a considerable reduction of the deciduous forest as steppe vegetation increased and perhaps reached its maximum extent in Iowa between 6600 and 5400 BP (Ruhe, 1970:192). The extension of a grassland wedge east of Iowa (often called the Prairie Peninsula) evidently reached its maximum during the Atlantic—a period frequently referred to as the Xerothermic. The northern border of the Prairie Peninsula was in central Minnesota and the southern edge in Missouri (Wright, 1968:78-79).

Because a wedge of dry continental air from the west was then (and still is) a distinctive feature of this region, any variation in the extent of dry air would affect the climate. For example, failure of northward-moving Gulf air to impede the movement of continental air in summer, as likely was the case at this time (Wright, 1968:79), could be a major factor in extension of steppe eastward. The

exact nature of the vegetation of Iowa during the Atlantic is unclear, although bog studies by Walker (1966) suggest that, at least in the north-central part of the state, conditions were drier than at present (before agricultural drainage) and the predominant vegetation was steppe. Additionally, McComb and Loomis (1944:73) suggested that morainal hills and eroded slopes likely were grass-covered during this time. How much of the earlier deciduous forest remained in Iowa is unknown but presumably enough remained to provide refugia for non-steppe species of mammals. If fire was a major factor in maintenance of steppe vegetation as suggested by Gleason (1913), Komarek (1962) and others, the Atlantic would have been a time when atmospheric conditions favored an increase in lightning and presumably also in maximum fire conditions. It is of interest to note here that one of the major effects of fire in grasslands, as shown in the Flint Hills of eastern Kansas, is a reduction of soil moisture in the upper surface (Anderson, 1964:92), which suggests that the effects of drier climatic conditions were compounded, at least in the upper levels of the solum (see also Curtis, 1959).

Sub-Boreal (4680 to 2690 BP).—This was a period of general cooling as a southward shift of winter and summer arctic frontal zones occurred in about 3500 BP (Hoffmann and Jones, 1970:361). In Minnesota, the reversal of prairie expansion is indicated by a sequence of prairie to oak-savannah to deciduous forest to coniferous forest (Wright, 1968:83). Probably this same sequence (excluding the coniferous forest) also occurred in Iowa, although deciduous forest species in refugia (presumably in eastern Iowa) likely would have expanded their ranges westward along the river valleys (see Eilers, 1965) and, with reduced fire conditions, onto ridge tops between river valleys. Wright (1968:83) suggested that coniferous species, such as white pine (*Pinus strobus*) invaded the deciduous forests of Minnesota from the northeast during this time and not until a somewhat later date did mesic species of deciduous forest enter southeastern Minnesota—perhaps even as late as 1000 BP. If this is the case, the *Tilia-Acer* hardwood forest of northeastern Iowa probably also resulted from relatively recent invasion. Furthermore, coniferous species in Iowa, such as white pine and balsam fir (*Abies balsamea*), presumably represent vanguard populations of conifers, which invaded the area from northeastern North America at this time, rather than boreal relicts of late-glacial origin as presumed by Conard (1952). Mesic deciduous forest may have had its greatest westward expansion either during this period or even more recently in sub-Atlantic times.

Sub-Atlantic (2690 to 1690 BP).—A northeastward shift of upper-air anti-cyclonic eddy was postulated by Bryson and Wendland (1967:292) to account for wetter climatic conditions in central North America during this period.

Scandic (1690 to 1000 BP).—This period evidently started with a trend toward warmer and drier conditions (perhaps including an increase in incidence of fire), and thus an expansion of steppe vegetation and a comparable recession of deciduous forests. During this and subsequent periods, the vegetational patterns, except for minor fluctuations, evidently varied little and presumably maintained the basic characteristics found by European man in Iowa—tall-grass prairie on

the uplands and deciduous forest along river valleys, protected scarps, and topographic irregularities.

Neo-Atlantic (1000 to 760 BP).—This was a period of continued warming and increased moisture (Bryson and Wendland, 1967:294). The recent (*ca.* 1000 BP) invasion of mesic deciduous elements into southern Minnesota (Wright, 1968:84), and presumably Iowa, implies that conditions were relatively moist in those states. Likewise, McComb and Loomis (1944:73) postulated that “during the last 700 or 800 years forests had covered townships in northeastern Iowa, advanced one to four miles from the main streams of central Iowa, and advanced as scattered trees and clumps in western Iowa.” The forest invasion of poorly drained soils of north-central Iowa evidently was minimal, as it was on planosols on broad tabular ridge tops in the southern part of the state (McComb and Loomis, 1944:73).

Pacific (760 to 410 BP).—A shift to drier conditions evidently took place about AD 1200 and the “prairie peninsula climate, carried by the westerlies, opened a wider wedge of prairie eastward across Illinois” (Bryson and Wendland, 1967:294).

Neo-Boreal (410 to 115 BP).—A return to colder, moister conditions occurred in this period—apparently due to “a reduced summer penetration of tropical air northward across the United States and into Canada” (Bryson and Wendland, 1967:296).

Recent (115 BP to present).—In about AD 1850, an increase in dry westerlies resulted in the warm, dry conditions presently existing in midlatitudes of North America (Bryson and Wendland, 1967:296).

PAST FAUNAS OF THE UPPER MISSISSIPPI VALLEY AND EARLY HOLOCENE DISTRIBUTION OF MAMMALS OF IOWA

Except for the early work by Hay (1914, 1924) and recent studies to the south of Iowa (see especially Parmalee, 1967; Parmalee *et al.*, 1969; Semken, 1969), little has been published concerning the Pleistocene and early Holocene mammals of the upper Mississippi Valley. A few Wisconsin faunas are available from the Great Plains, which are useful in interpretation of past mammalian distribution in Iowa, but Hoffmann and Jones (1970:362) noted that such faunas give only a general indication of broader past distributional patterns in midcontinental North America.

Full-Glacial and *Late-Glacial*.—At least three boreal species that now occur in Iowa (*Sorex cinereus*, *Microtus pennsylvanicus*, and *Synaptomys cooperi*) have been reported from faunas in central Texas dated as Full-Glacial (Hoffmann and Jones, 1970:362), and these three along with *Condylura cristata*, *Sorex arcticus*, *Sorex palustris*, *Lepus americanus*, *Clethrionomys gapperi*, *Synaptomys borealis*, and *Mustela nivalis* were members of a Late-Glacial fauna from Crankshaft Cave, Jefferson County, Missouri (Parmalee *et al.*, 1969). *Condylura*, *S. arcticus*, *S. palustris*, and *L. americanus* presently are known as far south as southern Minnesota; *Synaptomys borealis* and *Microtus xanthognathus* (the latter known from an early Holocene fauna of Meyer Cave, Monroe County,

Illinois—see Parmalee, 1967) now range only as far south as northern Minnesota and central Canada, respectively; the remaining species occur today in Iowa. Evidently, extensive cold steppe or savannah did not occur in the vicinity of the glacial front, at least during Cary glaciation (see Wright, 1968:82), and may have been no closer to Iowa than southwestern Kansas (Hoffmann and Jones, 1970:363). Schultz (1967) reported a Late-Glacial fauna from the latter area that included *Sorex cinereus*, *Sorex palustris*, *Microsorex hoyi*, *Microtus pennsylvanicus*, *Synaptomys cooperi*, and *Zapus hudsonius*; of these, only *S. palustris* is not now known from Iowa. With the persistence of boreal coniferous forest, adjacent to the Cary ice, well into the early Holocene, all of the above-mentioned species of mammals likely occurred in suitable habitats south of the ice in Iowa during that time. Other boreal kinds now present (or at least known from historic records) in Iowa and that presumably occurred there during Cary glaciation include *Tamiasciurus hudsonicus*, *Martes pennanti*, *Mustela erminea*, *Gulo gulo*, and *Lynx canadensis*. These species suggest a preponderance of boreal mammals well into Late-Glacial and probably early Holocene in Iowa. The presence of *Rangifer* (Banfield, 1961:34) and the tundra-inhabiting *Ovibos* (Hibbard *et al.*, 1965:516) in Iowa at or near the height of Wisconsin glaciation also is of interest.

Holocene.—With the warming conditions in early Holocene and westward expansion of the deciduous forest onto the Great Plains, especially along the tributaries of the Missouri River, there was a consequent invasion of mammals of eastern origin. The extent of such an invasion, however, is not well-documented. Hoffmann and Jones (1970:387) suggested that “mammals associated primarily with the eastern deciduous forest may have reached limits far beyond those of the same species today, only to be displaced eastward again in drier times.” They further noted that relict populations of *Myotis keenii* in the Black Hills and *Peromyscus leucopus* and *Neotoma floridana* elsewhere in the Northern Great Plains are indicative of broader past distributions of these eastern species. *Neotoma floridana* has not been reported in the literature from Iowa, but fossil remains from as far north as Meyer Cave, Monroe County, Illinois (Parmalee, 1967:141), and Jerry Long Cave, Ralls County, Missouri (Parmalee and Jacobson, 1959), in addition to an isolated population in northern Nebraska, suggest that *Neotoma* likely occurred in Iowa, at least along the Mississippi and Missouri rivers in the early Holocene and perhaps even more recently (see also Jones, 1964:27). Additionally, *Blarina brevicauda*—a shrew of the eastern deciduous forest—has been reported in a faunal assemblage from Frontier County, southwestern Nebraska, dated 9524 BP, yielding a time reference and a measure of invasion of eastern species in the early Holocene (Jones, 1964:24).

Boreal mammals may have continued to exist south of Iowa in early Holocene times, however, for a fauna (*ca.* 10,000-8000 BP) from Meyer Cave, Monroe County, Illinois (Parmalee, 1967), contained fossils of *Microsorex hoyi*, *Tamiasciurus hudsonicus*, *Clethrionomys gapperi*, *Microtus xanthognathus*, *Synaptomys cooperi*, *Zapus hudsonius*, *Mustela erminea*, and *Mustela nivalis* (all but the *Microtus* now are present in Iowa). The Meyer Cave fauna and a considerably more recent fauna (*ca.* 4290 ± 170 BP) from Peccary Cave, Newton

County, Arkansas (Semken, 1969), seem to suggest that suitable local habitats for boreal mammals (perhaps cool and moist) prevailed in the Ozarks and locally along the Mississippi River well into the Holocene. The Peccary Cave fauna included six species (*Sorex cinereus*, *Sorex palustris*, *Mustela nivalis*, *Erethizon dorsatum*, *Microtus pennsylvanicus*, and *Clethrionomys gapperi*) that are not now known from Arkansas and is especially noteworthy as it is dated as post-Atlantic—after the commonly postulated eastward grassland expansion during maximal warm, dry climatic conditions.

Fossils of several western grassland mammals, from localities to the east of their present ranges, are evidence of their dispersal eastward during periods conducive to steppe vegetation. For example, *Spermophilus tridecemlineatus* may have reached Pennsylvania and Virginia in early Holocene, or even late Pleistocene (Guilday *et al.*, 1964), whereas maximum northeastward extension of *Microtus ochrogaster* in Michigan and eastward movement of *Spilogale putorius* across the Mississippi River into southwestern Illinois evidently occurred during the warm, dry climate of the Atlantic (see especially Hoffmann and Jones, 1970: 363, and Parmalee, 1967).

Fossil remains of grassland mammals such as *Lepus* (either *californicus* or *townsendii*), *Perognathus* (*cf. hispidus*), *Onychomys* (*cf. leucogaster*), and *Vulpes velox* in Crankshaft Cave in east-central Missouri (see Parmalee *et al.*, 1969) suggest that conditions conducive to their presence likely occurred in much of Iowa at the same time—probably Atlantic. However, Hoffmann and Jones (1970: 367) noted that Crankshaft Cave is located south of the Missouri River, and it is possible that the Missouri was a barrier to dispersal farther north, in northern Missouri and Iowa. Furthermore, Jones (1964:39-40) commented that the deciduous riparian association along the Missouri River “or the river itself (or both) have prevented the dispersal eastward of at least nine . . . species at the latitude of Nebraska. The nine, all typical of arid or semiarid grasslands, are *Lepus californicus*, *Lepus townsendii*, *Cynomys ludovicianus*, *Perognathus flavescens*, *Perognathus hispidus*, *Onychomys leucogaster*, *Vulpes velox*, *Mustela nigripes*, and *Antilocapra americana*.” He noted further (p. 40) that “the ranges of several of these species approach (or formerly approached) the Missouri near the Nebraska-South Dakota border, and farther north in the Dakotas, where the deciduous vegetation thinned and became discontinuous in some sections, some crossed the river and expanded their ranges into the tall-grass prairie to the east.” Thus any (or all) of the above-mentioned steppe mammals could have occurred east of the Missouri River during times of eastward grassland expansion, although of these nine, only *Lepus townsendii*, *Perognathus flavescens*, *Onychomys leucogaster*, and *Antilocapra americana* have been authentically reported from Iowa in historic times.

A faunal assemblage (Semken, 1971) from Wittrock archeological site near Waterman Creek in O'Brien County, Iowa, dated 1425 ± 150 BP (therefore during the Scandic), included stream-associated species (*Lutra canadensis*, *Mustela vison*, *Ondatra zibethicus*, and *Castor canadensis*), those found typically in woodland or gallery forests (*Sylvilagus* sp. and *Odocoileus* sp.), and steppe

mammals (*Spermophilus franklinii*, *S. tridecemlineatus*, *Geomys bursarius*), in addition to those with less restrictive requirements (*Canis latrans* and *Mephitis mephitis*). This fauna suggests that, even though the Scandic was a period in which a trend toward warmer and drier climate persisted, conditions similar to those at present probably then existed in eastern Iowa.

HISTORICAL AND PRESENT DISTRIBUTIONAL PATTERNS OF RECENT MAMMALS OF IOWA

The present distributional patterns of Iowan mammals are the result of their biogeographic affinities, availability of suitable habitat, effect of human interference (both on habitat and animal) and of various combinations of these. Because of the geology and topography of the state and the ecotonal nature of the vegetation, there are no clear biotic provinces in Iowa similar to those found in mountainous states as, for example, Wyoming (see Long, 1965). Likewise, because man has influenced the biota of virtually the entire state, biotic communities as such are difficult to identify and categorize relative to mammalian distribution. For example, except for a few small protected patches, there is no longer any significant area of tall-grass prairie. Rather, most grassy habitats consist principally of brome (*Bromus inermis*) or bluegrass (*Poa pratensis*) or combinations of these with other introduced species. Rarely do clumps of native prairie species occur anywhere in the state—especially in eastern counties. It is of interest, therefore, that most native steppe species of mammals recorded from Iowa in historic time apparently have continued to exist within a state that has so high a percentage of its land under cultivation.

Elimination of prairie fires and planting of woodlots in the former tall-grass prairie has increased markedly brush cover and wooded habitat in many parts of Iowa—particularly so in western Iowa along the Missouri River (see McComb and Loomis, 1944:73)—thus increasing the habitat availability for species associated with deciduous forest.

However, rapidly changing agricultural technology is presently placing increased pressure on farm land, and some biotic communities are undergoing drastic changes. Intensive corn-soybean production on ever-enlarging farms in the north-central region has eliminated much fencerow habitat (Maddy, 1970; Nomsen, 1970), and, likewise, considerable destruction of brush patches and woodlots is associated with increased agricultural use of topographically rough parts of southern Iowa (Stempel, 1970). On the other hand, creation of artificial lakes and impoundments, along with increased grass-seeding of drainage waterways and other soil stabilization programs, have created new habitats, especially for grassland species of mammals (see especially Johnson *et al.*, 1970; Maddy, 1970; Moon, 1970).

The discussion that follows seeks to emphasize the ecogeographic relationships of the mammals of the state along with appropriate comments on evident or probable effects of man on the distributional status of some species (see especially Hoffmann and Jones, 1970), rather than to emphasize biotic communities (see, for example, Hoslett, 1965).

Nine species associated with the interior grasslands of North America occur in Iowa (see Table 10). Of these, three (*Lepus townsendii*, *Spilogale putorius*, and *Reithrodontomys megalotis*) probably were restricted to extreme western Iowa prior to the early 1800's, but subsequently expanded their ranges eastward (perhaps as a direct consequence of both the agricultural activities of European man as well as warming climatic conditions). The eastward movement of *Reithrodontomys megalotis* across the Mississippi River into Illinois and more recently Indiana has been well documented (see Jones and Mursaloğlu, 1961; Stains and Turner, 1963; Whitaker and Sly, 1970). The Mississippi evidently now is a barrier to eastward dispersal of *Spilogale*, although the spotted skunk also has extended its range northward in historic times (see especially Van Gelder, 1959), and is known from fissure deposits east of the river. A northward shift of *Lepus townsendii* since the time of early settlement in Kansas and Nebraska was commented on by Jones (1964) and, although such a shift on the Great Plains may well have been associated with a climatic change, movement of this species through northwestern Iowa into adjacent Illinois (see Hoffmeister and Warnock, 1955) and southward perhaps as far as northwestern Missouri seems to be correlated closely with the agricultural activities of the early settlers—particularly destruction of tall-grass habitat. The Mississippi and Illinois rivers evidently have been barriers to eastward and northward dispersal of *Geomys bursarius* to the east of Iowa. In contrast, *Spermophilus tridecemlineatus* and *Microtus ochrogaster* now occur at least as far east as Ohio, and *Spermophilus franklinii*, now exists in northern Indiana (see Mumford, 1969:60). It seems likely that agricultural practices as well as other activities of man (construction of golf courses, airports, roadways, and the like) have increased the available habitat for *S. tridecemlineatus* and *G. bursarius*, both of which prefer short-grass situations. On the other hand, because of disappearance of the tall-grass prairie in Iowa, populations of *S. franklinii* have been drastically reduced or restricted to local situations (principally tall-grass habitats on moist soils). The present distributional status of *Microtus ochrogaster* is not well understood. It probably occurs locally in north-central Iowa (although there are no published records from there) where it may compete (Findley, 1954) with *Microtus pennsylvanicus* (a mammal of boreal affinities) and perhaps has been reduced in numbers in that area since the late 1800's. That this apparent decrease in population was due to climatic effects seems unlikely, because there has been a general warming trend. Perhaps the decrease is due to *M. pennsylvanicus* being the better adapted of the pair to agriculturally affected situations.

Both *Onychomys leucogaster* and *Perognathus flavescens* probably ranged throughout much of Iowa during warm, dry climatic conditions (such as during the Atlantic), but the former is now restricted to the northwestern part and the latter to short-grass, sandy habitats in scattered localities throughout the state.

Boreal Species

Of the 12 mammals with boreal affinities (see Table 10) that occurred in Iowa in historic times, three (*Martes pennanti*, *Gulo gulo*, *Lynx canadensis*) may

TABLE 10.—*Mammals of Iowa, listed by faunal units.*

Steppe Species (9)

Lepus townsendii, white-tailed jack rabbit
Spermophilus franklinii, Franklin's ground squirrel
Spermophilus tridecemlineatus, thirteen-lined ground squirrel
Geomys bursarius, plains pocket gopher
Perognathus flavescens, plains pocket mouse
Reithrodontomys megalotis, western harvest mouse
Onychomys leucogaster, northern grasshopper mouse
Microtus ochrogaster, prairie vole
Spilogale putorius, eastern spotted skunk

Boreal Species (12)

Sorex cinereus, masked shrew
Microsorex hoyi, pygmy shrew
Tamiasciurus hudsonicus, red squirrel
Clethrionomys gapperi, southern red-backed vole
Microtus pennsylvanicus, meadow vole
Synaptomys cooperi, southern bog lemming
Zapus hudsonius, meadow jumping mouse
Martes pennanti, fisher
Mustela erminea, ermine
Mustela nivalis, least weasel
Gulo gulo, wolverine
Lynx canadensis, lynx

Deciduous Forest Species (18)

Didelphis virginiana, Virginia opossum
Blarina brevicauda, short-tailed shrew
Cryptotis parva, least shrew
Scalopus aquaticus, eastern mole
Myotis keenii, Keen's myotis
Myotis sodalis, Indiana myotis
Pipistrellus subflavus, eastern pipistrelle
Lasiurus borealis, red bat
Nycticeius humeralis, evening bat
Sylvilagus floridanus, eastern cottontail
Tamias striatus, eastern chipmunk
Marmota monax, woodchuck
Sciurus carolinensis, gray squirrel
Sciurus niger, fox squirrel
Glaucomys volans, southern flying squirrel
Peromyscus leucopus, white-footed mouse
Microtus pinetorum, woodland vole
Urocyon cinereoargenteus, gray fox

Invaders from the South (2)

Tadarida macrotis, big free-tailed bat
Sigmodon hispidus, hispid cotton rat

Widespread Species (25)

Myotis lucifugus, little brown myotis
Eptesicus fuscus, big brown bat
Lasionycteris noctivagans, silver-haired bat

TABLE 10.—Continued.

<i>Lasiurus cinereus</i> , hoary bat
<i>Castor canadensis</i> , beaver
<i>Peromyscus maniculatus</i> , deer mouse
<i>Ondatra zibethicus</i> , muskrat
<i>Erethizon dorsatum</i> , porcupine
<i>Canis latrans</i> , coyote
<i>Canis lupus</i> , gray wolf
<i>Vulpes vulpes</i> , red fox
<i>Ursus americanus</i> , black bear
<i>Procyon lotor</i> , raccoon
<i>Mustela frenata</i> , long-tailed weasel
<i>Mustela vison</i> , mink
<i>Taxidea taxus</i> , badger
<i>Mephitis mephitis</i> , striped skunk
<i>Lutra canadensis</i> , river otter
<i>Felis concolor</i> , mountain lion
<i>Lynx rufus</i> , bobcat
<i>Cervus elaphus</i> , wapiti
<i>Odocoileus hemionus</i> , mule deer
<i>Odocoileus virginianus</i> , white-tailed deer
<i>Antilocapra americana</i> , pronghorn
<i>Bison bison</i> , bison

have been only of peripheral occurrence there since the warm, dry Atlantic. Perhaps individuals ranged southward into Iowa only during population peaks and then primarily along protected waterways or other rough, forested terrain. On the other hand, it seems likely that *Mustela erminea* and *M. nivalis* maintained populations in Iowa throughout the Holocene, although the latter species now occupies a wider range of habitats than the former and is distributed farther south (to northern Missouri and Kansas); the ermine occurs sparingly only in the northern half of the state.

The only known population of *Clethrionomys gapperi* in Iowa is an isolated one, occurring in a small area along the eastern moraines of the Cary lobe of the Wisconsin glacier. Blagen (1967) considered this a relict population, isolated from the contiguous range of the species in southern Minnesota during the warm, dry Atlantic period. Existence of this species in the vicinity of Peccary Cave, Newton County, Arkansas, during the Atlantic (Semken, 1969), as well as in Delaware and Cedar counties in eastern Iowa perhaps as recently as about 2000 BP (Semken, personal communication), suggests, however, that southern red-backed voles existed locally over a wider geographic area during and subsequent to the Atlantic. More or less contiguous populations of this species thus may have occurred in much of northeastern Iowa and adjacent Minnesota until the warm, dry Scandic. Owing to recent destruction of habitat by European man, *C. gapperi* now exists in Iowa only in the vicinity of Pilot Knob State Park (see Blagen, 1967). In view of the proposed pattern of distribution in post-Atlantic, it is surprising that *Clethrionomys* has not been taken in the hardwood forests of extreme northeastern Iowa. It is noteworthy that *Microtus pinetorum*, primarily a mam-

mal of the eastern deciduous forests, occurs in northeastern Iowa. Because these two species presumably occupy similar habitats, *Clethrionomys* may have been excluded by the woodland vole in that area, but has been able to maintain itself where *M. pinetorum* does not now occur.

The historic distribution of *Tamiasciurus hudsonicus* is not well documented. It is doubtful that this species was statewide in distribution when European man arrived in Iowa, although isolated populations may have existed for a time in the southern part of the state. Possibly competition with *Sciurus carolinensis* and *S. niger* (both squirrels of the eastern deciduous forest) may be responsible for the absence of *Tamiasciurus* in southern and eastern Iowa where it surely occurred in early Holocene. The remaining boreal species (*Sorex cinereus*, *Microsorex hoyi*, *Microtus pennsylvanicus*, *Synaptomys cooperi*, and *Zapus hudsonius*) are most prevalent in grassland situations—although the shrews are known from a wide variety of habitats. The apparent absence of the southern bog lemming in north-central Iowa, where it probably was abundant in much of the Holocene, may well be due to recent agricultural tiling and drainage of former tall-grass prairie. In southern Iowa, *S. cooperi* is uncommon and usually occurs in moist, grassy situations, as does *Zapus hudsonius*. *Microtus pennsylvanicus*, on the other hand, is one of the most abundant species of mammals in Iowa, at least as far south as the southern two tiers of counties, where *Microtus ochrogaster* (of steppe origin) becomes the more dominant of the two microtines. Evidently the meadow vole is well suited to the activities of man and seemingly survives in a variety of habitats in Iowa, but the factors that limit the southern distribution of this species are not understood.

Deciduous Forest Species

Following the Wisconsin glaciation, 18 deciduous forest species of mammals (see Table 10) invaded Iowa from the east or southeast, and some ranged far westward onto the Great Plains, perhaps several times during the Holocene (see Hoffmann and Jones, 1970; Jones, 1964). Eight of these (*Didelphis virginiana*, *Blarina brevicauda*, *Scalopus aquaticus*, *Lasiurus borealis*, *Sylvilagus floridanus*, *Marmota monax*, *Sciurus niger*, and *Peromyscus leucopus*) are statewide in distribution and, excepting the red bat, have fairly broad (eurytopic) habitat requirements. Of these, the opossum, cottontail, woodchuck, and fox squirrel are known to have increased their distribution in Iowa within historic time, primarily because of the activities of European settlers that resulted in increased food and cover in former tall-grass prairie. *Myotis keenii*, *Pipistrellus subflavus*, *Nycticeius humeralis*, *Tamias striatus*, *Sciurus carolinensis*, *Glaucomys volans*, *Microtus pinetorum*, and *Urocyon cinereoargenteus* occur principally in the southern two-thirds of the state (all are restricted or absent in the northwestern part); the western limits of their geographic ranges approximate that of the deciduous hardwood forest in the upper Mississippi Valley and Great Plains (see also Hoffmann and Jones, 1970:378; Jones, 1964:46).

There is little information available regarding habitat requirements of *Myotis sodalis*, known only from southeastern Iowa, or of *Cryptotis parva*. The latter is

perhaps generally restricted to shrubby or moist grassy habitats throughout much of the state, but evidently is absent from poorly drained uplands of the north-central part.

It is of interest to note that in the case of *Blarina brevicauda* there are clearly distinct geographic variants—in this instance occupying mutually exclusive geographical areas of the state and acting more or less as separate species. Jones (1964:28-29) suggested an early postglacial westward invasion of the short-tailed shrew onto the Great Plains (at least by 9000 BP), and that subsequent warm, dry climate (probably during the Atlantic) eliminated this species from the north-western segment of its range. At least two stocks reinvaded the Plains region in post-Atlantic times and now form a “fairly well-defined zone of contact in southern Nebraska” that now is known to extend into southwestern Iowa and adjacent parts of Missouri (Hoffmann and Jones, 1970:389). Genoways and Choate (1971) recently have presented evidence suggesting that the two stocks may represent different species of *Blarina*.

Southern Species

Only two Recent species of Neotropical origin (see Table 10) are known from Iowa—*Tadarida macrotis* and *Sigmodon hispidus*. The big free-tailed bat is known only from two autumn-taken specimens—presumably stragglers from more southerly populations. The recent record of the cotton rat in extreme southwestern Iowa, however, represents an invasion that clearly is correlated with the general warming trend in continental North America in the mid-twentieth century, perhaps particularly associated with milder winters. Of note here is the summary by Genoways and Schlitter (1967) of information relative to the rapid northward dispersal of *S. hispidus* in Nebraska and across the Missouri River into northern Missouri.

Widespread Species

As pointed out by Hoffmann and Jones (1970:380), species of mammals that are widespread in central North America can be categorized on the basis of narrow (stenotopic) or broad (eurytopic) environmental requirements. The mammalian fauna of Iowa includes 25 such species (see Table 10) of which five carnivores (*Canis latrans*, *C. lupus*, *Mustela frenata*, *Mephitis mephitis*, *Felis concolor*, and *Lynx rufus*) can be considered as eurytopic. The wolf, mountain lion, wapiti, bison, and pronghorn were extirpated from the state by European man in the late 1800's. The remaining species appear to be more restricted now than formerly in habitat utilization. Those that were predominantly (although not exclusively) grassland inhabitants in Iowa include four large ungulates (*Cervus elaphus*, *Bison bison*, *Antilocapra americana*, and *Odocoileus hemionus*), one carnivore (*Taxidea taxus*), and one cricetid rodent (*Peromyscus maniculatus*). Other more or less stenotopic species include *Castor canadensis*, *Ondatra zibethicus*, *Mustela vison*, and *Lutra canadensis*, all of which have aquatic or semi-aquatic requirements, whereas those that primarily inhabit woodlands or gallery forests include

Erethizon dorsatum, *Vulpes vulpes*, *Ursus americanus*, *Procyon lotor*, and *Odocoileus virginianus*. In addition, widespread species of bats in Iowa include two tree bats (*Lasiurus noctivagans* and *Lasiurus cinereus*) and two with somewhat less stringent habitat requirements (*Myotis lucifugus* and *Eptesicus fuscus*). The little brown bat, however, is uncommon in the extreme northwestern part of Iowa and adjacent parts of adjoining states.

ANALYSIS OF LATE PLEISTOCENE
AND HOLOCENE CHANGES IN IOWA

Paleozoological and botanical evidence indicates that during Late-Glacial and early Holocene times southern Iowa was occupied by boreal coniferous forest with its associated faunal elements, and that tundra, if present, was immediately adjacent to the receding ice. During the height of Wisconsin glaciation, however, mammals such as *Ovibos* and *Rangifer* ranged as far south as what now is Iowa, and grasslands existed far to the south and west of the state (see Hoffmann and Jones, 1970:360). With subsequent amelioration of the climate, steppe extended northward and possibly eastward—perhaps as far east as Pennsylvania (see Guilday *et al.*, 1964:183-185)—but evidently not through Iowa at that time.

In early Holocene (Boreal), deciduous forest biota invaded from the east and southeast so that Iowa, at least for a time, was occupied by mixed (deciduous and coniferous) forest habitats. Mammals of eastern origin probably ranged throughout Iowa and westward onto the Great Plains in the Boreal period, dispersing far west in company with gallery forests that extended in a fingerlike manner along the major western tributaries of the Missouri River. Presumably at this time, woodland species of eastern origin, including *Blarina brevicauda*, *Myotis keenii*, *Peromyscus leucopus*, and *Neotoma floridanus*, extended westward well onto the Great Plains (*Neotoma* has not been recorded from Iowa in historic time but likely occurred there in the early Holocene).

With the subsequent warm, dry climatic trend of the postglacial period, coniferous forests disappeared from the state (displaced northward) and maximum conditions for deciduous forest maintenance also diminished. Climatic conditions (including strong westerlies) then favored maximal eastern advance of the steppe (as the "Prairie Peninsula") during the Atlantic (often called "Xerothermic"). This was a time that steppe species (including those with presently restricted distributions in Iowa such as *Perognathus flavescens* and *Onychomys leucogaster*) invaded the state in the northwestern corner and dispersed southward and eastward, perhaps as far as the Mississippi River. A grassland fauna, probably including *Lepus* (either *californicus* or *townsendii*), *Perognathus hispidus*, *Onychomys leucogaster*, and *Vulpes velox* extended eastward (south of the Missouri River) at least to the Mississippi River in central Missouri. A few species, notably *Geomys bursarius* and *Spilogale putorius*, crossed the Mississippi River, but northward dispersal of the pocket gopher apparently was restricted by the Illinois River. Other grassland species of mammals—*Microtus ochrogaster*, *Spermophilus franklinii*, and *Spermophilus tridecemlineatus*—ranged far to the north and east of Iowa—apparently not hindered in dispersal by any of the major

river systems. It is noteworthy that the lined snake (*Tropidocloaneum lineatum*) in Iowa was found by Smith and Smith (1963) to be more closely related (same subspecies, *lineatum*) to those in the Northern Great Plains than to southern Missouri or Illinois populations (subspecies *annectens*). The distributional pattern of this snake approximates that of *Perognathus flavescens* in Iowa and suggests that *Tropidocloaneum* also may have entered Iowa from the northwest. Populations in extreme southeastern Iowa, however, are intergrades between the two subspecies, indicating that the Mississippi River was not a complete barrier to dispersal. Additional evidence of eastward invasion by grassland herpetofaunal units during the Atlantic has been presented elsewhere by Smith (1957, 1965). Presumably at least some habitat with favorable microclimate for boreal and deciduous forest mammals continued to exist, at least in eastern Iowa, during the Atlantic, allowing for maintenance of populations of *Clethrionomys gapperi* and *Tamiasciurus hudsonicus*, among others.

Following the warm, dry conditions of the Atlantic, the deciduous forest and associated biota again dominated much of Iowa. Of particular significance is the origin and biogeographic relationship of the tall-grass prairie—a topic of long standing debate. Shimek (1948:88), for example, suggested that the majority of grassland plant species in Iowa had originally migrated there from the southwest, whereas others (notably Gleason, 1922:77; Weaver and Albertson, 1956:10; Braun, 1955:321), have argued essentially for southeastern origin (at least for prairie dominants such as *Andropogon gerardi*, *A. scoparius*, *Sorghastrum nutans*, and *Spartina michauxiana*). Likewise, the role of fire in the origin and maintenance of the tall-grass prairie in Iowa and elsewhere has been disputed (see especially Curtis, 1959; Gleason, 1913; Komarek, 1962; Shimek, 1911, 1948; White, 1870). If the early historic vegetation of Iowa—both tall-grass prairie and deciduous forest—was principally of eastern origin, a preponderance of mammals of eastern affinities that occupied both habitats would be expected, as indeed seems to be the case. Of the 70 species recorded from Iowa, 43 are either of eastern affinity or are widespread in distribution. Presumably then, conditions favoring fire in the grasslands existed in Iowa and eastward, at least periodically, from the Atlantic until early settlement. Western steppe species (such as *Perognathus flavescens*, *Onychomys leucogaster*, and *Reithrodontomys megalotis*) were thus able to survive, at least in part, because of continued effects of prairie fires. On the other hand, the rough terrain of eastern and southern Iowa may have prevented complete fire destruction of arboreal vegetation during warm, dry periods and thus allowed for continuation of conditions favorable to woodland mammals, including *Clethrionomys* and *Tamiasciurus*, throughout the Holocene. Perhaps only recently, possibly even within historic time, have populations of the southern red-backed vole been severely restricted.

SUMMARY

During maximal Wisconsin ice coverage, the nonglaciated part of Iowa was covered by boreal coniferous forest and dominated by spruce and fir. At least during the final glacial advance in Iowa (Cary), little, if any, tundra was present

and large expanses of steppe probably occurred no closer than the southwestern Great Plains. Although some tundra species undoubtedly occurred in Iowa during Cary glaciation, the mammalian fauna was dominated by wide-ranging boreal species, many of which also occurred far to the south of the ice front. Following recession of ice in the early Holocene, the boreal forest withdrew to the northward and at one time probably covered the entire state. As a consequence of a gradual warming trend, deciduous forest invaded Iowa from the east and southeast, migrating first along river valleys and probably later to the uplands, until it had advanced far beyond the borders of the state along the western tributaries of the Missouri River. During the period of maximal coverage by eastern deciduous forest (termed Boreal here, but equivalent to the "Climatic Optimum"), its mammalian fauna ranged far to the west, generally establishing present patterns of distribution of some species—notably *Blarina brevicauda*, *Myotis keenii*, *Peromyscus leucopus*, and *Neotoma floridana*. Under the influence of subsequent continual warming and a concurrent increase in the strength of dry westerlies, a warm, dry climate prevailed and biota of the western steppe advanced eastward (perhaps aided by an increase in fire) at the expense of arboreal vegetation. During this maximum warm, dry climatic period (Atlantic or Xerothermic), an eastern protruding wedge of grassland developed (the Prairie Peninsula) allowing for penetration of western steppe species far east of Iowa. Some western species, for example *Onychomys leucogaster* and *Perognathus flavescens*, were blocked by the Missouri River at the latitude of Nebraska and southward, but crossed the river farther to the north and entered Iowa through the northwestern corner. For others, including *Spermophilus franklinii*, *Spermophilus tridecemlineatus*, and *Microtus ochrogaster*, major rivers (such as the Missouri and Mississippi) did not hinder eastward advance. During the Atlantic, deciduous forest continued to exist along river valleys and areas of rough terrain in eastern and southern Iowa, providing habitat for survival of woodland mammals, including two boreal species—*Tamiasciurus hudsonicus* and *Clethrionomys gapperi*. By Atlantic time (8450 to 4680 BP), then, a biotic complex similar to that at present existed in Iowa. Although major quantitative differences occurred during subsequent periods of climatic oscillations throughout the Holocene, a mammalian fauna with the majority of species from boreal (northern), steppe (western), and deciduous forest (eastern) ecogeographic units, together with widespread species, was maintained. Coincident with the arrival of European man, the biota of Iowa evidently was in the process of adjustment to a climatic oscillation of increased dry westerlies and relatively warm, dry climatic conditions—those that have allowed at least one mammal of southern origin (*Sigmodon hispidus*) to enter the state within historic time.

When Iowa was settled by European man in the mid-1800's, at least 64 species of native mammals occurred in the state (*Sigmodon* and *Tadarida* being more recent). However, as a consequence of the activities of the early settlers, five relatively abundant large mammals (gray wolf, black bear, mountain lion, wapiti, and bison) were extirpated in Iowa, whereas others including beaver, otter, and white-tailed deer were nearly or completely eliminated and have only recently

become reestablished. Because of intensive agricultural use of virtually all land in Iowa, no extensive prairie remains. Likewise, much of the original timber was removed or reduced and, conversely, planted woodlots occur in areas of former prairie—thus changing the distribution of deciduous forest habitat.

The present distributional patterns of mammalian fauna of Iowa reflect biogeographic history, availability of suitable habitat, influences of European man, and various combinations of these. There are no clearly evident biotic provinces in Iowa and, except for the special case of *Blarina brevicauda*, there are no marked examples of geographic variation; only in *Mephitis mephitis* is there a suggestion of a north-south cline in size, for example, in accordance with Bergmann's rule.

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