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Mollusca on the University of Kansas Natural History Reservation

BY

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ABSTRACT: The University of Kansas Natural History Reservation consists of approximately 1 square mile of wooded, hilly land situated on the north slope of the Kansas River Valley in Douglas County, Kansas. Until 1948 the land was subjected to cultivation and grazing. The molluscan fauna was studied soon after agricultural activities ceased on the Reservation. Four species of aquatic mollusks and 21 species of terrestrial gastropods were observed at 10 stations, which were selected for their differences in local habitat conditions. All species are illustrated by photographs, and the distribution of mollusks at the several collecting stations is shown by a tabular compilation of the fauna. Photographs of the collecting stations are included.

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INTRODUCTION

The principal aim of this report is to record the kinds of mollusks that live on the University of Kansas Natural History Reservation. This report is the first in what is expected to be a series covering the various invertebrate and vertebrate groups to be found on the Reservation.

In the years preceding this study much of the land now in the University of Kansas Natural History Reservation was grazed by domestic livestock while other parts were cultivated. The ground is now being allowed to revert to natural conditions. The information here recorded should be useful in discovering changes in the molluscan population which may result from changes in the flora and the remainder of the fauna.

The Reservation is on or near the southern and western margins of the range of many northern and eastern species as well as on or near the northern margin of the ranges of a few snails of southern distribution.

LITERATURE

Literature directly concerned with the ecology of land and fresh-water snails is scarce and only within the last two decades have papers appeared in any appreciable quantity. One of the earliest studies was a quantitative account of the molluscan fauna of one log (Van Hyning, 1904:130). Sterki (1911:98) noted the effect of civilization on several species of terrestrial snails, and this subject has received further treatment from Archer (1937:117) and Goodrich (1940:6) who studied the effects of civilization on aquatic

Mollusca. Archer (1935:77;1939:1;1941:4) has published accounts of the ecology of faunas of snails in North Carolina, Michigan, and Alabama. The effects of environmental conditions upon characters of the shell have been discussed by Goodrich (1939:124).

Literature concerning the molluscan fauna of Kansas has been reviewed thoroughly by Franzen and Leonard (1947:314) in their monographic treatment of the Pupillidae of Kansas.

HISTORY AND DESCRIPTION OF THE AREA

The University of Kansas Natural History Reservation is situated four miles north and one and one-half miles east of the Kansas River bridge at Lawrence, Kansas. It includes all of section 4, T. 12S, R. 20E, Douglas County, Kansas, with the exception of fifty acres in the southwest corner.

This section lies among the hills which flank the north border of the Kansas River valley. The character of these hillsides is much the same throughout the lower region of the Kansas River, being sparsely to heavily wooded. Although erosion has been slow, owing to the cover of trees and grass, it has been sufficient to produce irregular topography along the sides of the valley. The valley terraces extend in fingerlike fashion into numerous small valleys which dissect the hills. Between the hillsides, left in the wake of eroding gully streams, there are small fields and meadows sloping gently toward the valley floor. On the hilltops, the extensions of the drier upland area are comparatively level and are either cultivated or, more often, used for grazing. The residual soil is permeated with small limestone rocks and each hillside is crowned with outcropping limestone. In the east central part of the Reservation a small stream exposes a thick bed of shale.

The land now utilized as the University of Kansas Reservation was willed to the University of Kansas by the late Governor Charles Robinson (1818-1894). Upon the death of the widow of Governor Robinson in 1914 the lands came under the active management of the University and on July 1, 1948, Dr. Henry S. Fitch and associates began a study of the biota of the area.

Within the memory of older local residents the land has undergone little change and until late in 1948 most of the untimbered areas were either cultivated or subject to grazing. Grazing had been discontinued on most of the timbered areas some time prior to 1938. In 1936, under the CCC program, some of the land was cleared and a series of check dams were constructed in the grazed meadow (Plate XCVIII) in an attempt to halt the severe erosion

of that pasture. The present policy of the administration is to allow the Reservation to revert to natural conditions.

The first accounts by early settlers describe this section of Kansas as having few trees except along waterways, the slopes and valleys being covered by grass. In this area big bluestem grass, which is resistant to the spread of trees, was abundant. The settlers planted trees and destroyed most of the big bluestem by turning the sod or by overgrazing. As a result, the wooded areas were extended and by the late 1800's the terrain was much as it is today.

CLIMATE

The climate of Kansas is characterized by extremes of temperature and precipitation. "The State lies across the path of alternate masses of warm moist air moving north from the Gulf of Mexico and currents of cold, comparatively dry, air moving from the polar regions. Consequently, its weather is subject to frequent and often sharp changes, usually of short duration" (Flora, 1948:1).

The higher temperatures and lessened rainfall of the summer months often result in a hot, dry period. For example, in 1936 Lawrence recorded an average monthly rainfall of .84 inch for the three summer months and an average temperature of 88 degrees, with a high of 113 degrees for the month of July (Flora, 1948:70, 192). In other years the summer months have passed with temperatures no higher than 100 degrees and with an average monthly rainfall of more than five inches. Annual precipitation is especially subject to year to year variation. Douglas County records show 42.93 inches annual rainfall in 1935 and the following year, the driest in the state's history, only 22.12 inches (Flora, 1948:70).

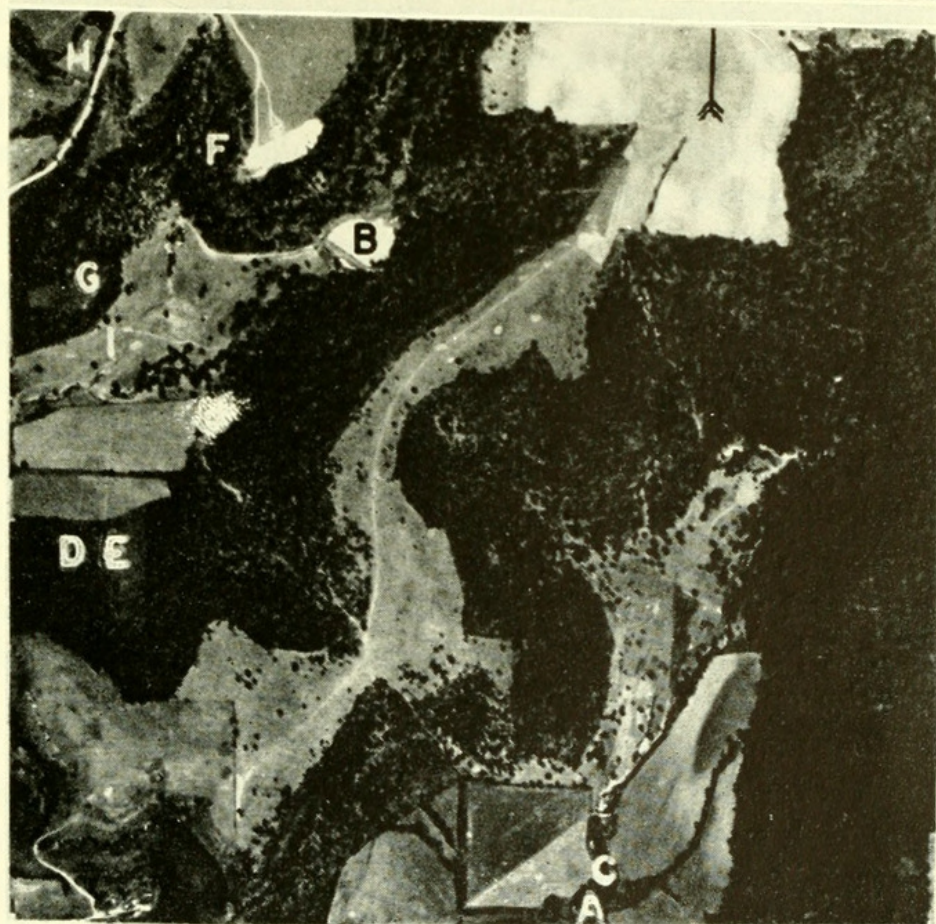
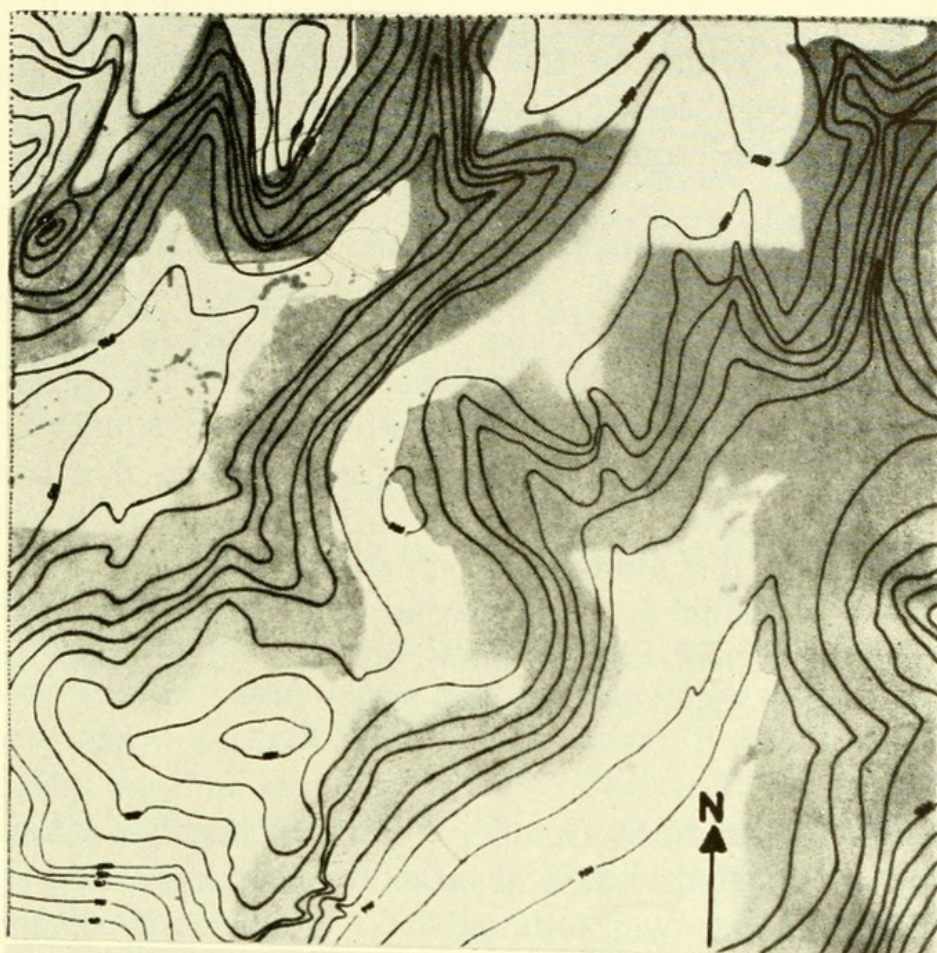
The prevailing wind in the northeastern section of the state is from the south during all the months except January, February, and March when it is from the north or northwest. This prevailing south wind has a drying effect on the soil which is particularly noticeable when one compares the south-facing hillsides with the protected and hence, more moist, north-facing slopes. This condition is reflected in the flora of the two slopes as well as in the molluscan fauna found there. On the north-facing slopes are found

PLATE XCVIII

Upper figure: Contour map of University of Kansas Natural History Reservation. Contours are drawn at intervals of 20 feet. Elevation ranges from 900 to 1060 feet above sea level.

Lower figure: Aerial photograph of the Reservation. Letters indicate the position of each of the 8 collection stations discussed in the text.

PLATE XCVIII



such trees as shagbark hickory (*Carya ovata*), black oak (*Quercus velutina*), white ash (*Fraxinus americana*), and black walnut (*Juglans nigra*) while on the south facing slopes elm (*Ulmus americana*), honey locust (*Gleditsia tricanthos*), osage orange (*Maclura pomifera*), and yellow oak (*Quercus muehlenbergii*) predominate.

The effect of such climatic conditions upon the molluscan fauna is, of course, pronounced. Aquatic molluscan life is limited, in many instances, to those species which can exist in ponds, lakes, and streams of a more or less ephemeral nature. Terrestrial snails are limited to those species that can survive the frequent hot, dry periods either by making physiological adaptations, that is to say, by aestivation and the formation of an epiphragm, or by limiting their habitats to the most moist situations. While climatic conditions do not permit as many species to occur here as are found in more northern and eastern states, the individual snails of local species are often found in abundance.

METHODS

From September 20 to October 1 of 1948 first hand inspection was made of the Reservation in order to select collecting stations. Collecting by Goble was initiated on October 1, 1948, and continued until mid-November when winter weather halted further field work. From March 1, 1949, to June 20, 1949, regular field trips were made to the Reservation. In this period field notes were taken on the flora of each station and snails were collected and given a field number which designated both the station and the date of collection.

The specimens were collected in vials and taken to the laboratory. The snails were then cleaned and placed in a cabinet where they were available for future reference and study. If it was found necessary to kill the live snails and remove the soft parts; they were killed by placing them in boiling water for several minutes. The bodies were then easily removed with a small needle. It was not necessary to remove the soft parts from snails as small as pupillids. If the soft parts were to be preserved, the snail was drowned in water that had been heated to remove the oxygen. When this was done the animal died in an extended position.

Field equipment included an aspirator, which was most useful in the collection of small shells; vials with cotton plugs; screens for sifting soil and stream gravel; a 10x hand lens; a one-foot quadrat frame for population studies; and a folding rule.

After the specimens had been studied and all the data assembled

catalogue numbers were assigned and the collection was filed in the Mollusk Collections of the University of Kansas Museum of Natural History.

In the following account no attempt has been made to list the complete flora of the various collecting stations. The predominant flora is listed in order to convey to the reader a picture of the habitat conditions.

For the sake of brevity, stations are referred to by the letter S followed by a letter indicating a particular station.

COLLECTING STATIONS

STATION A—SMALL STREAM

This stream arises in the extreme northeast corner of the section and flows to the south. It drains that part of the Reservation to the southeast of the high plateau that divides the section diagonally into two approximately equal halves. One mile south of the Reservation it empties into a small stream known locally as Mud Creek. Collecting was limited to that part of the stream within 800 feet of the southern boundary of the Reservation, this area having an abundance of plant cover not to be found along the more northern parts of the stream.

Except for periods following rains the stream is less than five feet in width, receiving a constant water supply from small seeping springs along its course. The larger pools are only six to ten inches in depth. The banks are high and steep, in many places being nearly vertical. In the southern half of the Reservation the stream bed is entrenched approximately fifteen feet below the level of the surrounding fields. Crayfish (*Orconectes nais*) are numerous and the larger pools support schools of small fish. The absence of the larger species of fish eliminates the possibility of a unionid mussel fauna.

Living aquatic snails were represented by a large colony of *Physa hawni* Lea. These snails were collected from the margin of the stream where they were crawling on leaves, roots, debris, and plants which were growing in the water. A few dead specimens of *Pisidium* cf. *compressum* Prime were recovered from gravel.

STATION B—SILTED POND

This small pond is located at the eastern end of the meadow (Pl. XCVIII) where the pond receives drainage from the hills which border it on three sides. The pond was formed by the construction of an earthen dam more than twenty years prior to this

study. In the ensuing years the pond has gradually filled with silt until, at the time this study was made, it was no more than two feet deep when filled and remained dry many weeks during the year in the absence of rains.

During the wet seasons several species of aquatic plants are abundant in the pond. Cattail (*Typha latifolia*) and bulrush (*Scirpus sp?*) occur around the margins of the pool as do willow (*Salix sp?*) and cottonwood seedlings (*Populus deltoides*). Sweet clover (*Melilotus alba*), ragweed (*Ambrosia trifida*), and dock (*Rumex altissimus*) are found along the banks. Near the pond at the margin of the wooded area are such trees as yellow oak (*Quercus muehlenbergii*), shagbark hickory (*Carya ovata*), poplar (*Populus alba*), and ash (*Fraxinus americana*).

The snails found here were *Helisoma trivolvis*, *Physa hawni*, *Sphaerium sp*, and *Succinea concordialis* which is a terrestrial snail found close to water. They are species which can survive long dry periods. Specimens were first collected during a dry period lasting from mid-September to late December of 1948. No living snails were found and a re-check of the pond during the wet season failed to reveal any living examples. A search for aestivating individuals in the summer also proved fruitless.

STATION C—BANKS OF SMALL STREAM

The location and a description of the small stream is to be found under the discussion of station A; the collections were made on that portion of the stream within 800 feet of the southern boundary of the Reservation.

Along this part of the stream the slope of the bank varies from 20 to 80 degrees. The steepness of the banks and the narrowness of the stream affords protection from both the sun and wind, causing the relative humidity to be high. The soil is loose and moist and lacks a heavy cover of decaying leaves, although the underbrush is dense.

There are fewer kinds of trees at this station than on the higher slopes. The few large trees are elm and cottonwood. The underbrush is largely seedlings and young trees of the same species. In the underbrush coralberry, smooth sumac, prairie mimosa, and wild grape are present. Near the water, bulrush and scouring rush grow in large patches.

This station is the most moist of the truly terrestrial habitats, and *Vertigo ovata* and *Lymnaea parva* were found only at this station.

STATION D—DECAYING LOG HABITAT

In the interest of wild life conservation, logs on the Reserve proper are left undisturbed but a number of logs were examined at a place in the southwest corner of the section. This particular place was near the summit of the north facing slope immediately below the limestone outcrop which caps all the hills in this area. The logs were in the oak-hickory-walnut association of station E.

Thirteen species of snails were recovered from decaying logs. Although the collecting was not so remunerative as on the forest floor, the percentage of living snails was much higher. Only four species occurred in abundance. These were *Zonitoides arboreus*, *Retinella electrina*, *Stenotrema monodon aliciae*, and *Strobilops labyrinthica*. Each of these species is limited to woodland areas on the Reservation. *Zonitoides arboreus*, in particular, is closely associated with decaying logs. The examination of a single log, eight feet long and twelve inches in diameter, revealed twenty-six living snails of this species.

STATION E—NORTH-FACING WOODED SLOPE

This slope is situated south of the meadow. Two rectangular fields separate the grazed part of the meadow (SI) from the wooded slope (Pl. XCIX). Collecting on this hillside was restricted to an area within 1350 feet of the western boundary of the Reservation.

The slope is gentle, averaging a one and one-half inch drop per linear foot. The loose, rich soil is covered by a thick layer of moist humus. Outcropping limestone rocks dot the hillside and small flat stones are scattered throughout the soil. Rocks, decaying logs, and bases of trees are covered with moss.

On the upper half of the hillside yellow oak, shagbark hickory, and black walnut make up the bulk of the trees while farther down the slope black oak and elm predominate with honey locust and osage orange occurring at the margin of the wooded areas. Redbud and coralberry are the most abundant shrubs in the understory although patches of smooth sumac and wild plum are also common. Bittersweet (*Celastrus scandens*), wild grape, greenbrier (*Smilax hispida*), and wild rose (*Rosa sp.*) are scattered over the hillside. Virginia creeper (*Parthenocissus quinquefolia*) predominates in the lower vegetation. The abundance of redbud is the distinguishing feature of the flora of this slope.

There are eighteen to twenty-five snails per square foot in the

yellow oak-hickory-walnut area as against an average of fewer than five individuals in the more poorly drained area farther down the slope. It is worth noting that snails occur far less frequently on this slope than on the south and west facing hillsides (SF and SG) where they average from thirty to fifty specimens per square foot.

STATION F—WEST-FACING SLOPE

This steep slope is situated north of the meadow and immediately west of an old quarry (Pl. XCIX). Collecting was limited to the west face of the hill.

While the soil and general appearance of the slope is similar to the south facing slope (SG) the greater steepness (five inch rise per foot) and protection from the early morning sun is reflected in the flora and molluscan fauna found there. In many places all humus has been washed off the hillside. On other parts of the slope the humus is light except around the bases of trees and shrubs. In general this station is more moist than the south facing slope, being somewhat protected from the prevailing winds as well as from the direct rays of the sun. However moisture is less abundant than on the north facing hillsides.

On this west-facing hillside the large trees are limited to a few scattered honey locust and elm. Small trees are numerous and the underbrush is dense. Yellow oak is by far the most common tree and on this slope it grows to a height of only ten to fifteen feet. Also scattered over the hillside are osage orange, hackberry (*Celtis occidentalis*), crabapple (*Malus angustifolia*), and red-bud. Coralberry and gooseberry (*Ribes missouriense*) are abundant in the underbrush and poison ivy (*Rhu toxicodendren*) and Virginia creeper are the dominant species of the low vegetation.

PLATE XCIX

FIG. A. Silted pond habitat, Station B. Photograph made when there was no open water (November, 1950), in the pond.

FIG. B. Wooded, north-facing slope in distance, Station E.

FIG. C. Wooded, west-facing slope, Station F.

FIG. D. Grazed meadow, Station I, and wooded, south-facing slope in distance. Grasses and herbs have flourished in the meadow since cattle were withdrawn. Photograph made in November, 1950, 2 years after grazing of the meadow ceased.

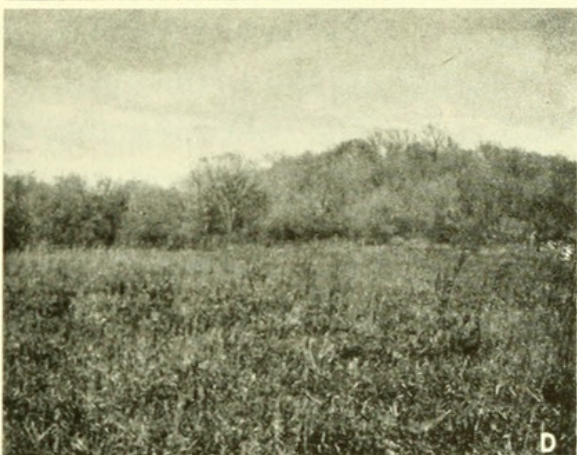
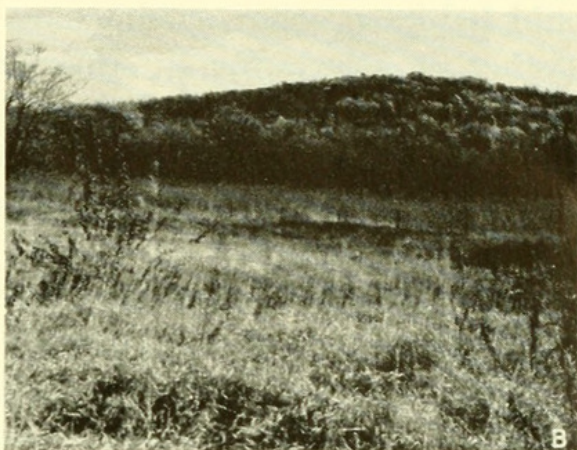
FIG. E. Fallen log habitat, Station D.

FIG. F. Small stream, Station A, and banks of stream, Station C. Stream had no open water when photograph was made, (November, 1950).

FIG. G. Limestone ledge, which is found near the summit of the hills, (Station J).

FIG. H. Ungrazed meadow (Station H) with luxuriant growth of blue-stem grass and herbs.

PLATE XCIX



The snail fauna at this station is unusual in that *Succinea avara*, a moisture loving species, and *Pupoides albilabris*, a snail of more arid habitats, occur on the same hillside. They do not occur together, however, for *P. albilabris* is found only on the steepest areas in the lower half of the hillside, whereas *S. avara* occurs near the top of the slope among the outcropping limestone ledges. Another peculiarity of this snail fauna is the abundance of *Gastrocopta holzingeri* which in many places on the slope is the most common species. It is not one of the common snails of Kansas and its occurrence in such numbers is indeed surprising. The dead and living specimens from this station average thirty to thirty-five per square foot.

STATION G—SOUTH-FACING WOODED SLOPE

This hillside lies to the north of the meadow and directly opposite Station E. The collecting area included only that part of the slope within 675 feet of the west boundary of the Reserve.

This south-facing slope is steeper than the north-facing hillside, averaging a two and two-thirds inch rise per foot. The rocky soil resembles that of the other hillsides but is not so moist nor so rich in decomposed vegetation as the north-facing hills.

The American elm and honey locust are the most abundant trees at this station. The honey locust is particularly numerous along the margin of the wooded area and in the open spaces farther up the hillside. Other scattered trees include Osage orange, yellow oak, crabapple, and hackberry. The underbrush is composed chiefly of coralberry, smooth sumac, and the seedlings of elm and honey locust. Wild plum, aromatic sumac (*Rhus aromatica*), gooseberry, blackberry (*Rubus ostryifolius*) and wild grape are also present. Conspicuous by its absence is the redbud.

From the standpoint of the number of specimens of snails present, this station is first; it has an average of forty-six dead and living snails per square foot. This figure includes only shells found on the surface and in the loose soil to a depth of one inch. As far as number of species is concerned the slope was fifth among the eight terrestrial stations. Only eleven species were collected from this station as compared with fourteen from the north-facing slope (SE) and thirteen from Station C and the same number from Station D. Three species, *Gastrocopta armifera*, *Vallonia parvula*, and *Retinella indentata*, comprised eighty percent of the snail fauna.

STATION H—UNGRAZED GRASSLAND

This small plot of high grass and herbs is in the extreme northwest corner of the Reservation on the edge of the plateau (Pl. XCVIII), and slopes gently to the east, draining into a gully that lies between the grassland and the north-south county road. The area is well covered by big bluestem grass (*Andropogon furcatus*). Prairie mimosa and compass plants (*Silphium laciniatum*) are scattered throughout the grass.

This habitat is less favorable for most of the species of snails than other habitats; less than one half of the species of snails found on the Reservation occur here. Moreover, an unusually large percentage of the specimens collected were empty shells. *Gastrocopta armifera* was the most common species but even it was not abundant.

STATION I—GRAZED MEADOW

The meadow extends in a northeasterly direction from an area near the mid-point of the west boundary of the Reservation to the north-central part of the section (Pl. XCVIII).

This station was grazed until March, 1949, when the cattle were removed from the Reservation. Even in this short period the grasses have recovered in great measure and erosion which was progressing at an alarming rate probably will be less rapid. The soil is well packed and becomes dry during periods without moisture, but with the improvement in grass and weed cover the soil will become looser and more moist.

The flora consists of mixed weeds and grasses. The predominant species are listed below:

Panicum dichotomiflorum—Fall panicum

Setaria lutescens—Yellow foxtail

Bromus inermis—Smooth brome

Bromus purgans—Canada brome

Capsella bursapastoris—Shepherd's purse

Erigeron philadelphicus—Fleabane

Lepidium sp?—Peppergrass

Ceanothus americanus—New Jersey tea

Desmanthus illinoensis—Prairie mimosa

Asclepias tuberosa—Butterfly weed

At the time the collection was made snails were all but completely absent from the meadow. *Gastrocopta armifera* was found at the margin of the meadow under small rocks but none was obtained from farther than thirty feet from the timbered areas. A

single dead specimen of *Gastrocopta procera* was found near the center of the meadow under cow dung in an area covered by buffalo grass. In an ungrazed part of the meadow near the pond there was a large colony of *Bulimulus dealbatus*.

STATION J—ARID LIMESTONE HABITAT

All the hills on the Reservation are capped by limestone which outcrops at the brow of each hill. Coinciding with the margin of the timbered areas, these rocky ledges are exposed to both the sun and the wind.

Collecting was not limited to any particular section of the Reservation, the habitat being similar at the summits of the various hillsides.

The flora of such habitats consists chiefly of coralberry, smooth sumac, elm, and honey locust. Gooseberry, wild rose, and stunted specimens of yellow oak and other species are common.

CHECK LIST OF MOLLUSCAN FAUNA

Phylum Mollusca

Class Gastropoda

Order Pulmonata

Suborder Basommatophora

Family Physidae

Genus *Physa* Draparnaud

Physa hawni Lea

Family Planorbidae

Genus *Helisoma* Swainson

Helisoma trivolvis lentum (Say)

Family Lymnaeidae

Genus *Lymnaea* Lamarck

Lymnaea parva Lea

Suborder Stylommatophora

Family Pupillidae

Genus *Gastrocopta* Wollaston

Gastrocopta armifera (Say)

Gastrocopta contracta (Say)

Gastrocopta holzingeri (Sterki)

Gastrocopta pentodon (Say)

Gastrocopta procera (Gould)

Genus *Vertigo* Draparnaud

Vertigo ovata Say

Genus *Pupoides* Pfeiffer

Pupoides albilabris (C. B. Adams)

Family Succineidae

Genus *Succinea* Draparnaud

Succinea avara Say

Succinea concordialis Gould

Family Vallonidae

Genus *Vallonia* Risso*Vallonia parvula* Sterki

Family Strobilopsidae

Genus *Strobilops* Pilsbry*Strobilops labyrinthica* (Say)

Family Endodontidae

Genus *Helicodiscus* Morse*Helicodiscus parallelus* (Say)

Family Polygyridae

Genus *Stenotrema* Rafinesque*Stenotrema monodon aliciae* (Pilsbry)

Family Bulimulidae

Genus *Bulimulus* Leach*Bulimulus dealbatus* (Say)

Family Limacidae

Genus *Deroceras* Rafinesque*Deroceras laeve* (Müller)

Family Zonitidae

Genus *Hawaiiia* Gude*Hawaiiia minuscula* (Binney)Genus *Retinella* (Shuttleworth) Fisher*Retinella electrina* (Gould)*Retinella indentata* (Say)Genus *Zonitoides* Lehman*Zonitoides arboreus* (Say)Genus *Euconulus* Reinhardt*Euconulus chersinus* cf. *polygyratus* (Pilsbry)

Class Pelecypoda

Order Eulamellibranchiata

Family Corbiculidae

Genus *Sphaerium* Scopoli*Sphaerium* sp?Genus *Pisidium* Pfeiffer*Pisidium* cf. *compressum* Prime

ACCOUNTS OF SPECIES

Physa hawni Lea

Plate C, fig. 2

Physa hawni Lea, 1864, Proc. Acad. Nat. Sci. Philadelphia, p. 114; Baker, 1928, Wisconsin Geol. and Nat. Hist. Survey, Bull. 70, pt. 1, p. 453.

Recognition characters: Shell sinistral, imperforate, light brown; size variable, approximately 13 mm. in height; whorls 5; spire sharply conic; body whorl large, $\frac{3}{4}$ or more of length of shell; aperture elongate, oval; lip thin with a distinct parietal callus.

Type locality: Verdigris River, Kansas.

Geographic distribution: Texas, northward in Oklahoma, Arkansas, Missouri, and Kansas.

Ecology: This hardy species lives in bodies of freshwater of all sizes, whether they be temporary or permanent, and whether natural or artificial. Franzen and Leonard (1943:408) state that in north-eastern Kansas *P. hawni* is "Common in roadside pools in colonies of considerable size. Much less common than *P. anatina* in streams, although Lea described it from the Verdigris River, Kansas." Alice Leonard (1943:238) reports *P. hawni* as "thriving in stock tanks supplied from wells," where there were no natural bodies of water within a distance of several miles.

P. hawni occurs on the Reservation at stations A and B. Ecological conditions at station B are described in the above account of *Helisoma trivolvis*. All the specimens from the pond (SB) were small and immature. A colony that included mature snails was found at the small stream (SA), where the snails were abundant among the plants and debris along the banks.

Helisoma trivolvis lentum (Say)

Plate C, fig. 9

Planorbis trivolvis Say, 1817, Nicholson's Encyc., 1st. American Ed., vol. 2, (no pagination), pl. 2, fig. 2.

Helisoma trivolvis, Baker, 1928, Wisconsin Geol. Nat. Hist. Survey, Bull. 70, pt. 1, pp. 330-334, pl. 20, figs. 1-13, 22, 23.

Recognition characters: Shell discoidal, flat, sinistral; color yellowish brown; whorls 4, whorls of spire form slightly concave surface; lip of aperture sharp, with thin parietal callus; surface sculptured with fine, oblique lines.

Type locality: "French Creek, near Lake Erie" (Baker, 1928:331).

Geographic distribution: "Atlantic coast and Mississippi River drainages, northward to Arctic British America and Alaska and southward to Tennessee and Missouri. The southern distribution is not clear owing to mixing with related species" (Baker, 1928:332). *H. trivolvis* is widely distributed in Kansas.

Ecology: *Helisoma trivolvis* occurs in ponds and lakes throughout the state of Kansas. It is frequently found in ephemeral roadside pools. "It can survive long periods of drouth, apparently by burrowing into the mud in the bottom of drying pools" (A. Leonard, 1943:235).

H. trivolvis and other aquatic species were collected from the pond (SB) on October 8 and October 27, 1948. At that time the pond was dry and had been since mid-September. No living examples were found on those dates, although from the color of the shells and their number, it was obvious that the pond had recently

supported a flourishing population. The pond became filled with water in early December, 1948, but at the time of this study no living snails were observed in the pond.

Lymnaea parva (Lea)

Plate C, fig. 8a

Lymnaea parva Lea, 1841, Proc. American Philosophical Soc., 2:33; Baker, 1911, Special Publ. No. 3, Chicago Acad. Sci., p. 243, pl. 29, figs. 5-14, Pl. 30, figs. 9-12; Franzen and Leonard, 1943, Univ. Kansas Sci. Bull., vol. 29, pt. 2, No. 9, p. 406, Pl. 30, fig. 6.

Recognition characters: Shell small, turreted, light brown; height variable; whorls 5; dextral; suture deeply impressed; body whorl inflated; aperture oval, about $\frac{1}{3}$ height of shell; spire acutely pyramidal; outer lip thin; inner lip reflected, reducing umbilicus to a fissure; growth lines fine, irregular.

Type locality: Cincinnati, Ohio.

Geographic distribution: "Connecticut west to Idaho; James Bay and Montana south to Maryland, Kentucky, Oklahoma, southern New Mexico and Arizona" (Baker, 1911:32).

Ecology: *Lymnaea parva* is a typical inhabitant of very moist situations. Archer (1939:16) reports this snail, in Michigan, "on mud and decaying vegetation out of the water along the edges of pasture pools." Baker (1911:247), in reference to its aquatic life, states, "The animal is more prone to leave the water than any other of the *Lymnaeas*." In Kansas, *L. parva* is usually found in habitats similar to those described by Archer. Moist drift and other decaying vegetation provide an optimum environment.

Only a few dead specimens of *Lymnaea parva* were found on the Reservation. These were collected from the loose moist soil on the banks of the small stream (SA).

Gastrocopta armifera (Say)

Plate CI, fig. 23

Pupa armifera Say, 1821, Jour. Acad. Nat. Sci. Philadelphia, 2:162.

Gastrocopta ramifera, Pilsbry, 1948, Acad. Nat. Sci. Philadelphia, Monographs No. 3, 2(2):874-877, fig. 472.

Recognition characters: Largest of the genus as represented in Kansas; oval; rimate; whorls $4\frac{1}{2}$ to $6\frac{1}{2}$; a large, bifid, angulo-parietal lamella; may have two palatal folds; basal fold; large, triangular, columellar lamella.

Variation in characters of the shell is the rule with this species. The height varies from 3.5 mm. to 5 mm. Other variable features are number of palatal folds, size of the basal fold, and size and shape

of the columellar lamella. These variations frequently occur among the individuals of a single population.

Type locality: Pilsbry (1948:875) has selected Germantown, Philadelphia, Pennsylvania as the type locality.

Geographic distribution: "It inhabits almost the whole country east of the continental divide, but is lacking in southwestern New Mexico, southern Texas, southern Florida, and the higher parts of the Alleghany Mountain system" (Pilsbry, 1948:875). This species is common throughout Kansas.

Ecology: In eastern Kansas *G. armifera* occurs in a wide variety of habitats. It may be found under leaf mold on wooded slopes, under limestone rocks on barren hillsides, beneath decaying wood, and among roots of tall grass. In other areas this snail does not enjoy such an ubiquitous distribution. In a paper concerning the Mollusca of Michigan, Archer (1939:23) reports, "This snail is very abundant in open country on slopes and in valleys but tends to avoid summit areas. It has not been found in woodland cover." In 1937 Archer wrote of *G. armifera* in Ohio, "*G. armifera* and *P. marginatus* (*P. albilabris*) are rare or absent in woods, but abundant in fields, on railroad embankments, and also in rocky, open country." Alice Leonard (1934:238) found that *G. armifera abbreviata* had "a distinct preference for woodlands . . ." in western Kansas. These inconsistencies in habitat occupied probably are related to differences in local climatic conditions.

On the University of Kansas Natural History Reservation *G. armifera* was collected from every terrestrial station, and was by far the most abundant snail. *G. armifera* is frequently associated with two other species, *Vallonia parvula* and *Retinella indentata*. At Station G, where eleven species of land snails are represented, these three species constitute 80 per cent of the total molluscan population. In some areas at this station the empty shells and living animals of *G. armifera* average eight per square foot. The species was found in greatest numbers at Stations F and G, where it occurs with surprising frequency under small limestone rocks in arid situations. On one rocky slope shells of *G. armifera* averaged seven specimens per stone, the stones ranging from four to eight inches in diameter. Several specimens were collected from under stones at the margins of the grazed meadow (SI) and from a similar environment on the plateau near the north boundary of the Reservation. *G. armifera* was also found under decaying logs beneath

humus on the north-facing slope but it was not common at either of these stations.

Gastrocopta contracta (Say)

Plate CI, fig. 11

Pupa contracta Say, 1822, Jour. Acad. Nat. Sci. Philadelphia, 2:374.

Gastrocopta contracta, Pilsbry, 1948, Acad. Nat. Sci. Philadelphia Monographs No. 3, 2(2): 880-881, fig. 474.

Recognition characters: Shell medium size for genus; ovate-conic; height 2.1 mm. to 3.0 mm.; rimate; whorls $4\frac{1}{2}$ to 6; body whorl contracted just behind aperture; aperture trianguloid, apex forming base of aperture; aperture almost closed by folds and lamellae; large fused angulo-parietal; two palatal folds connected by a callus; columellar lamella large, thin immersed.

Type locality: Occoquan, Virginia.

Geographic distribution: According to Pilsbry (1948:881) "Eastern United States and Canada, Maine, Ontario and Manitoba, south Miami, Florida, and Veracruz, Mexico; Cuba and Jamaica (probably introduced)" *G. contracta* occurs in Kansas as far west as Reno and Kingman counties (Franzen and Leonard, 1947:331).

Ecology: Since *G. contracta* is primarily an eastern species it is not abundant in Kansas, although it is fairly well distributed throughout the eastern division of the state. It is found principally "on shaded slopes along the watercourses, under dead wood, leaf mold and grass" (Franzen and Leonard, 1947:331).

Archer (1939:22) reported this species in Michigan, "in deep grass in marshes; in ferns in meadows; under logs in birch-maple swamp woods; . . . This snail is nowhere common." On the Reservation *G. contracta* was found in six of the eight terrestrial habitats, but was not abundant at any of these. It was most numerous on the south facing slope (SG) where it occurred under forest litter in the more poorly drained areas on the hillside. Its occurrence on the north facing slope (SE) was limited to the poorly drained region near the bottom of the hillside where it was found under a heavy layer of humus composed, chiefly, of the leaves of the black oak and elm. Other equally favorable habitats were: in loose soil and under leaves on the banks of the small stream (SC); in and around decaying logs (SD); in loose soil around roots of small trees and shrubs at Station F; in loose soil among the roots of tall grass and weeds (SH).

Gastrocopta holzingeri (Sterki)

Plate CI, fig. 13

Pupa holzingeri Sterki, 1889, Nautilus, 3:37, 96, 119.*Gastrocopta holzingeri*, Pilsbry, 1948, Acad. Nat. Sci. Philadelphia Monographs No. 3, 2(2):883-884, fig. 474.

Recognition characters: Shell small, oval; height 1.6 mm. to 1.9 mm.; rimate; whorls 5; aperture broadly oval; 7 lamellae and folds; angulo-parietal lamellae incompletely fused to form a mirror image of the letter "y"; heavy palatal callus; columellar lamella high, elongate.

Type locality: Will County, Illinois.

Geographic distribution: "Ontario and western New York to Helena, Montana, south to Illinois, Kansas, and Albuquerque and Mesilla, New Mexico" (Pilsbry, 1948:883). This snail has been collected from scattered localities over most of Kansas (Franzen and Leonard, 1947:335).

Ecology: *Gastrocopta holzingeri* is a northern species and not one of the dominant species of the fauna of Kansas (Franzen and Leonard, 1947:335). It has succeeded in adapting itself to the hot, dry summer months and, strangely enough, is to be found in many of the far western counties of the state.

Although *G. holzingeri* was found at five stations on the Reservation, it was abundant at only two of them (table 1). In the more moist areas on the west facing slope (SF) this species was the most numerous of the molluscan assemblage. Here it was found under the decaying leaves of the yellow oak and other forest debris. The species was not so abundant on the south facing slope (SG), but it was still common. A few specimens were collected from the banks of the small stream, from under decaying logs, and from under small stones in a rocky gully.

Gastrocopta pentodon (Say)

Plate CI, fig. 12

Vertigo pentodon Say, 1821, J. Acad. Nat. Sci. Philadelphia, 2:375.*Gastrocopta pentodon*, Pilsbry, 1948, Acad. Nat. Sci. Philadelphia Monographs No. 3, 2(2):886-889, fig. 477.

Recognition characters: Shell small, usually 1.5 mm. to 2.0 mm. in height; whorls 5; 5 to 7 lamellae and folds; denticles variable in size and shape; thick callus immediately below peristome; fused angulo-parietal typically straight, simple, but in many specimens fusion is incomplete.

Type locality: Pennsylvania.

Geographic distribution: "Eastern United States and Canada: Prince Edward and Magdalen Islands to Alberta, south to central Florida and Texas; New Mexico; west in Arizona to the Santa Cruz River. Eastern Mexico and Guatemala. This species is found over a greater area than any other North American *Gastrocopta*" (Pilsbry, 1948:888).

Ecology: There has been, in the past, some confusion as to whether Kansan specimens assigned to this species were correctly identified or whether they should properly be referred to *Gastrocopta tappaniana* (C. B. Adams) (Pilsbry, 1948:889). Two distinct "forms" have long been recognized in the local fauna; a broad ovoid type and a smaller, more elongate form. In recent years workers have been inclined to consider both "forms" as *G. tappaniana*. It has been the experience of those working with the local fauna that specimens of both "forms" are highly variable in size and shape, and in many localities specimens may be arranged in a graded series from the slender "pentodon" to the broad "tappaniana" type. Specimens from the University of Kansas museum collection that had been identified as *G. pentodon* and *G. tappaniana* were examined and the literature concerned with these species reviewed. It is our opinion, that the characters used to separate specimens of *G. pentodon* and *G. tappaniana* are inadequate for the retention of specific rank and by the law of priority the name *G. tappaniana* should be considered a synonym of *G. pentodon*.

On the Reservation, specimens of *G. pentodon* were collected from all the wooded slopes, occurring more abundantly on the drier west and south facing hillsides than on the north facing slopes. These specimens from the hillside were predominantly of the smaller, more elongate form. The broad ovoid type was found only as dead specimens in moist situations along the banks of the small stream. When more ecological information concerning this species is acquired these two "forms" may be accorded subspecific rank.

Gastrocopta procera (Gould)

Plate CI, fig. 15

Pupa procera Gould, 1840, Boston Jour. Nat. Hist., 3:401; 4:359.

Gastrocopta procera, Pilsbry, 1948, Acad. Nat. Sci. Philadelphia Monographs No. 3, 2(2): 907-908, fig. 492.

Recognition characters: Shell medium in size for genus; height 2 mm. to 3.2 mm.; cylindric; rimate; whorls 5 to 6½; aperture rounded; peristome thickened within; deep excavation at upper extremity of outer lip; 6 lamellae and folds; a bifid angulo-parietal;

lower palatal more deeply placed than upper palatal or basal fold; columellar lamella nearly one half length of a whorl.

Type locality: Baltimore, Maryland.

Geographic distribution: "Eastern United States, Maryland to South Carolina, west to Shawnee Co., Kansas and Payne Co., Oklahoma; south to Alabama and eastern Texas" (Pilsbry, 1948:907). *Gastrocopta procera* has a wide distribution in Kansas (Franzen and Leonard, 1947:343, fig. 8).

Ecology: As can be seen by its southern distribution, *G. procera* prefers higher temperatures than those which prevail in the northern states. Its success in Kansas is due to its ability to withstand periods of drouth along with the prevailing high temperatures of the summer months. While it favors timbered hillsides, it shuns extremely moist situations.

On the Reservation, *G. procera* is nowhere abundant, although it occurs at five of the eight terrestrial stations. It is most numerous at Station H where it occurs in the loose soil among the roots of tall grass and weeds. The species is rare at Stations C, F, and G, being found under decaying humus in all three situations. A single, small specimen was collected from under cow dung in the grazed meadow. This was the only occurrence of a snail in the grazed meadow any appreciable distance from the timbered slopes which border the pasture.

Vertigo ovata Say

Plate CI, fig. 14

Vertigo ovata Say, 1822, Jour. Acad. Nat. Sci. Philadelphia, 2:375; Pilsbry, 1948, Acad. Nat. Sci. Philadelphia Monographs No. 3, 2(2): 952-953, fig. 513.

Recognition characters: Shell small, approximately 2 mm. in height; ovate; rimate; whorls 5, convex, striate; body whorl greatly enlarged, $\frac{3}{4}$ height of shell; aperture oval, biarcuate; denticles 6 to 9; parietal lamella high, elongate; angular lamella low, tubercular; denticles on a heavy callus.

Type locality: Philadelphia, Pennsylvania.

Geographic distribution: "Prince Edward I[sland] and Ungava Bay, Labrador, south to Florida Keys and Texas, west to Puget Sound and Oregon, southwest to Fruita, Utah, Tempe and Huachuca Mts., Arizona. Alaska on Kodiak and Tigalda Is. West Indies" (Pilsbry, 1948:953).

Ecology: *Vertigo ovata* is an inhabitant of moist situations, and is uncommon in Kansas, being unable to adapt itself to the periodic drouths which obtain in that state. The species is found among

vegetation in swampy areas and along the banks of streams and other bodies of water.

Only two weathered shells of *V. ovata* were found on the Reservation. These were in loose soil on the steep banks of the small stream. It is unlikely that the living snails can be demonstrated from this habitat for, at present, the banks of the stream represent drier situations than *V. ovata* will normally tolerate.

Pupoides albilabris (C. B. Adams)

Plate CI, fig. 22

Pupa albilabris C. B. Adams (Ward's letter), 1841, American Jour. Sci., 40:271.
Cyclostoma marginata Say, 1821, Jour. Acad. Nat. Sci. Philadelphia, 2:172.
Pupoides albilabris, Pilsbry, 1948, Acad. Nat. Sci. Philadelphia Monographs No. 3, 2(2):921-923, fig. 499.

Recognition characters: Shell elongate-conic; height variable, usually 4.5 mm. to 5.6 mm.; whorls $4\frac{1}{2}$ to $6\frac{1}{2}$; aperture oval with a sinulus at the upper extremity of the outer lip; peristome heavy, reflected; no lamellae or folds present.

Type locality: Ohio.

Geographic distribution: "Eastern North America from Ontario and Maine to the Gulf of Mexico, west to the Dakotas, Colorado, and western Arizona; in northern Mexico on islands in the Gulf of California, at Monterrey and Tampico. Cuba; Haiti; Porto Rico; Bermuda" (Pilsbry, 1948:923). "Its occurrence in Kansas is general" (Franzen and Leonard, 1947:371).

Ecology: This widely distributed snail is unusual in its ability to flourish in arid regions as well as in those of more than moderate annual rainfall. In Michigan, Archer (1939:23) reported that *Pupoides albilabris*, "apparently does not occur in woodland cover." In 1937 Archer wrote of *P. albilabris* in Ohio, "*Gastrocopta armifera* and *Pupoides marginatus* are rare or absent in woods, but abundant in fields, on railroad embankments, and also in rocky, open country."

In Kansas, *P. albilabris* is found in woodlands as well as in open country. Franzen and Leonard (1947:371) report the species as occurring "in woodlands, in deep grass, or even among the roots of short grass in unshaded areas."

On the Reservation, *P. albilabris* was collected from three stations (table 1). It was abundant in the steep, well-drained areas of the west-facing, wooded slope (SF). The species was common on limestone ledges at the summit of the north-facing slope and a few specimens were collected from the loose soil around the roots of tall grass and weeds (SH).

Succinea avara Say

Plate C, fig. 8

Succinea avara Say, 1824, in Appendix to Keating's Narrative Exped. Source St. Peter's River, etc., Major Long's Second Expedition, 2:260, pl. 15, fig. 6; Pilsbry, 1948, Acad. Nat. Sci. Philadelphia, Monographs No. 3, 2(2):837-840, fig. 455a to k.

Recognition characters: Shell ovate, yellowish, translucent; height variable, usually a little less than one-half inch; whorls 3 to 4; spire only one fourth height of shell; aperture oval; lip thin, simple; surface sculptured with growth lines, irregularly spaced.

Type locality: Northwest Territory.

Geographic distribution: "Newfoundland; Ontario north to James and Hudson Bay; north to Lat. 62 degrees on the Makenzis River; British Columbia; south to Florida in the east and to Northern Mexico in the west" (Pilsbry, 1948:837). This species is widely distributed in Kansas.

Ecology: Franzen and Leonard (1943:425), in referring to the occurrence of *S. avara* (incorrectly identified as *S. grosvenori*) in Northeastern Kansas, report, "while it is widely distributed in a variety of habitats, it apparently thrives best on the grass and reeds near or above the water in roadside ditches and similar situations." Its distribution in Kansas reflects its ability to withstand dry periods.

On the Reservation, *S. avara* is restricted to the more moist habitats (table 1). It is probably more common than the collections would indicate, owing to the fact that, in life, the shell is often daubed with dirt, making it almost invisible to the collector. The species was most common under decaying vegetation on the banks of the small stream (SC) and among the moss-covered, limestone rocks near the summit of the north and west-facing hillsides. It was collected also from under decaying logs on the north-facing slope.

Succinea concordialis Gould

Plate C, fig. 3

Succinea concordialis Gould, 1848, Proc. Boston Soc. Nat. Hist., 3:38.

Succinea concordialis, Pilsbry, 1948, Acad. Nat. Sci. Philadelphia, Monographs no. 3, 2(2): 833, fig. 452.

Recognition characters: Shell elongate-oval, thin, horn-colored, glossy; spire shortly conic; height variable, usually 15 mm. to 19 mm.; whorls 3; body whorl greatly inflated, marked by fine growth lines; aperture oval, $\frac{5}{7}$ height of shell; lip thin; usually light callus over columella.

Type locality: Lake Concordialis (an abandoned meander of the Mississippi River opposite Natchez, Mississippi), Concordia county, Louisiana.

Geographic distribution: Southern and southeastern United States. Kansas records are from widely scattered localities.

Ecology: Little or nothing has been written concerning the ecology of this species. It is one of the most hygrophilic species of the genus. Its usual habitat is upon plants growing in or near the water. Only rarely is it seen actually submerged. The Succineas are often termed "amphibious" because they usually prefer moist situations.

No living specimens of *S. concordialis* were collected from the Reservation, but like other snails from the pond (SB), the empty shells were found in abundance while the pond was dry during the fall and early winter months. The number and appearance of these shells indicated that the pond had recently supported a large population.

Vallonia parvula Sterki

Plate CI, figs. 18, 19

Vallonia parvula Sterki, 1893, Man. Conch., 8:254, pl. 32, figs. 23-26; Pilsbry, 1948, Acad. Nat. Sci. Philadelphia, Monographs No. 3, 2(2):1027-1028, fig. 547.

Recognition characters: Shell depressed, less than 1 mm. in height; diameter 1.6 mm. to 2.0 mm.; spire slightly convex; large, round umbilicus; whorls 3 to 3½; peristome strongly reflected; last two whorls with prominent ribs.

Type locality: Joliet, Illinois.

Geographic distribution: Pilsbry (1948:1028) lists localities from Ontario, Ohio, Illinois, Iowa, South Dakota, Kansas, Oklahoma, and Texas. A more exact statement of the distribution of this species can not be given until the relationships between it and closely related kinds are better known.

Ecology: This highly successful snail is found throughout Kansas in a wide variety of habitats. Franzen and Leonard (1943:423) reported this species as occurring "under logs or stones, where there is considerable moisture, although it will survive arid periods." Alice Leonard (1943:240) in reporting on the Mollusca of western Kansas characterized this snail as successful in that arid country where large numbers were found even in ravines that had scant timber.

The occurrence of *V. parvula* on the Reservation reflects its ability to live under a variety of situations. It was recovered from seven of the eight terrestrial habitats and was common at all but one of these (table 1). Its association with *Gastrocopta armifera* and *Retinella indentata* is noted elsewhere. *Vallonia parvula* was exceptionally abundant at Station G where, in some areas, the dead and living specimens averaged nineteen per square foot. Here and on other wooded slopes it was found in loose soil under a thin layer of decaying vegetation. Although it was common in more moist situations (SC, SD, and SF) it never reached the abundance demonstrated at Stations F and G. The species was collected also from arid limestone ledges and under small stones on rocky slopes.

Strobilops labyrinthica (Say)

Plate CI, fig. 16

Helix labryinthica Say, 1817, J. Acad. Nat. Sci. Philadelphia, 1:124.

Strobilops labyrinthica, Pilsbry, 1948, Acad. Nat. Sci. Philadelphia, Monographs No. 3, 2(2):854-856, fig. 463.

Recognition characters: Shell small, conic; 2.0 mm. to 2.6 mm. in diameter; height approximately 2 mm.; whorls 5 to 6; suture distinct; three elongate lamellae, two of which can be seen at the aperture on the parietal wall; shell heavily sculptured with oblique ridges.

Type locality: Philadelphia, Pennsylvania.

Geographic distribution: "Maine and Quebec west to Manitoba, Minnesota, Kansas, and Arkansas, south to Georgia and Alabama" (Pilsbry, 1948:854).

Ecology: *Strobilops labyrinthica* is definitely a woodland snail. Pilsbry (1948:854) states that, "Its usual stations are under loose bark of logs, in half-decayed wood, among dead leaves and in sod at bases of trees." Franzen and Leonard (1943:423) noted that it was confined to moist woodland habitats in northeastern Kansas.

On the Reservation, the optimum habitat seemed to be around moist logs that were in advanced stages of decay. The snail is probably much more numerous than the collection would indicate, as the dull-brown shell is often hard to discern against the background of a decaying log. This species is often associated with *Zonitoides arboreus* and *Retinella electrina*. *S. labyrinthica* was also found beneath forest litter in oak-elm and oak-hickory-walnut areas on the north-facing slope (SE). The occurrence of this species on the arid limestone ledges (table 1) is no doubt correlated with the presence of many old logs in the vicinity.

Helicodiscus parallelus (Say)

Plate CI, fig. 24, 25

Planorbis arallelus Say, 1821, J. Acad. Nat. Sci. Philadelphia, 2:164 (corrected to *parallelus* in the index, p. 467).

Helicodiscus parallelus, Pilsbry, 1948, Acad. Nat. Sci. Philadelphia, Monographs No. 3, 2(2):625-628, fig. 339.

Recognition characters: Shell small, flattened, greenish white in color; about $\frac{3}{4}$ inch in diameter; spire slightly convex; umbilicus (if it can be termed such) broad, showing all the whorls; whorls 4, closely coiled; whorls show numerous, fine ridges parallel to the sutures; many specimens have 1 to 3 minute denticles on outer wall of aperture.

Type locality: Pilsbry (1948:627) has selected Council Bluffs, Iowa, as the type locality.

Geographic distribution: From the Atlantic coast as far west as Minnesota, South Dakota, Kansas, Oklahoma, and Arkansas. To Newfoundland, Quebec, and Ontario in the north, and south to Alabama and South Carolina (Pilsbry, 1948:626). This species occurs in Kansas as far west as Meade County.

Ecology: Although *Helicodiscus parallelus* is widely distributed in Kansas, it is not abundant except in local situations. It is primarily a woodland inhabitant. Pilsbry (1948: 627) lists its habitats as "Decaying wood in shady or humid places, also on damp leaves . . . leaf siftings and in drift debris." In eastern Kansas the species may occur in grassy fields, on sparsely timbered slopes, and on rocky ledges as well as in more moist places. In the more arid parts of the state, however, *H. parallelus* is limited to woodland cover, and usually occurs around decaying timber.

Helicodiscus parallelus was nowhere common on the Reservation. The optimum habitats seemed to be the limestone ledges (SJ) and forest debris in the oak-hickory-walnut area on the north-facing slope (SE). It also occurred under decaying vegetation at Station F and G and among grass roots at Station H.

Stenotrema monodon aliciae (Pilsbry)

Plate C, figs. 5, 6

Polygyra monodon aliciae Pilsbry, 1900, Proc. Acad. Nat. Sci. Philadelphia, p. 455.

Stenotrema monodon aliciae, Pilsbry, 1948, Acad. Nat. Sci., Philadelphia, Monographs No. 3, 1(2):679-681, fig. 421c.

Recognition characters: Shell subglobose, light brown; diameter variable, approximately 6.5 mm.; spire dome shaped; base distinctly convex; approximately 6 whorls, closely coiled; white lip

reflected outward, innermost portion almost covering deep, round umbilicus; single denticle on parietal wall, sinuous, lying only partly within peristome; surface of shell covered with minute "hairs".

Type locality: Near Lake Charles, Calcasieu Parish, Louisiana (Pilsbry, 1946:680).

Geographic distribution: West to Kansas, Oklahoma and Texas; south to Mississippi and Alabama; east to Virginia and Maryland; north to Illinois and Indiana (Pilsbry, 1948:680).

Ecology: *S. monodon aliciae* is a woodland snail, usually found in moist situations. At the present time it is limited to the eastern section of Kansas. Franzen and Leonard (1943:410) wrote of it in northeastern Kansas as "distinctly a woodland snail, . . . thrives best in leaves, or near old stumps or logs among trees." Although not a colonial species, the snails often are numerous at a favorable site, such as the underside of a decaying log.

On the Reservation *S. monodon aliciae* was found in three of the selected habitats (table 1). It was most abundant in and around decaying logs on protected slopes. The species was common under forest litter in oak-elm and oak-hickory-walnut associations. Numerous bleached shells were collected from arid limestone ledges near the top of the north facing slope, but no living snails were observed.

Bulimulus dealbatus (Say)

Plate C, fig. 10

Helix dealbata Say, 1831, Jour. Acad. Nat. Sci., Philadelphia, 2:159.

Bulimulus dealbatus, Pilsbry, 1946, Acad. Nat. Sci. Philadelphia, Monographs No. 3, 2(1):7-9, fig. 4.

Recognition characters: Globose-conic; mottled with grayish markings; height variable, usually 17 mm. to 23 mm.; whorls 6; umbilicus distinct, deep; aperture oval, large, one half height of shell; specimens in any single colony exhibit a great degree of variation in size and shape.

Type locality: Alabama? (Pilsbry, 1946:9).

Geographic distribution: Pilsbry (1946:9) lists localities from Alabama, Tennessee, Kentucky, Illinois, Missouri, Kansas, Oklahoma, Arkansas, Louisiana, and Texas. The species is distinctly southern in distribution; the northernmost occurrences are in Missouri and Kansas.

Ecology: *Bulimulus dealbatus* differs from other species in the local fauna in being limited to open, arid country. The snail is colonial; many are often found on a single weed or bush upon

which they aestivate. At other times they are difficult to find, as they hibernate by burrowing in the soil. In Kansas, *B. dealbatus* has a scattered distribution, the colonies usually occurring on summit areas, often on bluffs along rivers and streams.

On the Reservation a colony of *Bulimulus dealbatus* was discovered near the pond in a weed patch. This small area, while a part of Station I, had been fenced off from the grazed part of the meadow. The adult snails were first observed on the tall weeds on June 11 and the young on June 20. Both the adults and the young preferred to aestivate on the dead stalks of last year's crop of weeds. Only two individuals were found on green vegetation. A few dead shells were collected from limestone ledges at the summit of the north-facing hillside.

Deroceras laeve (Muller)

Plate C, fig. 7

Limax laevis Muller, 1774, Verm. Terr. et Fluv. Hist., 2:2.

Limax gracilis Rafinesque, 1820, Ann. of Nat., 1:10.

Deroceras gracile, Baker, 1939, Ill. Nat. Hist. Survey Manual 2, p. 129-130; Franzen and Leonard, 1943, Univ. Kansas Sci. Bull., vol. 29, pt. 2, p. 425, pl. 32, fig. 25.

Deroceras laeve, Pilsbry, 1948, Acad. Nat. Sci. Philadelphia, Monographs No. 3, 2(2): 539-552, figs. 289-291.

Recognition characters: Small, gray or black; body oval, elongate, terminating in a short carina; length about one inch; peduncles of eye long, tentacles short; foot narrow, whitish; mucus watery, not especially adhesive.

This slug can be recognized by its small size and its lack of distinct markings.

Type locality: Denmark.

Geographic distribution: "North America generally, from Arctic to middle Florida and Central America, the southern limit not determined" (Pilsbry, 1948:540).

Ecology: This small slug is common in wooded areas throughout Kansas. It is found in marshes, in woods, and on rocky slopes. It is active only when the relative humidity is high; at other times it retreats under stones, logs, leaves or any object that might serve as protection from the drying effects of the sun and wind. Although it is common, its small size and drab coloration make it difficult to find.

Deroceras laeve was collected from all the wooded slopes on the Reservation. It seemed to be most abundant in the poorly drained north-facing slopes. Here it was found around decaying logs and other forest debris.

Hawaiiia minuscula (Binney)

Plate CI, figs. 20, 21

Helix minuscula Binney, 1840, Boston Jour. Nat. Hist., 3:435.*Hawaiiia minuscula*, Pilsbry, 1948, Acad. Nat. Sci., Philadelphia, Monographs No. 3, 2(1):420-424, figs. 228, 229.

Recognition characters: Minute, depressed; less than 2.5 mm. in diameter; spire only slightly elevated; whorls 4; suture well impressed; umbilicus round, wide, showing all the whorls.

Type locality: Ohio? (Pilsbry, 1946:423).

Geographic distribution: "It is generally spread over every eastern and midwestern state, and in Florida as far south as Miami and Cape Sable, though not seen from the Keys. It becomes rather local in the Rocky Mountain States, and has not been seen from Washington, Oregon, Idaho, Nevada, and Utah" (Pilsbry, 1946:421).

Ecology: Although this small snail prefers a woodland environment, it is able to survive under arid conditions. Its occurrence in western Kansas is reported by Alice Leonard (1943:238).

On the Reservation, *H. minuscula* is not one of the most numerous species. It was collected from four of the eight terrestrial stations. While it was not rare at any of these, it was abundant only along the banks of the small stream (SC). Here, it was in the loose moist soil under a light layer of decaying vegetation. Other habitats included: under leaves in an oak-elm area (SE); among grass roots (SH); and under decaying logs on the north facing slope.

Retinella electrina (Gould)

Plate CII, figs. 28, 29

Helix electrina Gould, 1841, Invert. Massachusetts, p. 183, fig. 111.*Retinella electrina*, Baker, 1930, Journ. Acad. Nat. Sci. Philadelphia, 82:196-198; Pilsbry, 1946, Acad. Nat. Sci. Philadelphia, Monographs No. 3, 2(1):256-259, fig. 126.

Recognition characters: Depressed; spire slightly convex; yellowish; 4.5 mm. to 5 mm. in diameter; whorls 4; suture shallow; umbilicus round, deep; peristome thin.

Type locality: Borders of Fresh Pond, Cambridge, Mass.

Geographic distribution: Southern and eastern Canada; Rocky Mountain States; North Central and Northeastern states. Southern limits are Arizona, New Mexico, Kansas, Missouri, and Virginia (Pilsbry, 1946:257).

Ecology: *Retinella electrina* is distinctly a woodland snail, occurring in leaf mold, under bark, and under decaying logs. It is

frequently associated with *R. indentata*, *Zonitoides arboreus*, and *Strobilops labyrinthica*.

Retinella electrina was recorded from four stations on the Reservation. It was abundant only on the north-facing slope, where it was found under decaying vegetation in oak-elm and oak-hickory-walnut associations, around decaying logs and stumps, and in moss at the bases of trees. This species was collected also from the banks of the stream and a few examples were recorded from the south-facing, wooded slope. *R. electrina* occurs far less frequently on the Reservation than does *R. indentata*.

Retinella indentata (Say)

Plate CII, figs. 30, 31

Helix indentata Say, 1823, Journ. Acad. Nat. Sci. Philadelphia, 2:372.

Retinella indentata, Baker, 1930, Journ. Acad. Nat. Sci. Philadelphia, 82:209-210; Pilsbry, 1946, Acad. Nat. Sci. Philadelphia, Monographs No. 3, 2(1): 288-290, fig. 146.

Recognition characters: Depressed; spire slightly convex, yellowish; usually 4.0 mm. to 5 mm. in diameter; whorls 4; suture shallow; umbilical region indented but only slightly perforate.

Type locality: "Say gave localities in northern Philadelphia ("Harrigate") and New Jersey" (Pilsbry, 1946:289).

Geographic distribution: Southern Ontario and Quebec; south to Tennessee and northern Alabama; west to Shawnee Co., Kansas (Pilsbry, 1946:289).

Ecology: *Retinella indentata* is a highly successful snail, having a wide distribution and being found in a variety of ecological situations. Archer (1936:19) reports this species from such varied habitats as "in marsh grass . . . under rotten logs . . . around and under rock in the grass of the open fields; and on till among ironwood trees of the open slopes."

In Kansas, *R. indentata* is usually found on timbered slopes under stones, logs, loose bark, and other forest debris. It is rare in open country, although it occurs on rocky slopes having only a sparse cover of trees and shrubs.

On the Reservation, *R. indentata* was collected at all but one of the terrestrial stations (table 1). The association of *R. indentata* with *Gastrocopta armifera* and *Vallonia parvula* and the abundance of the three species has been noted elsewhere. At Station G the dead and living specimens of *R. indentata* averaged six per square foot. The species was most abundant under decaying vegetation at Stations G and F. Both of these slopes are covered with small

trees and brush and both are subject to the drying effects of the sun and wind. In this connection, it should be noted that *R. indentata* prefers drier habitats than does *R. electrina* although they frequently occur together in moist situations. Other habitats of *R. indentata* included the under sides of stones in rocky gullies, arid limestone ledges, the roots of deep grass and decaying logs.

Zonitoides arboreus (Say)

Plate CII, figs. 26, 27

Helix arboreus Say, 1816, (Nicholson's 1st American Edit. British Encycl., vol. 2, pl. 4, fig. 4.

Zonitoides arboreus, Pilsbry, 1946, Acad. Nat. Sci. Philadelphia, Monographs No. 3, 2(1):480-483, figs. 261, 262.

Recognition characters: Shell depressed; spire slightly convex; dark brownish-yellow in color; less than 5 mm. in diameter; whorls $4\frac{1}{2}$ to 5, growth lines fine, irregular; suture well impressed; lip thin, simple; umbilicus round, deep.

Type locality: Unknown.

Geographic distribution: Reported from all states except Nevada; as far north as Great Slave Lake in the Northwest Territory; as far south as Central America and the West Indies (Pilsbry, 1946:481).

Ecology: *Zonitoides arboreus* is one of the most widespread species of land snails in North America. In certain areas in the eastern and southern states the snail is an agricultural pest. In 1925 the root-rot disease, which was threatening Louisiana sugar cane industry, was traced to this species of snail; the snails feeding on the roots of the sugar cane damages the surface and permits the entrance of microorganisms from the soil (Johnson, 1925:70).

Zonitoides arboreus is not so abundant in Kansas as it is in the more eastern states, although it may be common in timbered areas. Its favorite habitats are around decaying logs, under loose bark, and among decaying vegetation (Franzen and Leonard, 1943:413). It is frequently found in association with *R. indentata* and *R. electrina*.

On the Reservation *Z. arboreus* was common on the north facing slopes, where it was found under decaying logs and under leaf humus in an oak-elm association. It was rare on the banks of the small stream and on the west-facing, wooded slope. The scarcity of *Z. arboreus* probably can be attributed to the absence of decaying logs on many of the wooded slopes.

Euconulus chersinus cf. *polygratus* (Pilsbry)

Plate CI, fig. 17

Conulus chersinus polygyratus Pilsbry, 1899, Nautilus, 12:116.*Euconulus chersinus polygratus*, Pilsbry, 1946, Acad. Nat. Sci. Philadelphia, Monographs No. 3, 2(1): 240-241, fig. 119f.

Recognition characters: Small, globose-conic; light amber; rimate; whorls $5\frac{1}{2}$ to 6, tightly coiled; aperture lunate; lip thin, reflected near columella; no lamellae or folds.

Type locality: Grand Rapids, Michigan.

Geographic distribution: "Ontario and Maine west in the northern tier of states to Wisconsin and to Malachi, Ontario, and Yonker, Saskatchewan" (Pilsbry, 1946:240).

On the Reservation, the species is nowhere abundant and it is limited to the wooded hillsides (table 1) where it occurs under rotten logs, decaying leaves, and other debris. It was collected from the three wooded slopes and occurred most frequently under logs on the north facing slope.

Sphaerium sp?

Plate C, fig. 1

Recognition characters: Oval, transversely inequilateral, inflated; epidermis brownish yellow; nacre bluish white; beak inflated, not prominent; anterior margin rounded; posterior margin somewhat blunt; sculpture fine, irregular; left valve: posterior lateral long, thin; anterior lateral short, high mid-way along ridge; right valve: posterior lateral double, upper posterior lateral small; anterior lateral small; cardinal teeth vestigial; anterior adductor scar prominent, others indistinct.

Ecology: Members of this genus and of the genus *Pisidium* belong to a group of bivalves that are not dependent upon the presence of fish for the completion of their life cycle. Without this restriction these species are able to occupy habitats that are prohibitive to fish, such as the ephemeral ponds and streams that are to be found throughout the state of Kansas. In Kansas, *Sphaerium* is more commonly found in streams than in ponds while the reverse is true of *Pisidium*.

On the Reservation, a species of *Sphaerium* was found in abundance in the silted pond (SB) where shells only were recovered, as the collecting was carried out during a period when the pond was dry.

Pisidium cf. *compressum* Prime

Plate C, fig. 4

Pisidium compressum Prime, 1851, Proc. Boston Soc. Nat. Hist., 4:164; 1865, Smithsonian Misc. Publ., No. 145, p. 64, fig. 68; Baker, 1928, Wisconsin Geol. Nat. Hist. Survey, Bull. 70, pt. 2, pp. 370-372, pl. C, figs. 9-13.

Recognition characters: Triangular, subequilateral, highly inflated; beak elevated, prominent; anterior margin bluntly rounded; posterior margin drawn out toward ventral margin; sculpture coarse, irregular; cardinals small; laterals short, high.

Type locality: "Massachusetts, in Fresh Pond, near Cambridge" (Baker, 1928:370).

Geographic distribution: "Over the continent, more common in East than in the West . . ." (Baker, 1928:371).

Ecology: As noted in the above discussion of *Sphaerium* species of the genera *Pisidium* and *Sphaerium* do not include a parasitic stage in their life cycle. *Pisidium* is found throughout Kansas in small ponds and streams. Alice Leonard (1943:234) reported the common occurrence of both *P. compressum* and *P. fabale* in Meade and Clark counties, Kansas.

Only a few bleached shells of this species were recovered from gravel in the bed of the small stream (SA) and it is possible that these are fossil.

SUMMARY

Some generalizations which can be made concerning the molluscan fauna of the University of Kansas Natural History Reservation are as follows:

1. The aquatic Mollusca are limited to four species: *Physa hawni*, *Pisidium compressum*, *Sphaerium* sp.?, and *Helisoma trivolvis*, all of which can survive long periods of drouth.
2. Three species of terrestrial snails, *Succinea concordialis*, *Vertigo ovata*, and *Lymnaea parva*, are found only in unusually moist situations close to water.
3. Only one species, *Bulimulus dealbatus*, is found exclusively in open areas. All of the other species were found on at least one of the wooded slopes.
4. Three species, *Gastrocopta armifera*, *Retinella indentata*, and *Vallonia parvula*, constitute, over most of the Reservation, between 60 and 80 percent of the total molluscan population.
5. *Gastrocopta armifera* is the most widely distributed snail on the Reservation, occurring in every terrestrial habitat.

6. *Vallonia parvula* is the most numerous of the terrestrial species.

7. The moist, north-facing slopes harbor a greater variety of species than the drier, south-facing slopes, but these south-facing slopes have more than twice as many snails per unit area as do the north-facing slopes.

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Species	Stations									
	A-Small stream	B-Silted pond	C-Banks of small stream	D-Rotten log habitat	E-Wooded slope, north facing	F-Wooded slope, west facing	G-Wooded slope, south facing	H-Ungazed grassland	I-Arid limestone habitat	J-Arid meadow
<i>Pisidium</i> cf. <i>compressum</i>	○									
<i>Physa</i> <i>hawni</i>	●	◐								
<i>Helisoma</i> <i>trivolvis</i>		●								
<i>Sphaerium</i> sp.		●								
<i>Succinea</i> <i>concordialis</i>		●								
<i>Vertigo</i> <i>ovata</i>			○							
<i>Lymnaea</i> <i>parva</i>			○							
<i>Succinea</i> <i>avara</i>			◐	○	○	○				
<i>Zonitoides</i> <i>arboreus</i>			○	●	◐	○				
<i>Deroceras</i> <i>laeve</i>			○	◐	◐	○	○			
<i>Retinella</i> <i>electrina</i>			○	◐	●		○			
<i>Euconulus</i> <i>chersinus</i> cf. <i>polygyratus</i>				○	○	○	○			
<i>Gastrocopta</i> <i>contracta</i>			○	○	○	○	◐	○		
<i>Hawaiiia</i> <i>minuscule</i>			●	○	◐			◐		
<i>Gastrocopta</i> <i>procera</i>			○			○	○	◐	○	
<i>Gastrocopta</i> <i>pentodon</i>			●		○	◐	○	○		○
<i>Gastrocopta</i> <i>armifera</i>			●	○	○	●	●	◐	○	◐
<i>Retinella</i> <i>indentata</i>			◐	◐	◐	●	●	◐		◐
<i>Vallonia</i> <i>parvula</i>			○	◐	◐	●	●	◐		◐
<i>Gastrocopta</i> <i>holzingeri</i>			○	○		●	◐			○
<i>Stenotrema</i> <i>monodon aliciae</i>				●	◐					◐
<i>Strobilops</i> <i>labyrinthica</i>				●	◐					○
<i>Helicodiscus</i> <i>parallelus</i>						○	○	○		○
<i>Pupoides</i> <i>albilabris</i>							◐		○	○
<i>Bulimulus</i> <i>dealbatus</i>									○	○

○ rare

◐ common

● abundant

TABLE 1. Distribution on the University of Kansas Natural History Reservation of molluscan species according to habitat.

PLATE C

FIG. 1. *Sphaerium* sp.

FIG. 2. *Physa hawni*.

FIG. 3. *Succinea concordialis*.

FIG. 4. *Pisidium* cf. *compressum*.

FIGS. 5, 6. Basal and spiral views of *Stenotrema monodon aliciae*.

FIG. 7. *Deroceras laeve* (living animal).

FIG. 8. *Succinea avara*.

FIG. 8a. *Lymnaea parva*.

FIG. 9. *Helisoma trivolvis lentum*.

FIG. 10. *Bulimulus dealbatus*.

All figures enlarged $3\frac{1}{2}$ diameters.

PLATE C

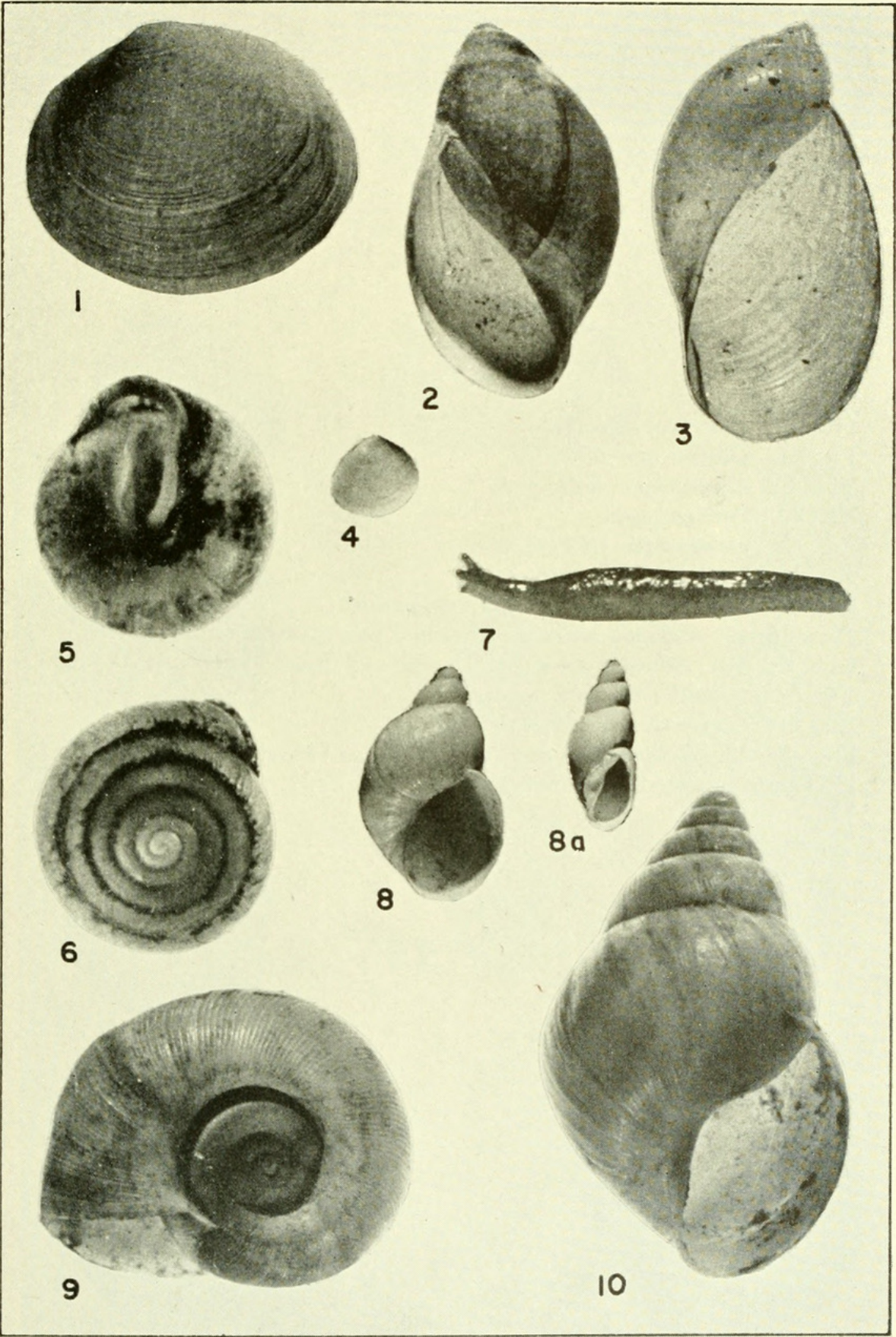


PLATE CI

- FIG. 11. *Gastrocopta contracta*.
FIG. 12. *Gastracopta pentodon*.
FIG. 13. *Gastrocopta holzingeri*.
FIG. 14. *Vertigo ovata*.
FIG. 15. *Gastrocopta procera*.
FIG. 16. *Strobilops labyrinthica*.
FIG. 17. *Euconulus chersinus* cf. *polygyratus*.
FIGS. 18, 19. *Vallonia parvula*, spiral and basal views.
FIGS. 20, 21. *Hawaiiia minuscula*, spiral and basal views.
FIG. 22. *Pupoides albilabris*.
FIG. 23. *Gastrocopta armifera*.
FIGS. 24, 25. *Helicodiscus parallelus*, spiral and basal views.
All figures enlarged 10 diameters.

PLATE CI

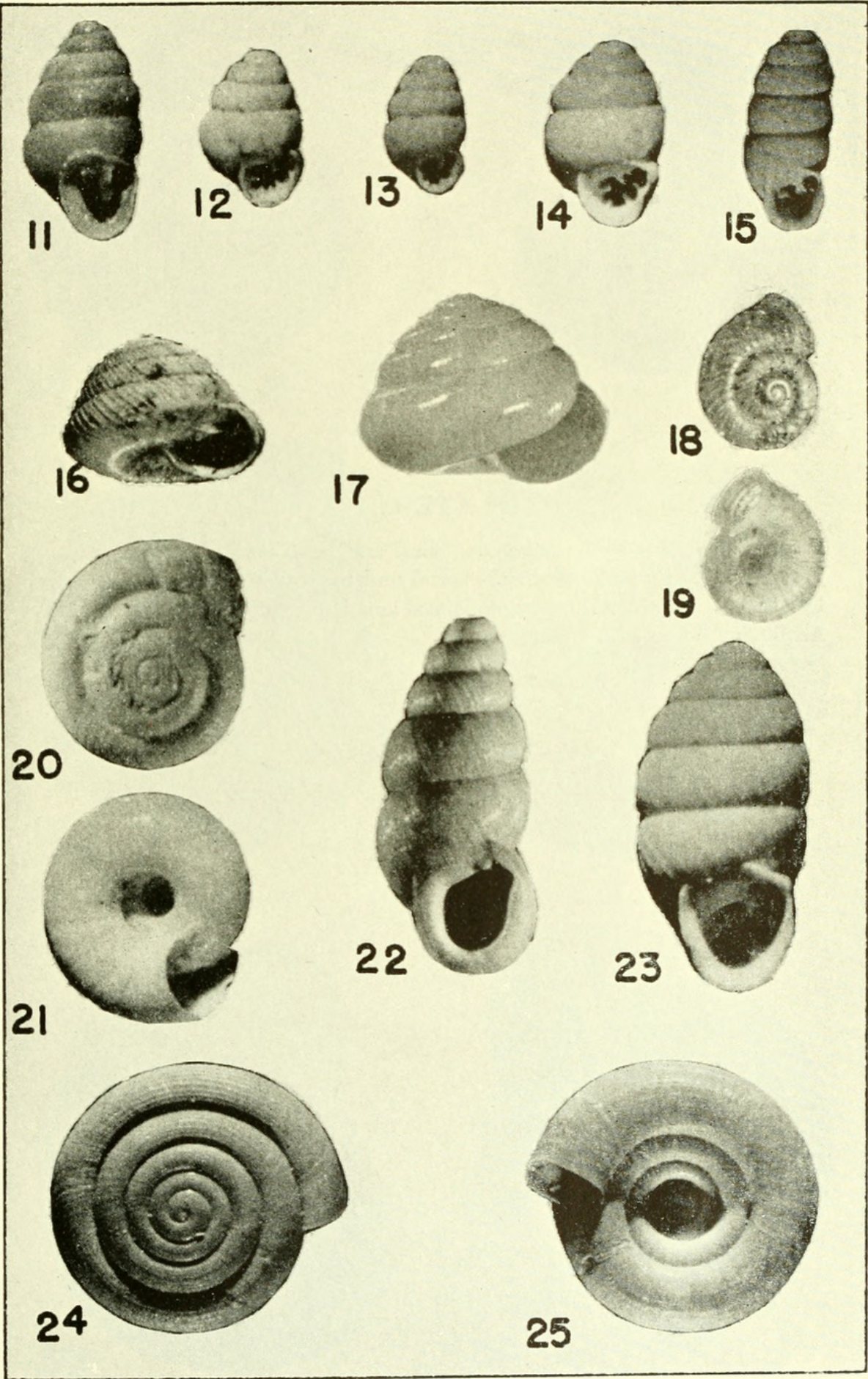


PLATE CII

FIGS. 26, 27. *Zonitoides arboreus*, spiral and basal views.

FIGS. 28, 29. *Retinella electrina*, spiral and basal views.

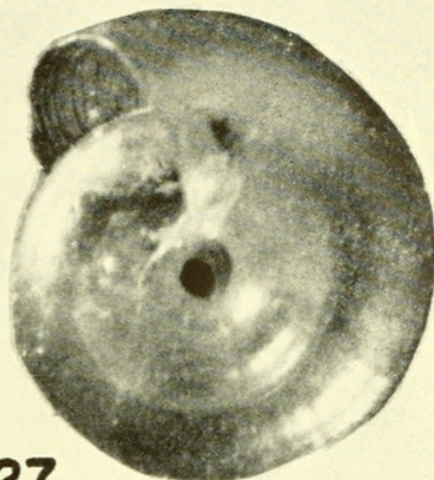
FIGS. 30, 31. *Retinella indentata*, spiral and basal views.

All figures enlarged 10 diameters.

PLATE CII



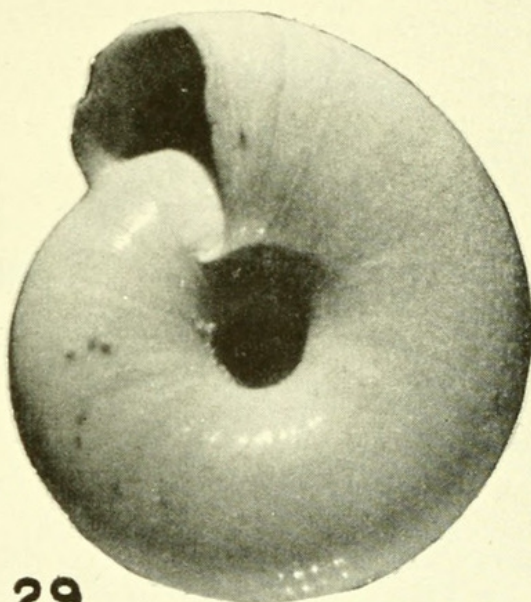
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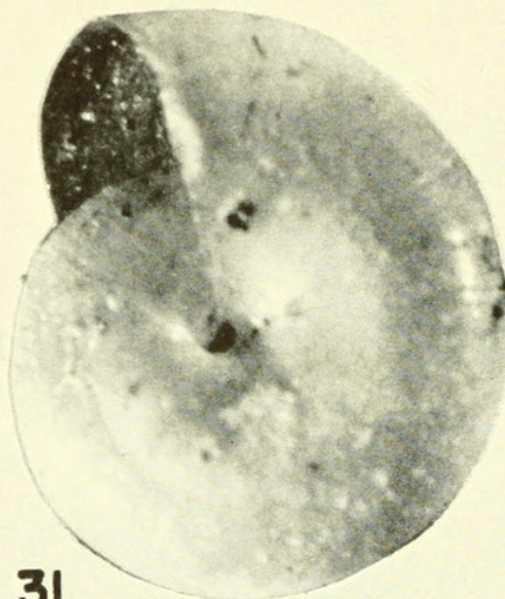
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29



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