

DIETARY PATTERN OF THE VIRGINIA OPOSSUM,  
*DIDELPHIS MARSUPIALIS VIRGINIANUS* KERR,  
LATE SUMMER-WINTER, SOUTHERN ILLINOIS

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The opossum (*Didelphis marsupialis virginianus* Kerr) is one of the most common furbearers in Illinois, and is especially abundant in the southern one-third of the State. Because of its wide range of tolerance, omnivorous diet, and high reproductive rate, this marsupial shows general population increases and continuing widening range, utilizing previously unoccupied areas not only in the United States but in Canada as well. Success among the mammalian fauna is further enhanced by its low-valued pelt, expanding urban developments, and decrease of emphasis on it as a food item or for sport hunting.

This study of the opossum was undertaken to (1) ascertain what food items are utilized and the frequency of occurrence and volume of each, (2) relate food utilization with seasons, and (3) evaluate this mammal as a predator. Although the literature failed to reveal a detailed study of the diet of the opossum in Illinois, several investigations of its food habits have been published for other states (Reynolds, 1945; Hamilton, 1958; Taube, 1947; Wiseman and Hendrickson, 1950; Sandidge, 1953; Lay, 1942; Wheeler, 1939; and Llewellyn and Uhler, 1952).

Standard laboratory techniques were utilized in analyzing digestive

tracts and in identifying their contents. The volume of each item of food was determined by water displacement; frequency of occurrence was computed on a percentage basis. For standardization of nomenclature of food items, Fernald (1950) was used for plants, Hall and Kelson (1959) for mammals, American Ornithologists' Union (1957) for birds, Conant (1958) for reptiles and amphibians, and Comstock (1947) for insects.

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#### RESULTS

The digestive tracts from 131 opossums collected in seven southern Illinois counties from August, 1958, through February, 1960, were used in this investigation. Number of samples according to month was as follows: January (11), February

TABLE 1. Major Food Items Occurring in Digestive Tracts of 131 Opossums, Southern Illinois, 1958-1960.

| Food Item                             | Per Cent Volume | Per Cent Frequency of Occurrence |
|---------------------------------------|-----------------|----------------------------------|
| ANIMAL FOODS.....                     | 76.2            | 100.0                            |
| Mammals.....                          | 48.7            | 76.3                             |
| Opossum.....                          | 16.3            | 52.7                             |
| Cottontail.....                       | 14.7            | 15.3                             |
| Prairie Vole.....                     | 6.4             | 5.3                              |
| Gray Fox.....                         | 2.8             | 3.1                              |
| Short-tailed Shrew.....               | 1.8             | 4.6                              |
| Raccoon.....                          | 1.7             | 1.5                              |
| Norway Rat.....                       | 1.5             | 0.8                              |
| Eastern Mole.....                     | 1.3             | 0.8                              |
| Deer Mice.....                        | 1.0             | 3.1                              |
| Striped Skunk.....                    | 0.5             | 3.1                              |
| Pine Vole.....                        | 0.5             | 1.5                              |
| Other Mammals.....                    | 0.2             | .....                            |
| Birds.....                            | 14.5            | 19.1                             |
| Domestic Chicken.....                 | 7.1             | 4.6                              |
| Grackle.....                          | 4.7             | 2.3                              |
| Towhee.....                           | 1.3             | 0.8                              |
| Meadowlark.....                       | 1.1             | 3.1                              |
| Other Birds.....                      | 0.3             | .....                            |
| Reptiles.....                         | 1.6             | 14.5                             |
| Blue Racer.....                       | 0.7             | 4.6                              |
| Other Reptiles.....                   | 0.9             | .....                            |
| Amphibians.....                       | 3.0             | 5.3                              |
| Frogs.....                            | 2.5             | 3.8                              |
| Toads.....                            | 0.5             | 1.5                              |
| Fishes.....                           | 0.1             | 1.5                              |
| Unidentified Scales.....              | .....           | .....                            |
| Insects.....                          | 6.3             | 93.1                             |
| Scarabaeidae Larvae.....              | 2.0             | 11.5                             |
| Short-horned Grasshoppers.....        | 1.5             | 54.2                             |
| Unidentified Lepidoptera Larvae.....  | 0.9             | 9.2                              |
| Other Insects.....                    | 1.9             | .....                            |
| Other Invertebrates.....              | 1.9             | .....                            |
| Earthworms.....                       | 1.3             | 3.8                              |
| Snails.....                           | 0.5             | 31.3                             |
| Miscellaneous Invertebrates.....      | 0.1             | .....                            |
| Undetermined Animal Materials.....    | 0.1             | 2.3                              |
| PLANT FOODS.....                      | 23.8            | 100.0                            |
| Persimmon.....                        | 8.1             | 21.4                             |
| Pokeberry.....                        | 5.1             | 25.2                             |
| Grapes.....                           | 1.8             | 11.5                             |
| Tree Leaf Fragments.....              | 1.3             | 87.0                             |
| Corn.....                             | 1.1             | 3.1                              |
| Gramineae Leaves and Stems.....       | 0.9             | 71.0                             |
| Plums ( <i>Prunus</i> spp.).....      | 0.9             | 3.1                              |
| Nightshade ( <i>Solanum</i> sp.)..... | 0.9             | 25.2                             |
| Unidentified Fleshy Fruits.....       | 0.9             | 3.8                              |
| Bark and Woody Twigs.....             | 0.8             | 37.4                             |
| Unidentified Seeds and Seed Pods..... | 0.7             | 9.2                              |
| Other Plant Foods.....                | 1.3             | .....                            |

(16), August (12), September (22), October (29), November (35), and December (6). One hundred and eleven individuals were taken by trapping, 4 by hunting, and 16 as DOR.

A total of 75 animal and 66 plant foods were recorded;<sup>1</sup> of these, only 24 animal and 11 plant foods individually constituted 0.5% or more by volume (Table 1). Animal foods yielded 76.2% of the total volume and plant foods 23.8%; both groups appeared in 100% of the tracts. Four occurrences of miscellaneous items (string, sacking material, cotton filter) were recorded; these were believed to have been ingested accidentally.

*Animal Foods.* Mammals represented the most important group of foods, constituting 48.7% of the total volume (Table 1). This is in close agreement with other studies with the exception of Lay (1942) who reported mammals yielding 7% by volume; however, his sample was small (16 stomachs) and represented a single month (September).

The highest ranking food item volumetrically (16.3%) was opossum (Table 1), suggesting considerable evidence of cannibalism. Although remains of opossums appeared in 52.7% of the tracts, only a small percentage of the occurrences was considered to be actual food items as hair and nails were the principle evidences; these probably were ingested during preening or trap-fighting. Four stomachs, which were filled with remains of opossum, somewhat distorted the volumetric value

<sup>1</sup> For detailed tabular data consult thesis by senior author on file in Library, Southern Illinois University, Carbondale.

for this food item. The majority of previous records of cannibalism were among captive animals (Pray, 1921; Seton, 1929; Raven, 1929; Wheeler, 1939; Wood, 1954). For wild-living forms Reynolds (1945) and Sandidge (1953) reported that volumetrically, opossum contributed 4.9% and 10.9%, respectively.

Cottontail rabbit (*Sylvilagus floridanus*) was the second most important food consumed, yielding 14.7% by volume and occurring in 15.3% of the tracts. In Kansas (Sandidge, 1953), Missouri (Reynolds, 1945) and Michigan (Taube, 1947), cottontail was the primary food.

The prairie vole (*Microtus ochrogaster*) represented the third ranking mammalian food item and was fifth among all foods. It is noteworthy that this species constituted 6.4% by volume whereas deer mice (*Peromyscus* sp.) comprised only 1.0%.

Large mammals did not contribute a significant portion of the diet as by volume gray fox (*Urocyon cinereoargenteus*) furnished 2.8%, raccoon (*Procyon lotor*) 1.7%, and striped skunk (*Mephitis mephitis*) 0.5%.

Short-tailed shrews (*Blarina brevicauda*) ranked fifth and eastern moles (*Scalopus aquaticus*) eighth among mammalian foods; collectively they represented 3.1% of the total volume (Table 1). Hamilton (1958) recorded insectivores from 46 of 461 stomachs. Opossums apparently do not share the distaste of the red fox (*Vulpes fulva*) for this group of mammals (Murie, 1936; Scott and Klimstra, 1955).

Domestic chicken (*Gallus gallus*)

comprised 7.1% of the volume of all foods taken and ranked fourth. It is doubtful if this represented actual depredation on poultry flocks; more likely it reflected availability of carrion.

Among other birds, the grackle (*Quiscalus* sp.) was taken on three occasions (ranked seventh by volume), meadowlark (*Sturnella magna*) four times, domestic pigeon (*Columbia livia*) twice, and towhee (*Pipilo erythrophthalmus*), junco (*Junco hyemalis*), cardinal (*Richmondia cardinalis*), and carolina wren (*Thryothorus ludovicianus*) once each. Tremendous numbers of grackles winter in this region, and in localized situations dead grackles could be one of the most available foods, especially in roosting areas.

Reptiles occurred in 14.5% of the tracts, but were significant only during late summer; only sporadic occurrences were recorded throughout the remainder of the study period. The blue racer (*Coluber constrictor*) was the most important reptile, constituting 0.7% of the total volume.

Frogs (*Rana* sp.) were taken on five occasions and constituted 2.5% by volume. Toads (*Bufo* sp.) were less important, appearing in two digestive tracts and comprising 0.5% of the total volume.

Insect remains appeared in 93.1% of the digestive tracts, but constituted only 6.3% of the total volume (Table 1). Larvae were taken in considerable numbers, possibly being more desirable and vulnerable than adults. Reynolds (1945) reported that insects comprised 34.2% by volume December through May; Wheeler (1939) found that insects fur-

nished 60.3% of the volume for 95 stomachs collected throughout the year; Sandidge (1953) noted that insects comprised 42.7% by volume in 60 digestive tracts taken from September through March. In contrast, Taube (1947), found 6% of the diet during September-December to be insects while Hamilton (1958) reported 7.9% of the total volume of 461 stomachs collected throughout the year.

The larvae of scarabaeid beetles (Scarabaeidae), the most important insect representative in the current study, constituted 2.0% of the total volume and showed a frequency of 11.5%. Although short-horned grasshoppers (Locustidae) occurred frequently (54.2%), they constituted only 1.5% volumetrically. Undetermined lepidopterous larvae had a frequency of 9.2%; no adults were recorded.

*Plant Foods.* Persimmon (*Diospyros virginiana*), which was the most utilized plant food, ranked third among all foods, comprising 8.1% of the total volume (Table 1). Pokeberry (*Phytolacca americana*) occurred in 25.2% of the tracts and furnished 5.1% of the total volume, ranking as the sixth most important food. Various other fleshy fruits constituted 4.9% of the total volume. Wild grapes (*Vitis* spp.) were eaten, but the volume furnished was relatively low (1.8%).

Dried fragments of tree leaves appeared in 87.0% of the tracts while bark and twigs appeared in 37.4%; this probably did not constitute important food. The majority of leaves were believed ingested accidentally during feeding activities on

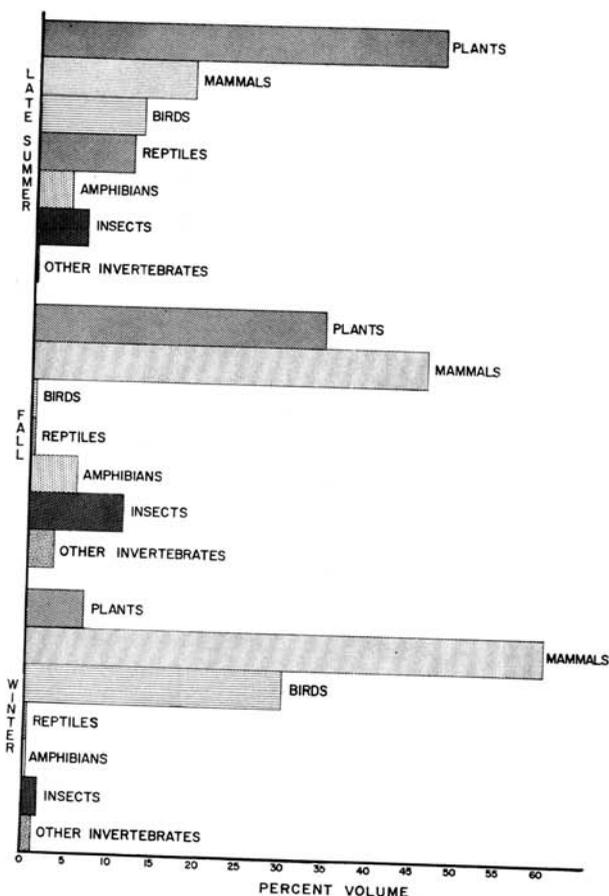


FIG. 1 Seasonal trends in the utilization of major food groups by opossums, southern Illinois, 1958-1960.

ground dwelling insects, snails, etc. Smith (1941) observed opossums to place leaves in their mouth during nest building activities which possibly accounts for the appearance of small quantities of leaves. Also, animals under the stress of being steel-trapped have been observed to ingest leaves, sticks, etc.

Kernels of corn (*Zea mays*) comprised 1.1% of the total volume (Table 2), and had a low frequency of occurrence (3.1%).

*Seasonal Trends.* In an effort to evaluate seasonal aspects of the opossum's diet, all digestive tracts were categorized into late summer (August and September), fall (Oc-

tober and November), or winter (December, January and February); 34, 64 and 33 samples were available, respectively, for each season.

Marked changes were noted in the seasonal utilization of plant and animal foods (Fig. 1). The volume of animal materials increased from 52.2% during late summer to 93.4% in winter; the importance of plant foods diminished in almost exact proportion.

Noticeable seasonal trends in the consumption of the various general food groups were also noted. The appearance of mammalian foods in the diet increased by over 300% between late summer and winter. As the variety of available foods decreased with the advent of severe weather, opossums possibly resorted more frequently to mammalian carrion. This is suggested by the marked increase in utilization of large forms such as gray fox, striped skunk, raccoon, woodchuck (*Marmota monax*), and opossum as the season progressed. Cottontail appeared infrequently during warm weather, but a major increase in utilization occurred with the onset of colder temperature and the beginning of the hunting season. The decline in consumption of cottontail during the winter period might be indicative of reduced cottontail populations.

Small mammals would tend to become more vulnerable to predation as the vegetative cover is reduced and they are exposed when in quest of food. Such is suggested by the utilization of prairie voles which showed an increase from 2.5% in the summer to 14.0% during the winter; however, predilection and

reduced availability of other foods are probably reflected as well.

Birds furnished 12.3% of the total volume during August and September, but their use dropped to virtually zero in the fall. With the advent of cold weather and probable increased avian winter mortality, utilization of birds increased to 29.8% by volume; over four-fifths of this total was domestic chicken and grackle.

Reptiles appeared most frequently during mild weather with seven species of snakes and one species of turtle being recorded. The relative importance of reptiles decreased as low temperatures reduced the activity of these cold-blooded forms; three occurrences were noted in the fall sample and two in winter. Amphibians showed a similar pattern as they comprised 4.0%, 5.4%, and 0.2% of the volume for late summer, fall, and winter, respectively.

The volumetric importance of insects varied between the seasons. During late summer they furnished 5.9% of the total volume but had a 97.1% frequency of occurrence; in fall the volume was 10.9% and frequency 96.9% and in winter these measurements were 1.8% and 78.8%, respectively.

In decreasing order of importance by volume, short-horned grasshoppers, scarabaeid larvae, adult ground beetles, and larval ground beetles were the chief insect items identified in late summer tracts. Scarabaeid larvae and short-horned grasshoppers made up over two-thirds of the total insect volume for fall. The relative importance of insects sharply decreased with the onset of lowered

temperatures during winter; lepidopterous larvae constituted over 80% of all insect materials recorded for this period. By volume and by frequency of occurrence, various Hemiptera were next in importance. Short-horned grasshoppers, an important food item through fall, appeared in almost one-fourth of the winter tracts, but constituted only a trace by volume.

Volumetrically, Gramineae was the leading plant family consumed during late summer; corn was the most important species. The amount of grasses consumed diminished markedly in October and November, but increased noticeably during winter; corn was the most prevalent representative.

The utilization of fleshy fruits reflected strongly the time of ripening. Grapes were the second most important plant food in late summer; utilization remained fairly constant in fall, but declined sharply during winter. Persimmons were heavily utilized when present; the volumetric importance varied from 5.1% in late summer, 15.4% in fall, to 1.4% during winter. Fruits of this species normally drop when ripe, and would thus be most available in late fall. Although opossums are adept climbers, it is believed that they avoid doing so if possible, and probably prefer to eat persimmons on the ground; no green fruits were noted.

By volume, pokeberry was relatively important in late summer (6.0%) and fall (9.8%). Field observations indicate that the berries shrivel and dry with the onset of low temperatures, and they probably lose their

appeal as a food item; this fruit was entirely absent in winter.

#### DISCUSSION

Opossums, like many predatory animals, are opportunists in the procurement of food as they probably use the most readily available, acceptable foods. Certain food preferences seem to be reflected by the preponderance of particular items; however, selectivity is probably geared to restrictions imposed by season, physical ability, familiarity, and predilection (Scott and Klimstra, 1955).

The consumption of carrion was more pronounced with the advent of winter and the subsequent reduced availability of favored foods. However, it was difficult to accurately determine the percentage of the diet which resulted from carrion. Sandidge (1953) suggested that cottontail, muskrat, and opossum remains reflected carrion feeding because of the association of silphid beetles (Silphidae) in 12 of 19 occurrences of these mammals. Silphid beetles appeared in two tracts collected in September and November in southern Illinois; one contained cottontail remains, but the other only insect fragments. The conclusion of Wheeler (1939), who felt that silphid beetles were taken too promiscuously to be an accurate indicator of carrion feeding activities, seems quite logical. In the current study Muscidae larvae appeared in several tracts, but were not always associated with carrion. Seventy-five fly larvae were recorded from a single stomach which contained only insect and plant materials, suggesting that

the larvae were taken as a food and not secondarily with carrion. Hamilton (1958) postulated that opossums may consume copious quantities of fly larvae when available, disregarding the carrion on which the larvae might be feeding.

It seems possible that prairie voles are more vulnerable to predation or are more preferred by the opossum than are deer mice; most trapping studies of the Cooperative Wildlife Research Laboratory show the latter forms much the more numerous. The home ranges of opossums in southern Illinois normally encompass habitats frequented by both of these mice. The relative abundance of pine voles (*Pitymys pinetorum*), which is quite low in relation to prairie voles and deer mice, is reflected in that the former appeared only twice. Because pine voles and prairie voles inhabit like habitats and have similar habits, their vulnerability as prey should be approximately the same. The use of large mammals probably resulted from carrion as it is doubtful if an opossum could subdue a healthy, adult animal of these species. A lead shot pellet noted in one stomach which contained gray fox suggested that hunting injuries might have been the actual cause of death. A low frequency of occurrence indicates that large mammals were chance items in the diet.

It is noteworthy that meadowlarks or other ground nesting and roosting species were not taken more frequently. This suggests that opossums may lack the agility to be an efficient predator on wild birds, even ground nesters. This is borne out

by the fact that the remains of non-domestic birds were recorded from only 17 digestive tracts.

Results indicated that reptiles were an acceptable item when available, and the species taken reflects the diverse habitat frequented by the opossum. Some snakes were probably picked up as road kills, but the opossum is capable of capturing snakes of considerable size (Lewis, 1929).

Earthworms (*Lumbricus* sp.) were unimportant in this study as they appeared in only five tracts, yielding 1.3% by volume. The consumption of this invertebrate seems to be a regional variable in regard to importance in the diet. Dexter (1951) found that earthworms comprised 15.3% volumetrically of 13 opossums collected in Northeastern Ohio during the winter. Hamilton (1958) reported that earthworms constituted 10.3% of the total volume in New York. Michigan studies indicated that earthworms comprised about 8.0% of the total volume (Taube, 1947).

Insects present an example of the fallacy of relying entirely on per cent volume as a basis for rating foods in dietary studies. These invertebrates ranked low volumetrically (6.3%) in the current study (Table 1), but occurred in 93.1% of the tracts examined; this possibly reflected some predilection. Conversely, the high frequency of occurrence and low volume furnished by insects may reflect in some cases chance or promiscuous feeding habits. This proposition would account for some of the incongruous values obtained for frequency of occur-

rence and per cent volume in this study.

The majority of plant foods recorded were available only during restricted seasons, but were heavily utilized at such times as they were present. This availability-consumption relationship is best illustrated by the example of pokeberry. Pokeberry fruits mature early in September in this area and remain available to opossums for an extended period. The tendency of pokeberry stems to bend and break makes the terminal fruiting heads available at a height conducive to feeding by the opossum. Dried fruits frequently adhere to the plant as late as March, but these were seemingly not as palatable to the animals as the juicy berries.

It is surprising that there was not greater utilization of corn in view of the abundance of this plant in southern Illinois. Hartman (1952) stated that opossums may procure corn in the manner of raccoons, i.e., by pulling up the seedling corn. Hamilton (1943) suggested that corn in the milk stage is a favorite food of opossums, and Reynolds (1945) reported corn as comprising 7.3% of the opossum diet. Wiseman and Hendrickson (1950) noted its occurrence in 46 of 87 scats collected in Iowa.

Grasses (Gramineae), other than corn, were recorded in 71% of the tracts, but in most cases probably reflect accidental ingestion or food of secondary origin. Leaves and stems made up the greater part of the volume, although 18 species of seeds were recorded. Some grasses are probably ingested as the opossum

feeds on certain insects, particularly grasshoppers which commonly rest on this type of vegetation. Vegetative material or seeds of grasses were found in all tracts containing prairie voles, pine voles, or deer mice, possibly reflecting secondary ingestion.

Results indicate that predation by opossums during the period covered by this study was probably not an important influence on populations of game species. Of the major game animals found in southern Illinois, only the cottontail formed a significant part of the opossum's diet. Bobwhites (*Colinus virginianus*), tree squirrels (*Sciurus* sp.), white-tailed deer (*Odocoileus virginianus*), and ducks and geese (Anseriiformes) were not recorded from digestive tracts examined.

Probably a portion of the cottontail remains reflected actual opossum kills; but, there is a strong possibility that the larger percentage represented rabbits killed on highways or by hunters, or those deceased through natural causes. Hamilton (1958) proposed that opossums are capable of killing cottontails in their dens during winter; he reported five instances of predation by opossums on nestling rabbits. Unfortunately, the current study did not include sufficient quantities of tracts from the peak of the cottontail breeding season to determine the effects of predation on the young.

The absence of quail in the diet of opossums is an interesting facet. Field observations indicate that predation by various mammalian forms on quail nests is extensive, and opossums probably contribute to these

losses. There is a considerable difference of opinion as to the extent of opossum predation on nesting birds; Wheeler (1939) found that they were not destructive in this regard, but Roberts and Early (1952) felt that high opossum populations associated with concentrations of ring-necked pheasant (*Phasianus colchicus*) or rabbit nests might prove to be detrimental to these game species. Allen (1940) reported that in Michigan less than 5% of the nesting losses of ducks and pheasants were caused by opossums, but pointed out that opossum populations were low during the investigations.

## SUMMARY

Digestive tracts from 131 opossums, taken from August 1, 1958-March 1, 1960, in seven southern Illinois counties, were examined; all tracts contained food. Three seasons were represented; late summer (August and September); fall (October and November); winter (December, January, and February).

Animal materials made up 76.2% of the total food volume, and plant materials 23.8%. Both major food groups appeared in all of the tracts. Seventy-five animal and 66 plant foods were recorded. The ten most important foods by per cent volume were opossum, 16.3; cottontail, 14.7; persimmon, 8.1; domestic chicken, 7.1; prairie vole, 6.4; pokeberry, 5.1; grackle, 4.7; gray fox, 2.8; frogs, 2.5; and scarabaeid larvae, 2.0. According to per cent frequency of occurrence the ten top-ranking foods were grasses, 82.4; short-horned grasshoppers, 54.2; opossum, 52.7; ground beetles, 38.9; snails, 31.3;

pokeberry, 25.2; nightshade, 25.2; stinkbugs, 22.9; persimmon, 21.4; and cottontail, 15.3.

Noticeable variations in the utilization of foods seemed to reflect seasonal availability. The most marked variation was a steady decrease in consumption of plant materials from fall through winter, and an increase in utilization of mammalian foods during the same period.

Predatory activities apparently do not have a strong adverse effect on game populations. However, predation on cottontails might, on occasion, constitute a minor curb on populations of this species.

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