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Author(s): David D. Hopkins and Richard B. Forbes

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Dietary Patterns of the Virginia Opossum in an Urban Environment

DAVID D. HOPKINS and RICHARD B. FORBES

There are published reports of foods of the Virginia opossum (*Didelphis virginiana*) in rural areas east of the Rocky Mountains, but we have found no such reports on opossums introduced in the western United States, nor on opossums from urban areas. Here we report findings on stomach contents of Virginia opossums taken in and near Portland, Oregon, between December 1974 and May 1976.

MATERIALS AND METHODS

Stomachs were taken from 77 opossums, not including pouch-young. All were road-kills except for two killed by dogs and one shot. Each stomach and its contents were placed in a number 20 U.S.A. standard testing sieve fitted over a number 60 screen. When the stomach contents were thoroughly washed under running water, the two-screen assembly effectively separated coarse from fine materials. The two portions were stored in 70 percent ethanol for later examination. However, if green plant material or unusual matter was present, at least partial separation was made immediately. A portion of each grade of material was placed in a petri dish and scanned with a 10-45x dissecting microscope. This procedure was continued until the entire contents had been examined. Coarse material was scanned for small items that might not have washed through to the fine screen. Each type of item was removed from the mass and placed in a different petri dish for subsequent measurement and storage. Materials captured by the fine screen were similarly examined. The volume of each type of item recovered was measured and recorded for each stomach examined. Items measuring less than 0.1 cm³ were recorded as trace (T), as were items amounting to less than 0.1 percent of the seasonal or annual volumes.

RESULTS AND DISCUSSION

Thirteen (17%) of the 77 stomachs were empty. Numbers of stomachs with items were: winter, 23; spring, 16; summer, 13; fall, 12. Data for these 64 stomachs appear in appendix 1 and figure 1. Volume, frequency of occurrence, and importance value (IV) are shown for each class of item in appendix 1. IV is derived by multiplying the percent frequency times percent volume for a given item. Hence, a single figure may be used to suggest the relative importance of each kind of item recorded.

We note considerable seasonal variation in stomach contents. Leaf litter ranks first or second all year, but probably is ingested while grubbing for other foods (table 1). Mammals are of major importance during winter and spring. Slugs and snails, the most important food items in summer, appear in relatively small volume in the winter. Several foods are important only during certain seasons—e.g., pet food during winter and spring, beetles during the summer, and fruit during summer and fall. Earthworms, always an important food, do not show well-defined seasonal trends. Hamilton (1958) found six foods accounted for 72.3 percent of the total volume measured; our data are almost identical (72.5%) for the top six foods.

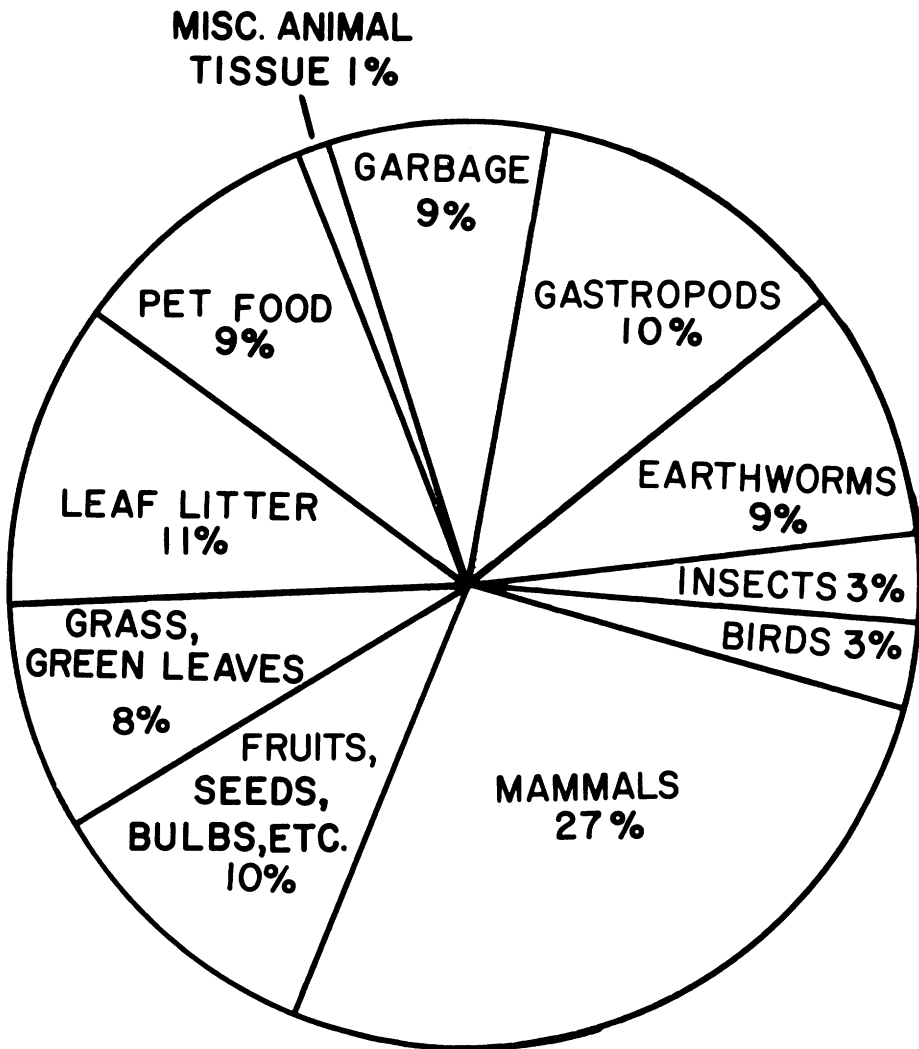


FIGURE 1. Proportionate annual volumes of major groups of items from stomachs of 64 Portland-area opossums taken between December 1974 and May 1976.

Animal matter predominates (52.9% by volume) in all seasons but fall in the diet of our opossums. In comparison, opossums' diets in rural Missouri (Reynolds 1945), Kansas (Sandidge 1953), and Illinois (Stieglitz and Klimstra 1962) consisted of 85.9 percent, 90.1 percent, and 76.2 percent animal matter, respectively.

Gastropods are prominent (low of 6.6% by volume in winter, high of 24.9% in summer) in the diet, in contrast to the 3.9 percent by volume recorded by Reynolds (1945), but Stieglitz and Klimstra (1962) reported the greatest frequency of gastropods (31.3%). Most investigators reported snails more frequently consumed than slugs; our findings are in contrast. Six species of slugs were recorded, all introduced except *Prophysaon andersoni*; the locally abundant *Ariolimax columbianus* was not found. The most important gastropod was *Arion ater*, although *A. hortensis* was the only species consumed throughout the year. Slugs are the most important food class during the summer. Use of slugs and snails is correlated with precipitation; 10 (43.5%) of 23 opossums collected on rainless days had eaten gastropods, as compared with 26 (63.4%) of 41 collected on rainy days.

Earthworms occurred in over half of the stomachs examined. This is a frequency nearly twice as great as any reported previously except by Dexter (1951), who found that seven of 13 opossums taken in Ohio in January had eaten earthworms. The volumetric percentage we recorded is close to that of Taube (1947) and Hamilton (1958), but far greater than the 1.3 percent reported by Stieglitz and Klimstra (1962). Reynolds (1945) and Sandidge (1953) did not report earthworms in the diets of their opossums. Our volume fluctuated between a low of 6.4 percent in spring and a high of 12.9 percent in summer (figure 2). No correlation was found between precipitation and the consumption of earthworms.

TABLE 1. The six most important foods seasonally and annually for Portland-area opossums.

WINTER		SPRING		SUMMER	
Item	I.V.	Item	I.V.	Item	I.V.
Mammals	1961.5	Leaf Litter	960.0	Gastropods	1531.4
Leaf Litter	1060.0	Mammals	936.9	Leaf Litter	941.5
Earthworms	639.0	Gastropods	537.5	Fruits	850.9
Gastropods	401.9	Earthworms	400.0	Grasses	507.7
Grasses	297.4	Grasses	385.0	Earthworms	298.0
Pet Food	165.3	Pet Food	200.0	Beetles	150.6
		FALL		ANNUAL	
		Item	I.V.	Item	I.V.
		Fruits	1942.5	Leaf Litter	1072.6
		Leaf Litter	1490.0	Mammals	948.0
		Grasses	933.0	Gastropods	639.5
		Gastropods	658.8	Earthworms	472.6
		Earthworms	440.0	Grasses	455.3
		Mammals	405.0	Pet Food	117.5

Arthropods other than insects occurred as no more than a trace annually; only millipedes occurred as high as 0.1 percent by volume seasonally in the stomachs we examined. Missouri (Reynolds 1945) is the only area from which millipedes were reported as more than a trace annually. Isopods were recorded at a frequency of 1.5 percent by Hamilton (1958), less than one-third as often as in our study. Spiders occurred in 4.7 percent of the stomachs we examined. Lay (1942) reported spiders in the stomachs of opossums in Texas. Water bears (Tardigrada), not previously reported from opossum stomachs, occurred in 6.3 percent of the stomachs we examined. Mites have not previously been reported either, but both free-living and parasitic species occurred in the stomachs we examined. The following free-living genera were identified: *Platynocheilus* (Camisiidae), *Scheloribates* (Parasitidae), and *Ereynetes* (Ereynetidae). *Ereynetes*, however, is a parasite of molluscs and may have been ingested with the gastropod found in the same stomach. Two species of mites parasitic on mammals were identified—*Haemogamasus nidi* (Laelapidae) and *Androlaelaps fabrenholzi* (Laelapidae). As these species were also found externally on opossums, their presence in stomachs is probably the result of grooming.

Insects from 16 families were recorded in an annual volume percentage of 2.8 and frequency percentage of 92.0. Opossums in Michigan contained 30.4 percent insects (Dearborn 1932), opossums in Missouri 34.2 percent (Reynolds 1945), and opossums in Kansas 42.2 percent (Sandidge 1953). Stieglitz and Klimstra (1962) and Hamilton (1958) reported volumes between two and three times those we found. Our lower volumes may reflect lower numbers of insects available in an urban setting. We recorded insects all year, but the greatest amount was taken in winter as reported by Reynolds (1945) in Missouri. Hamilton (1958) found that maximum consumption of insects occurred during the summer in New York. The Carabidae accounted for

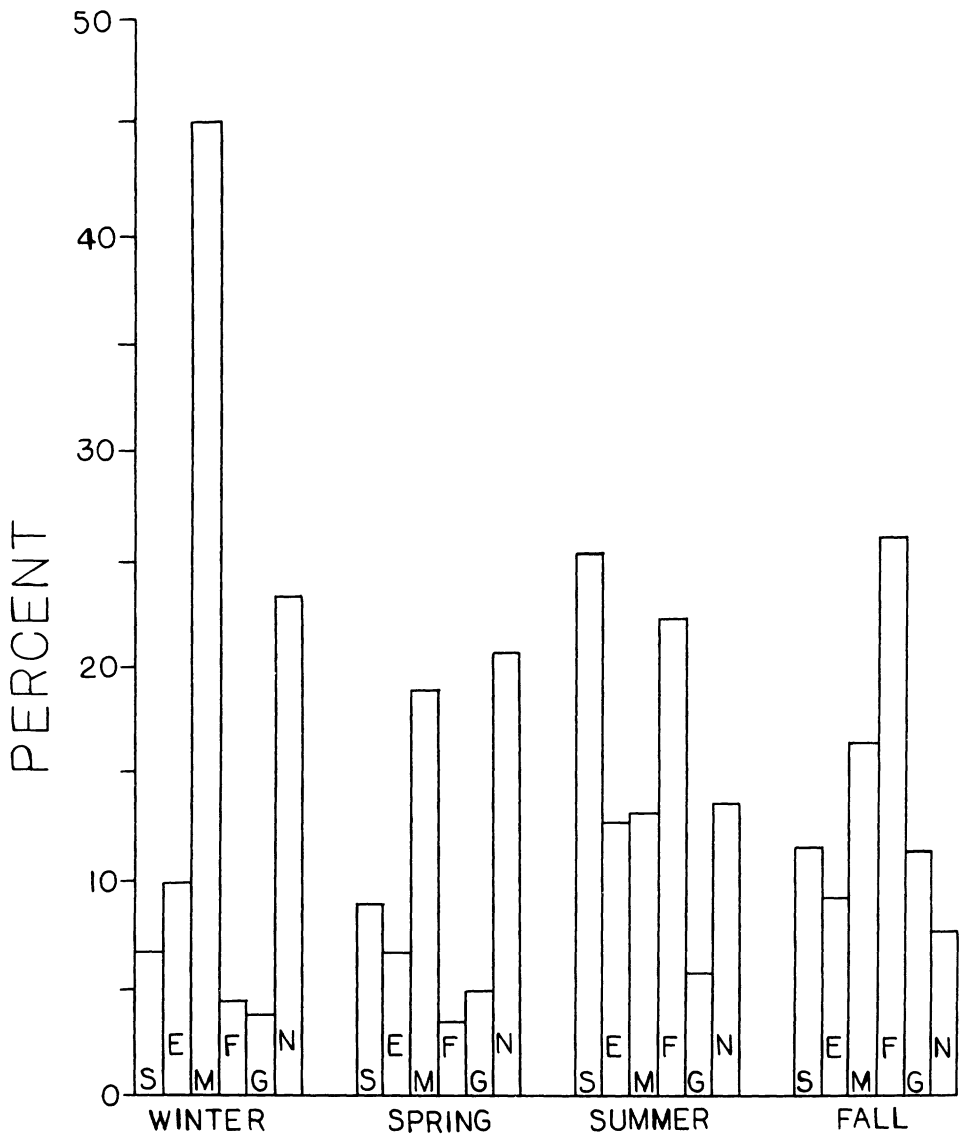


FIGURE 2. Seasonal volumetric percentages of types of foods recovered from the stomachs of 64 Portland-area opossums, and percent occurrence of empty stomachs in a total of 77 opossums collected between December 1974 and May 1976. S = slugs and snails; E = earthworms; M = mammalian remains; F = fruits; G = grasses; N = no stomach remains.

over half of the total insect consumption we recorded in all seasons; remains were present in 31.3 percent of the stomachs. In Missouri, carabids were 8.7 percent by volume of the total stomach contents (Reynolds 1945). Dipterous larvae, vespids, and cocoons were the only other insect items we recorded in more than trace amounts annually. Dipterous larvae were not always associated with carrion in stomach contents. Vespids were also reported by Reynolds (1945). Several kinds of insects probably ingested accidentally include some small species in the families Sminthuridae, Poduridae, Entomobryidae, Isotomidae, Tingidae, and Aphididae. Members of the Pulicidae and

Dolichopsyllidae are almost certainly ingested when the opossums groom. These two families and the Sminthuridae, Poduridae, Entomobryidae, Isotomidae, Forficulidae, Tingidae, Aphididae, and Erotylidae have not previously been reported from opossums' stomachs.

Few remains of reptiles and amphibians were encountered. One garter snake (*Thamnophis* sp.) was found. Other studies have reported reptile remains in quantities ranging from a trace (Taube 1947) to 5.6 percent and 10.0 percent as reported by Hamilton (1958) and Reynolds (1945), respectively. The low occurrence of reptile remains and absence of amphibian remains in our opossums' stomachs may reflect relatively low numbers of these vertebrate classes in urban settings.

Other workers have found that birds generally do not constitute more than about 7 percent by volume of the opossum's diet (Hamilton 1958, Lay 1942, Reynolds 1945, Sandidge 1953). Our opossums consumed less avian material than did opossums in any area other than Maryland (Llewellyn and Uhler 1952). In previous studies, chicken remains were often the predominant avian material recovered (Reynolds 1945, Sandidge 1953, Stieglitz and Klimstra 1962); however, we found no chicken remains. We found a higher frequency of bird remains than reported by other investigators; however, opossums often ingest only a few feathers (Hamilton 1958), an activity that may contribute to the high frequency we recorded for bird remains. Remains of three species of birds were identified in our study—Bewick's Wren (*Thyromanes bewickii*), Rufous-sided Towhee (*Pipilo erythrophthalmus*), and American Robin (*Turdus migratorius*); an unidentified fringillid was recorded, as were various unidentified feathers. Opossums have been accused of taking nestling birds; however, only one young American Robin was eaten, and it may have been carrion as dipterous larvae were also present in the opossum's stomach. Stieglitz and Klimstra (1962) and others have suggested that many bird remains represent carrion-feeding.

Mammalian material was recorded in 34.6 percent of the stomachs, with a volume of 27.4 percent. This is the lowest volume reported except for Lay's (1942) value of 7 percent for mammalian remains. We found mammalian remains ranging from a low of 13.1 percent by volume in summer to a high of 45.3 percent by volume in winter (figure 2).

The most important mammal in the opossum's diet is the opossum; this species accounts for more than one-half the annual total volume of mammalian remains. Only opossums in Illinois ate a greater volume of their own species (Stieglitz and Klimstra 1962). It is probable that nearly all of the opossums consumed are carrion resulting from road-kills. It seems unlikely that opossum flesh is a preferred dietary item; the number of road-killed opossums is lowest in the winter when the volume consumed is highest, but during late spring and summer when the number of road-kills is high, cannibalism is low. In spring, a young female which had been carrying pouch-young recently, as determined by the condition of her marsupium, was found to have eaten an opossum of pouch-young size. Infanticide, matricide, and cannibalism of young have previously been reported for opossums, but only among captives under stress (Pray 1921, Raven 1928).

Rodents are the next most important mammals in our opossums' diets. Rodents have been reported by other investigators, but we found no previous reports of northern flying squirrel (*Glaucomys sabrinus*) remains from opossum stomachs. House mouse (*Mus musculus*) and Norway rat (*Rattus norvegicus*) remains comprised most of the rodent material we recovered. Other reports have noted these two species only in small amounts (Reynolds 1945, Hamilton 1958, Stieglitz and Klimstra 1962); perhaps their preponderance in this study reflects their abundance in urban areas.

Carnivores were third in importance among mammal remains. Consumption of carnivore material—in fact, of most mammalian material—probably represents carrion-feeding. McManus (1970) concluded that opossums are not effective predators on

other mammals. We recorded remains of a domestic cat (*Felis catus*) once, and hair from a spotted skunk (*Spilogale gracilis*) once. Taube (1947) and Stieglitz and Klimstra (1962) reported remains of striped skunks (*Mephitis mephitis*) in their opossums' stomachs.

Previous studies have reported plant material to be relatively unimportant in the diet of the opossum. Reynolds (1945) reported only 14.1 percent plant remains, Sandidge (1953) 9.9 percent, and Stieglitz and Klimstra (1962) 23.8 percent. Stieglitz and Klimstra's value is within 6 percent of ours for plant material, but their study was mostly of opossums taken in the fall, a season when we found plant consumption to increase in volume. Plant material seemingly contributes a greater percentage to the diets of our opossums than has previously been reported. However, inclusion of leaf litter in our values may make this comparison invalid. We included leaf litter because 70.3 percent of the stomachs included more than 10 percent litter in their contents, 31.3 percent of the stomachs included more than 20 percent leaf litter, 20.3 percent included more than 30 percent leaf litter, 6.3 percent included more than 50 percent leaf litter, and 3.1 percent included more than 75 percent leaf litter. Only Stieglitz and Klimstra (1962) reported leaf litter in their analyses. We found plant material ranging from a volume low of 19.6 percent in winter to a high of 54.2 percent in the fall, the increase seemingly reflecting the quantity of fruit available in the latter season.

Fruits are encountered at low frequencies and volumes in winter and spring. With the advent of summer, they increase in both values and reach a peak in the fall (figure 2). Grapes (*Vitis* sp.) are the most important of fall fruits, occurring in half the stomachs we examined and forming 22.3 percent of the total fall diet. Cherries (*Prunus* sp.) are the most important of the summer fruits and rank second only to grapes annually. Prior to this study, only opossums in New York were reported to consume cherries (Hamilton 1958). Other fruits and vegetables recorded were never present in volumes greater than 1.0 percent annually for each kind. Several of these items—corn (*Zea mays*), rice (*Oryza sativa*), onions (*Allium*, sp), peas (*Pisum sativum*), carrots (*Daucus carota*), and dates (*Phoenix dactylifera*)—were probably or certainly available in garbage.

Grasses are seemingly eaten in greater quantity and more often by our opossums than by those previously studied. Michigan's opossums (Taube 1947) consumed 5 percent grass by volume, only slightly less than the 6.3 percent we recorded annually. However, Taube's animals were collected in September, November, and December, a period when our opossums showed high consumption of grass. Reynolds (1945) and Stieglitz and Klimstra (1962) reported amounts of grass below 1 percent, and Sandidge (1953) did not report grass from the stomachs of opossums in Kansas. We found grass consumption to increase from a low of 3.6 percent by volume in the winter to a high of 11.2 percent in fall.

Other material recovered from the stomachs we examined included a variety of items reflecting an urban environment. Most important of these is pet food, consumed in large amounts in winter and spring but in small quantities during the summer. Bacon grease is recorded at 5.4 percent by volume annually, but appeared only in one stomach. Other items included soda crackers, scrambled eggs, macaroni, paper, string, and a mica chip.

Fall is a period of heavy feeding for Portland-area opossums. The percent of empty stomachs falls from a winter high of 23.3 percent to 21.1 percent in spring, 13.3 percent in summer, and 7.7 percent in fall. Of the empty stomachs, 85.7 percent were those of males.

Although the Virginia opossum has often been regarded as a scavenger of garbage, surprisingly few items and little volume (9%) of our animals' diets are garbage. Over half of this amount reflects ingestion by one individual of bacon grease on one

occasion. Our findings are in agreement that the opossum is euryphagic. The Virginia opossum seems to be a highly opportunistic omnivore.

ACKNOWLEDGMENT

We thank Dr. Leonard Simpson for assistance in identifying the gastropods found in this study.

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Biology Section, Office of Environmental Health Service, Oregon State Health Division, 1400 S.W. 5th, Portland, Oregon 97201, and Department of Biology, Portland State University, Portland, Oregon 97201. Accepted 11 October 1979.

APPENDIX 1. Seasonal and annual percent volume, percent frequency, and importance values for food items recovered from 64 Portland-area opossums in 1975 and 1976. Items not previously reported in the diet of Virginia opossums are marked with an asterisk.

	WINTER			SPRING			SUMMER			FALL			ANNUAL		
	% Vol.	% Freq.	I.V.	% Vol.	% Freq.	I.V.	% Vol.	% Freq.	I.V.	% Vol.	% Freq.	I.V.	% Vol.	% Freq.	I.V.
ANIMAL FOODS	68.6	95.8	6571.8	41.4	100.0	4140.0	55.9	100.0	5590.0	39.4	91.7	3613.0	52.9	96.9	5116.3
Unidentified animal matter				1.7	12.5	21.3							0.6	3.1	1.9
Invertebrate eggs*	T	13.0		T	50.0		T	61.5		T	41.7		T	37.5	
Mollusca	6.6	60.9	401.9	8.6	62.5	537.4	24.9	61.5	1531.4	11.3	58.3	658.8	10.4	60.9	639.5
Gastropoda															
<i>Limax</i> sp.	0.6	4.4	2.6												
<i>L. maximus</i> *				0.5	6.3	3.2									0.3
<i>L. marginatus</i> *	0.4	8.7	3.5	0.1	6.3	0.6	8.1	7.7	62.4				0.2	1.6	0.3
<i>Deroceras reticulatum</i> *	0.8	4.4	3.5	0.9	6.3	5.7	1.5	15.4	23.1				1.3	6.4	8.3
<i>Arion ater</i> *				2.5	18.8	47.0	14.4	21.1	303.8	1.5	8.3	12.5	3.0	11.1	33.3
<i>A. hortensis</i> *	1.0	8.7	8.7	0.1	12.5	1.3	0.1	7.7	0.8	4.5	16.7	75.2	1.1	11.1	12.2
<i>Prophysaon andersoni</i> *	2.8	4.4	12.3	3.7	12.5	46.3				3.5	8.3	29.1	2.8	6.4	17.9
Snails	0.1	4.4	0.4	0.2	12.5	2.5	T	7.7		T	8.3		0.1	9.5	0.9
Unidentified	1.0	26.1	26.1	0.5	6.3	3.2	0.8	15.4	12.3	1.8	16.7	30.1	0.9	15.9	14.3
Annelida															
Oligochaeta															
<i>Lumbricus terrestris</i>	9.8	65.2	639.0	6.4	62.5	400.0	12.9	23.1	298.0	8.8	50.0	440.0	8.9	53.1	472.6
Tardigrada*															
Heretotardigrada*	T	4.4		T	18.8					T	8.3		T	6.4	
Arthropoda	5.1	87.5	446.3	0.8	100.0	80.0	3.5	92.3	323.1	1.2	91.7	110.0	2.8	92.2	258.2
Arachnida	T	21.7		T	41.7		T	23.1		T	16.7		T	25.0	
Acari*	T	21.7		T	18.8		T	23.1		T	16.7		T	20.3	
Araneida				T	12.5		T			T	8.3		T	4.7	
Crustacea	T	8.7		T	6.3		T	7.7					T	6.4	
Diplostraca*	T	4.4		T	6.3		T	7.7					T	4.7	
Isopoda	T	4.4		T	6.3		T	7.7					T	4.7	
Diplopoda	T	4.4		T	6.3		T	7.7					T	4.7	
Insecta	5.1	87.5	446.3	0.8	93.3	74.6	3.5	92.3	323.1	0.1	16.7	1.7	2.8	90.6	253.7
Unidentified insect parts	T	26.1		T	18.8		T	23.1		T	16.7		T	21.9	
Unidentified insect larvae	T	8.7		T	12.5		T	23.1		T	25.0		T	17.2	
Collembola*	T	20.8		T	12.5		T	15.4		T	16.7		T	17.2	
Sminturidae*	T	17.4		T	6.3		T	7.7		T	8.3		T	9.4	
Poduridae*															

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	WINTER			SPRING			SUMMER			FALL			ANNUAL		
	% Vol.	% Freq.	I.V.	% Vol.	% Freq.	I.V.	% Vol.	% Freq.	I.V.	% Vol.	% Freq.	I.V.	% Vol.	% Freq.	I.V.
Entomobryidae*	T	4.4		T	6.3		T	7.7		T	8.3		T	3.1	
Isotomidae*															
Orthoptera															
Acrididae															
Dermaptera*															
Forficulidae*															
Hemiptera	T	4.4								0.1	8.3	0.8	T	1.6	
Unidentified										T	8.3		T	3.1	
Tingidae*	T	4.4								T	8.3		T	1.6	
Homoptera*															
Aphididae*															
Coleoptera	3.7	33.3	123.2	0.8	53.3	34.1	2.8	53.8	150.6	T	25.0	66.7	T	6.4	106.5
Unidentified larvae	T	8.7								1.0	66.7		T	48.4	
Unidentified imagines	T	17.4		T	31.3		0.6	23.1	13.9	T	8.3		0.1	20.3	2.0
Carabidae	3.7	26.1	96.6	0.8	18.3	15.0	2.2	30.8	67.8	1.0	58.3	58.3	2.1	31.3	65.7
Larvae	1.7	21.7	36.9	0.1	6.3	0.6							0.7	9.4	14.2
Imagines	2.0	26.1	52.2	0.7	18.8	13.2	2.2	30.8	67.8	1.0	58.3	58.3	1.4	31.3	28.4
Staphylinidae										T	8.3		T	3.1	
Erotylidae*	T	8.7		T	6.3								T	3.1	
Lepidoptera															
Cocoon	1.1	4.4	4.8										0.4	1.6	0.6
Diptera	0.3	21.7	6.5	T	26.7		T	23.1		T	25.0		0.1	23.4	2.3
Unidentified larvae	0.3	21.7	6.5	T	18.8		T	23.1		T	25.0		0.1	21.9	2.2
Unidentified imagines															
Tipulidae															
Siphonaptera*	T	21.7		T	6.3		T	38.5		T	50.0		T	1.6	
Pulicidae*	T	12.5		T	25.0		T	30.8		T	50.0		T	31.3	
Dolichopsyllidae*	T	12.5		T	6.6		T	30.8		T	25.0		T	17.2	
Hymenoptera	T	26.1		T	20.0		T	23.1		T	25.0		T	18.8	
Unidentified				T	6.3		0.7	38.5	27.0	T	8.3		0.1	17.2	1.2
Formicidae	T	26.1		T	6.3		0.2	7.7	1.5	T	8.3		T	1.6	
Vespidae							0.1	23.1	2.1	T	8.3		T	17.2	
Chordata	47.3	45.8	2166.3	23.9	73.3	1751.9	14.6	36.4	531.4	18.1	50.0	905.0	0.1	1.6	0.2
Unidentified cartilage				1.2	7.7	9.2							30.2	45.3	1327.3
													0.2	1.6	0.3

APPENDIX 1. Seasonal and annual percent volume, percent frequency, and importance values for food items recovered from 64 Portland-area opossums in 1975 and 1976. Items not previously reported in the diet of Virginia opossums are marked with an asterisk.

	WINTER			SPRING			SUMMER			FALL			ANNUAL		
	% Vol.	% Freq.	I.V.	% Vol.	% Freq.	I.V.	% Vol.	% Freq.	I.V.	% Vol.	% Freq.	I.V.	% Vol.	% Freq.	I.V.
Unidentified bone							0.2	7.7	1.5						
Unidentified meat															
Osteichthyes															
Crenoid scales															
Reptilia															
Squamata															
<i>Thamnophis</i> sp.	0.6	4.4	2.6												
Aves	1.4	25.9	36.3	5.2	37.7	196.0	0.1	23.1	2.3	1.4	25.0	35.0	2.5	28.2	70.2
Unidentified feathers	T	13.0		0.6	18.8	11.3	0.1	23.1	2.3	0.1	16.7	1.7	0.2	17.2	3.4
Passeriformes															
<i>Troglodytes bewickii</i> *	0.8	4.4	3.5												
<i>Turdus migratorius</i>	0.6	4.4	2.6	0.4	6.3	2.5				1.3	8.3	10.8	0.6	4.7	2.8
Unidentified Fringillidae				0.1	6.3	0.6							T	1.6	
<i>Pipilo erythrophthalmus</i>	T	4.4		4.1	6.3	25.8							1.4	3.1	4.4
Mammalia	45.3	43.3	1961.5	18.7	50.1	936.9	13.1	7.7	100.9	16.2	25.0	405.0	27.4	34.6	948.0
Marsupialia															
<i>Didelphis virginiana</i>	19.2	30.4	583.7	16.0	31.3	500.3				15.7	16.7	262.2	14.9	21.9	326.3
Insectivora															
<i>Neurotrichus gibbsii</i> *				2.5	12.5	31.3							0.9	3.1	2.8
Rodentia	15.3	8.7	133.1	0.2	6.3	1.3	13.1	7.7	100.9				7.5	6.4	48.0
<i>Glaucomyx sabrinus</i> *	1.1	4.4	4.8										0.4	1.6	0.6
Unidentified Cricetidae				0.2	6.3	1.3							0.1	1.6	0.2
<i>Mus musculus</i>							13.1	7.7	100.9				1.8	1.6	2.9
<i>Rattus norvegicus</i>	14.2	4.4	61.1										5.2	1.6	8.3
Carnivora	10.8	4.4	46.4							0.5	8.3	4.2	4.1	3.1	12.7
<i>Spilogale gracilis</i> *										0.5	8.3	4.2	0.1	1.6	0.2
<i>Felis catus</i>	10.8	4.4	46.4										4.0	1.6	6.4
PLANT FOODS	19.6	100.0	1960.0	23.0	100.0	2300.0	38.4	100.0	3840.0	54.2	100.0	5420.0	29.1	100.0	2910.0
Gramineae	3.6	82.6	297.4	4.4	87.5	385.0	5.5	92.3	507.7	11.2	83.3	933.0	5.3	85.9	455.3
<i>Zea mays</i>				0.3	6.3	1.9							0.1	1.6	0.2
<i>Oryza sativa</i> *													T	1.6	
<i>Allium cepa</i> *	0.1	4.4	0.4	0.2	6.3	1.3				0.1	8.3	0.8	0.1	3.1	0.3
<i>Malus</i> sp.				0.2	6.3	1.3	0.5	7.7	3.9	2.0	25.0	50.0	0.4	7.7	1.9

APPENDIX 1. Seasonal and annual percent volume, percent frequency, and importance values for food items recovered from 64 Portland-area opossums in 1975 and 1976. Items not previously reported in the diet of Virginia opossums are marked with an asterisk.

	WINTER			SPRING			SUMMER			FALL			ANNUAL		
	% Vol.	% Freq.	I.V.	% Vol.	% Freq.	I.V.	% Vol.	% Freq.	I.V.	% Vol.	% Freq.	I.V.	% Vol.	% Freq.	I.V.
<i>Pinus</i> sp.							18.5	7.7	142.5				2.5	1.6	4.0
<i>Pyrus commutis</i>	1.2	4.4	5.3	1.5	6.3	9.5							0.9	3.1	2.8
<i>Prunum sativum</i> *	1.8	4.4	7.9										0.7	1.6	1.1
<i>Juglans</i> sp.*	1.1	4.4	4.8							0.5	8.3	4.2	0.5	3.1	1.5
<i>Yitis</i> sp.	T	4.4								22.3	50.0	1115.0	3.5	10.9	38.2
<i>Daucus carota</i> *				1.0	6.3	6.3				1.9	8.3	15.8	0.6	3.1	1.9
<i>Phoenix dactylifera</i> *							1.1	7.7	8.5				0.2	1.6	0.3
<i>Helianthus annuus</i> *										0.1	8.3	0.8	T	1.6	
Green leaves	1.1	39.1	43.0	5.6	25.0	140.0	0.6	23.1	13.9	2.0	25.0	50.0	2.8	29.9	83.7
Unidentified fruits	0.1	4.4	0.4				2.0	30.8	61.6	1.0	16.7	16.7	0.5	10.9	4.4
Unidentified seeds	T	47.8		0.2	25.0	5.0	T	46.1		0.1	41.7	4.1	0.1	40.6	3.9
Leaf litter	10.6	100.0	1060.0	9.6	100.0	960.0	10.2	92.3	941.5	14.9	100.0	1490.0	10.9	98.4	1072.6
MISCELLANEOUS FOODS															
Pet food*	11.8	79.2	934.6	35.6	87.5	3104.3	5.6	76.9	430.6	4.6	75.0	345.0	18.0	81.3	1471.5
Bacon grease*	9.5	17.4	165.3	16.0	12.5	200.0	3.1	15.4	47.7				9.4	12.5	117.5
Fur balls*				15.8	6.3	99.5							5.4	1.6	8.6
Soda crackers*				2.1	12.5	26.3							0.7	3.1	2.2
Paper	0.9	17.4	15.7	0.5	18.8	9.4				3.9	8.3	32.4	0.6	1.6	1.0
Macaroni*	1.1	4.4	4.8							0.3	8.3	2.5	0.5	12.5	6.3
Sand	0.3	82.6	24.8	T	73.3		1.5	61.5	92.3	0.4	66.7	26.7	0.4	1.6	0.6
Scrambled eggs				0.5	6.3	3.2	0.7	7.7	5.4				0.3	3.1	0.9
Plastic wrap				0.7	12.5	8.8							0.3	3.1	0.9
Unidentified							0.3	7.7	2.3				T	1.6	T
Tin foil*	T	4.4		T	6.3		T	7.7					T	4.7	
Wood chips*	T	4.4											T	1.6	
Plastic fragment*	T	4.4											T	1.6	
String*	T	4.4											T	1.6	
Plastic filament*	T	4.4											T	1.6	
Mica chip	T	4.4											T	1.6	
Glass*													T	1.6	
Paint chip*							T	7.7					T	1.6	
Rubber*													T	1.6	

*Indicates item not previously reported from the Virginia opossum's diet.