COMPARATIVE FOOD HABITS OF TWO COTTONTAIL RABBIT POPULATIONS IN VIRGINIA

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Abstract: Food habits of cottontail rabbits *(Sylvilagus floridanus)* were determined by microscopic analysis of stomach contents from 2 physiographic regions of Virginia during 4 seasons of the year. The area examined in the mountain region (Radford Army Ammunition Plant [RAAP]) contained a high population of rabbits whereas the area studied in the piedmont region (Fort Pickett) was an area with a history of relatively low rabbit populations for the past 2 decades. Food habits of rabbits from the 2 areas were different; rabbits from Fort Pickett subsisted on much greater quantities of forbs throughout the year than RAAP rabbits which consumed primarily grasses. Collectively, leaf and stem parts of grasses and forbs made up well over 90% of total food items found in stomachs throughout the year. At Fort Pickett grasses occurred in greater volumes in winter and spring, whereas forbs were more numerous in summer and fall. Grasses predominated in all seasons at RAAP. Seventy different plant species were found in the stomachs of rabbits from both areas. The possible role of different diets in leading to different population levels in the 2 areas is discussed.

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Jacobson et al. (1978) documented differences in cottontail populaton size between Fort Pickett and RAAP and studied physiological and parasitic factors in an attempt to determine the cause of a continued low populatoin at Fort Pickett. They suggested that the disease tularemia was a primary cause. Food habits of animals from the 2 areas were not determined in that study although stomachs were collected and preserved. The objective of the present study was to determine food habits of cottontails from the 2 areas by microscopic examination of stomach contents collected by Jacobson et al. (1978) and thus to begin an investigation of whether differences in food habits and nutritional quality of diets may have contributed in some way to differences in populations of the 2 areas.

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METHODS

Rabbits were collected between September 1973 and July 1974 as reported by Jacobson et al. (1978), and stomachs were removed and stored in 10% formalin. Five stomachs were selected randomly for each season from samples available from both Fort Pickett and RAAP. Stomach contents were rinsed in a Buchner funnel with distilled water to remove the formalin in which they were preserved, then placed in a 10% nitric-chromic acid solution for up to 45 min to clear excess mesophyll. The contents were then rinsed again to remove the acid, transferred to a 1% safranin in distilled water solution, and left for at least 2 weeks. The sample was then washed with ethanol and distilled water to remove any excess stain. An aliquot measured in a ring 9 mm in diameter and 3 mm deep was mounted on a 76 × 51 mm glass slide with Hertwig's solution (Baumgartner and Martin 1939) and covered with a 48 × 60 mm coverslip.

Twenty-six microscopic fields per stomach were examined at 40 power. The fields were systematically located on at least 2 slides per stomach. All epidermal fragments in each field were identified to species where possible using a key prepared from a reference collection (Shoemaker 1979). They were then classified as forb (dicotyledon leaf and stem), grass (monocotyledon leaf and stem), pine (gymnosperm plant part), bud, seedcoat, or bark. Fragments that were not identified to species also were put into one of the above classifications. Because the stomach was fragile after being in formalin for 2 years, it was not possible to grind the material to insure that all fragments would be of similar size. The surface area of each species within a given microscopic field was estimated with a Whipple Ocular Grid.

The areas of all fragments were summed over the total stomach sample. Where several different species of the same genus were present, or when the fragment was identifiable to genus but not to species, these were lumped under that genus name and thereafter treated as a species. For example, all species of bluegrass were treated as *Poa* spp. For each species and each classification, the percentage of the total area it occupied in that stomach was determined. For both study areas, in every season, the mean percentage total surface area that each species or each classification occupied was calculated. This value represented the relative abundance of each species or classification in that diet.

A 2-way analysis of variance was performed on the grass, forb, seedcoat, and bud classifications to detect differences between seasons and areas. Insufficient data were available in the other classifications to perform meaningful tests. Duncan's Multiple Range Test was used to test for significant seasonal or area differences (Barr et al. 1976).

RESULTS

Broad Classification Data

Although it was difficult to identify plants to species, it was possible to classify fragments into broad categories with a high degree of certainty. In both areas the seasonal food consumption patterns were similar; grasses were the major diet components in the spring and winter and forbs became increasingly important in the summer and fall (Table 1).

Table 1. Percent surface area of plant epidermal fragments by classifications in each season for Fort Pickett and RAAP, September 1973 to July 1974.

Classification	Location	Season							
		Spring		Summer		Fall		Winter	
		$\bar{X}$	± SE	$\bar{X}$	± SE	$\bar{X}$	± SE	$\bar{X}$	± SE
Forb	FP	27.8[a]	8.8	66.8	18.2	70.0	26.6	22.5	27.0
	RAAP	7.1	6.5	33.4	24.3	38.0	19.5	11.7	16.6
Grass	FP	71.3	8.6	19.8	18.2	24.9	28.2	77.3	27.3
	RAAP	92.1	6.2	60.9	27.3	41.9	6.7	86.8	16.2
Seedcoat (forb & grass)	FP	0.3	0.5	11.4	6.7	4.7	5.1	0.0	0.0
	RAAP	0.8	1.5	5.2	4.2	18.4	19.0	1.1	1.9
Bud (forb & grass)	FP	0.6	1.1	2.0	1.3	0.4	0.6	0.2	0.4
	RAAP	0.0	0.0	0.6	0.7	1.4	2.0	0.3	0.7
Bark (not pine)	FP	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0
	RAAP	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.3
Pine (all parts)	FP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	RAAP	0.1	0.1	0.0	0.0	0.2	0.5	0.0	0.0

[a] Means of 5 stomachs/subgroup

Differences in the amount of both grasses and forbs consumed between areas were highly significant ($P < 0.01$); grasses were eaten significantly more frequently at RAAP. There also were highly significant differences ($P < 0.01$) in the amount of grasses, forbs, and seedcoats consumed in different seasons. There was a significant interaction of season and areas for seedcoats ($P < 0.05$).

The amounts of both grasses and forbs in the summer and fall diets were significantly different ($P < 0.05$) from the amount in the spring and winter diets; forb consumption was significantly greater in the summer and fall, and grasses were consumed significantly more in the spring and winter (Table 2). Seedcoat consumption was significantly higher in the summer and fall than the spring and winter, and buds tended to be consumed more in the summer than in the other seasons.

Species Data

Seventy different plant species, representing 46 genera and 24 families, were identified in the stomachs. Of these, 61 species were found in the RAAP stomachs and 54 in the Fort Pickett stomachs.

Only 3 species, bentgrass (*Agrostis* spp.), fescue (*Festuca* spp.), and bluegrass (*Poa* spp.) were found in the diets for all 4 seasons for both RAAP and Fort Pickett, although bentgrass was never present in any great abundance. Six species,

Table 2. Seasonal comparisons of percentage surface area of epidermal fragments by classifications for Fort Pickett and RAAP combined, by Duncan's Multiple Range test procedure.[a]

Season	Classification			
	Grass	Forb	Seedcoat	Buds
Spring	81.7A	17.5B	0.6B	0.3B
Summer	39.8B	50.1A	8.3A	1.3A
Fall	33.4B	54.0A	11.5A	0.9AB
Winter	82.1A	17.1B	0.5B	0.2B

[a] Means with different letters within each column are significantly different ($P < 0.05$).

wild carrot *(Daucus carota),* tick trefoil (*Desmodium* spp.), plantain (*Plantago* spp.), dwarf cinquefoil *(Potentilla canadensis),* goldenrod (Solidago spp.), and clover (*Trifolium* spp.), were found year-round in the Fort Pickett diets. Hawkweed (*Hieracium* spp.), timothy *(Phleum pratense),* and pine (*Pinus* spp.) were the only species found in all 4 seasons at RAAP.

Wild aster (*Aster* spp.), dayflower (*Commelina* spp.), wood-sorrel (*Oxalis* spp.), dewberry (*Rubus* spp.), and dandelion *(Taraxacum officinale)* were found exclusively in the Fort Pickett diets whereas dogbane *(Apocynum cannabinum),* wild lettuce *(Lactuca canadensis),* basil *(Satureja vulgaris),* greenbrier (*Smilax* spp.), chickweed *(Stellaria media),* and elm (*Ulmus* spp.) were found only in the RAAP diets.

Overall, bluegrass and fescue were the most abundant species, being among the top 10 most abundant species in all but the summer diets in both areas and the fall Fort Pickett diet (in which fescue but not bluegrass was found) (Table 3). Most of the species found were monocots (grasses), whereas dicots (forbs) were present in abundance only in the summer and fall diets. Forbs were almost entirely absent from the RAAP diets.

DISCUSSION

Although numerous food habit studies of cottontails have been conducted (Dusi 1946, 1949; Sagar 1962; Turkowski 1975; Flinders and Crawford 1977; Hansen and Gold 1977; Spann 1978) none has been done in southeastern United States, and few have compared food habits between 2 areas. The actual species composition of forages in the stomachs of rabbits from RAAP and Fort Pickett was generally similarly to those in other studies conducted in the Midwest and Northeast (Dalke and Sime 1941, Dusi 1952, Corder 1955).

In the present study, more forbs were consumed than grasses in the summer and fall, and grasses were consumed more than forbs in the winter and spring. There was little or no utilization of bark, pine, or buds, as has been reported for the winter in the Northeast (Todd 1927, Siegler 1937, Trippensee 1938, Allen 1939, Dalke and Sime 1941, Petrides 1942). Seedcoats of herbaceous material such as grasses and forbs were utilized to some extent, mainly in the fall, and few were eaten in the spring. This indicated that winters in Virginia generally were not severe enough to cause a switch to bark or buds.

Table 3. The 10 most abundant plant species in the diets of rabbits collected at Fort Pickett and RAAP for each season as determined from epidermal fragments in stomachs, September 1973 - July 1974.

	Fort Pickett				RAAP			
			Mean % surface area				Mean % surface area	
Season	Species	N[a]	of total fragments	of identifiable fragments	Species	N	of total fragments	of identifiable fragments
Spring	Unidentified grass	5	46.8		Unidentified grass	5	56.9	
	Unidentified forb	5	22.3		*Poa* spp.	5	16.6	45.0
	Poa spp.	5	17.7	58.3	*Festuca* spp.	5	8.8	23.4
	Festuca spp.	4	3.3	9.1	Unidentified forb	5	6.6	
	Dactylis glomerata	5	2.1	7.2	*Dactylis glomerata*	5	3.6	
	Ambrosia artemisiifolia	3	1.6	5.8	*Phleum pratense*	4	3.1	9.9
	Plantago spp.	3	1.5	5.2	*Carex* spp.	3	2.1	5.1
	Unidentified bud	2	0.6		Unidentified seedcoat	3	0.8	
	Medicago sativa	1	0.6	1.5	*Agrostis* spp.	4	0.7	2.1
	Allium spp.	1	0.6	2.7	*Lonicera japonica*	1	0.4	1.0
Summer	Unidentified forb	5	52.1		Unidentified grass	5	43.1	
	Unidentified grass	5	14.0		Unidentified forb	5	25.2	
	Echinochloa spp.	2	4.5	26.0	*Dactylis glomerata*	3	7.7	17.2
	Unidentified seedcoat	5	4.2		Unidentified seedcoat	3	4.3	
	Solidago spp.	3	3.7	10.2	*Setaria* spp.	3	3.6	6.5
	Pinus spp.	5	3.3	12.5	*Polygonum* spp.	4	1.9	4.7
	Lespedeza spp.	3	2.9	9.6	*Plantago* spp.	4	1.8	7.3
	Dactylis glomerata	1	2.7	6.4	*Agrostis* spp.	2	1.7	15.7
	Asclepias spp.	2	2.2	5.3	*Echinochloa* spp.	1	1.7	5.8
	Plantago spp.	1	1.8	4.3	*Trifolium* spp.	2	1.7	8.9

[a] N is the number stomachs (out of 5) in which a particular species was found.

Table 3. (cont.)

	Fort Pickett				RAAP			
			Mean % surface area				Mean % surface area	
Season	Species	N[a]	of total fragments	of identifiable fragments	Species	N	of total fragments	of identifiable fragments
Fall	Unidentified forb	5	48.9		Unidentified grass	5	33.4	
	Unidentified grass	5	19.4		Unidentified forb	5	31.2	
	Lespedeza spp.	4	7.5	26.4	Unidentified seedcoat	4	16.8	
	Plantago spp.	5	4.6	13.2	*Echinochloa* spp.	3	4.0	20.1
	Festuca spp.	2	3.3	7.0	*Ambrosia artemisiifolia*	2	3.1	11.7
	Unidentified seedcoat	4	2.0		*Festuca* spp.	3	1.3	5.1
	Aster spp.	4	1.6	5.3	*Solidago* spp.	2	1.3	4.4
	Quercus spp.	1	1.4	2.5	*Poa* spp.	4	1.2	10.2
	Pinus spp.	3	1.2	5.0	*Quercus* spp.	1	1.0	2.9
	Taraxacum officinale	1	1.0	1.8	*Agrostis* spp.	1	0.9	9.7
Winter	Unidentified grass	5	32.9		Unidentified grass	5	50.5	
	Poa spp.	5	23.8	44.6	*Poa* spp.	5	16.9	41.6
	Festuca spp.	5	15.2	28.7	Unidentified forb	5	10.2	
	Unidentified forb	5	15.1		*Allium* spp.	1	7.6	15.5
	Plantago spp.	4	5.1	10.7	*Festuca* spp.	3	5.3	12.0
	Allium spp.	2	3.6	6.6	*Carex* spp.	3	4.6	19.6
	Dactylis glomerata	1	1.2	3.0	*Phleum pratense*	2	1.2	2.8
	Potentilla canadensis	2	0.5	1.2	*Pinus* spp.	1	0.7	2.5
	Solidago spp.	2	0.4	0.8	*Cardamine* spp.	2	0.6	1.4
	Carex spp.	2	0.4	0.8	*Dactylis glomerata*	2	0.4	1.2

[a] N is the total number stomachs (out of 5) in which a particular species was found.

On a year-round basis, RAAP rabbits consumed more grasses than forbs. Fort Pickett rabbits consumed more grasses than forbs in winter and spring and more forbs in the summer and fall. Comparing areas, Fort Pickett rabbits consumed more forbs in all seasons, and RAAP rabbits consumed more grasses in all seasons than the Fort Pickett rabbits.

The greater consumption of grasses at RAAP and of forbs at Fort Pickett was probably due to a difference in the structure of these plant communities. Although Jacobson et al. (1978) detected no major significant differences in the species composition of the 2 areas in the summer, grasses were found in all of the sample plots at RAAP and in only 88% of the plots at Fort Pickett. The species composition of grasses, which were not analyzed by Jacobson et al. (1978), could be somewhat different on the 2 areas. The nutritional aspect of this difference is speculative without further investigation. In Ohio, Spann (1978) found that legumes had a higher percentage crude protein than grasses and that grasses had a higher percentage ash than forbs during the summer. Bailey (1969) reported grasses to be poorly digested by cottontails in Illinois in the spring, summer, and fall. Marten and Andersen (1975) found that 10 of 12 common weed species in Minnesota, both forbs and grasses, were more digestible than oat forage, and that the forb and grass species were comparable to each other. Investigation of specific plant species might contribute to the nutritional picture of the grass-forb role.

Studies are currently underway at Virginia Tech with the objective of determining nutritional quality (digestibility) of diets of wild herbivores using Van Soest analysis (Van Soest 1973) of stomach contents and regression equations. Results to date in pine voles *(Microtus pinetorum)* indicate that cell solubles of stomach contents are an excellent predictor of digestibility for that species (Servello 1981). Future studies of cottontails from Fort Pickett and RAAP can hopefully use this technique to determine differences in nutritional quality of diets more accurately.

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