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# The Raccoon (*Procyon lotor*) on St. Catherines Island, Georgia. 5. Winter, Spring, and Summer Food Habits

DENNIS M. HARMAN[1] AND HOWARD J. STAINS[2]



## ABSTRACT

Raccoons on St. Catherines Island, Georgia, eat more animals as food items from winter into spring, during which time native fruits decrease in availability and insects, marsh crustaceans, mollusks, and fish increase in availability. Crustaceans became less important from June to August, as they were replaced in the diet by vegetation, mainly grapes.

## INTRODUCTION

Food habits of the raccoon *Procyon lotor* have not been studied at all in coastal Georgia and few studies have been made in the southeastern states. Studies have been made in 16 states of the United States: Alabama (Johnson, 1970), Colorado (Tester, 1953), Illinois (Yeager and Elder, 1945; Yeager and Rennels, 1943), Iowa (Cabalka, Costa, and Hendrickson, 1953; Giles, 1939, 1940), Kansas (Stains, 1956), Louisiana (Fleming, Palmisano, and Joanen, 1978; Cagle, 1949), Maryland (Llewellyn and Uhler, 1952), Michigan (Stuewer, 1943), Minnesota (Schoonover and Marshall, 1951), New York (Hamilton 1936, 1940, 1951), South Carolina (Kinard, 1964), South Dakota (Geis, 1966), Texas (Baker, Newman, and Wilke, 1945; Wood, 1954), Virginia (Kellner, 1954), Washington (Tyson, 1950) and Wisconsin (Dorney, 1954).

Food habits of raccoons, *Procyon lotor litoreus*, in the winter and spring (January through May) were studied by Harman on St. Catherines Island, Liberty Co., Georgia. Food habits in the summer were studied by Stains. General trends in foods used and differences in foods used in two major habitats of the Island were compared. These habitats were (1) areas above the average high tide line which were defined as inland habitats and (2) brackish tidal marshes below the average high tide line.

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## STUDY AREA

St. Catherines Island, member of a chain of barrier islands included in the Atlantic Coastal Plain Province (Thornbury, 1965), is situated in the central region of the Georgia coast. Somes and Ashbaugh (1973) gave dimensions of St. Catherines as follows: surface area, 5668 hectares (ha.); minimum distance from mainland, 8.2 kilometers (km.); greatest length, 16.5 km.; maximum width (including adjacent tidal marshes), 6.3 km. Johnson et al. (1974) cited a surface area of 2915 ha., excluding associated tidal marshes. Johnson et al. (1974), Somes and Ashbaugh (1973), and Hudson (1978) have discussed the climate and geology of the sea islands and St. Catherines Island.

Approximately 51 percent (2967 ha.) of the 5765 ha. mapped during a vegetation survey of St. Catherines (Somes and Ashbaugh, 1973) was classified as tidal marshes, and 97 percent (2880 ha.) of the marshes were composed of low-water cordgrass (*Spartina alterniflora*). The marshes are connected to and interact with the Atlantic Ocean through a system of tidal streams and estuaries.

The inland topography of the sea islands consists of wide areas approximately at sea level associated with gently sloping ridges; maximum elevation is approximately 7.6 meters (m.) (Johnson et al., 1974). Thirty-nine percent (2242 ha.) of St. Catherines (including contiguous marshes) consists of various forest associations (Somes and Ashbaugh, 1973). Pine forests (21 ha.) are composed of pure stands of slash pine (*Pinus eliottii*) or longleaf pine (*P. palustris*). Pine-oak forests (699 ha.) consist of slash pine (occasionally longleaf pine and rarely pond pine, *P. serotina*) associated with scattered laurel oak (*Quercus laurifolia*) and live oak (*Q. virginiana*). Oak-pine forests (554 ha.) are characterized by live and laurel oaks as dominants with scattered slash and longleaf pines. Mixed forests (477 ha.) possess equal amounts of live oak, laurel oak, slash pine, and, occasionally, longleaf pine, and water oak (*Q. nigra*). Oak forests (249 ha.) are principally comprised of live oak. Oak-palm forests (170 ha.) are characterized by cabbage palm (*Sabal palmetto*) being an associate of live oak. Cabbage palm is dominant in palm forests (39 ha.). Wind-pruned oak and wind-pruned oak palm forests are found on 28 ha. along the eastern shore. Black gum forests (4 ha.) possess a canopy of black gum (*Nyssa sylvatica*).

The remaining 10 percent of St. Catherines is composed of various floristic types including meadows (153 ha.), scrub areas (99 ha.), savannas (161 ha.), upland grasslands (132 ha.), herblands (3.2 ha.), and aquatics (7.3 ha.). For details of the vegetation on St. Catherines see Somes and Ashbaugh (1973), Johnson et al., (1974), or Hudson (1978).

## MATERIALS AND METHODS

The types, quantities, and frequencies of foods and the season and locality in which they were consumed were studied in field and laboratory. Data from 627 scats, nine stomachs, and 26 colons were quantified in two ways. "Percent frequency" was calculated using the number of samples in which each item occurred, and "percent volume" was defined as the summation of all volumes for each item divided by the total food volume.

Scats were the primary source of data. Scats were easily obtained and thus allowed for a progressive evaluation of the relative amounts of foods being consumed. In all, 627 scats (from the months shown in table 1) were analyzed. Previous studies have demonstrated that raccoons use distinctive defecating stations

TABLE 1
**Months of Collection of 627 Raccoon Scats from St. Catherines Island, Georgia**

| | Marsh | Inland | Total |
|---|---|---|---|
| January 1975 | 35 | 1 | 36 |
| February 1975 | 85 | 8 | 93 |
| March 1975 | 73 | 8 | 81 |
| April 1975 | 78 | 19 | 97 |
| May 1975 | 99 | 14 | 113 |
| January 1976 | 102 | 18 | 120 |
| June 1975 | — | — | 20 |
| July 1975 | — | — | 50 |
| August 1975 | — | — | 17 |

(Giles, 1939, 1940; Hamilton, 1940; Tester, 1953; Stains, 1956). These were abundant at the interface of the tidal marshes and higher ground. This abundance was probably due to high concentrations of foods in the marshes. Scats in the marshes were readily available and easily collected. Scats collected more than 100 m. from the high tide line were classified as inland samples. Scat stations in such areas were scarce, probably as the result of dispersed food supplies. Consequently, the number of scats collected in such areas was relatively small. Most of these scats were from animals live-trapped in inland habitats.

Only freshly deposited scats were collected. Heavy rain fragments scats and they assume a bleached white coloration after prolonged exposure to the sun. Scats collected were probably no older than two or three weeks. Mid-monthly samples allowed a reasonably accurate dating as to the months in which foods found in the scats were consumed. All samples were placed in small paper bags on which the date and collection site were recorded, then allowed to air dry.

The scat data were supplemented by the analysis of nine stomachs and 26 colons from 27 digestive tracts collected at various locations and times. Digestive tracts were collected from animals caught in Tomahawk live-traps and immobilized with ketamine hydrochloride, a veterinary injection used intramuscularly. Chloroform was used to sacrifice the animals. Digestive tracts were removed and contents of stomach and colon washed separately in a no. 18 U.S. standard sieve (1.0 mm. openings). The residue was then air dried and stored in small paper bags on which the date and collection site were recorded.

When thoroughly dried, scats and residues from digestive tracts were broken apart on pieces of white paper. The finely masticated remains, which appeared as dust in the scats, were discarded. The remains of various food items were segregated and individual items identified. The volume of each item was measured in milliliters (ml.) in a graduated cylinder. The material was packed with a glass rod to reduce error due to interstices. Any volume measuring less than 0.5 ml. was recorded as being present in trace amount.

Both plant and animal reference collections, consisting of available food items, were established and utilized in the identification of items found in the samples. Identification of food items was based on nondigested remains such as seeds and exoskeletons. The plant collection consisted mostly of fruits and the animal collection of invertebrates. The reference collections were supplemented with field notes regarding availability of food items.

## LIMITATIONS OF THE DATA

Problems arise when trying to study the diet of animals, such as raccoons, whose behavior and food habits are so diverse. In raccoon food habit studies, scat analysis only shows general dietal trends (Yeager and Elder, 1945). Foods represented by bulky remains tend to be overemphasized in percent volume figures (e.g., cordgrass and *Melampus* spp., a tidal marsh snail), whereas foods of a soft nature are more completely digested and underestimated (e.g., the ribbed mussel, *Modiolus* spp.). Foods eaten frequently but in small quantities tend to be overemphasized in percent frequency figures. Differential rate of passage of various types of foods might result in misleading percent frequency figures (Stains, 1956). Scats are most abundant and conveniently collected in areas of high food concentration, resulting in an unknown bias against more dispersed food items (Johnson, 1970; e.g., foods typical of inland

habitats). In the present study, direct observation of raccoon foraging and interpretation of feeding sign increase the reliability of the data. Wood (1954) found similar volumetric measurements for raccoon scats and digestive tracts, and 31 more items in scats than in digestive tracts, and thus, concluded that scat analysis was a better indicator of diet than were digestive tracts.

Analysis of digestive tracts in conjunction with scats may increase reliability of the results by allowing for identification of certain soft, completely digestible foods (Hamilton, 1951). Wood (1954) found the colon to be the most reliable section of the digestive tract for study of raccoon food habits. In the present study, no items were found in the gut which would not have been detected in scats.

An obvious problem arose when samples from the marsh and inland were compared. Inland samples may not be representative of foods eaten in that area due to foraging in the marsh with subsequent movement inland. Scats collected within 100 m. of the marsh might have represented foraging in both habitats, but were probably more representative of the marsh.

Some light on this problem is provided by observations on a radio-tagged raccoon. During this study, one adult male raccoon (no. 227) was located 32 times by live-trapping and radio-tracking from February 15, 1975, to May 24, 1975. All locations were in inland habitat, and the closest location to the marsh was 200 m. The overall range of activity measured approximately 150 ha. A scat collected from this animal in April consisted of 37.5 percent unknown insect, 25.0 percent unknown vegetation, 25.0 percent snake, 7.5 percent beetle, 2.5 percent grasshopper, 2.5 percent crayfish, and a trace of centipede. A scat collected in May consisted of 95.7 percent beetle, 4.3 percent unknown vertebrate, and a trace of unknown crab. Foods in both scats were predominantly inland in nature, and this animal was observed foraging along the edge of freshwater ponds. Observations on this animal seemed to support the assumption that a sample collected more than 100 m. from the marsh was more representative of inland food trends than of marsh trends. Raccoon mobility studies have indicated that individual animals possess relatively small ranges which tend to be correlated with food availability, and that there seem to be seasonal shifts in activity ranges (Ellis, 1964; Geis, 1966).

The probability that foods identified in inland samples were representative of inland feeding habits was further increased by the fact that material apparently passed through the gut at a rapid rate. Of all the animals sacrificed, those that had been in the trap less than eight hours tended to have both full stomachs and colons, whereas those that had been in traps 13 hours had empty stomachs but full colons. The actual time necessary for food to pass completely through the digestive tract was unknown. However, it was assumed that an animal foraging in an inland area would tend to defecate there.

Moreover, the occurrence of food items, available only in the marsh, in inland samples can most plausibly be explained by foraging in the marsh with subsequent movement into and defecation in the inland habitat. This, no doubt, occurred and introduced an unknown amount of bias into the results.

Any comparison of marsh and inland samples should be done with caution because of the small sample size from the inland habitat. Many of the digestive tracts collected in 1975 were obtained in inland habitats, which increases the representation of samples from those areas. These digestive tracts were generally collected farther from the marsh than were the inland scats and may thus be more representative of the inland diet. The stomachs and colons were considered to represent separate meals, which increases the sample size. For example, in January 1975, four stomachs and five colons were collected: a sample of nine meals was thus obtained. If the stomach and colon from the same animal do not always represent two separate meals, an unknown amount of bias might be involved.

Due to these biases the figures for percent volume and frequency should be regarded as reasonable approximations, rather than precise measurements of actual diets.

The diet of an animal may change from year

to year. Environmental and climatic conditions or long-term biological cycles of foods may affect food availability from one year to the next, and an animal's diet may undergo a corresponding change. Long-term studies are needed to gain a fuller understanding of diet and to clarify the possible correlations of food utilization with food availability, food preference, and habitat type.

## RESULTS

Monthly and seasonal trends of all food items encountered in this study are presented in tables 2 to 6 (1975 monthly scat data), 7 to 11 (1975 monthly digestive tract data), 12 to 14 (1975 seasonal scat data), 15 to 16 (1975 seasonal digestive tract data), 17 to 18 (January 1976, scat data), 19 (January 1976, digestive tract data), and 20 (1975 summer scat data).

The relative importance of any food item in the diet is represented by the percentage of the total volume of food made up by that kind of food and by the frequency of occurrence of that food among scats or digestive tracts studied. A very important food would have high values for both figures. Interpretation of the percent volume and frequency is improved if consideration also can be given to food availability, food preference, and individual learning. However, these are difficult to measure and express quantitatively. In this study, the degree to which these factors influence the diet can only be estimated. Throughout the section, usage of the words important or importance, when referring to various food items, denotes relatively high values for measurements of percent volume and/or percent frequency of occurrence, with only cursory consideration of influencing factors. Influencing factors are considered under Discussion.

If a food item was found as a trace in all samples, the percent volume was listed as trace (Tr.) in the tables. In several cases, the sum of the percent volumes of all animal material and all plant material was not 100 percent but was several tenths of a percent from 100, as a result of rounding values for individual food items to the nearest tenth of a percent.

Animal foods increased in importance (from about 60 to 94 percent of volume, see tables 12 and 13) from winter through spring in 1975. Correspondingly, the importance of plant foods decreased as the seasons progressed. When the inland and marsh scats were considered as separate samples, food trends followed the same pattern. In the marsh, animal foods changed from 59.3 percent of the marsh food volume in the winter to 93.4 percent in the spring. Animal foods in the inland scats changed from 62.3 percent of the inland food volume in the winter to 99.2 percent.

Animal foods consisted almost entirely of invertebrates; vertebrate foods were insignificant in terms of percentage of the total diet (table 14). As a group, crustaceans were the most important overall food, increasing in importance from 52.8 percent of the volume in the winter diet to 86.0 percent in the spring. Crustaceans were eaten in both habitats, but were especially important in the tidal marsh where crabs were readily available. Fiddler crabs (*Uca* spp.) were the most important food item in all the months except in January; (tables 2 to 6). Other types of crabs, including *Panopeus* spp., *Eurytium* spp., and unknown crabs, were also important. Mollusks (*Melampus* spp. and ribbed mussels) comprised 3.2 percent of the winter diet and only 1.5 percent of the spring diet; during the winter, mollusks occurred only in the marsh diet, whereas the spring diets of both habitats included mollusks (table 14). As a group, insects (2.0% of the winter diet) increased in importance during the spring (to 5.3%). Insects were more important in the inland diet than in the marsh diet. Vertebrate foods were taken infrequently and in small quantities: included were fish, snakes, birds, and unknown vertebrates (tables 12 and 13). More vertebrates were eaten during the winter (0.8%) than in the spring (0.3%; table 14).

Unknown insects, beetles, crayfish, centipedes, and grasshoppers were all found in small quantities and were more typical of the inland diet than of the marsh diet (tables 12 and 13). Ten animal foods were found in the winter inland scats (table 12). Thirteen animal foods were found in the spring inland scats (table 13). Fiddler crabs, *Eurytium* spp. (a type of mud

crab), *Melampus* spp., squareback crabs (*Sesarma* spp.), and fish were of more importance in the marsh diet than in the inland diet (tables 12 and 13). Fourteen animal foods were found in the winter marsh scats (table 12). Fourteen types of animal food were found in the spring marsh scats (table 13). In terms of percent of volume, *Panopeus* spp. was of about equal importance in both habitats during both seasons, but was taken more frequently in the marsh (tables 12 and 13). Vertebrate foods, except for fish, did not show any definite tendency to be more prevalent in one habitat.

Scat analysis revealed cordgrass to be the most important plant food in 1975. It was found almost exclusively in marsh samples from January through March (tables 2 to 4). Other plant materials were present in lesser quantities but served as significant winter food sources; included were fruits of mistletoe (*Phoradendron* sp.), yaupon (*Ilex vomitoria*), and Carolina laurelcherries (*Prunus caroliniana*) (table 12). Five plant foods were found in the winter inland scats and seven plant foods were found in the winter marsh scats (table 12). Cordgrass and yaupon berries were more typical of the marsh diet than of the inland diet; other plant foods did not show any clear tendency to be more prevalent in one habitat. In the spring (table 13), plant foods were not significant in the inland diet where unknown vegetation and cordgrass were the only plant foods found; and, cordgrass was of limited importance in the marsh diet. Five plant foods were found in the spring marsh scats. Raspberries (*Rubus* sp.) were found in late May (table 6) and were used later in the year more heavily.

Data from digestive tracts in 1975 (tables 15

TABLE 2
**Foods Eaten by Racoons on St. Catherines Island, Georgia in January 1975[a]**

| Food Item | Combined | | Marsh | | Inland | |
|---|---|---|---|---|---|---|
| | Vol. | Freq. | Vol. | Freq. | Vol. | Freq. |
| Fiddler Crabs | 24.6 | 47.2 | 25.8 | 46.6 | — | — |
| *Panopeus* spp. | 8.4 | 16.7 | 8.8 | 17.1 | — | — |
| *Eurytium* spp. | 3.5 | 11.1 | 3.6 | 11.4 | — | — |
| Isopods | 1.3 | 2.8 | 1.4 | 2.9 | — | — |
| Unknown Crabs | 1.1 | 5.6 | 0.1 | 2.9 | 23.9 | 100.0 |
| Unknown Birds | 1.0 | 2.8 | — | — | 22.4 | 100.0 |
| Squareback Crabs | 0.8 | 5.6 | 0.8 | 5.7 | — | — |
| Fish | 0.8 | 2.8 | 0.9 | 2.9 | — | — |
| Ribbed Mussels | 0.7 | 8.3 | 0.8 | 8.6 | — | — |
| Unknown Insects | 0.5 | 8.3 | 0.5 | 8.6 | — | — |
| Cockroaches | 0.2 | 2.8 | 0.2 | 2.9 | — | — |
| Millipedes | 0.1 | 2.8 | 0.1 | 2.9 | — | — |
| Beetles | Tr. | 2.8 | Tr. | 2.9 | — | — |
| Total Animal Material | 43.0 | 75.7 | 43.0 | 75.0 | 46.3 | 100.0 |
| Cordgrass | 42.3 | 61.1 | 44.3 | 62.9 | — | — |
| Yaupon Berries | 6.1 | 11.1 | 6.4 | 11.4 | — | — |
| Mistletoe Berries | 3.1 | 8.3 | 3.3 | 8.6 | — | — |
| Laurelcherries | 2.9 | 5.6 | 0.5 | 2.9 | 53.7 | 100.0 |
| Unknown Vegetation | 2.4 | 2.8 | 2.5 | 2.9 | — | — |
| Acorns | 0.1 | 2.8 | 0.1 | 2.9 | — | — |
| Cabbage Palm Berries | Tr. | 2.8 | Tr. | 2.9 | — | — |
| Total Plant Material | 56.9 | 78.4 | 57.1 | 80.6 | 53.7 | 100.0 |

[a]As represented in 36 scats, 35 from marsh and 1 from inland. Volumes and frequencies are given as percent total volume and number of scats, respectively.

TABLE 3
**Foods Eaten in February 1975**[a]

| Food Item | Combined | | Marsh | | Inland | |
|---|---|---|---|---|---|---|
| | Vol. | Freq. | Vol. | Freq. | Vol. | Freq. |
| Fiddler Crabs | 46.8 | 58.1 | 49.3 | 62.4 | 22.7 | 12.5 |
| *Panopeus* spp. | 8.5 | 16.1 | 8.6 | 16.5 | 7.6 | 12.5 |
| *Melampus* spp. | 2.5 | 3.2 | 2.7 | 3.5 | — | — |
| Unknown Insects | 1.8 | 5.4 | Tr. | 1.2 | 19.3 | 50.0 |
| Unknown Crabs | 1.6 | 6.5 | 1.7 | 7.1 | — | — |
| Ribbed Mussels | 1.5 | 16.1 | 1.7 | 16.5 | Tr. | 12.5 |
| Raccoon Hair | 0.7 | 6.5 | Tr. | 3.5 | 6.9 | 37.5 |
| Beetles | 0.5 | 6.5 | Tr. | 2.4 | 5.0 | 50.0 |
| Fish | 0.5 | 3.2 | 0.6 | 2.4 | Tr. | 12.5 |
| *Eurytium* spp. | 0.3 | 5.4 | 0.3 | 5.9 | — | — |
| Centipedes | 0.2 | 1.1 | — | — | 2.2 | 12.5 |
| Grasshoppers | 0.1 | 1.1 | — | — | 1.3 | 12.5 |
| Unknown Mollusks | Tr. | 1.1 | Tr. | 1.2 | — | — |
| Total Animal Material | 65.0 | 78.9 | 64.9 | 79.1 | 65.0 | 75.0 |
| Cordgrass | 25.9 | 62.4 | 28.6 | 67.1 | Tr. | 12.5 |
| Mistletoe Berries | 5.1 | 6.5 | 4.7 | 5.9 | 9.3 | 12.5 |
| Laurelcherries | 3.5 | 4.3 | 1.4 | 3.5 | 24.5 | 12.5 |
| Yaupon Berries | 0.3 | 1.1 | 0.3 | 1.2 | — | — |
| Unknown Vegetation | 0.2 | 4.3 | 0.1 | 3.5 | 0.6 | 12.5 |
| Greenbrier Berries | 0.1 | 1.1 | — | — | 0.6 | 12.5 |
| Total Plant Material | 35.1 | 74.5 | 35.1 | 74.4 | 35.0 | 75.0 |

[a]As represented in 93 scats, 85 from marsh and 8 from inland.

and 16) provide additional information on inland foods. During the winter, 10 animal foods were found. The value for waterfowl was inflated due to a large quantity found in a single digestive tract. *Panopeus* spp., unknown insects, and grasshoppers were the most significant animal foods. Centipedes and millipedes, although taken in small amounts, were important food sources because they were taken frequently. In the winter, five plant foods were found inland. The value for greenbrier berries (*Smilax* spp.) was inflated due to a large quantity found in a single digestive tract. No plant food, except unknown vegetation, occurred in more than two samples. Overall, 56.2 percent of the total winter inland diet consisted of animal material and 43.7 percent of plant material (table 15). In the spring, the digestive tracts contained 87.3 percent animal material and 12.7 percent plant material by volume (table 16). Eight animal foods and two plant foods were found. Fiddler crabs, unknown insects, and beetles were the most significant animal foods. Plant foods were not important.

In January 1976, (table 17) fiddler crabs and acorns dominated the diet. The apparent increase in acorns in 1976 was due to the fact that the mast crop of the previous autumn was very good, whereas the 1974 crop (available in early 1975) was extremely poor. Ten animal foods and four plant foods were found in inland scats. Eleven animal foods were found in the marsh scats. The relative importance of major animal foods in January 1976 is summarized in table 18. Crustaceans ranked as the most important animal food category with approximately equal volumetric utilization in both habitats. Fiddler crab was the most important crustacean food, and in contrast to the winter of 1975 (table 12) *Eurytium* spp. had a greater percent volume than *Panopeus* spp. (table 17). Fish were the only vertebrate food and most fish

TABLE 4
**Foods Eaten in March 1975[a]**

| Food Item | Combined | | Marsh | | Inland | |
|---|---|---|---|---|---|---|
| | Vol. | Freq. | Vol. | Freq. | Vol. | Freq. |
| Fiddler Crabs | 60.0 | 64.2 | 63.6 | 71.2 | — | — |
| *Panopeus* spp. | 11.2 | 23.5 | 10.6 | 24.7 | 22.2 | 12.5 |
| *Melampus* spp. | 3.8 | 2.5 | 4.0 | 2.7 | — | — |
| Unknown Crabs | 3.2 | 4.9 | 3.4 | 5.5 | — | — |
| Unknown Insects | 2.1 | 8.6 | Tr. | 2.7 | 37.0 | 62.5 |
| Beetles | 1.7 | 3.7 | Tr. | 1.4 | 29.3 | 25.0 |
| Squareback Crabs | 0.5 | 6.2 | 0.5 | 6.8 | — | — |
| Unknown Invertebrates | 0.5 | 1.2 | — | — | 9.3 | 12.5 |
| *Eurytium* spp. | 0.4 | 13.6 | 0.4 | 15.1 | — | — |
| Ribbed Mussels | 0.1 | 11.1 | 0.1 | 12.3 | — | — |
| Beetles | 0.1 | 4.9 | — | — | 2.2 | 50.0 |
| Raccoon Hair | 0.1 | 3.7 | 0.1 | 2.7 | Tr. | 12.5 |
| Fish | 0.1 | 2.5 | 0.1 | 2.7 | — | — |
| Millipedes | Tr. | 1.2 | — | — | Tr. | 12.5 |
| Unknown Birds | Tr. | 1.2 | Tr. | 1.4 | — | — |
| Total Animal Material | 83.8 | 91.4 | 82.8 | 90.4 | 100.0 | 100.0 |
| Cordgrass | 14.7 | 46.9 | 15.6 | 52.1 | — | — |
| Midtletoe Berries | 1.4 | 2.5 | 1.4 | 2.7 | — | — |
| Unknown Vegetation | 0.1 | 4.9 | 0.1 | 5.5 | — | — |
| Greenbrier Berries | Tr. | 1.2 | Tr. | 1.4 | — | — |
| Total Plant Material | 16.2 | 53.1 | 17.1 | 58.9 | 0.0 | 0.0 |

[a]As represented in 81 scats, 73 from marsh and 8 from inland.

were eaten in the marsh. Fish were used as a winter food more in 1976 than in 1975. Insects made up a higher percentage of the inland diet than of the marsh diet. Mollusks and other invertebrates were relatively insignificant animal foods. Six plant foods were eaten in the marsh. The importance of cordgrass as a winter food in 1976 was considerably less than in 1975. Considering all samples as a single group, animal materials made up 53.3 percent of the total diet and plants, 46.6 percent. No additional foods were found in the analysis of one stomach and three colon samples (table 19).

## DISCUSSION

Previous studies may be compared in a general way with this one, but the wide range of sample sizes and analytical methods involved must be considered. Most previous studies are of habitats quite unlike those on St. Catherines Island, e.g., freshwater marshes, wooded bottomlands, and agricultural areas. Many studies are from more northern latitudes, where the winters are longer and more severe than those of coastal Georgia.

Previous studies have shown that the raccoon's diet is basically omnivorous and that they are highly adaptable with respect to diet. Local food habits are diverse and dependent on the types of foods available. In some reports, plant foods comprise most of the diet in all seasons (Wood, 1954; Stains, 1956) and in other reports diets are predominantly carnivorous (Tyson, 1950; Fleming, Palmisano, and Joanen, 1978). Generally, animal materials are most important during late winter and early spring when plant foods are scarce (Stuewer, 1943; Llewellyn and Uhler, 1952; Kellner,

1954, Johnson, 1970). In many regions, this is the time of year when the acorn crop, the winter staple, is depleted (Johnson, 1970). Apparently, late winter and early spring represent a period of hard times for raccoons as they are compelled to use any remaining, and frequently less preferred, foods.

Data from St. Catherines Island are consistent with these general patterns. In 1975 the amount of animal food taken and the frequency of its use increased (as noted above) appreciably from winter into spring. Field observations noted decreased availability of native fruits (e.g., mistletoe, laurelcherry, and yaupon) in the late winter and spring. However, availability of the primary winter plant food, cordgrass, did not noticeably change. In southern coastal marshes, cordgrass grows to some extent throughout the year, e.g., in Georgia, grass of the previous warm season covers new growth which begins in the winter (Teal and Teal, 1969). The decreased use of cordgrass during the spring probably reflects an increased availability of, and a higher preference for, insects and marsh crustaceans. This speculation is based on field observations and the assumption that an increasing percentage of volume correlated with an increasing frequency indicates that a food is being used in relation to its availability. The data suggests that cordgrass is a less preferred food.

Fleming, Palmisano, and Joanen (1978) reported that stems and tubers of hogcane (*Spartina cynosuroides*) were important fall foods in a brackish Louisiana coastal marsh. In eastern Iowa, Giles (1940) found grass to be an important dietary item in the spring; he believed that it was not consumed exclusively for nourishment, but as a tonic food or roughage as well. Hamilton (1936) reported miscellaneous green grasses in the winter diet of New York raccoons and suggested that they served as "tonics."

In February 1975, a stomach sample was found to contain stems of cordgrass. During the same month, a raccoon was observed foraging

TABLE 5
**Foods Eaten in April 1975**[a]

| Food Item | Combined | | Marsh | | Inland | |
|---|---|---|---|---|---|---|
| | Vol. | Freq. | Vol. | Freq. | Vol. | Freq. |
| Fiddler Crabs | 87.3 | 89.7 | 92.6 | 97.4 | 54.4 | 57.9 |
| Beetles | 3.6 | 11.3 | — | — | 25.8 | 57.9 |
| *Eurytium* spp. | 3.2 | 17.5 | 3.7 | 21.8 | — | — |
| Ribbed Mussels | 1.1 | 8.2 | 0.1 | 6.4 | 7.2 | 15.8 |
| Unknown Insects | 0.7 | 5.2 | Tr. | 1.3 | 4.8 | 21.1 |
| *Panopeus* spp. | 0.8 | 3.1 | 0.8 | 2.6 | 0.7 | 5.3 |
| Raccoon Hair | 0.5 | 8.2 | 0.1 | 3.8 | 2.8 | 26.3 |
| Unknown Snakes | 0.2 | 1.0 | — | — | 1.3 | 5.3 |
| Unknown Crabs | 0.1 | 7.2 | Tr. | 5.1 | 0.9 | 15.8 |
| Fish | 0.1 | 2.1 | 0.1 | 1.3 | Tr. | 5.3 |
| Centipedes | Tr. | 6.2 | — | — | Tr. | 31.6 |
| Grasshoppers | Tr. | 2.1 | — | — | 0.1 | 10.5 |
| *Melampus* spp. | Tr. | 1.0 | Tr. | 1.3 | — | — |
| Unknown Crayfish | Tr. | 1.0 | — | — | 0.1 | 5.3 |
| Total Animal Material | 97.6 | 97.9 | 97.4 | 97.4 | 98.1 | 100.0 |
| Cordgrass | 2.2 | 9.3 | 2.5 | 10.3 | Tr. | 5.3 |
| Unknown Vegetation | 0.3 | 13.4 | Tr. | 11.5 | 1.8 | 21.1 |
| Total Plant Material | 2.5 | 22.7 | 2.5 | 21.8 | 1.8 | 26.3 |

[a]As represented by 97 scats, 78 from marsh and 19 from island.

TABLE 6
**Foods Eaten in May 1975[a]**

| Food Item | Combined | | Marsh | | Inland | |
|---|---|---|---|---|---|---|
| | Vol. | Freq. | Vol. | Freq. | Vol. | Freq. |
| Fiddler Crabs | 83.0 | 87.6 | 89.4 | 94.9 | 23.5 | 35.7 |
| Beetles | 6.8 | 10.6 | 0.9 | 4.0 | 62.0 | 57.1 |
| *Eurytium* spp. | 2.0 | 9.7 | 2.2 | 11.1 | — | — |
| *Panopeus* spp. | 2.3 | 8.8 | 2.6 | 10.1 | — | — |
| Unknown Crabs | 2.2 | 5.3 | 2.4 | 4.0 | Tr. | 14.3 |
| Raccoon Hair | 0.9 | 10.6 | 0.6 | 8.1 | 4.4 | 28.6 |
| Unknown Insects | 0.7 | 6.2 | Tr. | 3.0 | 6.9 | 28.6 |
| Unknown Birds | 0.3 | 0.9 | 0.4 | 1.0 | — | — |
| Unknown Crayfish | 0.2 | 0.9 | — | — | 2.0 | 7.1 |
| Centipedes | 0.1 | 3.5 | Tr. | 1.0 | 1.1 | 21.4 |
| Ribbed Mussels | Tr. | 0.9 | Tr. | 1.0 | — | — |
| Bird Eggs | Tr. | 0.9 | Tr. | 1.0 | — | — |
| Squareback Crabs | Tr. | 0.9 | Tr. | 1.0 | — | — |
| Unknown Vertebrates | Tr. | 0.9 | Tr. | 1.0 | — | — |
| Total Animal Material | 98.5 | 98.2 | 98.5 | 98.0 | 99.9 | 100.0 |
| Raspberries | 1.3 | 2.0 | 1.4 | 2.0 | — | — |
| Unknown Vegetation | 0.1 | 4.4 | 0.2 | 5.1 | — | — |
| Total Plant Material | 1.4 | 6.1 | 1.6 | 7.0 | 0.0 | 0.0 |

[a]As represented by 113 scats, 99 from marsh and 14 from inland.

along the bank of a small tidal creek and eating cordgrass. Highly vigorous stands of cordgrass grow along the banks of tidal creeks (Somes and Ashbaugh, 1973). In scat samples, the part of the plant consumed could not be determined; however, the stems are the most succulent parts and were probably consumed in many, if not most, cases.

The role of cordgrass as a dietary item on St. Catherines is unclear. The heavy use of cordgrass in the winter of 1975 (table 12) contrasts markedly with its low use in January, 1976 (table 17). This may be due, in part, to the poor acorn crop produced in 1974. Perhaps cordgrass is utilized as is hogcane in Louisiana tidal marshes (Fleming, Palmisano, and Joanen, 1978), i.e., as a frequently used fall food. When the mast crop is substantial, acorns may be used heavily during the fall and early winter. However, when the mast crop is poor, cordgrass may continue to be a significant food into the winter.

Cordgrass was only found in small quantities in inland scats and digestive tracts during the winter (tables 12 and 15). Cordgrass is restricted to tidal marshes. Inclusion of cordgrass in inland samples suggests that raccoons forage in both habitats.

In addition to low-water cordgrass (*Spartina alterniflora*), there occurs on St. Catherines another species, *S. patens* (high-water cordgrass or salt hay) (Somes and Ashbaugh, 1973). Salt hay is found mainly in southern and eastern marshes near the upper limit of tidal action and also, to some extent, on beaches and low dunes. Methods used in this study did not distinguish between low-water cordgrass and salt hay in the samples.

Acorns were readily available and the most important food in January, 1976 (table 17). At this time most of the available, suitable acorns (those on the ground and not damaged by insects) were of the laurel oak. The importance of acorns in the raccoon's diet has been well-documented (Stuewer, 1943; Baker et al., 1945; Yeager and Elder, 1945; Schoonover and Mar-

shall, 1951; Wood, 1954; Stains, 1956; Johnson, 1970). In years when the mast crops are poor, food trends are known to adjust as raccoons use available but less preferred foods (Stuewer, 1943; Wood, 1954). This occurred on St. Catherines Island in the winter of 1975.

In terms of nutrition, acorns aid raccoons in getting into physical shape to withstand the cold winter months (Hamilton, 1936; Llewellyn and Uhler, 1952). During the winter of 1975 when acorns were unavailable, many raccoons were in poor physical condition. In January, three sick raccoons were observed, two of which were handled. In February, two sick raccoons were collected, and two animals died overnight in live-traps, apparently in connection with their weakened physical condition. In March, one sick animal was collected. The symptoms of these animals were those of distemper which is known to occur in raccoons (Menges, Habermann, and Stains, 1955). From January through May 1975, the remains of 32 raccoons that had died in late winter and early spring were collected. Many of the animals handled in 1975 had only small amounts of subcutaneous fat tissue. In comparison, animals handled on the 10-day visit in January 1976, showed no signs of undernourishment.

The exact nutritional values of acorns and cordgrass were not determined. However, considering an equal volume of each, cordgrass is

TABLE 7
**Foods Eaten in January 1975**[a]

| Food Item | Stomachs Per. Vol. | Stomachs Per. Freq. | Colons Per. Vol. | Colons Per. Freq. |
|---|---|---|---|---|
| *Panopeus* spp. | Tr. | 25.0 | 9.4 | 20.0 |
| Fiddler Crabs | — | — | 6.4 | 40.0 |
| Unknown Vertebrates | — | — | 1.3 | 20.0 |
| Unknown Insects | 2.1 | 25.0 | Tr. | 20.0 |
| Grasshoppers | 2.1 | 25.0 | Tr. | 20.0 |
| Beetles | Tr. | 25.0 | — | — |
| Centipedes | Tr. | 25.0 | Tr. | 20.0 |
| Total Animal Material | 4.2 | 75.0 | 17.1 | 60.0 |
| Cordgrass | 42.8 | 50.0 | 55.3 | 40.0 |
| Yaupon Berries | 52.8 | 25.0 | 27.6 | 40.0 |
| Unknown Vegetation | Tr. | 25.0 | Tr. | 40.0 |
| Total Plant Material | 95.6 | 100.0 | 82.9 | 100.0 |

[a]As represented by samples from stomachs and five colons.

TABLE 8
**Foods Eaten in February 1975**[a]

| Food Item | Stomachs Per. Vol. | Stomachs Per. Freq. | Colons Per. Vol. | Colons Per. Freq. |
|---|---|---|---|---|
| Waterfowl | 62.9 | 33.3 | 9.6 | 14.3 |
| *Panopeus* spp. | 2.1 | 33.3 | 28.1 | 28.6 |
| Unknown Insects | — | — | 15.0 | 57.1 |
| Fiddler Crabs | — | — | 13.7 | 14.3 |
| Grasshoppers | — | — | 4.3 | 28.6 |
| Millipedes | Tr. | 33.3 | 1.4 | 28.6 |
| Unknown Lizards | — | — | 0.6 | 14.3 |
| Centipedes | 1.4 | 33.3 | Tr. | 14.3 |
| Beetles | — | — | Tr. | 14.3 |
| Unknown Birds | — | — | Tr. | 14.3 |
| Total Animal Material | 66.4 | 100.0 | 72.7 | 100.0 |
| Greenbrier Berries | 21.0 | 33.3 | 23.7 | 14.3 |
| Unknown Vegetation | 9.1 | 33.3 | 2.2 | 42.8 |
| Laurelcherries | 3.5 | 33.3 | 1.4 | 14.3 |
| Total Plant Material | 33.6 | 100.0 | 27.3 | 57.0 |

[a]As represented by three stomachs and seven colons.

TABLE 9
**Foods Eaten in March 1975**[a]

| Food Item | Percent Volume | Percent Frequency |
|---|---|---|
| Unknown Insects | 43.7 | 60.0 |
| Fiddler Crabs | 31.0 | 20.0 |
| Grasshoppers | 7.0 | 40.0 |
| Centipedes | Tr. | 40.0 |
| Beetles | Tr. | 40.0 |
| Raccoon Hair | Tr. | 20.0 |
| Total Animal Material | 81.7 | 80.0 |
| Unknown Vegetation | 12.7 | 60.0 |
| Cabbage Palm Berries | 5.6 | 20.0 |
| Total Plant Material | 18.3 | 60.0 |

[a]As represented by five colons.

TABLE 10
**Foods Eaten in April 1975[a]**

| Food Item | Percent Volume | Percent Frequency |
|---|---|---|
| Fiddler Crabs | 56.2 | 33.0 |
| Unknown Insects | 14.1 | 33.0 |
| Unknown Animals | 10.9 | 33.0 |
| Raccoon Hair | 7.8 | 33.0 |
| Grasshoppers | Tr. | 33.0 |
| Millipedes | Tr. | 33.0 |
| Centipedes | Tr. | 33.0 |
| Unknown Snails | Tr. | 33.0 |
| Total Animal Material | 89.0 | 100.0 |
| Unknown Vegetation | 10.9 | 100.0 |
| Total Plant Material | 10.9 | 100.0 |

[a]As represented in three colon samples.

of less nutritional value due to the large, non-digestible cellulose component. Acorns may represent a major carbohydrate source which aids in building subcutaneous fat that is necessary for maintaining good health during the winter. The overwintering success of the dense raccoon population on St. Catherines Island appears to be influenced by the amount of acorns produced by laurel and live oaks.

Comparison of acorn use between the marsh and the inland is only possible in the January 1976 scats. Acorns were abundantly available, and use was roughly equivalent in both samples (table 17). Oak trees are common along the edges of the marshes.

Mistletoe berries were used in winter 1975, but were less used in the spring as availability declined. In winter scats, mistletoe berries were the second most important plant food and were used in both habitats (table 12); however, they were only found in the marsh during the spring (table 13). Mistletoe plants grow in the tops of large deciduous trees located in forested inland areas and also along borders of tidal marshes. Carolina laurelcherries were found in the winter scats and digestive tracts of 1975. Based on the scats, laurelcherries were the most important winter inland plant food and ranked third in the marsh (table 12); they were also found in the winter inland digestive tracts (table 15). The large seed size tends to inflate percentage of volume figures. Neither mistletoe berries nor laurelcherries were found in the 1976 samples, and no speculation regarding preference is made.

Yaupon berries are a winter food of some importance. Wood (1954) found yaupon and deciduous holly berries to be used in a Texas upland post oak forest. The increased use of yaupon in January 1976 (table 17), as compared to winter, 1975 (table 12), was due to more abundant berries in 1976. The availability of yaupon decreases in the spring. Data from scats and digestive tracts (tables 12, 15, and 17) suggest that yaupon berries are more important in the marsh than in the inland diet. Yaupon trees grow abundantly on higher ground bordering the marshes, and thus are more available in the marsh.

Fruit of the cabbage palm is primarily a fall food. The appearance of cabbage palm in the January diet (tables 2 and 17) suggests that limited use occurs into the early winter. In January of both 1975 and 1976, the available berries had decomposed and only the seed and tough external skin remained. Numerous old scats, representative of the fall diet, were observed, consisting entirely of cabbage palm seeds. This food was found in both marsh and inland samples.

TABLE 11
**Foods Eaten in May 1975[a]**

| Food Item | Stomachs | | Colons | |
|---|---|---|---|---|
| | Per. Vol. | Per. Freq. | Per. Vol. | Per. Freq. |
| Unknown Insects | — | — | 46.7 | 100.0 |
| Beetles | 64.3 | 100.0 | — | — |
| Unknown Mollusks | — | — | 46.7 | 33.0 |
| Raccoon Hair | 35.7 | 100.0 | 6.6 | 33.3 |
| Millipedes | Tr. | 100.0 | Tr. | 33.3 |
| Fiddler Crabs | — | — | Tr. | 33.3 |
| Unknown Vertebrates | — | — | Tr. | 33.3 |
| Total Animal Material | 100.0 | 100.0 | 100.0 | 100.0 |
| Total Plant Material | 0.0 | 0.0 | 0.0 | 0.0 |

[a]As represented by one stomach and three colons.

Greenbrier berries were found in the February and March scats of 1975 (tables 3 and 4) and also in the winter digestive tracts (table 15). Berries were found in both inland and marsh samples. In terms of the overall diet, greenbrier berries are of limited significance. Previous studies have demonstrated that greenbrier is a low preference food, used only during winter and early spring, i.e., during times of food scarcity (Johnson, 1970; Llewellyn and Uhler, 1952; Yeager and Elder, 1945; Yeager and Rennels, 1943). The same situation probably exists on St. Catherines Island; however, greenbrier availability was limited during the winter of 1975, and the situation is unclear.

Unknown vegetation was found regularly in small amounts in all months. This item was probably, in many instances, merely bits of debris taken incidentally as other foods were ingested. However, Johnson (1970) examined raccoons in Alabama during the late winter and frequently found either empty stomachs or stomachs filled with decayed wood, moss, or unidentifiable material. Presumedly, in the absence of suitable foods, raccoons resorted to eating items of little nutritional value. The ex-

TABLE 12
**Foods Eaten in January and February 1975[a]**

| Food Item | Combined | | Marsh | | Inland | |
|---|---|---|---|---|---|---|
| | Vol. | Freq. | Vol. | Freq. | Vol. | Freq. |
| Fiddler Crabs | 41.6 | 55.0 | 43.6 | 58.3 | 19.8 | 11.1 |
| *Panopeus* spp. | 8.5 | 16.3 | 8.6 | 16.7 | 6.6 | 11.1 |
| *Melampus* spp. | 1.9 | 2.3 | 2.0 | 2.5 | — | — |
| Unknown Insects | 1.5 | 6.2 | 0.1 | 3.3 | 16.8 | 44.4 |
| Unknown Crabs | 1.5 | 6.2 | 1.3 | 5.8 | 3.0 | 11.1 |
| Ribbed Mussels | 1.3 | 14.0 | 1.5 | 14.2 | Tr. | 11.1 |
| *Eurytium* spp. | 1.0 | 7.0 | 1.1 | 7.5 | — | — |
| Unknown Fish | 0.6 | 3.1 | 0.6 | 2.5 | Tr. | 11.1 |
| Raccoon Hair | 0.5 | 4.7 | Tr. | 2.5 | 6.0 | 33.3 |
| Beetles | 0.4 | 5.4 | Tr. | 2.5 | 4.3 | 44.4 |
| Isopods | 0.3 | 0.8 | 0.3 | 0.8 | — | — |
| Squareback Crabs | 0.2 | 1.6 | 0.2 | 1.7 | — | — |
| Unknown Birds | 0.2 | 0.8 | — | — | 2.8 | 11.1 |
| Centipedes | 0.2 | 0.8 | — | — | 1.9 | 11.1 |
| Grasshoppers | 0.1 | 0.8 | — | — | 1.1 | 11.1 |
| Millipedes | Tr. | 0.8 | Tr. | 0.8 | — | — |
| Cockroaches | Tr. | 0.8 | Tr. | 0.8 | — | — |
| Unknown Mollusks | Tr. | 0.8 | Tr. | 0.8 | — | — |
| Total Animal Material | 59.8 | 77.9 | 59.3 | 77.9 | 62.3 | 77.8 |
| Cordgrass | 29.8 | 62.0 | 32.4 | 65.8 | Tr. | 11.1 |
| Mistletoe Berries | 4.6 | 7.0 | 4.3 | 6.7 | 8.1 | 11.1 |
| Laurelcherries | 3.4 | 4.7 | 1.2 | 3.3 | 28.2 | 22.2 |
| Yaupon Berries | 1.7 | 3.9 | 1.8 | 4.2 | — | — |
| Unknown Vegetation | 0.7 | 3.9 | 0.7 | 3.3 | 0.6 | 11.1 |
| Cabbage Palm Berries | Tr. | 0.8 | Tr. | 0.8 | — | — |
| Acorns | Tr. | 0.8 | Tr. | 0.8 | — | — |
| Greenbrier Berries | Tr. | 0.8 | — | — | 0.6 | 11.1 |
| Total Plant Material | 40.2 | 76.3 | 40.4 | 76.2 | 37.5 | 77.8 |

[a]As represented by 129 scats, 120 from marsh and nine from inland.

TABLE 13
**Foods Eaten in spring 1975, March through May[a]**

| Food Item | Combined | | Marsh | | Inland | |
|---|---|---|---|---|---|---|
| | Vol. | Freq. | Vol. | Freq. | Vol. | Freq. |
| Fiddler Crabs | 77.7 | 81.8 | 82.5 | 88.8 | 34.4 | 39.0 |
| *Panopeus* spp. | 4.4 | 11.0 | 4.5 | 12.0 | 4.1 | 4.9 |
| Beetles | 4.2 | 8.9 | 0.3 | 2.0 | 390 | 51.2 |
| *Eurytium* spp. | 1.9 | 13.4 | 2.2 | 15.6 | — | — |
| Unknown Crabs | 1.8 | 5.8 | 1.9 | 4.8 | 0.4 | 12.2 |
| Unknown Insects | 1.1 | 6.5 | Tr. | 2.4 | 11.1 | 31.7 |
| *Melampus* spp. | 1.1 | 1.0 | 1.2 | 1.2 | — | — |
| Raccoon Hair | 0.5 | 7.9 | 0.3 | 5.2 | 2.8 | 24.4 |
| Ribbed Mussels | 0.4 | 6.2 | 0.1 | 6.0 | 3.5 | 7.3 |
| Unknown Invertebrates | 0.2 | 0.3 | — | — | 1.6 | 2.4 |
| Centipedes | 0.1 | 4.8 | Tr. | 0.4 | 0.8 | 31.7 |
| Squareback Crabs | 0.1 | 2.1 | 0.2 | 2.4 | — | — |
| Unknown Fish | 0.1 | 1.4 | 0.1 | 1.2 | Tr. | 2.4 |
| Unknown Crayfish | 0.1 | 0.7 | — | — | 0.8 | 4.9 |
| Unknown Birds | 0.1 | 0.7 | 0.1 | 0.8 | — | — |
| Unknown Snakes | 0.1 | 0.3 | — | — | 0.6 | 2.4 |
| Grasshoppers | Tr. | 0.7 | — | — | 0.1 | 4.9 |
| Unknown Vertebrates | Tr. | 0.3 | Tr. | 0.4 | — | — |
| Bird Eggs | Tr. | 0.3 | Tr. | 0.4 | — | — |
| Millipedes | Tr. | 0.3 | — | — | Tr. | 2.4 |
| Total Animal Material | 93.9 | 96.2 | 93.4 | 95.6 | 99.2 | 100.0 |
| Cordgrass | 5.1 | 16.2 | 5.7 | 18.4 | Tr. | 2.4 |
| Mistletoe Berries | 0.4 | 0.7 | 0.4 | 0.8 | — | — |
| Unknown Vegetation | 0.2 | 7.6 | 0.1 | 7.2 | 0.9 | 9.8 |
| Raspberries | 0.4 | 0.7 | 0.5 | 0.8 | — | — |
| Greenbrier Berries | Tr. | 0.3 | Tr. | 0.4 | — | — |
| Total Plant Material | 6.1 | 24.6 | 6.7 | 26.7 | 0.9 | 12.2 |

[a]As represented by 291 scats, 250 from marsh and 41 from inland.

tent to which this occurs on St. Catherines could not be determined. Comparing the winter and spring scats of 1975 (tables 12 and 13), the winter percent volume for unknown vegetation is larger than in the spring; however, the winter percent frequency is smaller than in the spring. These seasonal differences are contradictory, and the season in which unknown vegetation is more important is not clear. The percent volume of unknown vegetation during January 1976, is identical with the 1975 winter figure, 0.7 percent, and the frequency is relatively high (table 17). Based solely on percent volume, unknown vegetation is more important in the winter than in the spring diet. In all scat samples, unknown vegetation was more frequently found in the inland than in the marsh (tables 12, 13, and 17). In the 1975 digestive tracts, unknown vegetation was frequently found in inland samples (tables 15 and 16). The high frequency of unknown vegetation in inland samples is probably due to more frequent incidental ingestion of such matter as raccoons forage for invertebrates in the leaf litter of the forest floor.

Two additional plant foods were found infrequently and in small quantities. Raspberries were found in May 1975, in scats (table 6). These represent early use of a summer food. Persimmons (*Diospyros virginiana*) were found in scats collected in January 1976 (table 17).

Previous studies have shown that crustaceans

are important foods in raccoon diets. In areas where only freshwater is available, crayfish are utilized primarily from the spring into fall (Giles, 1940; Yeager and Rennels, 1943; Baker et al., 1945; Schoonover and Marshall, 1951; Dorney, 1954; Stains, 1956; Geis, 1966). In coastal areas similar to St. Catherines Island, various types of crabs have been reported as food items (Fleming, Palmisano, and Joanen, 1978) and, in addition to crabs, various other marine and/or marsh-dwelling crustaceans (Tyson, 1950). Six types of crustaceans were used on St. Catherines Island. Fiddler crabs, two types of mud crabs (*Panopeus* spp. and *Eurytium* spp.), squareback crabs, and unknown crabs are available in tidal marshes and creeks, and unknown crayfish are available near inland freshwater ponds.

Fiddler crabs were the most important food during the winter and spring of 1975 (tables 12 and 13). Increased spring use probably reflects increased availability with warmer daily temperatures. In January 1976, fiddler crabs were the second most important food (table 17). Teal and Teal (1969) reported that fiddler crabs become active when burrow temperatures reached 16° C. During the coldest months of 1975 (January and February), warm afternoon temperatures on St. Catherines frequently resulted in fiddler crabs becoming active. During such times, groups of as many as six raccoons were observed foraging on mudflats, salt marshes, and along tidal creeks. *Uca pugilator* (Bosc) were collected in such areas, and this species is assumed to comprise most of the food categorized as fiddler crab. However, field observations suggest that *Uca minax*, a larger species inhabiting parts of the marsh where freshwater is more prevalent (Teal and Teal, 1969), may also be used. In this characteristic habitat, chelipeds of *Uca minax* were found in areas where raccoon tracks were abundant; raccoons might have removed the chelipeds prior to eating the crabs. Fleming, Palmisano, and Joanen (1978), Teal and Teal (1969), and Tyson (1950) have reported fiddler crab use by raccoons. In

TABLE 14
**Summary of Major Categories of Animal Foods, Expressed as Percentages of the 1975 Winter and Spring Diets**[a]

| Food Item | Combined Volume | Marsh Volume | Inland Volume |
|---|---|---|---|
| | | Winter Diet | |
| Crustaceans | 52,8 | 54.8 | 29.4 |
| Mollusks | 3.2 | 3.5 | 0.0 |
| Insects | 2.0 | 0.1 | 22.2 |
| Other Invertebrates | 0.5 | 0.3 | 1.9 |
| Vertebrates | 0.8 | 0.6 | 2.8 |
| | | Spring Diet | |
| Crustaceans | 86.0 | 91.3 | 39.7 |
| Insects | 5.3 | 0.3 | 50.2 |
| Mollusks | 1.5 | 1.3 | 3.5 |
| Other Invertebrates | 0.3 | 0.0 | 2.4 |
| Vertebrates | 0.3 | 0.2 | 0.6 |

[a]Based on 420 raccoon scats collected on St. Catherines Island, Georgia. Raccoon hair was not considered to be a food item, and the percent volumes of raccoon hair were not included in this table. Plant material comprised 40.2% of the winter diet and 6.1% of the spring diet.

TABLE 15
**Foods Eaten in Winter 1975, January and February**[a]

| Food Item | Inland Per. Vol. | Inland Per. Freq. | Marsh Per. Vol. | Marsh Per. Freq. |
|---|---|---|---|---|
| Waterfowl | 21.7 | 18.2 | — | — |
| *Panopeus* spp. | 14.4 | 27.3 | 13.2 | 25.0 |
| Unknown Insects | 13.5 | 45.5 | Tr. | 12.5 |
| Fiddler Crabs | Tr. | 9.0 | 11.9 | 25.0 |
| Grasshoppers | 4.4 | 36.4 | — | — |
| Millipedes | 1.2 | 27.3 | — | — |
| Unknown Vertebrates | — | — | 0.9 | 12.5 |
| Centipedes | 0.5 | 27.3 | — | — |
| Unknown Lizards | 0.5 | 9.0 | — | — |
| Beetles | Tr. | 9.0 | Tr. | 25.0 |
| Unknown Birds | Tr. | 9.0 | — | — |
| Total Animal Material | 56.2 | 100.0 | 26.0 | 62.5 |
| Cordgrass | Tr. | 9.0 | 48.6 | 37.5 |
| Greenbrier Berries | 27.4 | 18.2 | — | — |
| Yaupon Berries | 12.0 | 9.0 | 23.4 | 25.0 |
| Laurelcherries | 2.4 | 18.2 | — | — |
| Unknown Vegetation | 1.9 | 54.5 | 2.0 | 12.5 |
| Total Plant Material | 43.7 | 90.9 | 74.0 | 75.0 |

[a]As represented by samples from 19 digestive tracts, 11 from inland and eight from marsh.

TABLE 16
**Foods Eaten in Spring 1975, March through May**[a]

| Food Item | Inland Per. Vol. | Inland Per. Freq. | Marsh Per. Vol. | Marsh Per. Freq. |
|---|---|---|---|---|
| Fiddler Crabs | 36.9 | 18.2 | Tr. | 100.0 |
| Unknown Insects | 30.0 | 54.5 | Tr. | 100.0 |
| Raccoon Hair | 7.0 | 36.4 | — | — |
| Beetles | 5.7 | 27.3 | — | — |
| Unknown Animals | 4.5 | 9.0 | — | — |
| Grasshoppers | 3.2 | 27.3 | — | — |
| Centipedes | Tr. | 27.3 | — | — |
| Millipedes | Tr. | 27.3 | — | — |
| Unknown Snails | Tr. | 9.0 | — | — |
| Unknown other Mollusks | — | — | 100.0 | 100.0 |
| Unknown Vertebrates | — | — | Tr. | 100.0 |
| Total Animal Material | 87.3 | 90.9 | 100.0 | 100.0 |
| Unknown Vegetation | 10.2 | 54.5 | — | — |
| Cabbage Palm Berries | 2.5 | 9.0 | — | — |
| Total Plant Material | 12.7 | 54.5 | 0.0 | 0.0 |

[a]As represented by samples from 12 digestive tracts, 11 from inland and one from marsh.

contrast, Cagle (1949) found no use of abundant fiddler crabs and much use of a crayfish (*Procambarus clarkii*) in the May diet of marsh raccoons near the tip of the Mississippi Delta.

Fiddler crabs were important in both marsh and inland samples. In the scats and digestive tracts of 1975 (tables 12, 13, 15, and 16), fiddler crabs increased in importance during the spring in both habitats. The high percent volume and frequency in the inland samples suggest that individual raccoons forage in both habitats. The fiddler crab appears to be a preferred food and an important protein source.

Three other categories of crabs (*Panopeus* spp., *Eurytium* spp., and unknown crab) each made up 1 percent or more of the diet and occurred in at least 5 percent of all scats collected in the winter and spring of 1975, and in January 1976 (tables 12, 13, and 17). Mud crabs are typically abundant low in the tidal zone and move up to the edge of the marsh to forage during low tide (Teal and Teal, 1969). On St. Catherines, mud crabs are most available to raccoons along tidal creeks in oyster beds that are partially exposed during low tides. Raccoons were observed foraging in such areas. During the winter and spring, mud crabs are probably a significant protein source, especially during prolonged cold periods when fiddler crabs are less plentiful. Together, *Panopeus* spp. and *Eurytium* spp. comprised 9.5 percent of the winter diet and 6.3 percent of the spring diet in 1975, and 8.6 percent of the diet in January 1976 (tables 12, 13, and 17). Decreased spring use may result from increased use of the more readily available fiddler crab, thus reducing predation pressure on mud crabs. During 1975, *Panopeus* spp. had roughly equivalent percentages of volumes in both habitats, but was more frequent in the samples from the marsh; *Eurytium* spp. was restricted to the marsh. In 1976, *Eurytium* spp. was found in the diets of both habitats. *Panopeus* spp. was more important than *Eurytium* spp. in 1975, whereas the reverse was true in 1976. The remains of other types of crabs, that could not be identified, were found in scats during all collection periods. Blue crabs (*Callinectes sapidus*) and green crabs (*Carcinus maenas*) typically inhabit tidal creeks, but range into muddy portions of the marsh, taking refuge in the mud at low tide (Teal and Teal, 1969). There are, however, numerous other types of marine crabs that may be found occasionally in the marsh and used by raccoons; larger types may be taken frequently as carrion. Unknown crabs made up 1.5 percent, 1.8 percent, and 7.3 percent, respectively, of the 1975 winter, spring, and January 1976 scats (tables 12, 13, and 17). This item was found in both habitats.

The squareback crab is common in tidal marshes, where the purple squareback (*Sesarma reticulatum*) inhabits muddy areas near tidal streambanks and the brown squareback (*Sesarma cinereum*) inhabits landward, higher parts of the marsh (Teal and Teal, 1969). On St. Catherines Island, the squareback crab was the least used of the tidal marsh crabs, found only in the winter and spring scats of 1975 (tables 12 and 13). Use in the winter and spring was approximately equal and occurred only in the

marsh. Squareback crabs are available on warm winter days and in the spring; they are observed frequently among debris and erosion-exposed roots of trees along the high tide line. Such habitat may reduce vulnerability to raccoon predation. The low incidence of this food in the diet may also be due, in part, to the low numbers of this crab, particularly in comparison to fiddler crabs which are abundant and thus, more attractive prey. The methods did not distinguish between the two *Sesarma* species in the samples.

Crayfish remains were found in only three scats collected in the spring of 1975 near freshwater ponds. This low occurrence is due to the restricted availability of crayfish. In addition, predation pressure on this food, which is generally an important food in raccoon diets, may be reduced due to the abundance of other types of crustaceans. Also, some of the remains, classified as unknown crabs, found in inland scats may have been from crayfish.

Insects have been reported in raccoon diets from a variety of geographical regions, during all seasons. Long-term studies, such as Llewellyn and Uhler (1952) and Kinard (1964), have found that insects are eaten year-round, but particularly during the spring, summer, and fall. During the spring, insects become more abundant and may be the only natural food until fruits ripen (Johnson, 1970). Use increases steadily during the summer as insect populations increase (Hamilton, 1951). Generally, beetles are used during the spring and summer, and grasshoppers predominate in the fall. However, a diverse variety of insects has been reported in raccoon diets.

On St. Catherines Island, four categories of

TABLE 17
**Foods Eaten in January 1976**[a]

| Food Item | Combined | | Marsh | | Inland | |
|---|---|---|---|---|---|---|
| | Vol. | Freq. | Vol. | Freq. | Vol. | Freq. |
| Fiddler Crabs | 28.4 | 46.7 | 28.0 | 51.0 | 30.9 | 22.2 |
| Fish | 6.6 | 10.0 | 7.6 | 10.8 | 0.6 | 5.6 |
| *Eurytium* spp. | 7.5 | 8.3 | 7.2 | 8.8 | 9.6 | 5.6 |
| Unknown Crabs | 7.3 | 13.3 | 7.7 | 12.7 | 4.7 | 16.7 |
| Unknown Insects | 2.2 | 13.3 | 0.3 | 15.9 | 13.9 | 55.6 |
| *Panopeus* spp. | 1.1 | 5.0 | 1.2 | 5.9 | — | — |
| Unknown Invertebrates | 0.1 | 3.3 | 0.1 | 3.9 | — | — |
| Unknown Snails | 0.1 | 2.5 | — | — | 0.8 | 16.7 |
| Unknown Other Mollusks | Tr. | 1.7 | Tr. | 1.0 | Tr. | 5.6 |
| Grasshoppers | Tr. | 1.7 | Tr. | 1.0 | Tr. | 5.6 |
| Centipedes | Tr. | 0.8 | — | — | Tr. | 5.6 |
| Beetles | Tr. | 3.3 | Tr. | 1.0 | Tr. | 16.7 |
| Ribbed Mussels | Tr. | 0.8 | Tr. | 1.0 | — | — |
| Total Animal Material | 53.3 | 84.2 | 52.1 | 81.4 | 60.5 | 100.0 |
| Acorns | 32.4 | 70.0 | 33.9 | 71.6 | 23.5 | 61.1 |
| Yaupon Berries | 7.2 | 10.8 | 8.0 | 11.8 | 2.5 | 5.6 |
| Cabbage Palm Berries | 3.9 | 5.0 | 2.7 | 4.9 | 11.2 | 5.6 |
| Cordgrass | 2.0 | 5.8 | 2.3 | 6.9 | — | — |
| Persimmons | 0.4 | 1.7 | 0.5 | 2.0 | — | — |
| Unknown Vegetation | 0.7 | 10.0 | 0.5 | 6.9 | 2.2 | 27.8 |
| Total Plant Material | 46.6 | 80.0 | 47.9 | 80.4 | 39.4 | 77.8 |

[a]As represented by 120 scats, 102 from marsh and 18 from inland. To be compared with table 2 for January 1975.

TABLE 18
**Relative Importance of Major Categories of Animal Foods, Expressed as Percent of the 1976 January Diet[a]**

| Food Item | Combined Volume | Marsh Volume | Inland Volume |
|---|---|---|---|
| Crustaceans | 44.3 | 44.1 | 45.2 |
| Vertebrates | 6.6 | 7.6 | 0.6 |
| Insects | 2.2 | 0.3 | 13.9 |
| Mollusks | 0.1 | Tr. | 0.8 |
| Other Invertebrates | 0.1 | 0.1 | — |

[a]From raccoon scats collected on St. Catherines Island, Georgia. Plant material comprised 46.6% of the diet. Compare with table 14 for 1975.

insects were present in the diet: unknown insects, beetles, grasshoppers, and cockroaches. Insect use increased in the spring (table 14). In the scats from January 1976, insects had a percentage of volume about equal to that in winter 1975 (tables 12 and 17). Insects were much more important in the inland diet than in the marsh diet; they were found frequently and made up considerable portions of the inland diet. Insects were the most frequent inland food in all collection periods. During 1975, the volume of insects increased from 22.2 percent of the winter inland diet to 50.2 percent in the spring (table 14); this increase was due, in large part, to an approximately ninefold increase of the beetle percent volume (4.3% in winter and 39.0% in spring) (tables 12 and 13). During 1975, grasshoppers were found only in inland samples and in small quantities. Insects are available in the leaf litter of the forest floor, and many of the inland scats containing insects were collected near freshwater ponds and sloughs, suggesting that insects are more available in such areas. Fleming, Palmisano, and Joanen (1978) reported that, in the diets of Louisiana tidal marsh raccoons, insects were most important in the summer and less so in fall and spring. Teal and Teal (1969) suggested that mollusks and crabs of tidal marshes may be more attractive to larger predatory mammals and birds than are smaller-sized insects. Such observations may partially explain the low use of insects in the marshes of St. Catherines Island in the spring.

Generally, mollusks are used in small quantities throughout the year (Giles, 1940; Yeager and Elder, 1945; Hamilton, 1951; Stains, 1956; Johnson, 1970), and include terrestrial and aquatic gastropods and also freshwater clams. The overall dietary importance of mollusks has probably been underestimated in studies that are based solely on the analysis of gut contents and scats, due to thorough digestion of mollusk bodies. Feeding sign and observations on St. Catherines suggest that raccoons crack open ribbed mussels by biting them, extracting the animal, and then discarding much of the shell. Thus, very little evidence of mussel consumption remains in the scats.

On St. Catherines, four categories of mollusks were found in the winter and spring diets, and included *Melampus* spp. (a tidal snail), ribbed mussel, unknown snail, and unknown other mollusk. During 1975, mollusks made up 3.2 percent of the winter scat volume and 1.5 percent in the spring (table 14); however, mollusks made up only 0.1 percent of the scats collected in January, 1976 (table 18). In 1976, the abundant acorn crop might have partially reduced predation pressure on mollusks during the winter; similarly, abundant alternative foods (especially fiddler crabs) present when temperatures are warmer might have resulted in re-

TABLE 19
**Foods Eaten in January 1976[a]**

| | Stomachs | | Colons | |
|---|---|---|---|---|
| Food Item | Per. Vol. | Per. Freq. | Per. Vol. | Per. Freq. |
| Fish | — | — | 34.0 | 25.0 |
| *Eurytium* spp. | — | — | 28.0 | 50.0 |
| *Panopeus* spp. | — | — | 12.0 | 25.0 |
| Fiddler Crabs | — | — | 6.0 | 50.0 |
| Unknown Insects | — | — | Tr. | 50.0 |
| Unknown Mollusks | — | — | Tr. | 25.0 |
| Total Animal Material | 0.0 | 0.0 | 80.0 | 100.0 |
| Acorns | 100.0 | 100.0 | 14.0 | 25.0 |
| Unknown Vegetation | Tr. | 100.0 | 6.0 | 50.0 |
| Total Plant Material | 100.0 | 100.0 | 20.0 | 75.0 |

[a]Represented by samples from one stomach and three colons.

TABLE 20
**Foods Eaten in Summer 1975, June through August**[a]

| Food Item | Percent of Volume and Percent of Scats Containing | | | | | |
|---|---|---|---|---|---|---|
| | June | # Scats | July | # Scats | August | # Scats |
| Crustacean | 94.2 | 19 | 73.6 | 43 | 26.2 | 13 |
| Isopod | 0 | 0 | 1.6 | 1 | 0 | 0 |
| Insect | .3 | 17 | 1.9 | 11 | 5.4 | 9 |
| Mollusk | 0 | 0 | trace | 1 | 0 | 0 |
| Vegetation | 5.5 | 8 | 17.9 | 17 | 67.6 | 14 |
| Fish | 0 | 0 | 2.2 | 2 | 0 | 0 |
| Amphibian | 0 | 0 | 1.0 | 1 | 0 | 0 |
| Bird | 0 | 0 | 0 | 0 | .9 | 1 |
| Total # Scats | | 20 | | 50 | | 17 |

[a]Represented by 87 scats.

duced mollusk use during the spring of 1975. The ribbed mussel was the most frequently occurring mollusk in 1975, but it was present in small quantities. This mussel is common in marsh mud, along tidal creeks, and in other areas where tides regularly flood the marsh (Teal and Teal, 1969). The presence of ribbed mussels in both marsh and inland samples indicates that individual raccoons forage in both habitats. In terms of percentage of volume, *Melampus* spp. was more important than the ribbed mussel in 1975, but it occurred much less frequently. Bulkiness of the nondigestible *Melampus* shells tends to inflate the percentage of volume. *Melampus* is abundant in the upper portions of the marsh, secreted under grasses in damp areas during low tides (Teal and Teal, 1969). *Melampus* remains were only found in marsh samples. Unknown mollusks were found infrequently, in extremely small quantities, and only during the winter (tables 12 and 17). Unknown snails were found in the scats collected in January 1976 (table 17) and in the spring digestive tracts of 1975 (table 16). This food item was only found in inland samples and probably were terrestrial gastropods, available near freshwater ponds.

Fleming, Palmisano, and Joanen (1978) reported use of ribbed mussels in a Louisiana tidal marsh. Tyson (1950) found marsh mollusks to make up 44 percent of the summer diet in coastal Washington. On St. Catherines, marsh mollusks (*Melampus* spp. and especially the ribbed mussel) may be an animal food constantly available and possibly utilized to some extent year round.

Four additional categories of invertebrates were found in the scats and digestive tracts of 1975 and 1976. These were isopods, centipedes, millipedes, and unknown invertebrates. These items were found in small quantities and are probably of only minor importance. Relative percent frequencies are used to interpret their dietary importance.

The frequency of centipedes in the scats of 1975 increased from one occurrence in a winter inland scat to one occurrence in a marsh scat and 13 in inland scats during the spring (tables 12 and 13). The increased spring use is due to an increased availability of centipedes in the leaf litter during the spring. The importance of centipedes in the inland diet is further substantiated by: frequencies of approximately 27 percent in inland digestive tracts collected during the winter and spring of 1975 (tables 15 and 16); and occurrence in one inland scat in January 1976 (table 17).

Millipedes occurred only in the 1975 samplings with one in a winter marsh scat and one in a spring inland scat (tables 12 and 13). Millipedes were found in three inland digestive tracts in both winter and spring (tables 15 and 16), suggesting that millipedes are more characteristic of the inland than of the marsh diet. Isopods were found in one marsh scat in the winter of 1975; the collection site was near a beach shore where isopods were abundant in small puddles during low tide. Unknown inver-

tebrates were found in one marsh scat in the spring of 1975 (table 13) and in four marsh scats collected in January 1976 (table 17).

Previous studies have demonstrated that raccoons are generally inefficient predators of mature birds and mammals. However, where vertebrates are readily available, the opportunistic raccoon may utilize them, e.g., kit muskrats (Wilson, 1953; Dorney, 1954), young rabbits (Atkeson and Hulse, 1953), and hunter-crippled ducks (Yeager and Rennels, 1943; Yeager and Elder, 1945; Dorney, 1954). A diversity of vertebrates have been used, and these include small mammals, birds, reptiles (snakes, lizards, and turtles), amphibians (frogs, toads, and salamanders), and fish. The heaviest vertebrate use occurs in later winter and spring when other foods are scarce (Giles, 1940; Stuewer, 1943; Schoonover and Marshall, 1951; Cabalka et al., 1953; Stains, 1956; Johnson, 1970; Fleming, Palmisano, and Joanen, 1978).

On St. Catherines Island, vertebrates were most important in the winter, making up 0.8 percent of the winter diet in 1975 (table 12) and 6.6 percent of the January, 1976, diet (table 17), but only 0.3 percent in the spring of 1975 (table 13). In addition, four types of vertebrates were found in digestive tracts collected during the winter of 1975 (table 15) as compared to one type in the spring (table 16). The six types of vertebrates found were fish, birds, waterfowl, lizards, snakes, and unknown vertebrates.

Fish was the primary vertebrate food in the winter scats, with more use in the marsh than in inland habitat. The percent volume of fish in the winter of 1975 was 0.6 percent (table 12), as compared to 6.6 percent in January, 1976 (table 17). This higher figure along with a higher frequency in 1976 suggests that fish were more available that year. Fish were of lesser importance in the spring diet (table 13). Stains (1956) found the peak period of fish use when water levels in streams and ponds were low. Geis (1966) and Giles (1940) reported the heaviest fish use during spring flooding, when they were stranded in small puddles. Fleming, Palmisano, and Joanen (1978) found heavy fish use during the spring and summer in a Louisiana tidal marsh. Tyson (1950) reported that fish made up a significant part of the summer diet in coastal Washington. In the marshes of St. Catherines Island, fish are probably taken from small puddles during low tide, or as carrion.

Birds were found infrequently and in small quantities during 1975. In the winter, bird remains were found in four inland samples, including two occurrences of waterfowl (tables 12 and 15). Wintering ducks are common on freshwater sloughs and ponds of St. Catherines Island. Birds were found in two marsh samples in the spring (table 13). Reptile remains included a lizard in an inland digestive tract collected in the winter of 1975 (table 15) and a snake in an inland scat in the spring of 1975 (table 13). Unknown vertebrate remains were found in a marsh digestive tract in the winter (table 15) and also in a scat and in a digestive tract in the marsh in spring (tables 13 and 16). On St. Catherines Island, the availability of alternative foods, requiring less energy expenditure to capture, may significantly reduce predation pressure on the less easily captured vertebrates. The absence of small mammals in the diet is related to the depauperate small mammal fauna.

Raccoon predation on eggs of ground-nesting birds and reptiles has not been extensively investigated. Egg-eating may be a learned trait, only found in certain populations (Johnson, 1970). In the present study, a trace of bird egg was found in a scat from the marsh in spring (table 13). Similarly, infrequent observations of egg-eating have been reported elsewhere (Dorney, 1954; Kinard, 1964; Johnson, 1970). There is a noted absence of ground-nesting birds on St. Catherines, supposedly due to trampling and predation by feral hogs, trampling by deer and feral cattle, and raccoon predation. During the spring of 1975, there were concentrations of nesting wading birds, particularly common egrets (*Leucophoyx thula*), snowy egrets (*Hydranassa tricolor*), and cattle egrets (*Dichromanassa reufescens*), on several freshwater ponds; such nesting situations are apparently safe from raccoon predation.

Raccoons have been reported as serious predators of nests of the Atlantic loggerhead turtle (*Caretta caretta*) during the summer egg-laying season (Carr, 1967; Johnson et al., 1974). On the afternoon of May 10, 1975, a loggerhead nest was found on a northern beach;

the eggs were apparently laid the previous night. Predation by raccoons and pigs had occurred and only 15 eggs survived. A second inspection of the nest during the evening showed that further disturbance had occurred. A live-trap was set at the nest site, and a raccoon was captured. Blackbeard Island, one of the six largest rookeries on the Atlantic coast (Johnson et al., 1974) is immediately south of St. Catherines. Raccoon predation may limit the nesting success of loggerhead turtles on St. Catherines and the relationship between loggerhead nesting and raccoon predation on St. Catherines Island is certainly worthy of further study.

Fleming, Palmisano, and Joanen (1978) reported that raccoon predation of alligator nests in Louisiana occurred in the absence of a preferred food, crayfish. Alligators are common in the sloughs, ponds, tidal creeks, and marshes of St. Catherines; however, no observations were made of raccoon predation on alligator nests.

Sandy beaches on the northern and southern portions of St. Catherines are a habitat quite different from the marsh and inland areas. Although beaches were not intensively studied, field observations showed that some raccoons forage there. Most of these observations were made during low tide. Raccoons commonly foraged along the high tide line searching among the newly washed-in debris; food items were taken as carrion. Another foraging strategy involved foraging in small puddles where aquatic marine animals were stranded during low tide.

Some evidence suggests that some raccoons do not restrict their foraging solely to one habitat or the other. Local residents of St. Catherines expressed the opinion that some raccoons tend to restrict their activity to inland areas ("hill coons") and others, to tidal marshes ("marsh coons"). Although the primary concern of this study was not to determine the extent to which such a segregation occurred, several relevant observations were made. The occurrence of foods, available only in the marshes, in samples collected in inland areas suggests that some movement occurs between the two areas; in several cases, foods available only in the marsh were found in samples also containing foods more typical of inland areas. However, from the latter part of January through early March 1975, trapping success decreased in inland areas, as did field sightings of raccoons. During this time, most of the raccoon field sightings were in marshes. Such observations suggest that many raccoons concentrated their foraging efforts in the marsh where foods, such as cordgrass and marsh crustaceans, were available. Inland scats became more plentiful during the spring, suggesting that some raccoons became less dependent on the marsh as insects became more available in inland areas. Thus, raccoons on St. Catherines may restrict their activities to one habitat depending on food availability; however, such restrictions are probably of a temporary nature.

## CONCLUSIONS

The amount and frequency of animal foods increased from winter into spring of 1975 and then decreased in the summer. This shift is explained, in part, by the decreased availability of native fruits and increased availability of insects and marsh crustaceans during the late winter and spring.

During the winter of 1975, the mast crop was poor and cordgrass was the most important plant food. In January 1976, mast was abundant and acorns were the most important plant food; cordgrass was of much less importance. Cordgrass is a low-preference food, and the heavy use during the winter of 1975 occurred in the absence of the more preferred acorns. Acorns are a significant source of carbohydrate and are necessary to build subcutaneous fat which aids raccoons in withstanding cold winter temperatures. The overwintering success of the raccoon population on St. Catherines is influenced by the amount of mast produced by laurel and live oaks. Less significant winter plant foods included mistletoe berries, Carolina laurelcherries, yaupon berries, cabbage palm berries, greenbrier berries, persimmons, and unknown vegetation. During the spring, cordgrass, mistletoe berries, cabbage palm berries, greenbrier berries, raspberries, and unknown vegetation were included in the diet.

Cordgrass and yaupon berries are more typical of the marsh than of the inland diet, and such patterns of use are largely determined by

availability. In January 1976, acorn availability and use were roughly equivalent in both habitats. In terms of the overall diet, the other plant foods were of limited importance.

Crustaceans were the most important animal food in the winter and spring diets in 1975. They increased in importance from making up 53 percent of the winter diet to 86 percent of the spring diet, as availability increased with warmer weather. Crustaceans are important in both habitats, but are especially significant in the marsh diet, where crabs are readily available. Fiddler crabs were the most important overall food in the winter and spring diets of 1975, and second, only to acorns, in January 1976. They are a preferred food and an important protein source. Fiddler crabs are used in both habitats. Mud crabs (*Panopeus* spp. and *Eurytium* spp.) were significant foods in both habitats, during the winter and spring of 1975. Decreased spring importance suggests that use of more readily available foods reduces predation pressure on mud crabs. Mud crabs may serve as a significant protein source, especially during prolonged winter cold periods when fiddler crabs are less available. Unknown crabs and crayfish were two additional categories of crustaceans found in 1975.

Insect use occurred in both the winter and spring of 1975, increasing as warmer spring temperatures prevailed. Insects are most important in the inland habitat and less important in the marshes; concentrations of insects may be located near freshwater ponds and sloughs. The heavy use of insects in inland areas is correlated with abundant insects in the leaf litter of the forest floor. Insects encountered in this study included unknown insects, beetles, grasshoppers, and cockroaches.

Mollusks found in the winter and spring diets in 1975 included ribbed mussels, *Melampus* spp., unknown other mollusks, and unknown snails. Mollusk use dropped from 3.2 percent of the winter diet to 1.5 percent of the spring diet, perhaps reflecting a shift to more easily obtainable foods. Mollusks comprised only 0.19 percent of the diet in January 1976, and this low usage may have been due to the abundant mast. Ribbed mussels and *Melampus* spp. may represent a constantly available food source that is most used during times of food scarcity, e.g., during the winter of 1975.

Centipedes, millipedes, isopods, and unknown invertebrates were found in small quantities in 1975. Centipedes and millipedes are more typical of the inland diet than of the marsh. Centipede use increases as their availability increases in the leaf litter during spring.

Except for fish, vertebrates were insignificant foods during the winter and spring of 1975. Vertebrates are most important in the winter; whereas, more readily available foods may reduce predation pressure on vertebrates in the spring. Fish are the most important vertebrate foods, and are more significant in the marsh than in inland areas. Fish comprised a larger percentage of the diet in 1976 than in 1975, possibly reflecting greater availability in 1976. Other vertebrate foods included birds, waterfowl, lizards, snakes, and unknown vertebrates. Evidence was found indicating that raccoons destroy nests of the Atlantic loggerhead turtle; however, the extent of predation could not be ascertained.

Late winter and early spring of 1975 was a period of food scarcity, particularly in the inland areas. Commensurately, many raccoons concentrated their foraging in the tidal marshes, where foods were more readily available. While the overall picture of habitat use is unclear, the occurrence of marsh foods in inland samples, also containing inland foods, suggests use of both habitats by some raccoons.

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