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BARN OWL (*Tyto alba*) DIETS AND THE OCCURRENCE OF MEADOW VOLES (*Microtus pennsylvanicus*) ON THE SOUTHEASTERN ATLANTIC COAST OF NORTH AMERICA

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The diet of the Barn Owl (*Tyto alba*) is well known due to the availability of the pellets or boluses of undigested prey remains they leave at their nest sites (Marti et al. 2005, Taylor 1994). In most habitats small mammals are the main prey of Barn Owls; in southeastern North America, primarily cotton rats (*Sigmodon hispidus*) in upland habitats, and rice rats (*Oryzomys palustris*) in wetlands (Blem and Pagels 1973). Barn Owls are opportunistic predators and their prey varies between localities and habitats (Tores et al. 2005). The Barn Owl is an efficient mammal collector, and in some cases may reveal the presence of species not otherwise known to occur at a locality (Woods et al. 1982). The Barn Owl frequently preys on meadow voles (*Microtus pennsylvanicus*), which are considered absent or rare on the Atlantic Coast south of Currituck Sound, North Carolina, near the Virginia border. Analysis of Barn Owl diet provides information about the distribution of the vole on the southeastern coastal plain. The objective of this paper is to further delineate the range of the meadow vole on the southeastern coastal plain using Barn Owl pellet analysis.

METHODS

We collected regurgitated pellets from eight nest boxes occupied by Barn Owls. The boxes were on observation or fire towers at four locations on a 21-km transect from Cape Island, Charleston County, to Cat Island, Georgetown County, South Carolina. The towers were in or on the edges of salt marshes that were vegetated by smooth cord grass (*Spartina alterniflora*), salt meadow grass (*S. patens*), needle-rush (*Juncus roemerianus*), salt grass (*Distichlis spicata*) and sea ox-eye (*Borrchia frutescens*). The locations are on the immediate coast, which we define as the area whose inland border is 10 km from the Intracoastal Waterway.

The dried pellets were dissected, and the bones and feathers were washed in detergent; bones were then washed in 2% hydrogen peroxide. When necessary, cleaned bones and feathers were identified by comparisons with reference collections at the Charleston Museum.

RESULTS

From October 2002 to March 2003, we collected over 91 boluses that had been regurgitated by Barn Owls nesting in or next to salt marshes in Charleston and Georgetown Counties, South Carolina. We found the remains of 324 individual mammals and birds. The most frequent prey of the Barn Owls was the meadow vole (204 individuals, 63% of the prey), the remains of which we found at all four locations. The next most common prey was the rice rat (61; 19%) followed by the black rat (*Rattus rattus*, 13) and cotton rat (3). Meadow voles outnumbered rice rats at all four stations, at ratios ranging from 6.2:1 to 1.3:1 (Table 1)

We found the remains of 12 birds. The most common identified passerine was the Red-winged Blackbird (*Agelaius phoeniceus*, three specimens). Also included were the remains of five unidentified passerines. Two large rails, either Clapper (*Rallus longirostris*) or King (*R. elegans*) were found.

Table 1. Vertebrate prey of Barn Owls on the immediate coast of South Carolina, based on contents of regurgitated pellets found at nest sites, October 2002-March 2003.

Prey species	Location (no. of nest sites; no. of pellets)				Total (%)
	Minim Island (4; 73)	Murphy Island (2; 15)	Cedar Island (1; 3)	North Santee (1; unknown)	
Meadow vole	123	33	8	40	204 (63)
Rice rat	20	7	2	32	61 (19)
Black rat or Norway rat	7	0	0	6	13 (4)
Cotton rat	0	2	1	0	3 (<1)
Unidentified rodent	7	2	0	22	31 (10)
Unidentified rail	2	0	0	0	2 (<1)
Red-winged Blackbird	3	0	0	1	4 (1)
Unidentified passerine	2	1	2	0	5 (2)
Total	164	45	13	101	323 (100)

DISCUSSION

The most common species in the diet of the coastal Barn Owls was the meadow vole, presumably taken in salt marshes in the Cape Romain area. The owls were seen foraging in the salt marshes near their nests. The presence in the owls' diet of two salt-marsh habitat specialists, the Clapper Rail (*Rallus longirostris*) and Seaside Sparrow (*Ammodramus maritimus*) is further evidence that the owls were foraging in salt marshes.

Coastal distribution of meadow voles.—The first live meadow vole (Charleston Museum # 39.221) recorded on the South Carolina Coast was trapped on Cape Island, on 21 September 1939 by W. P. Baldwin. He collected three more at the same locality 9 days later. Baldwin wrote on specimen labels that the habitat in which the voles were captured was high (irregularly flooded) salt marsh, covered by salt meadow grass and salt grass.

Three studies from 1933 to 1937 reported the presence of 73 meadow voles in Barn Owl pellets. In 1933 E. B. Chamberlain collected 60 Barn Owl pellets on Cat Island, southern Georgetown County, in the Santee River Delta. Nelson (1934) examined the pellets and found 59 meadow vole skulls. In 1936 Nelson (1937) examined 21 pellets found on Cape Romain. He found the remains of seven voles, as well as bones of an unknown number of rice rats, Clapper Rails, Virginia Rails (*Rallus limicola*) and Seaside Sparrows. Cottam and Nelson (1937) examined 21 Barn Owl pellets in 1936. They were taken from a nest box at the edge of a salt marsh in McClellanville (22 km southwest of Cat Island). They found the remains of seven meadow voles, 17 rice rats, five Seaside Sparrows, one Virginia Rail, one unidentified rodent, and three rails, either Clapper Rails or King Rails.

In 1978 W. D. Chamberlain (1979) collected the remains of 47 vertebrates in 60 pellets from Lighthouse Island (formerly part of Cape Island). His results are similar to ours: most prey consisted of meadow voles (72%) and rice rats (17%), compared to our percentages of 63% meadow voles and 19% rice rats (Table 1).

Andre (1981) captured small mammals on Bull Island, which is the next island southwest of Cape Island. On 23 days he trapped on transects in seven habitats: freshwater marsh, salt marsh (vegetated by smooth cord grass), sand dunes, salt spray forest, maritime forest, residential area and old field. The only rodents he captured were 44 rice rats and 12 cotton rats. The absence of voles in the habitats he sampled and the apparent abundance of voles at nearby sites indicate that Barn Owls in the area foraged in a limited area where voles were common.

Meadow voles are not known to occur on the coast south of Cape Island, but except for Tomkins (1936), few small mammal studies have

Table 2. Main prey of Barn Owls at inland and coastal locations in South Carolina.

Prey species	Number (%)	
	Inland ¹ (4, 4) ²	Coastal ³ (6; 10)
Meadow vole	0	245 (61)
Rice rat	123 (45)	111 (27)
Cotton rat	49 (18)	12 (3)
Black rat	1 (<1)	19 (5)
Harvest mouse (<i>Reithrodontomys humulis</i>)	14 (5)	0
Unidentified rodent	1 (<1)	4 (1)
Short-tailed shrew (<i>Blarina brevicauda</i>)	5 (2)	0
Least shrew (<i>Cryptotis parva</i>)	34 (12)	0
Sora	24 (9)	0
Clapper or King Rail	5 (2)	4 (1)
Swamp Sparrow	4 (1)	0
Seaside Sparrow	0	5 (1)
Red-winged Blackbird	15 (5)	4 (1)
Total	275 (100)	404 (100)

¹Inland locations: Green Pond, Adams Run, Savannah National Wildlife Refuge.

²Number of locations; number of nests.

³Data from present study (locations are listed in Table 1), Cottam and Nelson (1937), and Chamberlain (1979).

been conducted on the immediate coast south of Cape Island. In 1936 Tomkins found Barn Owls nesting on a channel marker in the Savannah River Delta, Jasper County, South Carolina. He found pellets containing the remains of 5 rice rats, 2 black rats, 4 cotton rats, 6 house mice (*Mus musculus*), 1 marsh rabbit (*Sylvilagus palustris*), as well as 12 passerine birds of 3 species.

Inland occurrence of meadow voles.—Examinations of Barn Owl pellets and mammal trapping have so far indicated that south of Currituck Sound, North Carolina, coastal meadow voles occur only within a 11 X 25-km coastal band extending from Cat Island to Cape Island, South Carolina. Do meadow voles occur inland from the immediate coast? Post (unpublished data) in 1999 conducted small mammal censuses on a 6-ha study area in a high salt marsh on James Island, Charleston County. During 786 trap-nights, 80 rice rats and three cotton rats were marked, but no other small mammals were captured. In another high marsh study area (6.9 ha) on James Island, Herbert (2007) ran 66 trap on 10 days, 1 May-13 Jul 2007 (660 trap nights). The two study sites are on the Intracoastal Waterway and 70 km southwest of Cape Island. Neither study revealed the presence of voles.

Barn Owl pellets have been collected at three inland locations in South Carolina, 30-40 km north of the Intracoastal Waterway. In 1926 in a Barn Owl nest at Prospect Hill Plantation, near Adams Run, Charleston County, Townsend (1926) found the bones of 65 Rice Rats and one cotton

rat (number of pellets not indicated). At the same location in 1927, E. B. Chamberlain (unpublished data, Charleston Museum) examined 75 pellets, which had the remains of 52 rice rats and 14 cotton rats. In 1933 at White Hall Plantation, near Green Pond, Colleton County, E. B. Chamberlain (unpublished data, Charleston Museum) examined six pellets and found 4 cotton rats and 14 house mice. At Savannah National Wildlife Refuge, Jasper County, French and Wharton (1975) collected 30 Cotton Rats and 6 Rice Rats from an unreported number of owl pellets. None of the pellets collected in the interior from 1926 to 1975 contained meadow vole bones.

Lee et al. (1982) listed no meadow vole specimens from the North Carolina coast south of Currituck Sound, the type locality for *Microtus pennsylvanicus nigrans* (Reich 1981), stating that the vole is "probably absent from the southwestern counties". The meadow vole is not known to occur on the immediate coast of Georgia (Golley 1962, Neuhauser and Baker 1974, Laerm et al. 1980). On Butler Island, McIntosh County, Georgia, French and Wharton (1975) collected Barn Owl pellets containing the remains 66 rice rats, 59 cotton rats and 7 house mice, but no voles. French and Wharton also found no *Microtus* in Barn Owl pellets collected in other areas of the Georgia outer coastal plain.

Meadow voles are common prey of Barn Owls in most areas where the voles occur. Assuming the owls are efficient mammal collectors, the vole's absence in the owls' diet is evidence that they do not occur in the areas where the owls forage. Both Barn Owl diet analysis and small mammal trapping studies so far indicate that south of Currituck Sound, North Carolina, the voles are found only in salt marshes along a narrow, 25-km long fringe of the South Carolina Coast.

While conducting studies of Seaside Sparrows and rice rats, Post (1981) trapped meadow voles in a salt marsh on Waccasassa Bay (Levy County) on the Florida Gulf Coast. These were the first live meadow voles found in Florida (Woods et al. 1982). The voles occupied high salt marsh habitat similar to that in which they have been found in South Carolina. The meadow voles found in Florida are believed represent a Pleistocene relict population, and have been described as members of a new subspecies, *M. p. dukecampbelli* (Woods et al. 1982). Because of their supposed rarity, this race has been classified as endangered in Florida. Although the voles collected on Cape Island, South Carolina in 1939 were assumed to be *M. p. nigrans* (Nelson 1934), more detailed examination of specimens from that area may reveal them to be from a distinct population.

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