postulates the existence of neural centers controlling the behavior in question, such as those postulated by proponents of theories of instinctive behavior which propose complex models of presumably inherited neural mechanisms which have no known physiological correlates in the nervous system.

This simpler hypothesis could be tested by carefully recording the movements and postures of young birds immediately after fledging and for a period of time thereafter, to see whether the species-specific locomotor pattern appears at once or only gradually.

I am grateful to Andrew J. Berger for making the birds studied available to me. This work was supported by grant no. 1-F02-GM-36, 212-01 from the National Institutes of Health.—ROBERT J. RAIKOW, *Department of Biology, University of Pittsburgh, Pittsburgh, Pennsylvania 15260.* *Accepted 1 July 1974.*

Foraging of Pine Warblers allopatric and sympatric to Yellow-throated Warblers. —Pine (*Pinus* spp.) forests in the southeastern United States usually support a single nesting species of *Dendroica* warbler, the Pine Warbler (*D. pinus*). However, Ficken, Ficken, and Morse (Evolution, 22:307–314, 1968) described a case in which Pine Warblers and Yellow-throated Warblers (*D. dominica*) coexist in loblolly pine (*P. taeda*) forests on the Delmarva Peninsula of Maryland. They suggested that niche-partitioning is accomplished primarily through the ability of Yellow-throated Warblers to probe in pine cones for invertebrates, a behavior that the Pine Warbler cannot perform, because its bill is too short and its skull too large to reach to the stalk of the pine cones. In addition, Yellow-throated Warblers usually foraged somewhat higher than Pine Warblers, though overlap in this measure was high.

The present paper compares data collected upon Pine Warblers in a loblolly pine forest where no Yellow-throated Warblers occur with additional data from the Delmarva Peninsula. The primary purpose of these observations was to determine whether Pine Warblers in allopatry and sympatry forage differently. Unfortunately, I know of no pine forests occupied only by Yellow-throated Warblers, so it has not been possible to test the converse. In addition, I compare the foraging patterns of male and female Pine Warblers at both locations and relate these data to other studies.

If Yellow-throated Warblers affect the exploitation patterns of Pine Warblers, then Pine Warblers at the one-species site should forage more frequently in high positions than they do at the two-species site, for those were the parts of the habitat used most frequently by Yellow-throated Warblers. However, as the forest at the one-species site is somewhat shorter than the one at the two-species site, an absolute change in height might not occur. Further, it is possible that Pine Warblers might hawk for insects more frequently at the former location than at the latter location, as Yellow-throated Warblers in the latter hawked for insects much more frequently than did Pine Warblers.

Observations of Pine Warblers were made during March and April of 1967 and 1968 at Cedarville State Forest, Brandywine, Prince George's County, Maryland, and in March and April of 1967 at Shad Landing State Park, Worcester County, Maryland (the Delmarva site). Cedarville lies approximately 135 km WNW of Shad Landing, the study site for the two-species observations (Ficken et al., op. cit.), and is separated from it by the Chesapeake Bay. The forest at Cedarville, planted in the early 1930's, is somewhat shorter than the one at Shad Landing, averaging 15 m in height at the time of the study, approximately three m shorter than the one at Shad Landing. Other than this, the two areas are very similar, with only scattered deciduous trees and little underbrush occurring within the forest. Only a few Virginia pines (*P. virginiana*) grow on the main study area at Cedarville, although they are common in adjacent locations.

TABLE 1

SECONDS SPENT FORAGING (WITH NUMBER OF OBSERVATIONS IN PARENTHESES) BY PINE WARBLERS IN DIFFERENT STATIONS

Height (m)	Trunk	Foraging station: Limb, proximal one-half	Limb, distal one-half	Tips of foliage	Dead growth	Deciduous growth	Total
CEDARVILLE			Male				
0–3	–	6 (1)	186 (2)	–	22 (1)	12 (1)	226 (5)
3–6	7 (1)	734(28)	1,083 (52)	384 (25)	271(13)	–	2,479(119)
6–9	–	523(29)	3,367(110)	720 (47)	380(13)	133 (3)	5,123(202)
9–12	–	397(19)	2,020 (62)	216 (18)	55 (4)	–	2,688(103)
12–15	–	314 (7)	944 (25)	94 (3)	–	–	1,352 (40)
15–18	–	8 (2)	423 (7)	40 (2)	85 (1)	–	556 (12)
Total	7 (1)	1,982(86)	8,033(258)	1,454(100)	813(32)	145 (4)	12,412(481)
			Female				
0–3	–	–	–	–	–	27 (1)	27 (1)
3–6	3 (1)	98 (5)	624 (16)	53 (5)	47 (2)	–	825 (29)
6–9	–	169(16)	1,729 (59)	338 (23)	92 (8)	–	2,364(108)
9–12	–	149(12)	1,468 (52)	360 (23)	72 (2)	–	2,049 (89)
12–15	–	21 (3)	252 (8)	97 (6)	6 (1)	–	376 (18)
15–18	–	–	5 (1)	–	–	–	5 (1)
Total	3 (1)	437(36)	4,078(136)	848 (57)	217(13)	27 (1)	5,646(246)
SHAD LANDING			Male				
0–3	14 (2)	8 (1)	22 (1)	175 (17)	–	–	219 (21)
3–6	–	195(13)	525 (28)	423 (33)	–	65 (2)	1,208 (76)
6–9	5 (1)	144 (9)	995 (52)	498 (27)	50 (2)	157 (2)	1,849 (93)
9–12	7 (1)	305(17)	1,180 (63)	253 (19)	63 (5)	–	1,708(105)
12–15	–	81 (8)	886 (33)	145 (6)	–	–	1,112 (47)
15–18	–	24 (2)	354 (16)	–	11 (1)	–	389 (19)
Total	26 (4)	757(50)	3,962(193)	1,494(102)	124 (8)	222 (4)	6,585(361)
			Female				
0–3	–	–	27 (1)	–	–	170 (3)	197 (4)
3–6	–	46 (6)	275 (12)	5 (1)	–	97 (1)	423 (20)
6–9	2 (1)	125(10)	960 (39)	229 (13)	81 (3)	64 (2)	1,461 (68)
9–12	3 (1)	255(23)	1,292 (64)	311 (24)	5 (1)	–	1,866(113)
12–15	–	90 (8)	477 (25)	145 (11)	–	–	712 (44)
15–18	–	–	274 (7)	91 (2)	–	–	365 (9)
Total	5 (2)	516(47)	3,305(148)	781 (51)	86 (4)	341 (6)	5,034(258)

Observations of feeding behavior followed those used in the earlier Shad Landing study (Ficken et al., op. cit.), with notes made of where and how each individual observed foraged for periods of up to three min following its discovery. The habitat was divided by height (into three-m segments) and part (medial and distal parts of limbs,

TABLE 2

FORAGING MOVEMENTS OF PINE WARBLERS (FREQUENCY IN OBSERVATIONS PER 1,000 SECONDS OF FORAGING IN PARENTHESES)

Sex and locality	Seconds of foraging	Hawk for insects	Hover in foliage
Male, Cedarville	12,412	11 (1.1)	6 (0.5)
Female, Cedarville	5,646	2 (0.3)	1 (0.2)
Male, Shad Landing	6,585	9 (0.7)	–
Female, Shad Landing	5,034	5 (1.0)	–

tips of vegetation, etc.) (see Table 1). Foraging motions of the birds (hawking for insects, etc.) were recorded when noted.

The Pine Warblers at Cedarville foraged somewhat lower than those at Shad Landing (Table 1); however, only in the case of females was this difference significant ($0.05 > P > 0.02$) in a two-tailed t test for paired comparisons (males $= 0.2 > P > 0.1$ in same test). In both cases the modal height category dropped one three-m unit, which exactly matches the difference in height of the two forests.

No significant difference existed in the major positions (proximal part of limb, distal part of limb, tips of foliage) in which male Pine Warblers foraged at the two localities (Table 1) ($0.3 > P > 0.2$ in same test). A difference did occur between females at the two localities ($0.05 > P > 0.02$ in same test), with birds from Cedarville foraging somewhat more distally on vegetation than at Shad Landing.

Males did not hawk for insects with significantly different frequencies at the two localities (Table 2) ($P > 0.5$ in a two-tailed χ^2 test). Data for females were inadequate for testing, as was the case for hovering in the foliage by both sexes. No examples of cone-probing were seen.

No significant differences occurred in the locations foraged in by males and females (Table 1) (height at Cedarville, $0.1 > P > 0.05$; height at Shad Landing, $0.2 > P > 0.1$; position at both Cedarville and Shad Landing, $0.2 > P > .01$; all in two-tailed t tests for paired comparisons), although a trend occurred in both localities for females to forage slightly higher than males. Neither did significant differences exist in the frequencies with which males and females hawked for insects at Shad Landing (Table 2) ($P > 0.5$ in a two-tailed χ^2 test). Observations were inadequate to permit testing of other foraging movements.

The data suggest that Yellow-throated Warblers did not cause sympatric Pine Warblers to change their foraging patterns. The difference in heights frequented by Pine Warblers at the two locations can be explained as a function of the structure of the two forests. While females at Cedarville foraged more frequently in the peripheral parts of trees than their counterparts at Shad Landing, this trend runs in the opposite direction of what would be predicted if Yellow-throated Warblers were affecting their foraging patterns (see Ficken et al., op. cit.). As Pine Warblers at Shad Landing usually are socially dominant to Yellow-throated Warblers in encounters (Ficken et al., op. cit.), such a finding is not surprising. Pine Warblers prevailed over Yellow-throated Warblers in each of the 11 fights, chases, or supplanting attacks observed, this difference being highly significant ($P = 0.001$ in a two-tailed binomial test). Socially dominant species

seldom change their patterns of resource exploitation appreciably in response to socially subordinate species (Morse, in press).

Comparison of males and females suggests a pattern different from the one seen among species of *Dendroica* in spruce forests, where four or five congeners may occur. There males usually forage considerably higher than their females (Morse, Ecology, 49:779–784, 1968), a difference that is highly correlated with the areas in which other important activities are carried out by them (singing in the treetops by males, nesting at low to medium heights by females). While differences in the foraging heights of male and female Pine Warblers are not significant, females tended to forage slightly higher than males both at Cedarville and Shad Landing. Foraging of females centered near the height at which nests were found in the study areas (9 ± 1.0 m, $N = 5$). The low density of vegetation in pine forests relative to that of spruce forests should lower the advantage of singing in the tops of pines (vocalizations should not attenuate so rapidly) and hence the advantage to males in frequenting these areas (see Ficken and Ficken, Living Bird, 1:103–122, 1962). Male Pine Warblers in fact do much of their singing in the midst of foraging bouts. Males are usually socially dominant to females (12 out of 15 male-female encounters; $P = 0.036$ in a two-tailed binomial test); therefore it seems unlikely that females were excluding males from preferred locations. Smaller numbers of data upon Yellow-throated Warblers indicate that the two sexes use virtually idntical foraging positions, the foraging profile for this species in Ficken et al. (op. cit.) thus serving as an accurate indicator for both sexes.

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Common Grackle kills a Barn Swallow.—During a field trip on 13 May 1973 at Joliette, Quebec, I saw a mixed flock of swallows flying over a small pond surrounded by a fence and some coniferous trees. The day was sunny and the wind light. Some Barn Swallows (*Hirundo rustica*) were resting on the ground near the water, for no apparent reason. While I was watching the swallows, a Common Grackle (*Quiscalus quiscula*), searching for food at the water edge, moved up to one of the birds and struck it on the head with its bill. The swallow gave a few wing-flaps, but died immediately. A few moments later the grackle attempted to fly away with its victim in its bill, but it dropped the swallow in the water and did not try to recover it. My examination showed the swallow had been struck just over the orbit.

Among the many reports on Common Grackles attacking small birds, the most frequent victims are House Sparrows (*Passer domesticus*), both young (Gowanlock, Bird-Lore, 16:187–188, 1914; Davis, Auk, 61:139–140, 1944; Mayfield, Wilson Bull., 66:271, 1954) and adults (Hennessey, Ottawa Naturalist, 30:114–115, 1916; Mayfield, op. cit.; Taylor, Auk, 75:222–223, 1958). According to Townsend (in Bent, U.S. Natl. Mus., Bull. 211: 408, 1958) adult American Robins (*Turdus migratorius*) and the Gray-cheeked Thrush (*Catharus minimus*) are also recorded as victims. In addition, an adult Dickcissel (*Spiza americana*) (Baird and Smith, Wilson Bull., 77:195, 1965), a young Cedar Waxwing (*Bombycilla cedrorum*) (Fisk, Wilson Bull., 82:465, 1970), and two benumbed Pine Siskins (*Spinus pinus*) have also been recorded as killed by grackles. Finally, Christofferson (Bird-Lore, 29:119, 1927) reports a grackle killing a young Barn Swallow, but without saying if the latter could fly or not.