rophanes to stake out a space in the tree and systematically to feed on foraging insects. The arthropods are probably a rapidly renewing resource that is difficult to harvest, but which pays a relatively high nutritional reward. Renewal may be so rapid as to be "instantaneous"—making the resource temporally stable, quite unlike the rapidly depleted and slowly renewing nectar resource. The sedentary and aggressive characteristics of *Chlorophanes* may reflect the most economical foraging strategy.

I can only speculate as to why my limited Panamanian observations are so radically different from those I made in New Guinea. The birds that regularly visit flowering trees in New Guinea are more diverse and include many birds that are much larger than the honeycreepers. The Panamanian species all resemble the *Myzomela* honeyeaters—a small specialized subset of the diverse New Guinea assemblage. The majority of flower-visitors in New Guinea are only opportunistically nectivorous; most spent their time gleaning insects from the flowers and foliage (pers. obs., unpubl. data, Terborgh and Diamond 1970). Probably the level of insectivory makes cohabitation in the tree more difficult (as with *Chlorophanes*). The result in New Guinea is higher levels of aggression. The 2 specialized New Guinean groups, the lories and *Myzomela* honeyeaters, have probably been unable to form cooperative alliances (as in Panama) because of the effect of continual interference from aggressive and solitary species that share the feeding trees.

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Foraging by Yellow-bellied Sapsuckers in central Illinois during spring migration.—Yellow-bellied Sapsuckers (*Sphyrapicus varius*) breed throughout the coniferous and deciduous forests of the northeastern United States and Canada, and overwinter primarily in the southeastern U.S. (Howell, Auk 70:118–126, 1953). They regularly pass through the deciduous forests of central Illinois during spring and fall. In this note, I report on observations made on the foraging of these birds during the springs of 1974 and 1975.

My first 2 study areas were located in Hart Memorial Woods along the Sangamon River near Mahomet, Champaign Co., Illinois. The woods contained 2 distinct areas—a relatively dry upland (9.6 ha) and a wetter flood plain (3.4 ha). My third study site, called Briarwood (6.2 ha), was an open, pastured woodlot. A detailed analysis of vegetation composition and vertical structure for all 3 areas is presented in Williams (Ph.D. thesis, Univ. Illinois, Champaign, Illinois, 1977). Root et al. (Trans. Ill. State Acad. Sci. 64:27–37, 1971) provide a description of seedlings and saplings.

Hart upland, containing 565.3 trees/ha, was dominated by white (*Quercus alba*), black (*Q. velutina*) and red (*Q. rubra*) oaks. The floodplain area (239.9 trees/ha) was dominated by silver maple (*Acer saccharinum*). Briarwood, with the fewest trees (24.2/ha), contained mostly bur oak (*Q. macrocarpa*), shagbark hickory (*Carya ovata*) and white oak.

I examined the foraging of Yellow-bellied Sapsuckers by quantifying: (1) activity of the bird; (2) tree species occupied; (3) height of bird in tree; (4) condition of substrate (dead or alive); and (5) limb diameter, at signals given every 10 sec by an electronic metronome (Weins et al., Ecology 51:350–352, 1970). Observations were begun in March and ended in

TABLE 1

THE PERCENT USE BY YELLOW-BELLIED SAPSUCKERS OF TREE SPECIES IN 3 HABITATS IN CENTRAL ILLINOIS DURING SPRING

Tree species	Availability[a]	1974	1975
	Hart upland		
		N = 852	N = 608
Shagbark hickory	†	16.2	67.9
Mockernut hickory (*Carya tomentosa*)	†	54.5	17.3
Bitternut hickory (*C. cordiformis*)	0.02	12.1	3.1
Red, black oak	0.57	6.8	2.4
White oak	0.35	8.1	6.6
Other	0.04	3.2	3.7
	Hart lowland		
		N = 326	N = 372
Bitternut hickory	0.02	26.4	64.2
Maple	0.26	33.4	18.5
Black walnut	0.03	23.0	4.6
Cottonwood (*Populus deltoides*)	†	8.6	4.0
Other	0.67	8.6	8.7
	Briarwood		
		N = 585	
Shagbark hickory	0.14	92.7	—
Mockernut hickory	†	1.1	—
White oak	0.03	3.1	—
Other	0.43	3.1	—

[a] Availability index values are the proportion of the total basal area/ha for each species; Chi-square values for comparisons between trees available and trees occupied = 1095.6 (df = 5), 907.3 (df = 5) for 1974 and 1975 in Hart upland, respectively; in the lowland, values equal 288.1 (df = 4) for 1974 and 396.8 (df = 4) for 1975; in Briarwood for 1974, Chi-square = 668.5 (df = 3); $P < 0.005$ in all cases.

† Values less than 0.01.

mid-May for both years. I visited each study area at least every other day when Yellow-bellied Sapsuckers were present. After an individual was located, I timed the bird up to 5 min and then searched for a new bird. This method reduced my sample size somewhat, but it also reduced bias by including observations from as many different birds as possible.

The number of individuals observed during the course of this study is difficult to estimate. Assuming that birds left after spending only 1 day in an area, I timed 37 and 50 different birds in 1974 and 1975, respectively. Comparisons of data were tested for significance ($P < 0.05$) by Chi-square contingency analysis. Percentages of sugar in sap were transformed using the arcsine transformation and tested for overall significance with ANOVA. Means were compared using the Newman-Keuls test (Zar, Biostatistical Analysis, Prentice-Hall, Englewood Cliffs, New Jersey, 1974).

During migration Yellow-bellied Sapsuckers foraged almost totally on the exudate of trees.

TABLE 2

THE RATE OF FLOW AND PERCENT SUGAR OF EXUDATE FROM TREES IN HART WOODS

Tree species	Flow rate	% sugar $\bar{x}$ (±SE)	N	Significant difference at $P < 0.05$[a]
1. Shagbark hickory	+	10.1 (±0.85)	10	3, 4, 5, 6
2. Bitternut hickory	+	11.1 (±0.87)	10	3, 4, 5, 6
3. Mockernut hickory	+	6.4 (±0.71)	8	2, 4, 5, 6
4. Sycamore	+++	1.3 (±0.16)	3	3, 2, 1
5. Black walnut	+++	1.7 (±0.1)	8	3, 2, 1
6. Hop-hornbeam	+++	1.2 (±0.1)	5	3, 2, 1
7. Maple	+++	2–4[b]	—	—

[a] Numbers refer to trees in the "Tree species" column; mean values that were different from the species on left are given in right hand column.

[b] Maples did not yield sap when drilled 15 April 1979; I suspect they had "run" earlier; data from Marvin (The physiology of maple sap flow. Pp. 95–124 *in* The Physiology of Forest Trees, K. V. Thimann, ed., Ronald Press, New York, New York, 1958).

+ = light flow, ++ = moderate, +++ = heavy.

Pooled data from both years and all 3 areas showed they drilled rows of holes in trees 25% of the time and probed for sap 18% of the time (also see Tate, Auk 90:840–856, 1973).

Yellow-bellied Sapsuckers did not forage randomly, but rather concentrated their foraging on a narrow range of trees (Table 1). Notably, birds preferred hickory trees in all 3 areas. In another study, I reported similar observations (Williams, Am. Midl. Nat. 93:354–367, 1975). Additionally, they selected maple and black walnut (*Juglans nigra*) trees in the lowland. In the spring of 1975 (March–April), I mimicked sapsucker borings in the dominant tree species in Hart Woods at biweekly intervals (N = 5 for each species) and found that some trees exuded large volumes of sap, especially maples, black walnuts, sycamores (*Plantanus occidentalis*) and hop-hornbeams (*Ostrya virginiana*). Hickory trees consistently yielded only small volumes of exudate and oaks, ashes (*Fraxinus* sp.), elms (*Ulmus* sp.) and hackberries (*Celtis occidentalis*) exuded no sap at all. Unfortunately, I did not test for sugar concentration at this time. If sap wells in hickories do not produce as much sap as do holes in some other trees, then why do Yellow-bellied Sapsuckers forage more often on them? I hypothesized that the caloric reward in hickory sap is higher, making it a preferred food. To test this idea, I returned to Hart Woods on 15 April 1979, drilled holes (3 mm wide × 10 mm deep) in the limbs and trunks of all tree species in the woods, and measured the exudate with a hand refractometer. I qualitatively estimated the flow rate of those trees that yielded sap from borings made not only on 15 April 1979, but also during the spring of 1975. From this analysis, the exudate from hickory trees contained more sugar than did other species that yielded sap (Table 2, $F_{5,38} = 63.0$, $P < 0.001$), but flowed less. These data support the hypothesis.

The flow of sap from wounds in trees is a complex process influenced by the species of tree, weather, season and time of day (Zimmermann, The Formation of Wood in Forest Trees, Academic Press, New York, New York, 1964). Some tree species develop a positive pressure in their xylem vessels in early spring and, when punctured, yield large volumes of relatively dilute xylem sap (2–4% sugar), while other species exude relatively concentrated sap (10–20% sugar) from phloem cells in small amounts (Zimmermann, pers. comm.; Milburn

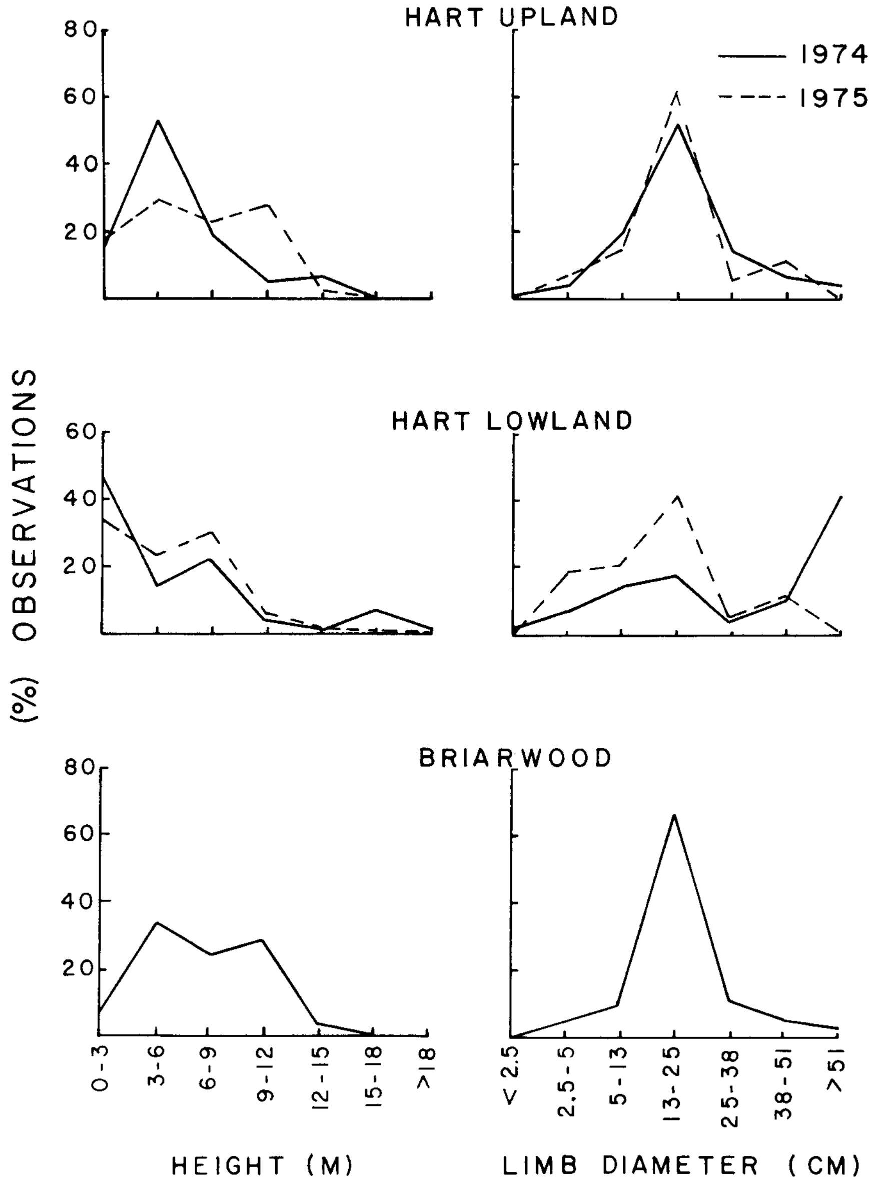

FIG. 1. Percent observations for height categories and limb sizes used by the Yellow-bellied Sapsucker during spring migration.

and Zimmermann, Principes, J. Palm. Soc. 18:67–68, 1974). The higher concentrations of sugars in hickory sap may indicate that sieve tubes of the phloem are, at least in part, the source; whereas the dilute sap of maples, black walnuts, sycamores and hop-hornbeams probably comes principally from xylem vessels. From borings made in trees (maples, elms, hackberries and red oaks) used by Yellow-bellied Sapsuckers in spring in Michigan, Tate (1973) found the sugar concentration of the sap to average about 3%. Kilham (Auk 81:520–527, 1964) reported that birches (*Betula* spp.) are the main sources of sap for Yellow-bellied Sapsuckers in summer in central New Hampshire, and found that phloem exudate from yellow birch (*B. lutea*) contained about 19% sugar.

Yellow-bellied Sapsuckers preferentially used the lower and middle height categories in all 3 study areas (Fig. 1). Moreover, they most often exploited living limbs in the 13–25 cm range in all 3 areas, but also used trunks of trees in the lowland. Larger limbs at lower heights may yield more sap per unit time for the birds.

Apparently Yellow-bellied Sapsuckers forage on hickory trees during spring migration because the exudate is relatively high in sugars. Why they forage in the middle and lower portions of the canopy on larger limbs needs further study, but at least for hickory trees, the phloem may be thicker in this region and thus the flow rates of exudate possibly higher.—JOSEPH B. WILLIAMS, *Dept. Natural Science, Pepperdine Univ., Malibu, California 90265.* (Present address: *Dept. Biology, Joseph Leidy Laboratory of Biology G7, Univ. Pennsylvania, Philadelphia, Pennsylvania 19104.*) *Accepted 16 Oct. 1979.*

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Mallards capture and eat American toads.—For more than 2 years I have kept Mallards (*Anas platyrhynchos*) in cages at the edge of a pond in the deer enclosure at the Field Station for the Study of Animal Behavior, Duke University, Durham, North Carolina. In addition to the caged ducks, 7 females and 3 males released in summer 1978 remained on the pond, and they spent much of their time near the cages.

As my son, Karl, and I approached the pond at 10:45 on 1 April 1979, we heard a chorus of the common American toad (*Bufo americanus*). The sky was clear and the temperature an unseasonally warm 25°C. We could see 30 or 40 toads in the shallow water near the duck cages, but when we approached for closer examination, the toads moved out from land. No duck showed any interest in the toads at the time.

The chorus continued, and we noticed that the larger toads were floating in the water with their legs outstretched. They retained this position and remained immobile as we approached; they were still too far from land to catch without a net.

At 11:30 Karl observed a female Mallard catch a large toad in the water. Immediately a male Mallard tried to take it from her, and there was a tug-of-war over the prey. The female maneuvered the immobilized toad into position in her mouth, the toad's legs dangling from the sides of her bill and after several attempts succeeded in swallowing it head first. The activity excited 4 other female ducks and another male; there were 7 ducks stalking, catching and swallowing toads. Male Mallards relied more on stealing toads from females than on capturing their own. A toad captured from behind was immobilized by being beaten on the surface of the water, after which it was manipulated in the mouth until it could be swallowed head first. Swallowing required considerable effort because of the large size of the toads; it usually took place in the water, but 1 male Mallard carried a toad onto land and swallowed it there. In 15 min the ducks caught and consumed at least 12 toads. They abruptly stopped feeding on toads and moved out toward the center of the pond at about 11:45.