Tree Trunk Arthropod Faunas as Food Resources for Birds[1]

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ABSTRACT. **The composition, abundance, and relationship to trunk-surface characteristics of the tree-trunk surface arthropod fauna were studied from August, 1984 to January, 1985 in a beech-maple forest in southwestern Ohio. Samples of trunk-surface arthropods were taken monthly from American beech and sugar maple trees. Although resource levels on the two tree species did not differ significantly, arthropod resource levels were dynamic, changing monthly in magnitude and composition. Live arthropods became progressively less abundant as winter approached; non-living/dormant items did not. Results suggest that trunk surface characteristics offer foraging birds few reliable clues about arthropod resource levels.**

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INTRODUCTION

Many bird species, such as woodpeckers, nuthatches, and creepers, spend much of their time gleaning food from the bark of trees. Numerous studies of the feeding behavior of bark-gleaning birds have documented differences in niche dimensions both between and within species (e.g., Kilham 1965, Jackson 1970, Williams and Batzli 1979) and in space and time (e.g., Travis 1977), indicating that characteristics of the resource base may affect avian foraging behavior. Jackson (1979) reviewed factors potentially affecting trunk arthropod abundance, including tree species, bark texture, tree injury, and presence of mosses, lichens, and fungi.

Several theoretical works (e.g., MacArthur and Pianka 1966, Charnov 1976, McNair 1982) model the behavior of foraging animals, and predict the relationship between foraging behavior and characteristics of the resource base. Nevertheless, the relationship between foraging behavior and resources available is not well understood (Johnson 1980, Smith 1982). Studies of other foraging guilds (e.g., Goss-Custard 1970, Feinsinger 1976) incorporating both foraging behavior and resource availability have led to an improved understanding of factors affecting foraging behavior. However, there have been few studies of the foraging behavior of bark-gleaning birds in relation to resources.

This study assessed arthropod density and faunal composition, and their relationship to trunk-surface characteristics of trees in order to determine whether features of trunk surfaces might serve as indicators of arthropod abundance. This information is important to evaluation of the applicability of various optimal foraging models to bark-gleaning birds. If birds are able to assess trunk resources from a distance, then optimal patch-choice models (e.g., MacArthur and Pianka 1966, Pyke et al. 1977) would be useful. On the other hand, if birds have to visit a trunk to assess its resources, then patch-choice models would not be relevant, and information on exploitation must be incorporated (e.g., Charnov 1976).

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MATERIALS AND METHODS

We sampled resources on tree trunks monthly from August, 1984 to January, 1985 (except December, 1984) on two 6.1-ha study sites in a beech-maple forest in Hueston Woods State Park, Preble County, Ohio (see site descriptions in Beissinger and Osborne 1982). We chose American beech (*Fagus grandifolia*) and sugar maple (*Acer saccharum*) for study because they are by far the dominant tree species in the study areas (Sperger and Peterson, unpubl. data), and because they have different bark morphology.

Several techniques have been used to sample arthropods on tree trunks, including sticky traps (Roling and Kearby 1977), x-ray analysis (Coulson et al. 1979), circular bark punch inspection (Furniss 1962), and visual inspection (MacLellan 1959, Jackson 1979). Despite potential problems with comparability of studies based on the work of different collectors, in our opinion, questions regarding resource abundance are best addressed by visual inspection. Visual inspection allows assessment of abundance of non-mobile (e.g., dormant insects, egg cases) and non-living (e.g., food items in spider webs) materials that the other methods would miss. Also, resources detected visually should be a more representative sample of those found by birds using visual search. Methodology for gathering quantitative data on trunk resources described in Jackson (1979) has received little attention, despite the potential importance of such information to studies of avian foraging behavior.

Each month, at each of nine sample points located on a grid on a map of each site, we inspected one trunk of each tree species (except in January, 1985, when sample sizes were seven per species). Only live, uninjured trees larger than 8 cm in diameter at breast height (dbh) with no brush or shrubs near the base were sampled. The grid of sample points was shifted 50 m monthly in one of the cardinal directions within each site to avoid sampling any tree twice. One of us (A.T.P.) did the sampling in order to avoid having to account for variance owing to different collectors' abilities.

At each tree, during a 3-min sampling period, we collected all arthropods, cocoons, food items in spider webs, and arachnid egg cases with forceps and an aspirator. (We did not use a fixed-size sample area because preliminary sampling indicated that this often led to missing widely scattered items altogether, thus considerably underestimating densities. Also, rough areas required more intensive searches in order to find all potential food items, thus allowing less area to be searched.) We recorded area searched, dbh, texture of bark searched (estimated % smooth — furrows <0.5 cm deep; % broken — furrows 0.5-1.0 cm deep; and % rough — furrows >1.0 cm deep), and percent coverage by mosses and lichens (visually estimated). Although samples from different heights would have been more informative, due to time limitations all collections were made 0.75-1.5 m above the ground.

All arthropods collected were identified to order, dried to constant weight (>48 h at 65 ∞ C), and weighed to the nearest 10^{-5} g with an analytical balance (Mettler H542). Weights of arthropods were later converted to dry-weight energy equivalents (in J) with data from Cummins and Wuycheck (1971). Because information on energy equivalents for cocoons and arachnid food masses and egg cases was not available, these items are reported in terms of mg dry weight.

To allow comparison of samples, we converted resource levels to J or mg per unit area searched. For analyses in which data from several months were combined, we further standardized resource levels by dividing the resource level on an individual tree by the mean resource level of all samples for that tree species and month. For months in which live arthropods were sufficiently common (August-October), we calculated the abundances of arthropod taxa as "importance percentages," which are averages of relative frequency, relative density, and relative dominance (in terms of biomass) in the monthly sample.

RESULTS AND DISCUSSION

Total arthropod density on beech and maple trunks (Fig. 1) declined significantly as winter approached (resource level regressed by month, beech: $r^2 = 0.874$, $P < 0.05$; maple: $r^2 = 0.763$, $P = 0.05$). Density of cocoons and arachnid food masses and egg cases on the trunks (Fig. 2) did not decline as winter approached (beech: $r^2 = 0.060$, $P > 0.5$; maple: $r^2 = 0.226$, $P > 0.4$). Neither live arthropod abundance nor abundance of other materials was significantly different (t-tests, $P > 0.05$ in all comparisons) between tree species in any month. High variances (coefficients of variation for live arthropod density estimates ranged from 0.54-9.00) indicated a highly uneven distribution of resources.

Differences in faunal composition between tree species and over the six months of the study were evident (Fig. 3). (No statistical tests were performed because of low sample sizes and because of the unusual nature of the importance percentage index.) For example, phalangids dominated the community in August, but became less common in September and October. Abundances of araneids and dipterans remained fairly constant through the study period.

Trunk-surface characteristics differed between tree species. Beech trunks (N = 108) averaged 78.5%

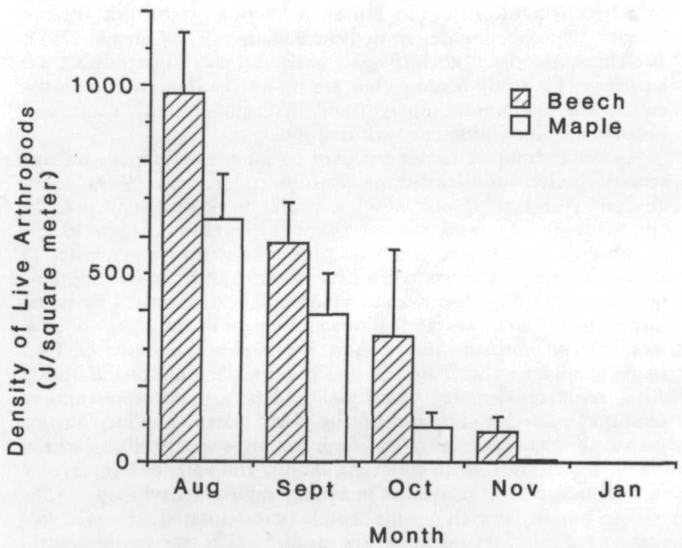

FIGURE 1. Mean monthly densities of live arthropods (J · m^{-2} ± 1 SE) on trunks (>8 cm dbh) of American beech and sugar maple trees.

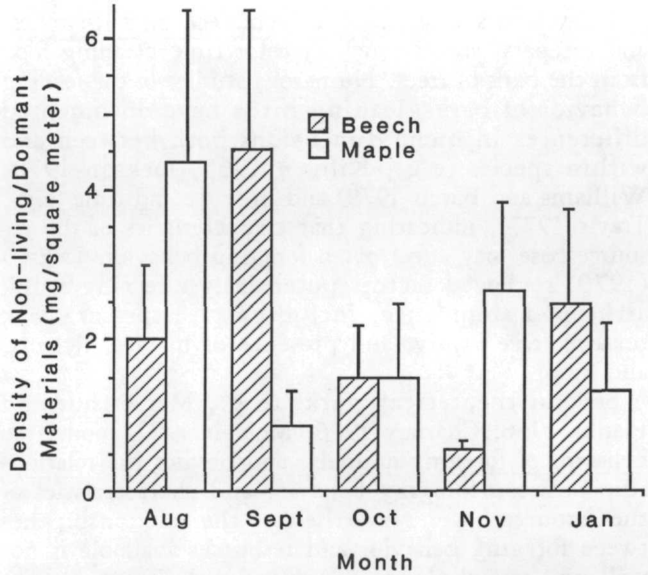

FIGURE 2. Mean monthly densities of non-living/dormant materials (cocoons, egg cases, and arachnid food masses; mg · m^{-2} ± 1 SE) on trunks of (>8 cm dbh) American beech and sugar maple trees.

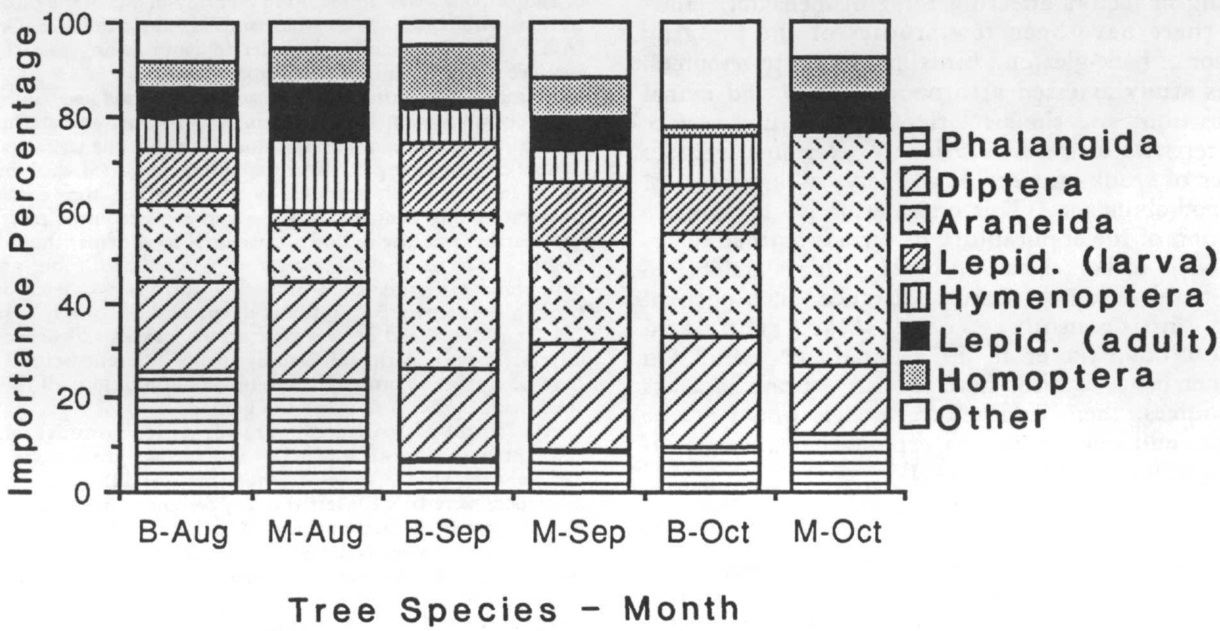

FIGURE 3. Importance percentages (i.e., sums of relative frequency, relative density, and relative dominance) for live arthropods on trunks of American beech (B) and sugar maple (M) trees from August through October, 1984.

smooth, 19.1% broken, and 2.4% rough; maple trunks (N = 108) averaged 4.7% smooth, 85.0% broken, and 10.2% rough. Beech trunks averaged 1.7% coverage by mosses and 2.5% coverage by lichens; maple trunks averaged 5.1% coverage by mosses and 6.6% coverage by lichens.

Resource levels were not correlated with either bark texture or cover by mosses or lichens on either tree specied ($P > 0.05$, in both cases). To confirm the lack of correlation, we made scatterplots for each variable and tested high vs. low categories with t-tests in each tree species; no differences were significant. Resource levels (both living and non-living/dormant materials) were significantly ($P < 0.05$) negatively correlated with tree diameter on beach trunks, but not on maple trunks.

Jackson (1970, 1979) suggested that rough-barked tree trunks offer a more suitable overwintering environment to invertebrates than smooth trunks. Results of this study suggest, however, that such microclimatic differences are not directly reflected in differences in resource density, as no significant differences in resource density were found between two tree species which differ in bark texture. In addition, no significant correlations were found between resource levels and bark texture within tree species.

This study summarizes patterns of change in the tree trunk arthropod fauna on two tree species over a six-month period. Although a more complete view of patterns of variation in this fauna as a resource for foraging birds would be provided by data from additional tree species and years, some interesting results were obtained. Contrary to the suggestions of Jackson (1979) and Travis (1977), the results of this study suggest that trunk-surface characteristics offer foraging birds few clues about resource levels. Rather, it appears that a bird must actually visit a tree trunk in order to assess its resource levels. For this reason, we suggest that optimality of avian bark-gleaning patterns is best analyzed with optimal patch-exploitation models (Charnov 1976, McNair 1982, Lima 1983, 1984) rather than patch-choice models (MacArthur and Pianka 1966, Pyke et al. 1977).

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