Frugivory by Birds: Red Elerberries (*Sambucus pubens*) in Northern Michigan

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INTRODUCTION

The relationship between birds and fruit can be viewed from two viewpoints: 1) the role of the fruit in the bird's life, and 2) the role of the bird in the plant's life. Two groups of people, ornithologists, and botanists have looked at this relationship from these two vantage points, but little synthesis has taken place between them.

Studies by ornithologists have concentrated on determining the diet of various species of birds, either by examening stomach contents (Martin, et al.,1951), or direct observation (Shultz,1975,1978). These studies have attempted to determine the role of fruits in the diets of birds, and hence their role on the population dynamics of birds. Although they have realized the possible role of fruit-eating in the plant populations, these ideas have not been tested in conjunction with observations.

Other investigations (Swank,1944; Kreting and Roe,1949; and Roessler,1936) have experimentally investigated the effect on germination of seeds passed through birds, but there has been no correlation between the birds observed consuming the fruit in the field, and those used experimentally.

Ornithologists have also recognized the possible role of birds in plant dispersal, but although McAtee (1947) lists more than one hundred references on bird dispersed seeds, all of the work done to date has been anecdotal and inconclusive.

Botanists and plant population biologists have examined the relationship between birds and fruit from the impact that the birds have on plant population dynamics.

The bird is viewed variously as a predator,disperser, and a necessary element in the germination of seeds (Harper,1977). Predation of fruit is detrimental to plant populations only if the seed is destroyed. Fruit predation may, however, be a disperal mechanism. The assumption is often made (Snow,1971) that the selective pressure in the evolution of fleshy fruits has been the attraction

of animal dispersers. This assumption is often made, but no studies have linked: 1) field observations of frugivory by birds, 2) experimental studies on the effect of feeding on seed germination, and 3) a study of the dispersal of seeds, in order to see if this system oft quoted actually occurs. Only if it does happen in the field- that birds are attracted to fruits, feed on them, disperse the seeds, and have a neutral, or beneficial effect on their germination, can one speculate on the evolutionary history of the system.

This study was designed to examine two components of that system: 1) observations on fruit-eating by birds, and 2) experimental studies on the effect on the germination of seeds which had passed through the birds. Due to experimental difficulties, only the observational studies were completed, and will be reported. An examination and synthesis of the previous literature will be made, and speculations on the role that birds and fruit have had on each other's evolution will be presented.

METHODS

Three shrubs of Red-berried elder (Sambucus pubens) were observed near Sturgeon Bay, Emmet Co., Michigan for 15 hours from 21 July through 1 August 1979. The shrubs were located along Lake Shore Drive, approximately ½ mile from Lake Michigan. The three shrubs formed a continuous row three meters in height and six meters long. The shrubs were exposed, located at the edege of a hemlock-white pine forest.

Sambucus pubens produces bright red fruit in mid to late summer. The fruits are berry-like drupes, 4-6 millemeters in diameter, each containing 3-5 seeds (Gleason and Cronquist,1963). The fruit are clustered in terminal panicles and are readily visible against the dark leaves.

Observations were made either from an automobile ten meters from the shrubs, or from the woods across the road from the shrubs, at a distance of five meters. All observations were made with 10x 50 binoculars, and the time of arrival, identification of the bird, behavior, and length of feeding noted for each bird visit. All successful observations were made in the mornings, between 6:30 and 10:00.

Observations were made in the afternoon and early evening, but no birds visited the shrubs. This may have been due to the relatively heavy traffic on the road at these times (approximately one vehicle

per five minutes). Bird activity in gerneral was much lower at this time compared to morning observations. Thus it may be that the birds fed only in the morning on the shrubs. Not enough time was spent obseving in the evening, however, to make any conclusions.

In an attempt to observe frugivory by birds on other fruit species, observations were made on the following shrubs: serviceberries (Amelanchier sp.), raspberries (Rubus sp.), blueberries (Vacinnium angustifolium), and choke cherries (Prunus virginiana) for a total of eight hours. Only one bird, a Blue Jay (Cyanocitta cristata) was observed feeding on any of these fruits (blueberries). Casual observation, however,. noted Cedar Waxwings (Bombycilla garrulus) feeding on serviceberry on several occassions, and a nesting study done at the same time near this study site revealed that serviceberries were the major food fed by Waxwings to their young (Kathy Bishop, personal communication).

OBSERVATIONS

Althogh the fruit of Sambucus pubens was ripe on 21 July, no feeding was recorded until 26 July. Ninety percent of the fruit was removed in eight days, from 27 July to 3 August.

A total of forty-seven visits were recorded, with the average feeding time of 52 seconds. Seven species of birds, representing two orders (Piciformes and Passeriformes) and seven families (Picidae, Tyrannidae, Turdidae, Vireonidae, Icteridae, Thraupidae, and Fringillidae) were observed eating the fruit (Figure One). Two species, Veery (Hylocichla fuscescens) and Downy Woodpecker (Dendrocopos pubescens), accounted for 61% of all visits, while the remaining five species, Reose-breasted Grosbeak (Pheucticus ludovicianus). Scarlet Tanager (Piange olivacea), Red-eyed Vireo (Vireo olivaceus), great Crested Flycatcher (Myiarchus crinitus), and Northern Oriole (Icterus galbula) accounted for 39% of the visits.

Peak feeding time was from 9:00-10:00 (Figure Two), although this distribution may be biased by unequal sample sizes. No differentiation in feeding time among the differnt species can be determined (Figure Three).

Most visits were made by the bird flying across the road to the bushes, although often an individual moved back into the woods behind

the shrubs, then returned to feed on the shrubs.

Feeding behavior was similar in all species in that they all swallowed the fruit whole. Most flights were initially made to the center of the shrubs, and the bird moved out as it fed. Scarlet Tanagers, Rose-breasted Grosbeaks, and the Northern Oriole fed well exposed, perched upright. The Downy Woodpeckers were the most exposed when feeding. Typically they flew into the shrubs, and waited on the trunk. After several minutes, they would hop out to the terminal clusters of fruit and feed upside down. The other species of birds fed more often on the interior of the shrubs.

Male and female Scarlet Tanagers, and Downy Woodpeckers fed on the fruit, often within several minutes of each other, but never were the two sexes of one species on the shrub at one time. Individuals of different species did, however, feed simultaneously. Once a Rose-breasted Grosbeak, Veery, and Red-eyed Vireo fed within four meters of each other.

Average feeding time per visit varied from 17 seconds (Red-eyed Vireo) to 142 seconds (Rose-breasted Grosbeak) (see Table One).

Ten other species of birds were seen or heard in the area, but were not seen feeding on the shrubs (Figure Four).

DISCUSSION

Red elderberries provide an abundant, and choice item in the diets of many different bird species. This is evidenced by the intense feeding activity over a brief period of time, during which virtually all of the fruit was consumed. This has immediate implications for both the birds and the plant.

All seven species of birds observed eating the fruit are considered primarily insectiverous (Martin, et al.,1951). Fruit are considered to be a minor portion of their diet during the entire year. Only when fruit is abundant do they briefly become mainly frugivorous. The Downy Woodpeckers observed appeared to become totally frugivorous, for although they were often in the area, and fed frequently on elderberries, only once were they heard drilling wood for insects.

Temperate latitudes could not support many birds specialized on fruits - for very few remain available throughout the winter.

Thus it appears that temperate latitude birds feeding on fruits are opportunistic in ther feeding habits.

Because virtually all of the fruit was removed from the shrubs, an obvious implication for the plant is that at least some seeds must have potential for germination after passing through a bird's gut, if the birds are dispersal agents.

A planned part of this project was to feed elderberries to a captive bird of a species observed eating the fruit in the field, and to then collect seeds which had passed through the bird. Germination tests, using uneaten fruits as a control, would determine the effect on the seeds from being passed through the bird gut. The adaptive significance of increased germination of those seeds that passed through birds might be an insurance that germination would occur away from the parent plant, and not en masse underneath, where germination of many young might be a strain on limited resources in the soil. Unfortunately, a bird was never obtained for these studies.

Some previous work has been done in this area, however (Sayle,1924; Roessler,1936; and Krefting and Roe,1949). Unfortunately, no correlation was made in these studies between the fruit used and the species of bird which fed upon them in the field. The results are mixed- some species had increased germination, some decreased, and some unchanged, using different species of birds.

Another problem with these studies is that because the germiation rquirements of the seeds is unknown, the percentage of both test and control seeds that germinate is so low as to make comparissons very difficult.

If such problems could be solved and they could with a fair amount of work, then the final assumption- that of dispersal could be tested. This is by far the most diffecult step to test. Obviously birds defecate away from the shrub, but where, and how far away? These are questions which need answers to determine the role of birds as dispersers. Perhaps observational studies of radio-tracked birds would give an approximate answer. Knowing the amount of time that seeds require to pass through a bird, coupled with accurate records of their travels within a period might be one way of determining these

dispersal capabilities.

Once the entire system is demonstrated to occur in the field, one may begin thinking and speculating on the evolution of the system, and its implications for both birds and plants.

Before discussing the selective advantages of a dispersal mechanism, it is desirable to document that the characters which confer the advantage are heretible and can be selected. On the part of the plants, evidence comes from the recent and rapid evolution of crop mimic weeds which have evolved crop-specific strains of different dispersal mechanisms to ensure that the seeds stay with the crop (Stebbins,1950).

Accepting the yet unproved hypothesis that fleshy fruits are adapted for dispersal, one may examine the features of fruit which confer a selective advantage upon them. These include attractive coloration, accesibility. and adequate food value to bird.. Selective forces would produce brightly colored fruits, especially red, the most sensitive portion of the color spectrum to birds, seen in many fruits; easily accessible fruits, exhibited by the terminal positim of many fruits on branches, and high nutrtive content, but not too much as to strain the resources of the plant.

The evolutionary consequences of frugivory in birds maybe:1) why, when available, fruit will play a prominent role in the diets of birds normally insectiverous, and 2) producing greater specialization among insectiverous birds than in frugivorous species.

Natural selection will tend to promote abundance and visibility in fruit, but the pressure will be the opposite on insects, producing more cryptic, and therfore less available food. The availability may thus cause birds to switch diets in time of fruit abundance, as demonstrated in this study.

Because it is a strategy of fruit to be readily conspicuous, and to have many dispersal agents, frugiverous birds should have broader niches than insectiverous birds because of their greater difficulty in obtaining insects. Snow (1971) makes this comparisson using frugivorous neotropical passerine families (Cotingidae and Piperidae) and insectiverous families (Formicariidae and Tyrannidae). The insectiverous families have two to four times as many species,

suggesting that the greater speciation in insectiverous families may be due to rather narrow diet niches.

SUMMARY

Seven species of birds were observed feeding on the fruits of Red-berried elder. The relationship between the birds and plants are considered both in an immediate context- the fruit as an abundant but ephemeral food source, the birds as dispersal agents for the seeds; and in an evolutionary context- the pressures which are responsible for fruit morphology, and implications on the feeding behavior, and diversity among frugivorous birds.

Species	Number of Feedings	Average length of time feeding/visit (second
Veery	16	30
Downy Woodpecker	12	49
Rose-breasted Grosbeak	6	142
Scarlet Tanager	5	35
Red-eyed Vireo	4	17
Great Crested Flycatcher	2	45
Northern Oriole	1	30
Total feeding visits	46	Average 52

Figure One. Birds observed eating Sambucus pubens fruit and average length of each visit.

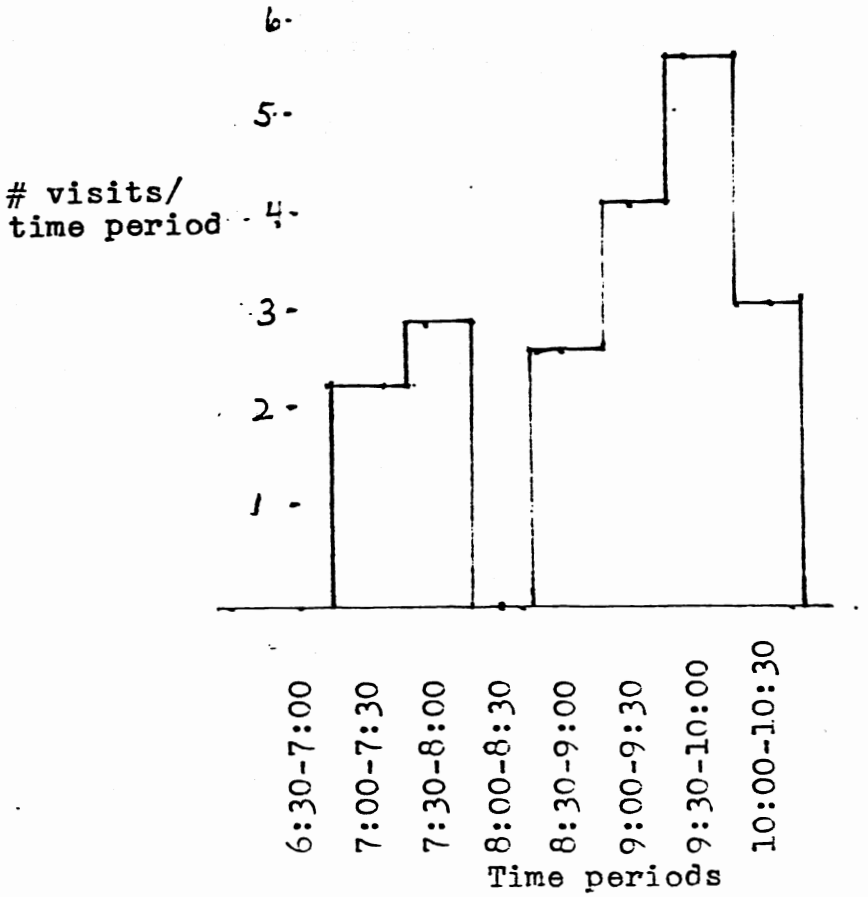

Figure Two. Distribution of visists over time.
Data are for all species.

Time Period	Bird Species	Veery	Downy Woodpecker	Rose-breasted Grosbeak	Scarlet Tanager	Great Crested Flycatcher	Red-eyed Vireo	Northern Oriole
	6:30-7:00							
	7:00-7:30	3	1	1	1			1
	7:30-8:00	3	2	2			1	
	8:00-8:30							
	8:30-9:00	1	2	1			1	
	9:00-9:30	5	3		2	2		
	9:30-10:00	4	3	2	2			
	10:00-10:30		1				2	
	Totals	16	12	6	5	2	4	1

Figure Three. Distribution of visits overtime, stratified by species.

Ruby-throated Humingbird

Eastern Wood Pewee

Blue Jay

Common Crow

Black-capped Chickadee

Cedar Waxwing

Black-and-white Warbler

Yellow-rumped Warbler

Common Yellowthroat

American Redstart

Figure Four. Birds seen or heard in the area but not observed feeding on Sambucus pubens.

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