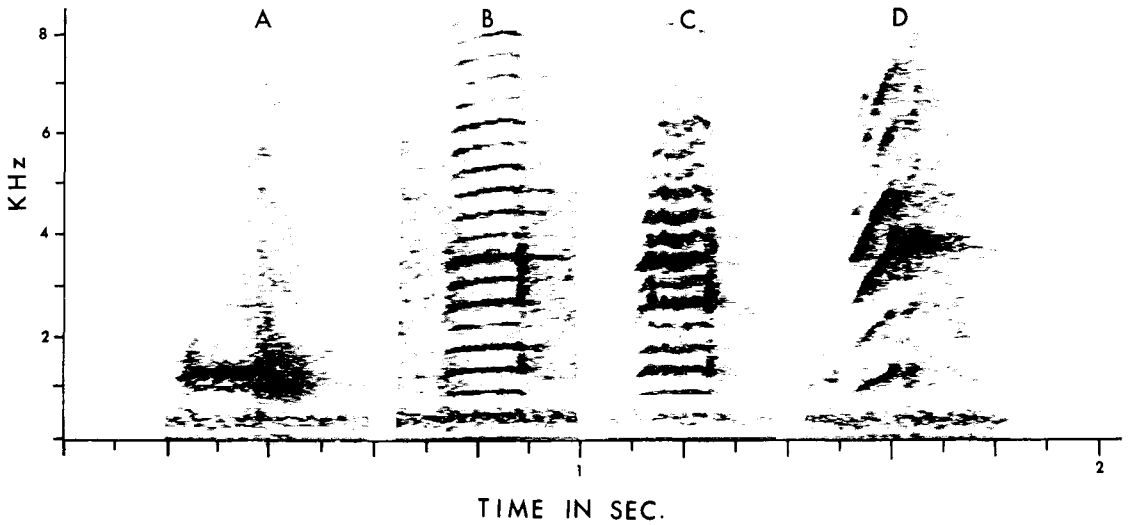

FIGURE 1. Audiospectrograms of four call notes of *Cyanocorax yucatanica* associated with attendance at swarms of army ants. A. "Foggy bell." B. Clear "Tin Horn Piping Note." C. Guttural "Tin Horn Piping Note." D. Metallic "Yelp." Technical data: recorded in the field on a Uher 4000 report tape recorder at 7.5 ips, using a parabolic reflector and an Altec 684A microphone. Analyzed on a Sona-Graph 7029A, with FL-1 and narrow band selector settings.

rufalbus), two Orange-billed Nightingale Thrushes (*Catharus aurantiirostris*), two Spotted-crowned Woodhewers (*Lepidocolaptes affinis*), and one White-throated Robin (*Turdus albicollis*). None of these displayed the intimacy of the jays to the swarm. They normally seized a prey object and retired from the scene to devour it before returning.

On 27 April 1968, 10 km SE of Compostela, Nayarit, México, I found a group of San Blas Jays at a swarm of ants on a hillside in dry, tropical deciduous woodland. The birds fled at my arrival; only afterward did I discover myself in the midst of an ant swarm at which they had been stationed. This is my only evidence that this species indulges in army ant swarm attendance. Although I studied this jay in the nesting season for 2 weeks in 1970 at Las Varas, Nayarit, no ant swarms were active in that area.

C. beecheii, the remaining form in the four-species complex of jays, remains to be studied in any detail in the wild. It will be interesting to learn whether it shares the ant-following habit with its close relatives. It will also be instructive to know if this habit has gone unnoticed in any of the other neotropical jays.

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THE EGG OF A COLLARED FOREST-FALCON

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In January 1968, a captive of the northern race of the Collared Forest-Falcon (*Micrastur semitorquatus naso*) in the National Zoological Park, Washington, D.C., a bird without a mate, laid two eggs on a crude assemblage of sticks and other nesting material in the temporary quarters in which it was housed for the winter season. One of the eggs was broken. The other came to the Division of Birds in the National Museum of Natural History. The specimen is of interest as there seems to be no authentic published record of the egg in this species (see Meise, in Schönwetter, Handbuch der Oologie, lief. 13, p. 771, 1967).

The slightly roughened shell in the specimen is dull pale buff, spotted and washed with dull chocolate, the larger dark markings forming irregular blotches over both ends of the egg. Elsewhere, the pattern of this duller shade merges in an indistinct wash that covers much of the surface. The egg measures 54.8 × 43.5 mm, and is short subelliptical in form.

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FEEDING ASSEMBLAGES OF JAMAICAN BIRDS

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The utilization of feeding trees by birds provides an opportunity to observe and to measure the degree of feeding overlap in a given community (Terborgh and Diamond 1970), and it also provides an opportunity to determine the importance of birds as agents of plant dispersal (Olson and Blum 1968). Although feeding assemblages have been investigated on the neotropical mainland by Diamond and Terborgh (1967), Leck (1969), and Willis (1966), little is known about the avian utilization of fruiting trees in the West Indian region, specifically on Jamaica, where this study was undertaken.

TABLE 1. Frequency of feeding visitations of birds to two fruiting trees, *Cecropia peltata* and *Ficus trigonata*. The number of species and individuals recorded, and the mean numbers recorded per hour at each tree.

Family and species	*C. peltata* no. of visitations	(20 hr) Mean no. visitations per hr	*F. trigonata* no. of visitations	(15 hr) Mean no. visitations per hr
Columbidae				
Columba leucocephala	—	—	3(1)	0.20
Geotrygon montana	—	—	2(1)	0.13
Psittacidae				
Aratinga nana	3(2)[a]	0.15	41(12)	2.73
Picidae				
Centurus radiolatus	31(2)	1.55	49(2)	3.25
Tyrannidae				
Tyrannus caudifasciatus	2(1)	0.10	27(2)	1.80
Cotingidae				
Platypsaris niger	—	—	5(3)	0.33
Corvidae				
Corvus jamaicensis	4(2)	0.20	2(1)	0.13
Turdidae				
Turdus jamaicensis	5(1)	0.25	55(3)	3.66
Turdus aurantius	—	—	31(2)	2.06
Myadestes genibarbis	—	—	3(1)	0.20
Vireoridae				
Vireo altiloquus	—	—	57(4)	3.80
Coerebidae				
Coereba flaveola	8(2)	0.40	12(4)	0.80
Euneornis campestris	12(2)	0.60	36(2)	2.40
Thraupidae				
Pyrrhuphonia jamaica	22(3)	1.10	56(4)	3.73
Spindalis zena	10(3)	0.50	78(6)	5.20
Piranga olivacea	1(1)	0.05	4(1)	0.26
Icteridae				
Icterus leucopteryx	31(2)	1.55	24(2)	1.60
Fringillidae				
Loxigilla violacea	—	—	45(4)	3.00
Loxipasser anoxanthus	—	—	28(2)	1.86

[a] Numbers in parentheses represent the number of individuals on which the feeding observations are based.

METHOD

This study was carried out in the Lluidas Vale (Worthy Park) region, St. Catherine Parish, Jamaica, during the spring of 1970 while the author was engaged in investigations of the Jamaican Woodpecker (*Centurus radiolatus*). The vegetation of this area is wet limestone forest (Asprey and Robbins 1953) and elevations range from 370 m in the valley to 950 m in the surrounding hills and mountains. Some of the characteristic trees are broadleaf (*Terminalia latifolia*). Jamaican cedar (*Cedrela odorata*), sweetwoods (*Nectandra* spp.), bulletwoods (*Daphnopsis* spp.), prickly yellow (*Fagara martinicensis*), trumpet tree (*Cecropia peltata*), and figs (*Ficus* spp.). In the upland pastures, where some of the original vegetation has been removed, characteristic trees also included guango (*Samanea saman*), pimento (*Pimento officinalis*), logwood (*Haematoxylum campechianum*), and citrus trees (*Citrus* spp.). Two fruiting trees (*Ficus trigonata* and *Cecropia peltata*) containing birds actively feeding on the fruits were located. The *C. peltata* tree was approximately 12 m tall and was located on a forest edge bordering an upland pasture. The fruit of this species consists of inflorescences of numerous minute fleshy seeds; each inflorescence measures approximately 60–100 cm. The *F. trigonata* tree has small (1.4–2.0 cm), rounded, red fruits, which are borne, singly or paired, on stalks which measure 0.4–0.8 cm. The tree observed was approximately 12 m tall and was located on a forest edge bordering an abandoned sugar cane field. Observations were made during the morning (07:00–12:00) and occasionally during the afternoon (15:00–17:00). Activity at the *F. trigonata* tree was observed for a total of 15 hr and at the *C. peltata* tree for 20 hr. Periods of observation varied from 1 to 3 hr. During this time data were obtained on the numbers and types of birds, frequency of exploitation, methods of feeding, aggressive behavior, and social attractions.

RESULTS AND DISCUSSION

FREQUENCY OF VISITATION

The number of species, individuals recorded, and the mean numbers recorded per hour are shown in table 1. Only those species which were actually observed feeding are listed. A total of 19 species representing 18 genera and 12 families were recorded (a reflection of the low number of species per genus and family that is usually characteristic of insular situations). Passerines observed feeding on the fruiting trees represented 50% of the Jamaican passerine avifauna and included 63% of the passerines observed in the study area (Cruz 1972). This large number of the total avifauna is in sharp contrast to some of

TABLE 2. Niche characteristics of birds visiting fruiting trees.[a]

Species	Foraging techniques[b]	Foods taken[c]	Stratum[d]
Columba leucocephala	FG	F,S?	M-H
Geotrygon montana	GG	F	G
Aratinga nana	FG	F	M-H,L
Centurus radiolatus	PR-FG,P,BR,G,S	I-F,V	L-M,H
Tyrannus caudifasciatus	S,HI,HF	I,F,V	M-H
Platypsaris niger	HI,HF,G,FG,S	I,F,V	M-H,L
Corvus jamaicensis	FG-G,PR,BR	I-F,V	M-H
Turdus aurantius	G,FG,GG	I-F,V	M-H,L,G
Turdus jamaicensis	G,FG,GG	I-F,V	M-H,L,G
Myadestes genibarbis	FG,HF,G,HI	F,I	L-M,H
Vireo altiloquus	G,FG,HI	F-I	M-H,L
Coereba flaveola	G,FG	N,F,I	L-M-H
Euneornis campestris	FG,G	F,N-I	L-H
Pyrrhuphonia jamaica	FG	F	M-H
Spindalis zena	FG,FH	F	M-H
Icterus leucopteryx	FG-G,PR,BR	I,F,N	M-H,L
Loxigilla violacea	GG,FG,G	F-S,I	G-L,M
Loxipasser anoxanthus	GG,FG	S,F	G-L,M

[a] Based on field observations and examination of stomach contents.
[b] Foraging techniques: gleaning for fruits (FG), ground gleaning (GG), gleaning from trunks, branches, leaves, nectar (G). Probing (PR), pecking (P), hovering for fruits (HF), hovering for invertebrates (HI), Sallying (S). Order indicates relative importance. When two categories are roughly equal in importance, the comma is replaced by a hyphen.
[c] Foods taken: fruits (F), seeds (S), nectar (N), invertebrates (I), vertebrates (V).
[d] Foraging heights: ground (G), low (L), medium (M), high (H).

TABLE 3. Mean weights and measurements of birds visiting fruiting trees.[a]

Species	Weight (g)	Length (mm)	Exposed culmen (mm)
Columba leucocephala	234(1)	336(99)	17(8)
Geotrygon montana	140	229(135)	11(15)
Aratinga nana	84(1)	244(10)	21(10)
Centurus radiolatus	108(25)	256(20)	34(20)
Tyrannus caudifasciatus	37(2)	200(9)	25(9)
Platypsaris niger	—	181(9)	17(9)
Corvus jamaicensis	—	357(2)	49(2)
Turdus jamaicensis	60(4)	210(13)	19(13)
Turdus aurantius	82(5)	238(17)	24(14)
Myadestes genibarbis	26(3)	188(13)	12(13)
Vireo altiloquus	18(8)	146(27)	16(12)
Coereba flaveola	8(7)	97(5)	12(3)
Euneornis campestris	15(6)	131(6)	14(6)
Pyrrhuphonia jamaica	17(3)	107(5)	9(5)
Spindalis zena	43(12)	178(6)	14(6)
Piranga olivacea	38(3)	164(24)	15(24)
Icterus leucopteryx	42(2)	192(6)	24(6)
Loxigilla violacea	30(7)	155(9)	15(9)
Loxipasser anoxanthus	11(2)	106(9)	9(9)

[a] The weights are from the author's unpublished data, except for *Columba leucocephala* which is from a Grand Cayman bird (D. W. Johnston, unpubl.) and *Geotrygon montana* which is from a Guatemalan bird (Smithe 1966). Measurements are from Ridgway (1902, 1904, 1907, 1914, and 1916). All weights and measurements are rounded off to the nearest number and represent mean values. The numbers in parentheses represent sample size.

the studies which have been published for the tropical mainland region, where the trees are visited by only a small portion of the total avifauna. In Panamá, Eisenmann (1961) compiled a list of 22 species of 11 families that he saw feeding on *Cecropia* catkins and, in Peru, Diamond and Terborgh (1967) recorded 11 species of 9 families in one fruiting tree and 16 species of 10 families in another (both trees unidentified). Leck (1972) noted similar differences between mainland and Puerto Rican birds that are in agreement with the present study. He states that: "This difference reflects the larger number of rare species on the mainland and the more specialized feeding niches of mainland birds, with many species strictly limited to non-fruit diets (e.g. antbirds)." This difference is also probably related to the low species diversity on islands which have allowed some of the species to have more flexible feeding habits and possibly to expand their feeding niches (Cruz 1973a,b). This assumption is supported by the use of fruits by birds belonging to primarily insectivorus families such as Picidae, Tyrannidae, and Vireonidae (table 1) and by the diversity in foods and feeding methods of some of the birds observed feeding on the fruiting trees (table 2).

Although more time was spent observing birds feeding on *Cecropia* catkins, more birds were observed feeding on *Ficus* fruits: 11 species on the former and 19 on the latter. All species that were observed feeding on *Cecropia* catkins were also recorded feeding on *Ficus* fruits. The greatest number of birds observed feeding simultaneously on *Cecropia* was 9, representing 5 species, and on *Ficus* 28, representing 15 species. The most common species feeding on *Cecropia* catkins were *Centurus radiolatus* and the Jamaican Oriole (*Icterus leucopteryx*), both making 31 individual visits or 1.55 visits per hr. The most frequent visitors on the *Ficus* tree were the Stripe-headed Tanager (*Spindalis zena*) and the Black-whiskered Vireo (*Vireo altiloquus*), the former recorded 78 times or 5.20 visits per hr and the latter recorded 57 times or 3.80 per hr.

The differences in species and numbers of birds observed between *F. trigonata* and *C. peltata* were probably due to the greater abundance of fruits on the former. The ground underneath the *Ficus* tree was covered with fruits and the limbs were laden with ripening fruits. In contrast, the *Cecropia* catkins were less abundant. It was estimated that there

were 125 catkins on the *Cecropia* tree and less than half appeared to be ripe. The difference in exploitation of the two study trees may also be related to presence of a greater number of fruiting *Cecropia* trees and the fewer number of fruiting *Ficus* trees in the study area. Leck (pers. comm.) notes that if there were many in fruit, then the exploitation per tree would be expected to be low.

An even more interesting aspect than the large numbers of species observed was the wide diversity of structural adaptations [e.g., bill size and shape, the Olive-throated Parakeet (*Aratinga nana*) and *Centurus radiolatus*], size [8 g in the Bananaquit (*Coereba flaveola*) to 234 g in the White-crowned Pigeon (*Columba leucocephala*)], and feeding habits [the Loggerhead Kingbird (*Tyrannus caudifasciatus*) primarily insectivorous and *Spindalis zena* frugivorous] represented by these birds. Weights and lengths of birds observed feeding on the fruiting trees are shown in table 3. The quantities of fruits in the diets of *C. radiolatus* (Picidae) and *T. caudifasciatus* (Tyrannidae) suggest that birds have flexible feeding habits in tropical insular environments; this should have interesting implications, particularly with regard to niche sizes.

FEEDING METHODS

Differences in foraging behavior may help to reduce interspecific competition. Consequently, the foraging patterns utilized by the various species on the fruiting trees were recorded. These are: (1) species taking fruit from a perched position—*Columba leucocephala, Aratinga nana, Centurus radiolatus,* Jamaican Crow (*Corvus jamaicensis*), Rufous-throated Solitaire (*Myadestes genibarbis*), Bananaquit (*Coereba flaveola*), Orangequit (*Euneornis campestris*), Jamaican Euphonia (*Pyrrhuphonia jamaica*), Scarlet Tanager (*Piranga olivacea*), *Icterus leucopteryx,* Greater Antillean Bullfinch (*Loxigilla violacea*), and Yellow-shouldered Grassquit (*Loxipasser anoxanthus*); (2) species feeding by hovering below or in front of fruit —*Tyrannus caudifasciatus;* (3) species feeding by using a combination of the above methods—Jamaican Becard (*Platypsaris niger*), White-chinned Thrush (*Turdus aurantius*), *Turdus jamaicensis, Vireo altiloquus,* and *Spindalis zena*; and (4) species feeding on fallen fruits and not on tree itself—Ruddy Quail-Dove (*Geotrygon montana*). In addition, differences in vertical stratification were noted in some of the species utilizing the same foraging pattern, but in many cases there seems to be a wide range of overlap.

The association of diverse species possessing a wide variety of sizes and bill shapes in the feeding assemblages suggests some degree of niche overlap in Jamaican birds. It is apparent that birds so conspicuously different from one another as pigeons, woodpeckers, flycatchers, vireos, bananaquits, tanagers, orioles, and bullfinches at least occasionally utilized the same food sources. By considering further the total diets of the birds that feed on the fruiting trees (table 2), it is possible to see that (1) the amount of dependency on fruits varies; (2) that there are alternate food sources available; and (3) that the morphological differences in the feeding apparatus, bill size and shape, tongue, etc., are adapted to utilizing this food resource. Moreover, the number of animal species in any wooded habitat in Jamaica must exceed enormously the number of kinds of fruits eaten by birds. In addition, fruits are conspicuous and the number of ways they can be plucked efficiently is very limited, affording little opportunity for specialized feeding adaptation. The reverse is true of the animal prey; invertebrates and small vertebrates occupy diverse micro-niches, conceal themselves, and are otherwise adapted to escape predation in many different ways. Consequently, the various morphological types of bills present are specialized for feeding on various animal prey. For additional information on this aspect of the feeding ecology of fruit-eating birds see Snow and Snow (1971).

TABLE 4. Aggressive encounters recorded at feeding trees.

Aggressor	Supplanted species									
	Centurus radiolatus	*Tyrannus caudifasciatus*	*Turdus jamaicensis*	*Turdus aurantius*	*Vireo altiloquus*	*Coereba flaveola*	*Euneornis campestris*	*Spindalis zena*	*Piranga olivacea*	*Icterus leucopteryx*	*Loxigilla violacea*
Centurus radiolatus	2				1	1		1			1
Tyrannus caudifasciatus		4									
Turdus jamaicensis			3								
Turdus aurantius			1	3	1						
Vireo altiloquus					12	1					
Euneornis campestris							1				
Pyrrhuphonia jamaica						1					
Spindalis zena						1		7			
Icterus leucopteryx									1	1	
Loxigilla violacea											1

AGGRESSIVE BEHAVIOR

Table 4 summarizes both the interspecific and intraspecific encounters observed. Although in one instance there were 28 individuals representing 15 species feeding, there was no pronounced interspecific competition of the interference type. In the majority of cases, it involved one individual moving to a different portion of the tree when a larger species flew to the area where the former was feeding. An exception to this took place when a Jamaican Oriole chased a Scarlet Tanager off the tree. On the other hand, intraspecific competition was greater. The majority of the intraspecific encounters (the main diagonal of table 4) resulted in the supplanted species being chased off the tree. This was most marked in *Vireo altiloquus* where 12 different encounters were observed. Part of this may be attributed to the fact that the Black-whiskered Vireo is a summer resident in Jamaica, wintering in South America. Some of the vireos may have been recent arrivals and were still in the process of establishing territories. An alternate explanation is that the feeding trees may have been located at the territorial boundaries of some of the vireos.

The minimal degree of interspecific aggressive interactions was probably due to a superabundance of food and, to a lesser degree, to differences in foraging and feeding behavior. Willis (1966) noted that in cases where productivity is far greater than utilization,

no one species would gain by expending energy to exclude others. In some species, the differences noted in methods of feeding and in portions of tree utilized may help to reduce competition, but in a number of cases there seems to be a wide range of overlap. Further study is needed to clarify the role that competition plays in the presence of a superabundance of food.

SOCIAL ATTRACTIONS

In general, birds arrived and left both feeding trees as individuals or as groups of several individuals belonging to the one species. Most groups consisted of two individuals, and in those cases where it was possible to tell the sexes apart, usually a male and a female bird, presumably a pair. Intraspecific groups of more than two birds were also noted. The largest observed was the arrival and departure of *Aratinga nana*, where up to 12 individuals were recorded.

Mixed species flocks were rarely observed arriving or leaving the fruiting tree. The largest interspecies flock observed consisted in the arrival of two Jamaican Euphonia, one Bananaquit, one Orangequit, and one Yellow-shouldered Grassquit. In contrast to mixed species flock where there is usually a strong social bonding (Davis 1946; Short 1961; Moynihan 1962; McClure 1967), the birds observed in this study had weak or little interspecific bonding. Rather, they may be considered as a chance assemblage of individuals or small groups of individuals which are attracted to an abundant food source.

BIRDS AS AGENTS OF PLANT DISPERSAL

Abundance of food is not only beneficial to the bird species involved but it is also of benefit to the tree. Snow (1971) noted that it must be part of the strategy of fruits not only to be conspicuous and abundant but also to be accessible to as many dispersal agents as possible, i.e., to as many different bird species. In this study viable *Ficus* and *Cecropia* seeds were collected from the digestive tract of a number of Jamaican birds. The abundance of both *C. peltata* and *F. trigonata* (and presumably other feeding trees) is probably a direct result of widespread avian feedings on the fruits and the viability of the seeds after having passed through the digestive tract.

SUMMARY

Feeding assemblages of birds on two fruiting trees (*Ficus trigonata* and *Cecropia peltata*) were studied in Jamaica, West Indies. Observations were made on the number and types of birds, frequency of exploitation, methods of feeding, aggressive behavior, and social attractions. A total of 19 species representing 18 genera and 12 families was recorded. Included in this assemblage were birds of diverse structural adaptations, size, and feeding habits. Intraspecific competition dominated the interactions, and interspecific competition was minimal. The minimal degree of interspecific competition was probably due to a superabundance of food and, to a lesser degree, to differences in foraging and feeding behavior. Differences in methods of feeding and portions of tree utilized were noted in some species, but in the majority of species there seems to be a wide range of overlap. The abundance of both *C. peltata* and *F. trigonata* (and presumably other fruiting trees) is probably a direct result of widespread avian feeding on the fruits and the viability of the seeds after having passed through the digestive tract.

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