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EXPLOITATION OF A SEASONAL RESOURCE BY NONBREEDING PLAIN AND WHITE-CROWNED PIGEONS: IMPLICATIONS FOR CONSERVATION OF TROPICAL DRY FORESTS

ALLAN M. STRONG[1,2,4] AND MATTHEW D. JOHNSON[1,3]

ABSTRACT.—Columbids often exhibit irregular movement patterns in response to fruit abundance. We tested whether the abundance of nonbreeding Plain (*Columba inornata*) and White-crowned (*C. leucocephala*) pigeons was correlated with *Thrinax parviflora* fruit production in a dry forest in southeastern Jamaica. Monthly, from November to March, we counted the number of pigeons leaving the forest to roost in an adjacent mangrove swamp. Within two days of each roost count, we also counted all fruits on ten *T. parviflora* trees in the forest. Columbid and fruit counts showed similar patterns of temporal abundance, with increases from November to January and decreases from January to March. Peak (January) counts of White-crowned Pigeon, Plain Pigeon, and unidentified columbids were 129, 77, and 151, respectively. The peak Plain Pigeon count was approximately three times greater than the highest counts previously recorded for Jamaica. These data indicate that the Portland Ridge dry forest may provide a critical resource for the Plain Pigeon, perhaps at a time when fruit abundance is low on other parts of the island. Given the globally significant number of Plain Pigeons that use this site, protection from further development should be a priority. *Received 8 June 2000, accepted 24 January 2001.*

The irregular temporal and spatial pattern of fruit abundance has been well documented and is thought to be a result of variation in climatic conditions such as temperature and rainfall, as well as interspecific variation in fruiting phenologies (Janzen 1967, Smythe 1970, Frankie et al. 1974, Crome 1975, Foster 1982). This variation in resource abundance is likely the ecological basis behind the irregular to nomadic distribution patterns of many frugivores (Wheelwright 1983, Levey 1988, Blake and Loiselle 1991, Loiselle and Blake 1991). Indeed, frugivory may be a precursor to migratory behavior (Levey and Stiles 1992).

Many columbiforms are frugivorous and exhibit movement patterns that range from nomadic to migratory, presumably in response to the temporal and spatial distribution of fruit availability (Crome 1975, Frith et al. 1976, Wiley 1979, Innis 1989, Lambert 1989, Milan-Rivera 1992). In the Caribbean, the genus *Columba* is represented by four native species, three of which occur regularly on Jamaica. These three species feed nearly exclusively on fruits, and are probably important seed dispersers (Bancroft and Bowman 1994, Strong and Bancroft 1994, Baptista et al. 1997). The Ring-tailed Pigeon (*C. caribaea*) is found at relatively high elevations whereas the Plain Pigeon (*C. inornata*) and the White-crowned Pigeon (*C. leucocephala*) generally prefer lower elevations (Downer and Sutton 1990).

Of these two lower elevation species, the White-crowned Pigeon is relatively common on Jamaica, but little is known about the distribution and abundance of the Plain Pigeon, which was recently reported as possibly extirpated from Jamaica (Miyamoto et al. 1994). In January 1996, we observed 16 Plain Pigeons flying from the dry limestone forest of Portland Ridge to a red mangrove (*Rhizophora mangle*) swamp to roost. The next evening we saw 86 Plain Pigeons and large numbers of White-crowned Pigeons flying to the mangrove roost.

We hypothesized that the use of the forest by columbids was a seasonal response to increased fruit availability, since many trees in Portland Ridge's dry forest produce ripe fruit during the dry season. In this paper, we document the seasonal use of a threatened Caribbean dry forest by Plain and White-crowned pigeons and examine their abundance in relation to the fruiting phenology of *Thrinax parviflora*, a common dry season fruiting species.

[1] Dept. of Ecology and Evolutionary Biology, Tulane Univ., 310 Dinwiddie Hall, New Orleans, LA 70118.

[2] Present address: Univ. of Vermont, School of Natural Resources, Aiken Center, Burlington, VT 05405.

[3] Present address: Dept. of Wildlife, Humboldt State Univ., Arcata, CA 95521.

[4] Corresponding author; E-mail: astrong@nature.snr.uvm.edu

TABLE 1. Mean counts (± S.E.) of fruits from 10 *Thrinax parviflora* trees and evening counts of columbids flying from the Portland Ridge dry forest to a mangrove roost site during the 1996–1997 dry season. Fruit counts and columbid counts were conducted within 2 days of each other.

	Count date				
	19 Nov	5 Dec	30 Jan	27 Feb	13 Mar
Fruit counts					
Unripe	1415 ± 203	1373 ± 215	582 ± 136	90 ± 87	32 ± 32
Ripe	0 ± 0	4 ± 2	200 ± 67	24 ± 10	16 ± 13
Desiccated	0 ± 0	0 ± 0	0 ± 0	57 ± 20	37 ± 16
Columbid counts					
Plain Pigeon	17	52	77	34	6
White-crowned Pigeon	0	5	129	79	50
Unidentified columbid	1	2	151	150	111
Total columbids	18	59	357	263	167

STUDY AREA AND METHODS

This study was conducted at Portland Ridge, Jamaica, (17° 44′ N, 77° 09′ W; 12 km southeast of Lionel Town), a peninsula that supports approximately 4,200 ha (D. B. Hay, pers. comm.) of relatively undisturbed dry limestone forest, ranging from 5–120 m elevation and characterized by <125 cm rainfall/year (Lack 1976). The canopy is dominated by *Metopium brownii*, *Bursera simaruba*, and to a lesser extent *T. parviflora*. The subcanopy was dominated by *Ateramnus lucidus* and *Oxandra lanceolata*.

T. parviflora is an endemic Jamaican palm that produces large spikes of 6.5–7.5 mm diameter white drupes (Adams 1972). We conducted complete counts of the fruit crops of 10 (6–8 m height) *T. parviflora* trees on five days during the 1996–1997 dry season (19 November, 5 December, 1996; 28 January, 27 February, and 12 March, 1997). We chose *T. parviflora* as a study species because we frequently flushed pigeons from these trees during field work at the site. Additionally, the architecture of the tree was amenable to complete fruit counts because the fruiting spikes typically hang well below the fronds. Although we were not able to document pigeon consumption of *T. parviflora* by direct observation, White-crowned Pigeons consume fruits of two other species of *Thrinax* in south Florida (G. T. Bancroft, pers. comm.), and both species consume royal palm (*Roystonea* spp.) fruits throughout the Greater Antilles (Plain Pigeons, Puerto Rico [Pérez-Rivera 1978]; White-crowned Pigeons, Puerto Rico, [Wiley and Wiley 1979], Cuba [Godinez 1993], and Jamaica [AMS, unpubl. data]). We chose trees along trails maintained by the P. W. D. Gun Club of Kingston with the criterion that all fruits were visible without obstruction from leaves and branches. We classified each fruit as unripe (green), ripe (white), or desiccated (brown).

Within two days of each fruit count, we conducted evening roost counts of columbids leaving the forest and flying to the mangrove roost. We began the counts at 16:30 November through January, at 17:15 in February, and 17:00 in March. All counts began at least 20 min prior to observing the first birds flying to the roost and continued until it was too dark to see birds, at which time the number of birds leaving the forest was near zero. Two observers conducted the counts from a lighthouse approximately 20 m above the canopy. The birds flew primarily from south to north, so one observer watched to the east and one to the west. One or two additional observers looked for birds from the base of the tower (just above the canopy level) as birds that flew low over the forest canopy were sometimes difficult to observe from the top of the tower. Birds were identified as Plain Pigeon, White-crowned Pigeon, or unidentified columbids. Although birds often were too distant to identify to species, we feel that very few individuals passed undetected.

RESULTS

Numbers of Plain Pigeons, White-crowned Pigeons, and unidentified columbids all peaked during the January count, with maximum counts of 77, 129, and 151 individuals, respectively (Table 1). Plain Pigeons dominated the first two counts, but the proportion of (identified) Plain Pigeons in the total count dropped from 21.5% in January to 3.5% in March. We suspect that most unidentified columbids were White-crowned Pigeons, but counts from additional observation points would be helpful to confirm the identity of distant birds.

In November, *T. parviflora* supported no ripe fruit, although the average crop was >1400 unripe fruits/tree (Table 1). By early December, a few fruits had ripened, but >99% of the crop was still unripe. In January, the percentage of ripe fruit peaked, coincident with the peak pigeon abundance. However, the total January (ripe + unripe) fruit crop was

50% lower than the November census, presumably as a result of consumption by birds, as we observed few fallen fruits below the trees. Fruit abundance decreased further during February, when about one-third of the crop was brown and desiccated. By March, the trees supported an average of only 16 ripe fruits.

We found positive correlations between the number of ripe fruits and the number of Plain Pigeons ($r = 0.775$), White-crowned Pigeons ($r = 0.857$), and total columbids ($r = 0.804$). Our small sample size ($n = 5$) did not provide enough power for meaningful statistical tests; however, the large positive r-values suggest a biological relationship.

DISCUSSION

The immigration of columbids into Portland Ridge appeared to be in response to fruit availability, although these birds were probably not responding solely to the *T. parviflora* fruit crop. The peak abundances of both columbid species coincided with the peak of ripe fruit abundance; however, Plain Pigeon numbers began to increase before *T. parviflora* had produced any substantial amount of ripe fruit. *Bursera simarouba* and *Oxandra lanceolata* both ripen fruit during the dry season and both may be more abundant than *T. parviflora* at Portland Ridge. Of 20 additional tree species found in >20% of sample quadrats ($n = 20$, 5 m × 5 m; Loveless and Asprey 1957), 8 produce fruit with a fleshy pulp (typical of fruit consumed by columbids) during the same time that *T. parviflora* is fruiting (Adams 1972). Thus, both columbids were probably responding to an increase in fruit abundance produced by a suite of plant species and slight dietary differences between the two species might be responsible for differences in the timing of immigration.

Our results underscore the significance of the Portland Ridge dry forest as a nonbreeding foraging site for columbids, and combined with our January 1996 observation, suggest that movement of Plain Pigeons into Portland Ridge during the dry season may occur annually. However, the low numbers of Plain Pigeons in November and March suggest that this species does not use the site throughout its annual cycle. Nonetheless, the Portland Ridge forests may provide an important food resource during a period when the pigeons experience food shortages in other parts of their range (*sensu* Howe 1984). As such, these forests should be protected from further development, as the Plain Pigeon numbers we observed appear to be three times greater than the highest counts documented previously in Jamaica (Pérez-Rivera 1990). Whether this species is nomadic or undertakes regular migratory movements, the fact that fruit production is frequently unpredictable makes reserve design exceedingly difficult for large frugivores (Karr 1982, Terborgh 1986). Large, dispersed tracts of forest at a variety of elevations containing tree species with distinct fruiting phenologies may be critical to maintain populations of these wide-ranging species (e.g., Powell and Bjork 1995).

The pigeons' movements also suggest the importance of safe roost sites near feeding areas. The mangrove forests adjacent to the dry upland forests may satisfy this requirement for both White-crowned and Plain pigeons. However, the degree to which safe roost sites are important in other feeding areas is unknown. Breeding male White-crowned Pigeons occasionally roosted in mangroves adjacent to feeding sites in south Florida (AMS, unpubl. data), and did so frequently in Puerto Rico (Wiley 1979). The juxtaposition of safe roosting sites and high fruit abundance may make Portland Ridge an especially important nonbreeding area for both White-crowned and Plain pigeons in Jamaica.

Our data document columbid and fruit abundance for only a portion of the annual cycle and leave several important unanswered questions for future research. The fact that hunters have not recorded Plain Pigeons in significant numbers at Portland Ridge during the hunting season (August and September; E. Ziadie, pers. comm.) suggests the possibility that *C. inornata* may undertake significant regional movements. Interisland movements have been documented for White-crowned Pigeons (Struthers 1927, Wiley 1979 and references therein, Paul 1977, Norton and Seaman 1985; AMS, unpubl. data), but little is known about the ecology or population status of Plain Pigeons outside of Puerto Rico (Pérez-Rivera 1990). Counts during other times of year and on other parts of the island in conjunction with foraging observations and

fruiting phenology studies of other tree species would be helpful in clarifying the ecology of these pigeons. As such, we recommend continued monitoring to determine the annual variation in use of Portland Ridge by columbids, especially the globally endangered Plain Pigeon.

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