TROPICAL PEST MANAGEMENT, 1985, 31(2), 148–152

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Aspects of woodpecker damage to cacao in the Dominican Republic

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Abstract. The Hispaniolan woodpecker, *Melanerpes striatus*, damages cacao by piercing the pod and eating the pulp surrounding the developing seeds. Piercing of the pod permits invasion by insects and micro-organisms. Pod damage was assessed at 3·7% in 1981 and 3·5% in 1982, close to the 4% estimate of the Ministry of Agriculture of the Dominican Republic. Although the Ministry established a bounty program in 1976, our study suggested this bounty should be discontinued. The program was found to be not cost effective, did not reduce damage, and had an adverse effect on other avifauna. Our preliminary attempts to protect cacao pods using chemical repellents and colour cues were inconclusive. None the less, additional crop protection work, as well as changes in agricultural production practices, may ultimately provide sufficient aid to offset losses.

Introduction

The Hispaniolan woodpecker, *Melanerpes striatus*, is endemic to Hispanolia. It is ubiquitous and inhabits swamps, woods, deserts, mesic scrubs, broadleaf forests, pinelands and urban areas of Santo Domingo (Wetmore and Swales, 1931).

Cacao, *Theobroma cacao*, is a major export crop in the Dominican Republic. In Fiscal Year 1981, the country produced about 32,000 million tonnes (Mt) of cacao (unprocessed dried seed), of which 26,886 Mt were exported with a value of US $44,587,874 (1 US $ = 1 RD Peso) (Memoria Annual, 1981). Cacao is grown in the foothills of fertile valleys in the northeastern and eastern regions. Lowlands are planted with field crops. At lower elevations, cacao is sometimes a monoculture bordered by citrus, *Citrus* spp. About 0·6 million ha of land are planted to cacao, mostly of the 'Sanchez' variety. Pods are attached directly to the larger limbs and trunks ('cauliflory') and require about 6 months to mature. Flowering is neither synchronous among trees nor within a single tree. Although pods mature throughout the year, peak harvests occur in June and July and in January and February. A typical mixed cacao plantation usually contains cacao, Sabal palm, *Sabal umbraculifera*, amapola, *Erythrina* spp., guineo, *Musa sapientum*, plantain, *Musa paradisiaca*, coffee and citrus. The overstory plants (usually amapola) provide shade for the cacao.

The Hispaniolan woodpecker has long been considered a pest to cacao in the Dominican Republic. Birds peck holes in the cacao pod, apparently to obtain moisture and eat the mucilaginous seed coat (aril) (Figure 1). They do not harm the seeds directly, but open the pods to insects and micro-organisms which cause additional damage through fermentation. Santoro (1960) reported cacao damage levels of 10% and judged the Hispaniolan woodpecker to be more destructive than beneficial. However,

Figure 1. Mr Tomas Vargas, Bird Research Division, Secretary of Agriculture, holds cacao pods damaged by woodpeckers

Wallace (1974), Short (1974) and Albaine Pons and Grullón Peña (1981) have described the bird as an omnivorous species which feeds heavily on insects. Other woodpecker species that reportedly are pests of cacao in the Caribbean Islands include the golden-olive woodpecker, *Piculus rubiginosus*, from Trinidad (Williams, 1922) and the Jamaican woodpecker, *Melanerpes radiolatus*. Woodpecker damage is easily distinguished from rat damage, which is characterized by a larger hole and gnawing.

Because of continuing complaints from farmers about woodpecker damage to cacao, the Secretary of Agriculture of the Dominican Republic organized a programme in

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1976 to sell ·22 caliber rifles to cacao farmers and established bounties for woodpecker tongues. Our study was motivated by the need for better understanding this species' pest status and to examine alternatives to shooting to reduce cacao losses. Our objectives were to determine the bird's movements in and around cacao plantations, quantify damage, evaluate the bounty program, and test possible damage reduction techniques. Although data on the taxonomy and biology of the Hispaniolan woodpecker exist (Selander, 1966; Wallace, 1974; Short, 1974; Albaine Pons and Grullón Peña, 1981), little information has been gathered on its pest status.

Methods

Study area

This study occurred during 1980 and 1981 in major cacao-producing areas located in the Cordillera Septentrional foothills near San Francisco de Macoris, Provincia Duarte, Dominican Republic.

Biology and ecology

Radiotelemetry studies. Radio transmitters were attached to four woodpeckers in two cacao plantations to determine the area they used, their movement patterns and damage potential. In August 1981, a radio transmitter, weighing 4·8 g (average 6·8% body weight) and having a plexiglass basal plate, was bolted and glued around the base of the tail feathers (Bray and Corner, 1972; Bray, 1973) on each of two female woodpeckers captured in mist nets in a plantation at Quita Espuela near San Francisco de Macoris. Both birds flew well immediately after attachment and were tracked for about 2·5 weeks during the day and at night to determine areas used and roost location, using methods similar to those described by Bray (1973) and Royall and Bray (1980). Visual confirmations of marked birds were made whenever possible. At Jaya, two more radio transmitters, weighing 2·5 g each (average 3·6% of male weight; 2·8% of female weight), were attached by metal bands (Bruggers *et al.*, 1981) to one leg of each member of a pair captured together at their nest cavity in a Sabal palm on 5 January 1982.

Feeding behaviour. Fifteen woodpeckers were either mist-netted in cacao plantations, trapped at nest cavities using a spring net (see Roberts, 1983 for description), or collected from hunters for stomach content analysis in 1981. Mist nets were positioned above the cacao canopy at 9–15 m in palm trees and at cacao canopy level 2–3 m off the ground throughout the day. The stomach contents from these birds were removed, dried, identified, and the proportion by weight of animal and vegetable material estimated.

Farmers and government officials believe that woodpeckers return to pods they have damaged to eat insects feeding on the exposed plant tissues. To evaluate this belief, we sprayed tracking chalk (Kaukeinen, 1979) around woodpecker holes in 113 pods and checked for tracks for 10 days.

Damage assessments. Manu difficulties are inherent in assessing damage to cacao. Because pods mature continuously, only a portion of the crop is susceptible to damage at any one time. Because damaged pods spoil rapidly and are reservoirs for micro-organisms, most farmers periodically remove them from trees. However, some farmers harvest damaged pods. For these reasons, we used two methods to assess damage:

(1) counting damaged and undamaged pods on trees along random transects in plantations;
(2) counting damaged and undamaged harvested cacao pods before they were sorted and split for seed extraction.

Thirty-three assessments were made at nine different cacao plantations between 1980 and 1982.

Lethal control of woodpeckers. The bounty program established by the Secretary of Agriculture began in 1976, with a payment of US $0·10 for each woodpecker tongue. To assist farmers with the program, approximately 900 ·22 caliber rifles were distributed at cost during 1976 and 1977, and the practice has continued. We evaluated the impact of this form of lethal control on woodpecker population numbers and damage at two cacao plantations near San Francisco de Macoris and Los Lanos. During 1981, observations were made at both farms along 1·5-km transects to estimate woodpecker density and damage. All woodpeckers seen or heard between 18.00 hours and night fall, their most active period, were counted. The proportion of damaged and undamaged cacao pods in randomly selected trees also was determined.

Cacao protection. Three different substances were tested to determine their effectiveness in protecting cacao from woodpeckers: methiocarb [(4-methylthio-3,5,-xylyl N-methylcaramate) ('Mesurol')] which causes an adverse physiological reaction and conditioned aversion in some bird species (Rogers, 1978); $CaCO_3$ or blue carpenter's chalk which visually alter the pod's colour; and an extract of a naturally occurring odiferous weed, tentatively identified as *Tabebuia* sp., which grows in cacao plantations and which may act as an olfactory repellent. Methiocarb was applied on 16 January 1982. All pods over 10 cm long on 20 randomly selected trees in each of two plots (0·4 ha total area) were painted with a suspension of 750 g (a.i.) methiocarb and 5 cm^3 of Rhoplex AC-33 adhesive in 4 *l* water. The same number of trees was left untreated in two other 0·4-ha plots. The solution left a chalky, white residue which was visible for about 2 weeks.

Because some bird species respond to colour cues in the laboratory (Elmahdi, 1982; Bullard *et al.*, 1983), $CaCO_3$ and carpenter's chalk were evaluated as possible repellents. Pods on 20 trees in one plot were sprayed white ($CaCO_3$) using a hand pump sprayer, those in a second plot were sprayed blue (carpenter's chalk), and those in a third plot were left untreated.

In March 1982, another 20-tree demonstration was conducted to evaluate the extract of *Tabebuia* sp. A 1·5 kg sample of *Tabebuia* sp. was boiled in 7·5 *l* of water for 1 h

and steeped overnight; 5 cm^3 Rhoplex AC-33 was added, and the liquid was painted on the pods. In all tests these materials, the test trees were marked with plastic surveyor's ribbon, and all previously damaged pods were removed at the time of experimental applications.

Results and discussion

Biology and ecology

Neither member of the woodpecker pair equipped with radio transmitters at Jaya returned to roost in the nest cavity, where they were captured. Three nights after the radio transmitters were attached, the female was located roosting in a palm cavity in the town of Jaya. The male roosted 0·5 km away, but joined the female on 13 January and they continued to roost together until 29 January when observations were terminated. Although the pair never returned together to their former nest cavity and roost site in the cacao plantation, each bird was frequently seen alone on that nest tree. During the 24-day tracking period, the birds were sighted together only at the roost site in Jaya, suggesting that the daily activities of paired individuals may differ.

Plotting all locations recorded for all four birds suggested that the three females used an area averaging 2·8 km^2 (1·7–4·2 km^2), while the male used an area of 3·2 km^2 (Table 1). Although it is difficult to draw conclusions from such a small sample, males and females seemed to occupy similar-size areas (Table 1) and frequently moved beyond the limits of the cacao plantations.

Feeding behaviour. The Hispaniolan woodpecker began foraging at dawn. In cacao plantations, woodpeckers gleaned and probed in bark, fruit, and bromeliads, mostly in the shade within fruit trees and in wooded ravines. The only woodpeckers we mist-netted in cacao plantations were females and were caught at 2- to 3-m heights between 11.00 and 16.00 hours. Our interviews with farmers, who have seen them damaging pods, supported this observation.

Woodpecker stomachs contained slightly more animal (insects, adult and larva—54%) than vegetable (seeds and fruit—42%) material by dry weight. Albaine Pons and Grullón Peña (1981) studied the species in northwestern Dominican Republic and concluded that, ". . .the percentage of foods of animal origin is very important in that the immense majority are insects that are pests to agriculture" (our translation). Cacao was not identified in any of the 15 woodpeckers analysed, nor did we find any signs of woodpeckers having visited those pods marked with tracking chalk. Although additional observations are needed, it seems unlikely that woodpeckers revisit damaged pods to harvest insects.

Damage assessments. Woodpeckers usually attacked the immature fruit during the months of December, January, March, July and August. The incidence of damage to harvested pods averaged 3·8%; damage to pods on trees averaged 3·5%. The combined damage to the 21,204 pods sampled from three plantations on 12 occasions during 1980 averaged 3·8% (range 2·0–18·6%). During 1981 and 1982, damage to 18,313 harvested pods averaged 2·5% (range 0·1–11·0%); damage to pods sampled on trees averaged 5·2% (range 4·0–11·3%). The combined damage to 21,937 pods sampled from farms on 21 occasions averaged 3·5%. These overall averages are similar to the 4·4% incidence of damage to 60,660 pods reported by Roberts (1983). The Ministry of Agriculture estimate of woodpecker damage is 4% (Memoria Annual, 1983), but farmers claim that damage is much greater.

Localized damage by woodpeckers to cacao at the Fond des Negres Experiment Station, Haiti, between April and July 1983 was 26% of 980 harvested pods (J. Keith, personal communication); this level exceeds all loss estimates reported in the Dominican Republic. However, the possible magnitude of damage in the Dominican Republic may be estimated by extrapolating the 4% damage figure to the total value of cacao exported for 1980 (21,931 Mt: US $50,787,000); thus approximately 89,943 kg, representing US $2,031,480 were lost. These high potential loss figures probably overestimate the actual losses because damage seems only to be serious locally.

Selander (1966) felt the Hispaniolan woodpecker population density probably exceeded the combined densities of all other woodpecker species occurring in any other area of North and Central America. In the cacao habitat, we estimated a density of 4·9 pairs/ha at Jaya and 3·4 pairs/ha at Quita Espuela. This is considerably denser than the range of 0·2–1·5 birds/ha estimated by Roberts (1983) in Haiti. We agree with Roberts (1983) that Hispaniolan woodpeckers may be pests to cacao because of their extremely high population density, which is probably due in part to many suitable nest sites and an abundant food supply.

Evaluating crop protection

Lethal control. The government bounty program seems to be expensive, ineffective, and a threat to non-target

Table 1. Areas used (maximum polygons) by radio-equipped Melanerpes striatus in and around cacao plantations near San Francisco De Macoris during 1981 and 1982

Bird	Weight (g)	Sex	Observation period	No. of days	No. of observations	Area used (km^2)
1575	72	F	28 Aug.–3 Sept.*	7	18	1·7
1574	67	F	28 Aug.–16 Sept.	20	42	2·6
2	89	M	5 Jan.–29 Jan.	24	74	3·2
06	70	F	5 Jan.–29 Jan.	24	91	4·2

* Tracking discontinued when radio became dislodged from the bird.

Table 2. Number of Melanerpes striatus *observed along 1·5-km census transects in 1981 and mean % damage in 1981 and 1982 in hunted and non-hunted cacao plantations in the Dominican Republic*

Location	Month						No. pods sampled	Mean % damage (±S.E.)
	May	June	July	Aug.	Sept.	Total		
Los Lanos (no hunting)	7	10	10	6	8	41	8352	2·1 ± 0·6
Seccion Aslor (hunting)	3	9	7	14	9	42	5730	4·4 ± 1·5

species. Although bounties were paid on a total of 247,465 tongues in 1980 and 1981, the population seemed to remain high and damage did not decrease. In 1980, the Secretary of Agriculture paid US $14,101.35 for 94,009 tongues and $30,691.20 for 153,456 tongues in 1981. The bounty was raised in 1981 from US $0·15 to US $0·20/tongue (Memoria Annual, 1980, 1981). The majority of the tongues came from the San Francisco region (74,843 in 1980; 124,296 in 1981). A plantation at Seccion Aslor near San Francisco de Macoris was a favorite shooting spot for local hunters and was the site of three hunting tournaments during 1981. The individuals who killed the most birds received an award in addition to the tongue bounty. Comparisons of damage and bird numbers were made between this plantation and another one at Los Lanos, near Castillo, where woodpeckers were not hunted. This was a large farm and, although some hunting occurred outside its limits, our observations were made deep within it. In neither area did we observe a decrease in bird numbers along our transects in hunted and unhunted cacao plantations, nor was damage any less in hunted areas (Table 2). Production levels and woodpecker densities appeared to be similar in the surveyed areas at both farms. Besides the ineffectiveness and expense of this kind of lethal control, it had adverse effects on beneficial avifauna of the region. During observations on four hunting days, we counted 14 Hispaniolan woodpeckers, one barn owl, *Tyto alba*, 11 ground doves, *Columbia passerina*, nine red-legged thrushes, *Turdus plumbeus*, 13 northern mockingbirds, *Mimus polyglottos*, nine bananaquits, *Coereba flaveola*, and six black-cowled orioles, *Icterus dominicensis*, shot by non-discriminating hunters. Roberts (1983) observed a greater abundance and diversity of birds in cacao farms with little or no hunting than in farms where hunting occured.

Cacao protection. Because cacao does not seem to be a significant part of the diet of Hispaniolan woodpeckers and many alternative food sources exist, we had hoped to be able to divert the birds from the cacao by using repellents. Although damage seemed to be reduced following application of these repellents, results were inconclusive (Table 3). More extensive field evaluations are needed of chemical repellents and other nonlethal methods to protect cacao pods from damage. James O. Keith (personal communication) has found that 3-cm-long strips of fluorescent, orange, polyvinyl 'Saflag' material, when attached to selected ears of corn on the field perimeter, will reduce woodpecker damage to corn in Haiti.

Conclusions

Despite the high potential national loss estimates, most woodpecker damage to cacao seems to be either locally serious or incidental and of low intensity. However, when locally serious, it is a highly visible pest problem that can be expensive to control. We agree with Roberts (1983) that the government bounty and gun distribution program should be discontinued. It appears that killing woodpeckers does not lessen damage, woodpeckers from areas other than cacao plantations are being killed, and birds other than woodpeckers also are killed.

Table 3. Numbers of damaged cacao pods of those either sprayed with methiocarb (16 January 1982), colour cues (2 February 1982), the extract of the local weed Tabebuia *sp. (4 March 1982), or left untreated*

Count period	Treatment								
	Methiocarb				Colour cue			Tabebuia sp. extract	
	Plot 1		Plot 2						
	Treated	Untreated	Treated	Untreated	White	Blue	Untreated	Treated	Untreated
No. pods sampled	100	100	100	100	80	60	80	100	100
Pre-application	6·0	0·0	10·0	1·0	7·0	10·0	6·0	36·0	22·0
Day of application	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0
Post-application average*	1·0	0·7	1·3	0·3	1·5	3·0	1·0	0·7	0·3

* Post-application average based on counts made on the following dates:
methiocarb = 20, 22, 26, 29 January and 4 February;
colour cues = 7, 10, 22 and 27 February;
Tabebuia sp. extract = 8, 13 and 19 March.

Roberts (1983) suggested that controlled programs of trapping, shooting, poisoning, and the use of wrappers be investigated. We personally feel that most of these methods are not practical for reducing woodpecker damage unless they can be directed only at woodpeckers in cacao plantations. By learning more about the biology and ecology of woodpeckers, baits or traps might be used to selectively remove those birds actually causing damage. However, such lethal control would not prohibit damage by birds entering the plantation; our radiotelemetry data indicated that some birds regularly fly distances of several kilometres. Also, these lethal measures may become just as misused as the present shooting and bounty programs.

Several non-lethal techniques may be worth considering. Roberts (1983) suggested wrapping pods with materials such as leaves, fabric, or basketry. This method is regularly used by traditional farmers in West Africa to prevent bird damage to sorghum heads. However, because it is labour intensive, it was rejected by Somali farmers (Bruggers, 1980); it would seem to be even more difficult to cover the many pods that hang at various heights from cacao trees. Damage might possibly be offset by initiating some agricultural changes such as decreasing the amount of shade in the plantations or increasing fertilization (Dominguez, 1983). Changing the habitat by removing cover and nesting trees may make the plantation less attractive to woodpeckers. We also feel that additional evaluations of chemical repellents or visual sensory cues are warranted. By more intensely studying the ecology of Hispaniolan woodpeckers, evaluating the damage they cause, and testing a variety of crop protection methods, more conclusive recommendations may be made to improve the pest management in this situation.

Acknowledgements

We wish to thank Tomas Vargas Mora, Manuel Gonzalez and Alberto J. Amaro of the Bird Research Division of the Secretary of Agriculture. Alexander Cruz, University of Colorado, and Wayne Arendt, University of Mourissi, provided training in methodology and encouragement during the study. Jean Bourassa, Denver Wildlife Research Center, built the radio transmitters and demonstrated field tracking techniques. G. Clay Mitchell, USAID/DWRC Project Leader in Hispaniola at the time of the study, provided financial and logistical assistance. Partial funds were provided to the U.S. Fish and Wildlife Service by the Agency for International Development PASA BLA-0584-P-IF-3083-04 (Reduction of Vertebrate Pest Crop Losses). The project was the assignment of the senior author while a U.S. Peace Corps volunteer. Walter Judd and David Hall, taxonomists at The Florida State Museum, identified *Tabebuia* sp. G. Clay Mitchell, Michael W. Fall, James O. Keith, John W. De Grazio, R. Chad Roberts and Charles A. Woods kindly reviewed the manuscript.

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