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FEEDING USE OF A TROPICAL AGROECOSYSTEM (CUBA) BY MOURNING DOVE (*Zenaida macroura L*)

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ABSTRACT

The Mourning dove (*Zenaida macroura* L.) is a species subjected to high consumptive use in Cuba, but there are a few publications related to its feeding habits in tropical regions. The goal of the present study was feeding analysis of Mourning dove to know its food spectrum, dietary importance and impact on a Caribbean agroecosystem. Seventy six samples of dove's crop were collected in a hunting area of Cienfuegos province. The farming habitat presented higher feeding quality for this dove. The diet spectrum showed 88% plant, 9% mineral and 3% from animal origin. The seeds of *Euphorbia heterphylla* and *Panicum maximum* were the most important food items consumed by this species. Its main diet composed of 79% of seeds from herbaceous plants, with a preference for the small seeds. Crop damage caused by this dove was low, because only 10% of consumed food came from agricultural species and this dove ate seeds from plants considered weeds by farmers. Thus we concluded that this dove is a beneficial species in tropical agrosystems.

Keywords: *Zenaida macroura*, fullness index, food spectrum, index of dietary importance, agricultural impact.

INTRODUCTION

The Mourning dove (*Zenaida macroura* L.) is an abundant species ranging from the south of Canada and United States to the south of Mexico and West Indies (Antilles). *Zenaida macroura macroura* is only one of five subspecies that is resident in Cuba (Acosta and Ponce de León, 2004). This dove is common found in pastures and flat agricultural lands with forest patches, but also occurs in residential areas and even urban parks. Like rest of the pigeons it is mainly herbivore, but it has adapted very well to the agricultural ecosystems, which provides it an agro-ecological feature different from other species of the family Columbidae. (Belda *et al*. 2011; Fahrig *et al*. 2011; Jiménez *et al*. 2006; Larruy and Burgas 2004; Meyers *et al*. 2005).

Population of Mourning dove has increased considerably during the last decade and it is considered one of the most important game species in Cuba. This is due to its characteristics such as excellent hunting aptitude that is evident through its fast and zigzagging flight especially in the hunter presence (Acosta and Ponce de León, 2004). Its meat has excellent quality. Its abundance depends on the seasonal availability of food, which means great concentrations (flocks) in certain places and times. The wide distribution and high abundance in the national territory is associated with agricultural lands which make hunting easer.

The Mourning dove diet has been studied in the United States of America (USA). Hayslette and Mirarchi (2002) investigate its dietary preferences and they found that this species prefers a varied diet. Hayslette (2006) and Poling and Hayslette (2006) reported a high degree of dietary overlap between the Collared dove (*Streptopelia decaoto*) and the Mourning dove (*Zenaida macroura*). Dietary preferences were similar in these species. Best and Smartt (1986) studied the feeding ecology of this species in the southeast of Mexico where Praire sunflower (*Helianthus petiolaris*) was the dominant food item. Ostrand *et al.* (1998) studied the selection of habitats of this dove and analysed the changes in the land use as a possible factor in the decrease of its population at the central part of Utah. Doves foraged primarily in harvested wheat fields, feed pens, and weedy patches. Blockstein *et al.* (1987) found that very few intact seed passed through the digestive systems of adult mourning doves and only a low amount of seeds, mainly *Euphorbia esula*, were recovered from faecal material found in dove nests, that is why they considered that this species of pigeon rarely acted as seed disperser. This dove particularly did not act as a dispersal agent of invasive plants in agricultural environments, except for some exotic plants introduced in America as *Commelina benghalensis* (Goddard *et al*. 2009).

A few studies had also been conducted earlier about Genus *Zenaida* in Cuba by Acosta and Berovides (1982); Acosta and Torres (1984) and Acosta and Ponce de León (2004). Despite the fact that Mourning dove is a

species subjected to a high consumptive use, there are only a few publications about its management, ecology and particularly feeding habits. Hence, the present study was conducted with the objectives to analyse the composition and structure of the Mourning dove diet, to know the feeding use and impact of this species on a Caribbean agro-ecosystem, that will allows us to make suggestions to improve the agro-tropical landscape as its habitat.

MATERIALS AND METHODS

Study area: This research study was conducted in the hunting area of Damuji, Rodas municipality, Cienfuegos province, Cuba (Fig. 1), centre of which is located at 22° 21.804N and 080° 33.430W, covering an area of 646 ha. The climate of the zone is "tropical and not too humid plain". It is characterized by hot, humid and rain from May to October and dry, less humid with less temperature from November to April. The mean annual temperature fluctuates between 22-24ºC and the annual rainfall is from 1000 to 1100 mm.

The relief is flat in almost all area with predominant typical Red Ferralitic and Brown Fersialitic soils. The major land use is agricultural crops and ranching with an extensive network of hedges that divide these areas. A big part of it is devoted to intensive agricultural crops (*Manihot esculenta*, *Ipomea batatas* & *Zea mays*). It also contains pastures and herbaceous plants bordering the watering canals that keep water almost all year. There are areas devoted to ranching where grasses are predominant, natural and artificially grown, (*Andropogon annulatus*, *Panicum maximun*, *Eleusine indica)*, although some pasture areas are invaded by Sickle bush (*Dichostachys cynerea*) and others weeds. The rest of the zone (63 ha) is occupied by a natural semi-deciduous woodland (*Samanea saman*, *Bursera simaruba*, *Guazuma tomentosa*) over limy ground, which in some places present an acceptable degree of conservation and in others areas appear open (clear) abandoned crops.

The study zone was selected because it has representative characteristics of most used biotopes by the species under study in Cuba. Thus based on distribution of plant species, there are two biotopes (habitats) used by Cuban wild fauna in the study area: 1) farm crops and/or pasture lands bordered by dispersed trees, small woodlands or brushwood, and well-drained grounds, 2) forest composed of semi-deciduous woodlands or scrublands, with good understory development and well-drained soils.

Methodology: The field work was carried out by sampling the hunted doves. Shooting was done at random with a blank cartridge shotgun on walking routes that covered all the study area and where each shot specimen was labelled according to the capture order. A total of 76 samples were studied, the crop of each bird was extracted, putting their contents in a labelled container with 70% alcohol for about 72 hours to apply the processing. Weight of the food content was done in laboratory and an analytic scale of 0.01g accuracy was used. The contents of each crop was placed in a filter paper, after that it was separated and weighed each kind of food, identifying those up to family and species category. This work was finished in 2013.

The fullness index (FI) was used following Godínez (1985), to determine whether the sample was sufficient to analyse the composition of the food spectrum and frequency of consumed species by this dove.

$FI = Wt/We$,

where:

Wt = the total dry weight of all food items found in a dove

We = the weight of each specimen of dove

A floral survey in two biotopes of the study area was conducted through Mostacedo and Fredericksen (2000) method. Thus, in the agricultural and pasture zones the selection method in small squared plot of 1.30 x 1.30 m^2 was used where each plant species was identified. In the woodland area transects of 500 m long and 4 m wide were used at random, ensuring the presence of all plant species.

The trophic preference of this dove was determined by the index of dietary importance (DI) according to Acosta and Berovides (1982): $DI = ai/N + wi/WN + ni/Nt$,

where:

ai = the abundance of food item i in the sample

N = the quantity of consumed items found in the sample

wi = the weight of the food item i in the sample

WN=the total weight of all consumed items of the sample

Ni = the number of cases where appears food item i

Nt = the number of total cases

The ecological analysis of major component of dietary spectrum of this species of dove was done through the indexes of richness and diversity of plants eaten.

Richness: S = Number of plant species

Diversity index from Shannon–Wiener (based on natural logarithm): $H' = \sum pi \times \ln pi$,

where**:**

ni = the abundance of consumed plant species i

N represents the total number of plants in the whole sample or consumed plant community

Firstly descriptive statistical techniques were applied to the obtained data, with the goal of summarize, numerically describe and facilitate their interpretation (measure of central tendency and variability). Finally U Man-Whitney test was applied to analyse the effect that could have in a random variable one qualitative variable

that acts as a factor. Excel and SPSS 15.0 for Windows programs were used in the information process.

RESULTS AND DISCUSSION

Fullness index: All 76 samples were valid for the Mourning dove dietary study (Fig. 2). Fullness index from Godínez (1985) showed a stable behaviour of its values with a suitable sample size of around 20 (Fig. 2). This index constituted an important object of study for the possibility offered to identify the major components of the diet of a wildlife species and in the way it projects the management of its habitat, ensuring an adequate and permanent availability of its most important foods. Thus the results provided by 76 samples were highly representative of the diet of this dove. Considering the monthly changes in the index during the year (Table 1), it showed consecutive high values in April, May and June. This period is associated with breeding season of this species having young pigeons (chicks), which require a higher consumption of energy. Furthermore, it is coincident with spring season having mild temperature and low rains and these factors determine the rotation and ripening process of growth of wild plant and their fructification which are present in the dietary spectrum of Mourning dove, which is required as food for this species. Similar results were obtained by Acosta and Torres (1984) in Cienfuegos Botanical Garden (Cuba), where Mourning dove consumed almost 26 different types of food in the rainy season. This weather synchronization can be inferred an opportunistic character in this species of dove and a great adaptable success that is concordant with Abu Baker and Brown (2009) study.

Table 1. Monthly changes in Fullness index (FI) of Mourning dove

Months	Mean	Standard Deviation	Confidence Interval (95%)	
			Lower limit	Upper limit
January	0.0775	0.0183	0.0558	0.1143
February	0.0462	0.0409	0.0099	0.0824
March	0.0381	0.0244	0.0176	0.0585
April	0.0687	0.0490	0.0277	0.1096
May	0.0595	0.0405	0.0170	0.1022
June	0.0648	0.0321	0.0378	0.0916
July	0.0200	0.0188	0.0017	0.0332
August	0.0458	0.0279	0.0163	0.0754
September	0.0601	0.0326	0.0078	0.1118
October	0.0442	0.0337	0.0022	0.0861
November	0.0325	0.0263	0.0034	0.0522
December	0.0264	0.0283	-0.0088	0.0616

The statistical treatment of the fullness index according to the dove sex by nonparametric test of Man-Whitney U showed no significant differences ($p > 0.05$), which is consistent with a similar feeding strategy in both sexes observed in other species of Genus *Zenaida* in tropical environments (Cezilly and Keddar, 2012). The application of the same statistical analysis to this index comparing the age classes (young/ adults) was not either significant ($p > 0.05$). But it is important to emphasize that the average fullness index (0.062) in young doves is higher than the average consumption (0.047) in adult birds, which is in agreement with Best and Smartt (1986) results obtained in Mexico. The mean age ratio of this dove in USA, obtained at random from hunters is 1.9 young/adult (Miller and Otis, 2010) and with an estimated recruitment of 4.1 young pigeon/adult female (Schulz *et al*. 2013). This difference in two age classes is related to the metabolic requirements of the growth and development processes that young pigeon try out (Miller 2010, 2011).

Feeding importance of Cuban habitats: Percentages of each category of plant species and total number of species in the study area was obtained in the vegetation survey, and from these how many plants Mourning dove uses as food (Table 2). A quarter of plant species provided food for Mourning dove in the agricultural (farming) area, where the grass species were predominant (70%), as source of food. A representative availability of tree and shrub species were found in this biotope, but only one shrub (*Erytroxilum havanensis*) was used as food. The tree and shrub plants grew up mainly in borders and hedges that lined the country roads and fences in pasture lands, and these ones were used as perches for resting, shelter and nesting substrate by this dove. All these agricultural landscape features can be translated into an excellent habitat quality for the population of the studied species.

Table 2. Percentage of plant species available by biotopes in study area and their occurrence in Mourning dove diet

Biotopes	% of species*					Total	% spp. in
	Herbs	Shrubs	Trees	Scansorial	Epiphytic	N spp.	dove diet
Farming	70	13	11	6	0	84	25
Forest	16	32	36	11	5	44	5
Total area	57	17	18	6	2	101	21

*Total percentage (100%) of each biotope and from study zone as a result of the sum of species (spp.) percentage in each line

In typical forest biotope a very small percentage of plant species provided food for Mourning dove, with a predominant presence (68%) of tree and shrub species, which showed a low-quality habitat for this species given its poor food potential, except in clearing forest patches where herbaceous species were abundant.

Composition and preference of diet: Table 3 shows the dietary content with a total of 33 food items, where 88% were plants (seeds, fruits, bulbous and young shoots), 9% came from mineral origin (quartz fragments, small stones from a ferrous rock, small lumps of clay) and 3% from animals (snail shell fragments). Comparing the results by Acosta and Ponce de León (2004), which found that this dove consumed grasshopper's eggs, ants, beetles and isopods (woodlice), this study showed consumption of land snails only.

Table 3. Classification of food items, sorted by the index of dietary importance (DI), which compose the feeding spectrum of Mourning dove.

DI	Dietary Items	Common name in Cuba	Botanical Family	Species
1.7367	Seeds	Lechosa	Euphorbiaceae	*Euphorbia heterophylla*
1.2952	Seeds	Hierba guinea	Graminaceae	*Panicum maximum*
0.7130	Seeds	Tua – tua	Euphorbiaceae	*Croton lobatus*
0.6839	Seeds	Arroz	Graminaceae	*Oryza sativa*
0.6832	Seeds	Canutillo	Graminaceae	*Rottboellia conchinchinensis*
0.6539	Seeds	Malva	Malvaceae	*Suda sp.*
0.6811	Seeds	Saca sebo	Graminaceae	*Paspalum distichum*
0.4083	Seeds	Hierba mora	Solanaceae	*Solanum nodiflorun*
0.2912	Seeds	Malva Blanca	Malvaceae	*Sida cordifolia*
0.2776	Seeds	Cortadera	Cyperaceae	*Cladium jamaicense*
0.2599	Seeds	Malva	Malvaceae	*Malvastrum coromandelianum*
0.2371	Clay	Arcilla roja		
0.2308	Seeds	Cardo santo	Papaveraceae	*Argemone Mexicana*
0.2232	Seeds	Higuereta	Euphorbiaceae	*Ricinus comunis*
0.2170	Seeds	Cambute	Graminaceae	*Paspalum conjugatum.*
0.2142	Seeds	Maní cimarrón	Caesalpinaceae	*Chamaescrista sp.*
0.1804	Seeds	Aguinaldo	Convolvulaceae	*Ipomea sp.*
0.1759	Seeds	Frijol Silvestre	Fabaceae	*Phaceolus sp.*
0.1732	Snails	Caracoles terrestres		
0.1719	Seeds	Frijol negro	Fabaceae	*Phaceolus vulgaris*
0.1707	Seeds*		Passifloraceae	
0.1502	Seeds	Malva	Malvaceae	*Sida sp*
0.1316	Stones	Perdigones de hierro		
0.1316	Stones	Piedras de Cuarzo		
0.1266	Seeds	Malva Blanca	Sterculiaceae	*Walteria indica*
0.1228	Seeds	Chufa	Cyperaceae	*Cuperus esculentus*
0.1140	Shoots			
0.1107	Seeds	Maíz	Graminaceae	*Zea mays*
0.1056	Seeds	Malva mulata	Malvaceae	*Malacara alceifolia*
0.0618	Seeds*		Graminaceae	
0.0533	Seeds	Malva de Puerco	Malvaceae	*Sida rhombifolia*
0.0357	Fruits	Jibá	Erythroxilaceae	*Erythroxylum havanense*
0.0289	Bulbs	Cebolleta	Cyperaceae	*Cyperus rotundus*

(*)Plant items that could not be identified at species level.

Item called "Perdigones de hierro" in Cuba does not refer to the munitions in cartridge shotguns used for hunting which are made of lead generally, but to a small stone from a ferrous rock that is common in Cuban soils. Hunting shots did not appear in the dietary analysis of this dove in Cuba. However, field studies with hunted individuals of Mourning dove have shown that the percentage of birds which ingested lead shots was 0.2 to 6,5% (Plautz *et al*. 2011).

Dietary base of this dove in the study area was mainly characterized by plants, composed of 79% of herb seeds and showing its preference on small seeds over others plant origin foods. Similar results were presented by Acosta and Ponce de León (2004), who stated that 99% of consumed food by this species were plant origin (seeds and others parts of the plants). Two food items showed their dietary importance index higher than (1) i.e. Wild poinsettia (*Euphorbia heterophylla*) and Guinea grass (*Panicum maximun*) seeds (Table 3). Wild poinsettia is an herbaceous species that spontaneously appears in crop fields, fallow lands, plough patches and in roadsides, and it is considered a weed by farmers. Guinea grass produces a lot of small seeds and it is a kind of plant that constantly and spontaneously grows up in humid and fertile lands, further it is considered the best pasture in Cuba. *Panicum* spp. is found in areas of agricultural grows, fallow patches, abandoned fields and along roads, occasionally also found associated species in fences or borders and in forest clearings. Rice (*Oryza sativa*) also stands out and it is a widespread crop in the territory, although it has certain period of preferential harvest, it is more or less found during whole year in the study area and provided an important food for Mourning dove. Acosta and Berovides (1982) reported that in the south of Pinar del Rio province (Cuba) rice took the first place as regards volume in the diet of this species of pigeon. In USA, Hayslette and Mirarchi (2002) and Hayslette (2006) studied the food selection based on seeds` size and they also found Mourning dove`s preference for small seeds such as Wheat *(Triticum aestivum*) and Millet (*Panicum miliaceum*) over others with bigger size like maize (*Zea mays*). According to Ostrand *et al*. (1998), this pigeon was feeding mainly in the wheat crops and in weed patches. Thus a decrease in the availability of wheat during spring contributed to population decline of this dove. Our study also shows some plant items of bigger size such as maize and Jiba fruit (*Erythroxylum havanense*) in food spectrum of this pigeon, but they were included in the low level group of feeding importance.

Impact on a Caribbean agro-ecosystem: The plant richness in the food spectrum of *Mourning dove* in the study area was of 29 species which only 3 (10%) agricultural crops. This result points out the importance of this dove by its low impact on agriculture, also, because it took the seeds straight from the ground, did not dig nor broke the crop spikes and only consumed harvest remains. Furthermore, Columbidae ate large amount of herbaceous seeds in agricultural zones considered weeds by farmers. This bird with a well-developed muscular stomach has the capacity of practically disintegrate all eaten seeds, avoiding the spread of weeds. Blockstein *et al*. (1987) found that very few intact seeds passed through the digestive systems of adult mourning doves and only a low amount of seeds were recovered from faecal material found in dove nests, that is why they considered that this species of pigeon rarely acted as seed disperser. This dove particularly did not act as a dispersal agent of invasive plants in agricultural environments, except for some exotic plants introduced in America as *Commelina benghalensis* (Goddard *et al*. 2009). The diet of Mourning dove in the study area was moderately diverse (H' = 1,738 nats/individual), and this may be an answer to the amount and distribution in which appeared plant food in their habitat, ensuring the species survival by allowing a wide use of feeding resources.

According to our study, Mourning dove is a small game species associated with agricultural ecosystems. This contrasts with studies about the interaction of other species from Columbidae family with different structural units of landscape (Jiménez *et al*. 2006 and Belda *et al*. 2011). Thus, in landscapes where natural vegetation is dominant, Wood pigeon (*Columba palumbus*) density is positively influenced by large forest areas, but it also adapts to environments deforested by agriculture (Larruy and Burgas, 2004). Nevertheless, animal biodiversity in agricultural landscapes can raise with the conversion of some low production grows in more natural lands or extensively managed lands; but it is unknown in what extent this biodiversity and abundance of pigeons can be improved by altering the landscape pattern without reducing agricultural production (Belda *et al*. 2011; Fahrig *et al*. 2011). European Turtledove (*Streptopelia turtur*) inhabits wooded shrubland matrix with irrigated fruit, but it avoids dense shrubland due to a lack of adequate food resources. Turtledove species coincides in its habitat preference with western subspecies of Mourning dove in USA, *Zenaida macroura marginella* (Meyers *et al*. 2005). Collared dove (*Streptopelia decaocto*) inhabits urban areas with wooded gardens or with forest patches, near urban settlements (which are preferred as nesting areas). A favourite mosaic landscape for this dove includes agricultural lands (irrigated fruit and dry vineyards) near forest and urban patches. This interspersed landscape mosaic provides food, nesting and shelter areas. The increase of urbanization within dense afforested pine is favouring the Collared dove density (Belda *et al*. 2011). Nevertheless, experimental studies in captivity show a high degree of diet overlapping and similar food preferences of Collared dove with Mourning dove (Poling and Hayslette, 2006).

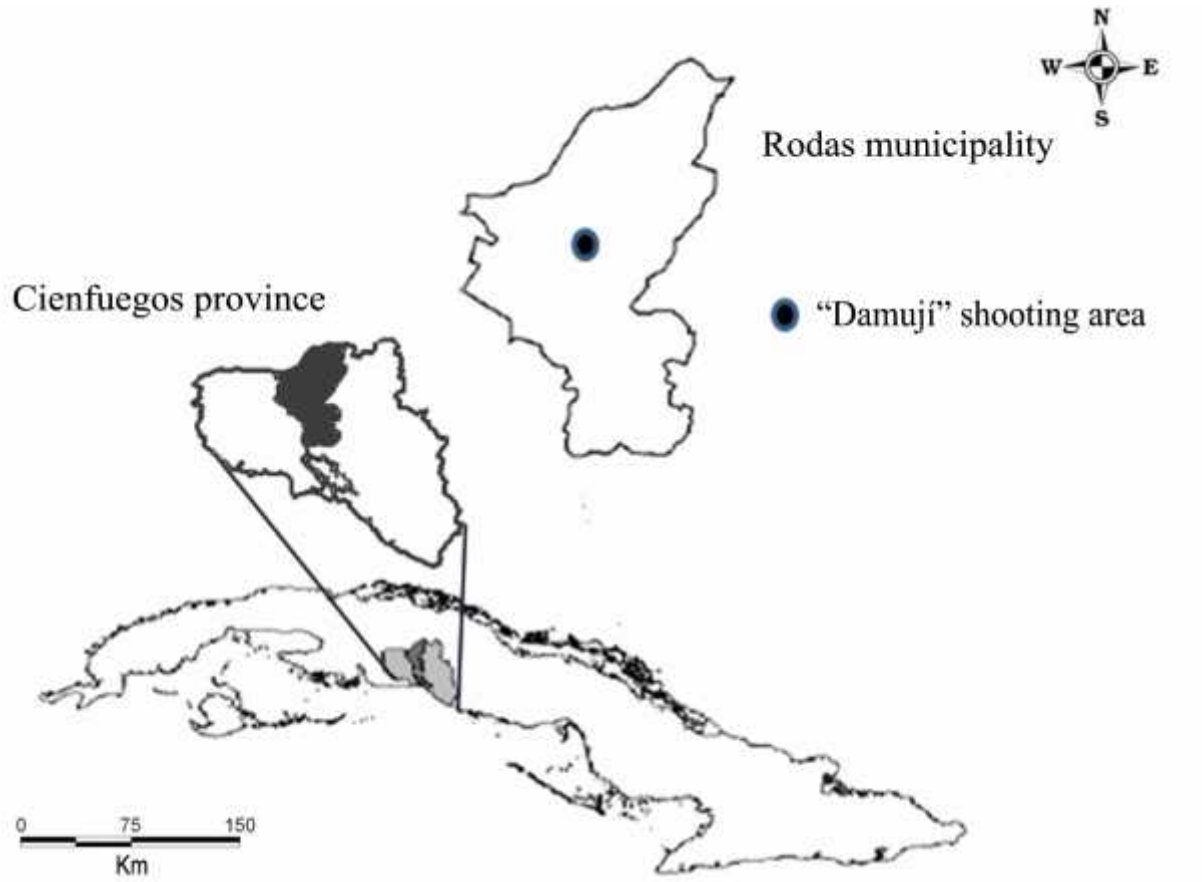

Figure 1. Location of "Damují" study area in Cuba

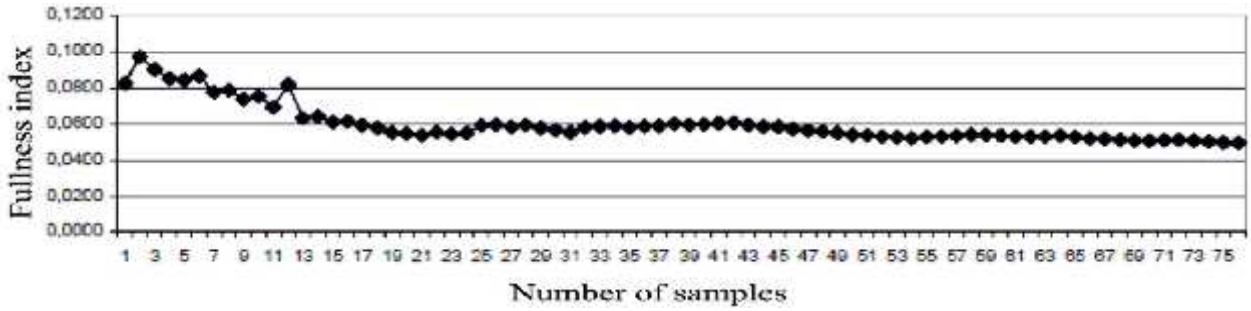

Figure 2. Fullness index of Mourning doves in tropical agroecosystems of Cuba

Conclusions: Agricultural (farming) biotope has higher quality as feeding habitat for Mourning dove. A sample size of 20 specimens can provide suitable quantitative information about the crop's content in this dove population. Fullness index varies according to the season's year (month). Both sexes have similar behaviour respect to the amount of consumed food. The young doves have higher index of food consumption. Trophic use of Mourning dove is characterized by plant origin principally and it is mainly composed of herbaceous seeds. This diet spectrum is moderately wide ranged according to diversity index. *Euphorbia heterphylla* and *Panicum maximum* seeds are the food items of higher dietary importance. Mourning dove causes a low agricultural trophic damage, and in addition it consumes seeds of plants considered weeds by farmers, thus we can conclude that it is a beneficial species in tropical agro-systems.

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