

THE BIOLOGY OF THE OPOSSUM (*DIDELPHIS MARSUPIALIS*) IN URBANIZED ENVIRONMENTS FROM NORTHERN VENEZUELA

BIOLOGIA DEL RABIPELADO (*DIDELPHIS MARSUPIALIS*) EN AMBIENTES URBANIZADOS DEL NORTE DE VENEZUELA

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ABSTRACT

This paper assesses the opossum (*Didelphis marsupialis*) biology, relative abundance and reproductive cycle and attempts to address the issue of the role it plays in urban environments at Caracas Metropolitan Area (CMA), Northern Venezuela. The opossum is commonly found in any patch of vegetation in urbanized areas. Relative abundance ranged from 6.3 to 12.5 and from 4 to 20 individuals per 100 trap-nights in the urban and suburban areas, respectively. The abundance is higher than the ones recorded for other Venezuelan localities. Dietary composition is significantly different (Mann-Whitney U-test, $P < 0.05$) between seasons, by volume and frequency of occurrence. Data showed that the opossum is an opportunist feeder that behaves as carnivorous or insectivorous in the wet season. It may play an important sanitation role by consuming slugs, centipedes, cockroaches and carrion of roadkills. Average litter size recorded was 6.8 ($S=1.99$, $N=20$), ranging from 4 to 10 young. Breeding activity may occur from January throughout November, producing 2 litters annually. The reproductive cycle is basically the same as in natural environments. The availability of natural forest around the city, fragments of forest patches and greenspaces within urban areas, food resources, absence or few predators, and a stable climate might explained the opossum success at CMA.

RESUMEN

Este trabajo evalúa la biología, abundancia relativa y ciclo reproductivo del rabipelado (*Didelphis marsupialis*) e intenta abordar el papel que juega en ambientes urbanos del Area Metropolitana de Caracas (AMC), Norte de Venezuela. El rabipelado se encuentra comúnmente en cualesquiera espacio verde en áreas urbanizadas. La abundancia relativa osciló desde 6.3 a 12.5 y de 4 a 20 individuos por 100 trampas-noches en las áreas urbanas y suburbanas, respectivamente. Estas cifras son más altas que las registradas en otras localidades en Venezuela. La composición de la dieta es significativamente diferente (Mann-Whitney U-test, $P < 0.05$) entre estaciones, en términos de volumen y frecuencia de aparición. Los datos muestran que el rabipelado es un consumidor oportunista que se comporta como carnívoro o insectívoro en la estación húmeda. Este animal puede jugar un papel sanitario importante consumiendo babosas, ciempiés, cucarachas y carroña de animales arrollados en las calles y carreteras. El tamaño medio de la camada fue 6.8 ($S=1.99$, $N=20$), variando de 4 a 10 crías. La actividad reproductiva abarca desde Enero a Noviembre, produciendo dos camadas anualmente. El ciclo reproductivo es básicamente igual que en ambientes naturales. La disponibilidad de bosques naturales alrededor de la ciudad, fragmentos boscosos y espacios verdes en áreas urbanas, recursos alimentarios, ausencia o pocos depredadores y un clima estable pudieran explicar el éxito del rabipelado en AMC.

Key words: opossum, body size, age group, habitat, abundance, food habits, breeding activity, suburban and urban environments, Northern Venezuela.

Palabras clave: rabipelado, tamaño corporal, grupo de edad, hbitat, abundancia, hábitos alimentarios, actividad reproductiva, ambientes urbanos y suburbanos, Norte de Venezuela.

INTRODUCTION

Urban greenspaces offer unique research opportunities for the study of wildlife living in close association with humans (VanDruff *et al.* 1996). Studies on wildlife inhabiting urban environments are common in North America and Europe (Goldstein-Golding 1991 & VanDruff *et al.* 1996). In Venezuela, few studies on urban wildlife are known (Crema 1968).

The opossum (*Didelphis marsupialis*) (Marsupialia: Didelphidae) is a dweller of urban environments at Caracas Metropolitan Area (CMA). In the urban and suburban areas of Caracas City, the opossum might come in close contact with people, their pets and synanthropic wildlife species by establishing in and around human habitations. This is a major concern because the opossum is considered a primary reservoir of *Trypanosoma cruzi* and *Leishmania* spp. (Telford *et al.* 1981, Scorza *et al.* 1986), the blood parasites responsible for the deadly diseases known as trypanosomiasis and leishmaniasis affecting people in rural and urban areas of Venezuela.

Recent field and laboratory studies have shown that opossums and rats are naturally infected with *T. cruzi* in urban areas of CMA, meaning that natural foci of trypanosomiasis (Chagas' disease) exist in the area (Sampson-Ward 1985, Herrera & Urdaneta-Morales 1992, 1997). Despite humans are not in direct contact with these mammals, there is nevertheless a potential epidemiological menace because infected reservoirs and vectors (*Panstrongylus geniculatus*) are present in the middle of dense human populations living in poor hygienic conditions (Sampson-Ward 1985, Pifano 1986, Herrera & Urdaneta-Morales 1997).

In Venezuela, the opossum biology and ecology is known from studies conducted in Barlovento Region, Miranda (O'Connell 1979, Cordero 1983, 1987, Cordero & Nicolas 1987), the Llanos Region (O'Connell 1979, Telford *et al.* 1979 a, b, Sunquist *et al.* 1987) and the Andes Region, Mérida (Cabello-Vilchez 1982). However, there is a paucity of information regarding opossum biology, population abundance, reproductive cycle and the role it plays in urban environments.

This paper attempts to address those issues and reports some findings on the biology of the opossum in Caracas City and its suburban areas.

MATERIAL AND METHODS

Study site. Fieldwork was conducted in and around CMA (10° 21'-10° 32' N, 66° 48'-66° 58' W). CMA is a megalopolis inhabited by approximately five million people. This megalopolis encompasses an area of approximately 1200 Km² (Municipal City Council 1972). The climate is seasonal with a humid period from May to November and a drought from December to April. Annual mean temperature is 20.6 °C and rainfall is 1011 mm. Caracas City is enclosed within a long and stretched valley surrounded by sloped hills and ridged landscape. According to Holdridge Life Zones (Ewel *et al.* 1976), the vegetation of Caracas and its surroundings is mostly a premontane humid forest. However, within the city and its suburban areas the vegetation is patchily distributed. Planted and wild grown trees, shrubs, and lawn grasses and herbs are found in public and private gardens around homes and buildings, recreational parks, streets and roads. Secondary scrub and forest vegetation is also found along the sides of streams and free ways connecting the big city to suburban areas in low and high sloped terrain. This scenario resembles that of a network of habitat patches and corridors connecting each other and serving as means of dispersal for wildlife. Additionally, CMA is surrounded by a network of protected areas as El Avila National Park (85192 ha), Macarao National Park (15000), and six Protected Zones (88768). All of these natural protected areas provide suitable forest habitats for source opossum populations.

According to Hoyos (1990), in Caracas City there are approximately 350 species of trees distributed among 67 plant families. In terms of number of species, the most important families are Caesalpiniaceae (34 spp), Papilionaceae (27), Mimosaceae (27), Moraceae (22), Euphorbiaceae (20), Myrtaceae (18), and Bignoniaceae (15). Thirty four per cent (119 spp) of the tree species produce edible fruits that are a source of food for urban wildlife throughout the year. The flora of El Avila

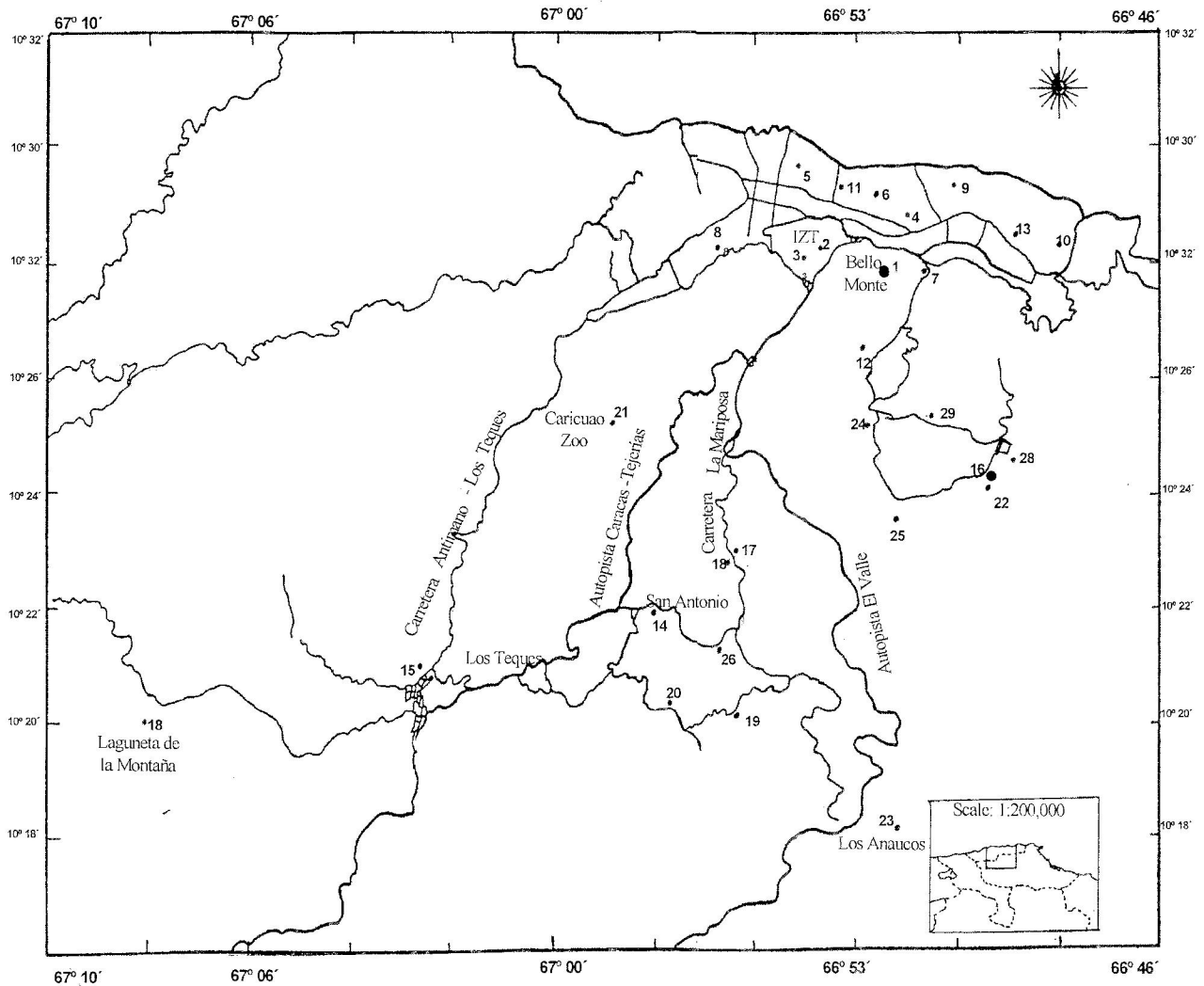


Figure 1. Map showing distribution of urban and suburban sampled locations for opossum (*Didelphis marsupialis*) at Caracas Metropolitan Area. Urban locations: 1. Bello Monte, 2. Gardens of Instituto de Zoología Tropical, 3. Las Acacias, 4. Country Club, 5. San Bernardino, 6. Alta Florida, 7. Las Mercedes, 8. El Paraíso, 9. Altamira, 10. El Márquez, 11. Mariperez, 12. Cumbres de Curumo, and 13. Los Dos Caminos. Suburban locations: 14. San Antonio de Los Altos, 15. Outskirts of Los Teques, 16. Los Guayabitos, 17. La Mariposa, 18. Laguneta de La Montaña, 19. San José de Los Altos, 20. San Diego, 21. Caricuao Zoo, 22. Oripoto, 23. Los Anaucos, 24. Baruta, 25. Sartenejas, 26. Potrero, 27. El Laurel, 28. El Hatillo, and 29. La Trinidad.

National Park comprise 861 genera and 1892 plant species, including Orchidaceae (173 species), Gramineae (156), Pteridophyta (151), Leguminosae (140), and Compositae (114) as the most conspicuous families (Steyermark & Huber 1978).

The wildlife inhabiting Caracas City and its surroundings is rich in terrestrial vertebrates. Mammals reported for the area include species of marsupials (5 spp), insectivores (1), bats (27),

xenarthrans (2), deers (1), rabbits (1), rodents (11), and carnivores (10) (Mondolfi 1967, Ojasti & Mondolfi 1968). Aveledo (1968) reported one hundred and fifty nine avian species for the Valley of Caracas. The families Bufonidae, Centrolenidae, Hylidae, Leptodactylidae, and Ranidae (Alemán 1952, Solano de Chacín 1968) represent amphibians. Reptiles comprise six families of snakes, including Boidae (2 spp), Colubridae (33), Elapidae (2), Leptotyphlopidae (1 spp), Typhlopidae

(2), and Viperidae (5) (Alemán 1952, Lancini 1968), whereas the lizards comprise the families Amphisbaenidae, Gekkonidae, Iguanidae, Scincidae, and Teiidae (Alemán 1952). Potential predators of the opossum at CMA could be the small carnivores, large boa and poisonous snakes, and stray domestic dogs and cats.

Collections. One to two nocturnal survey raids every two weeks were conducted along urban or suburban streets, roads and free way corridors in order to collect opossums. The survey started around 20:00 hours, ending at 24:00 to 01:00 hours. However, some road-kill opossums were collected in the morning from 07:00 to 12:00 hours.

Opossums were collected on a monthly basis from November 1979 to May 1985, either as roadkills or captured alive by trapping or manually. Removal live trapping was conducted in six occasions at three urban locations and in seven occasions at four suburban locations. Collapsible wire mesh Tomahawk live traps (48 X 15 X 15 cm) baited with banana slices were set in line-transects in and around house gardens and patches of forests around houses and apartment complexes. Distance between trap stations was 10 to 15 m. External body measurements and mass; sex, reproductive conditions and dental age of each animal were recorded, when possible. The age of each animal was determined based on tooth eruption and wear (Tyndale-Biscoe & MacKenzie 1976), allowing their classification into seven age groups (Cordero unpublished data, see Appendix 1).

The analysis of stomach contents was performed according to Korschgen's (1980) procedure. Each stomach and its contents were placed on a fine sieve (1-mm diameter mesh screen) and thoroughly washed under running water for sorting out fine from coarse material. After measuring the entire volume of the contents, each item was sorted out under a dissecting microscope and its volume recorded. A reference collection was used for the identification of insects.

RESULTS

Sampling of Specimens. Forty-eight opossums were taken from 13 urban localities, whereas 63 animals were taken from 16 suburban localities in

CMA (Fig. 1). The distribution of the specimens collected was 21 roadkills, 21 live-trapped, and six hand caught in urban environment, whereas 38 roadkills, twenty live-trapped, and five hand caught in the suburban environment (Appendix 2). Elevation of locations ranges from 800 to 1600 m.

Habitat and Relative Abundance. Opossum is a common species in private and public gardens, forests in recreational parks, National parks, and protected zones. It is also found in strips and patches of brush, scrub, and forest vegetation in the urban and suburban environments and corridors of vegetation along the sides of roads and highways connecting Caracas City with the suburban areas. Live and road-kill opossums are frequently sighted in streets, roads and areas around houses and apartment buildings. It is the main road-kill species of wild mammal found at CMA.

The number of opossum per 100 traps-nights (TN) recorded in several locations at CMA is portrayed in Table 1. Relative abundance of opossum ranges from 6.3 in January to 12.5 in April, but it reaches 15 in October in urban areas. In the suburban areas 20 opossums per 100 TN were recorded in February, March, and November, but in the forest core at Caricuao Zoo the abundance was lower. Unfortunately, it was not possible to conduct trapping for an entire year cycle.

Body Size. Opossum body weight and total length by dental age group are shown in Table 2. It appears that body mass is positively correlated with age groups. However, there is a large variance in body mass within age groups. Maximum body mass and total body length is reached at dental age groups VI and VII. Average adult body weights in urban environments by area and season and for the year are shown in Table 3. Overall average body weight is 1514 g, ranging from 853 to 2847.5. Average body weight was similar between seasons within each area and for the overall annual data. Opossums inhabiting suburban areas are on average heavier than the ones from urban areas (t-test, $P < 0.05$). In the rainy season, opossums from urban and suburban areas are similar in mean body weight, but they are

Table 1. Number of opossums per 100 traps-nights (TN) in urbanized environments at Caracas Metropolitan Area. Trapping was conducted in patch of forest (1), patch of forest around houses (2), patch of forest around domestic fowl coops (3), and house garden (4). Nbr = number.

Date	Location	Type of Habitat	Nbr TN	Number of opossum
Urban Environments				
January 1983	Altamira	2	16	6.3
February 1983	Bello Monte	2	16	12.5
March 1983	Bello Monte	2	16	6.3
March 1983	San Bernardino	2	16	12.5
October 1984	Bello Monte	2	20	15.0
April 1985	Bello Monte	2	40	7.5
Suburban Environments				
March 1980	Caricuao Zoo	1	77	4.0
July 1982	Outskirt of Los Teques	3	20	10.0
November 1982	Outskirt of Los Teques	3	20	20.0
March 1983	Outskirt of Los Teques	3	30	13.3
February 1984	Laguneta de la Montaña	3	10	20.0
March 1984	Laguneta de la Montaña	3	10	20.0
March 1984	Los Guayabitos	4	20	20.0

Table 2. Mean body mass and total length by dental age group for *Didelphis marsupialis* in urban and suburban environments of Caracas Metropolitan Area. M=mean; S=standard deviation; V=variance; N=number of specimens per dental age group.

	Dental Group						
	Age I	Age II	Age III	Age IV	Age V	Age VI	Age VII
Body Mass (g)							
M	221.4	600.6	777.9	1184.1	1390.6	1470.9	1895.8
S	76.5	130.4	200.5	360.8	251.7	138.2	450.4
V	5852.3	17004.2	40200.3	130176.6	63352.9	19099.2	202860.2
N	6	9	4	10	21	3	21
Total Length (mm)							
M	452.5	614.1	639.0	755.5	795.0	855.3	848.7
S	31.7	43.6	62.5	51.3	45.9	23.6	52.2
V	1004.9	1901.0	3906.3	2631.7	2106.8	557.0	2724.8
N	6	9	9	10	20	4	21

Table 3. Mean body weights (in grams) of adult opossums in urbanized environments by area and season and for the year and overall data.

Season	Urban			Suburban			All		
	Mean	S	N	Mean	S	N	Mean	S	N
Wet	1441.8	342.9	8	1550.5	512.7	23	1522.5	471.7	31
Dry	1380.7	466.2	25	1667.3	324.6	20	1508.1	429.8	45
Annual	1395.5	435.2	33	1604.9	434.5	43	1514.0	444.4	76

significantly different (t-test, $P < 0.05$) in the dry season between areas.

Feeding Habits: Opossum Foods and Seasonal Variation. Five (8.9%) of the 56 stomachs examined were empty. Numbers of stomachs with items were: dry season 12 (23.5%) and wet season 39 (76.5%). Percentage of volume and frequency of occurrence are shown for each class of items in Table 4. There is a substantial seasonal variation in the number of food items recorded. Food of animal origin is more important (66.2%, by volume) than plant food (20.4%) in the diet of opossums throughout the year. By volume, mammals (27.0%), birds (17.2%), insects (14.0%), plant remains (11.1%), and fruits (9.3%) are the main foods ingested by opossums. In terms of frequency, insects (51.0%), plant remains (17.6%), mammals (15.7%), fruits (15.7%), birds (13.7%), and annelids (7.8%) contribute to the annual diet. During the wet season, the most important food items are mammals (33.1%), birds (18.1%), and insects (11.9%), and plant remains (10.1%), by volume. In the dry season, fruits (22.7%), insects (20.3%), birds (15.0%), and plant remains (14.2%) are the most important food items. In terms of frequency, insects (43.6%), garbage (17.9%), mammals (15.4%), birds (15.4%), and plant remains (15.4%) are the main foods of opossum in the wet season, whereas insects (75.0%), fruits (25.0%), plant remains (25.0%), mammals (16.7%), and garbage (16.7%) make the bulk of the diet in the dry season.

Reptiles represented by the remains of small snakes are present in just 2.6% of the stomach contents and made 0.9% of the diet, by volume, in the wet season.

Invertebrates as mollusks (slugs), chilopods (centipedes), and annelids (earthworms) are more important in the wet season, by frequency.

Miscellaneous items basically composed of garbage (paper, candle wick, plastic bags, and thread filaments) and particulate material are important, by volume and frequency, in the wet season. There are significant differences (Mann-Whitney U-test, $P < 0.05$) (Siegel 1976) in the opossum dietary composition between seasons, by volume and frequency.

Variation of Food Items by Sex. By volume, males consume mainly plant remains (26.5%), mammals (17.8%), and insects (10.2%), whereas females take mammals (38.0%), birds (11.5%), and insects (10.9%). However, by frequency, males take mainly plants remains (25.8%) and insects (22.8%), whereas females eat insects (29.7%) (Table 5).

The dietary compositions of male and female opossum are similar (Mann-Whitney U-test, $P > 0.05$), by volume and frequency.

Breeding Activity. Twenty of 33 adult females examined had pouch youngs. The mean litter size recorded was 6.8 ($S=1.99$), ranging from 4 to 10 young. Females with pouch young were collected in February (1 female), March (9), April (6), May (1), June (1), July (1), and in November one lactating female with empty pouch. Based on their body size, I consider that it is likely that these pouch youngs were born in December (1 litter), January (2), February (10), March (1), April (2), May (2), and July (2). I am also reporting here three female opossums collected at Quebrada Chacaito, 3 Km

Table 4. Percentages of volume (V) and frequency (F) of food items of opossums in Northern Venezuela in 1983 and 1984, by season and for the year. T = Trace

Food Items	Wet season		Dry season		Annual	
	% V	% F	% V	% F	% V	% F
ANIMALS	69.0	92.3	57.1	133.3	66.2	102.0
MAMMALIA	33.1	15.4	8.0	16.7	27.0	15.7
<i>Rattus rattus</i>			0.5	8.3	0.1	2.0
<i>Felis catus</i>	8.9	2.6			6.7	2.0
Mammal remains	24.2	12.8	7.5	8.3	20.2	11.8
AVES	18.1	15.4	15.0	8.3	17.3	13.7
<i>Gallus gallus</i>	8.9	5.1	15.0	8.3	10.3	5.9
Dove	4.4	2.6			3.3	2.0
Bird remains	4.8	7.7			3.7	5.9
REPTILIA	0.9	2.6			0.7	2.0
Small snake	0.9	2.6			0.7	2.0
INSECTA	11.9	43.6	20.3	75.0	14.0	51.0
Coleoptera	4.2	15.4	2.8	16.7	3.9	15.7
Passalidae			0.8	8.3	0.2	2.0
Meloidae	0.7	2.6			0.5	2.0
Coccinellidae			2.0	8.3	0.5	2.0
Scarabaeidae	3.3	10.3			2.5	7.8
Unid. coleopteran	0.2	2.6			0.2	2.0
Orthoptera	4.7	15.4	1.2	8.3	3.8	13.7
Acrididae	4.7	15.4	1.2	8.3	3.8	13.7
Lepidoptera	2.2	7.7	2.7	8.3	2.3	7.8
Eruciformes	2.2	7.7	2.7	8.3	2.3	7.8
Cursores	0.8	5.1	11.6	33.3	3.5	11.8
Blattidae	0.8	5.1	11.6	33.3	3.5	11.8
<i>Periplaneta</i> sp.	0.8	5.1	11.6	33.3	3.5	11.8
Insect remains			2.0	8.3	0.5	2.0
MOLLUSCA	1.7	5.1	8.2	8.3	3.3	5.9
Vulimulidae	1.2	2.6	8.2	8.3	3.0	3.9
Veronicellidae	0.5	2.6			0.3	2.0
Chilopoda	1.2	5.1	0.2	8.3	1.0	5.9
Geophilomorpha	1.2	5.1	0.2	8.3	1.0	5.9
Annelida	2.1	10.3			1.6	7.8
Lumbricidae	2.1	10.3			1.6	7.8
Carrion			5.4	8.3	1.3	2.0
<i>Gallus gallus</i>			5.4	8.3	1.3	2.0
PLANTS	15.1	28.2	36.8	50.0	20.4	33.3
Fruits	5.0	12.8	22.7	25.0	9.3	15.7
Myrtaceae	0.7	5.1	8.2	8.3	2.5	5.9
<i>Psidium guajava</i>	0.7	5.1	8.2	8.3	2.5	5.9
Anacardiaceae	0.8	2.6			0.6	2.0
<i>Mangifera indica</i>	0.8	2.6			0.6	2.0
Cucurbitaceae			11.6	8.3	2.8	2.0
Cucumber			11.6	8.3	2.8	2.0
Fruit remains	3.5	5.1	2.9	8.3	3.4	5.9
Plant remains	10.1	15.4	14.2	25.0	11.1	17.6
Grass & Seeds	1.8	5.1			1.3	3.9
Unidentified remains	8.4	10.3	14.2	25.0	9.8	13.7
GARBAGE	1.5	17.9	0.7	16.7	1.3	5.9
Paper	1.1	10.3			0.8	7.8
Candle wick	0.4	2.6	T	8.3	0.3	3.9
Plastic bags	T	5.1			T	3.9
Thread filaments			0.7	8.3	0.2	2.0
PARTICULATED MATERIAL	14.4	15.4	5.4	8.3	12.1	13.7

NE Caracas City by the Smithsonian Venezuelan Project (Handley 1976) on May 1967 that were nursing 7, 8, and 9 pouch youngs each. The yearly reproductive activity of female opossums is shown in Figure 2. Additionally, 19 weanlings or juveniles were collected from March throughout December (Table 6). The number of juvenile opossums by sex and age group and their approximate date of birth and weaning estimated based on their absolute age (see Appendix 1) are portrayed in Table 6. Young opossums should have been born in December (3 youngs), January (2), February (2), March (3), June (6), July (2), and August (1).

Taken together the bulk of the breeding data, it suggests that females produce two litters annually. The first litter might be produced in December-January, January-February or February-March and young should be weaned in April-May, May-June or June-July; the second litter in April-May, May-June or June-July and the young should be weaned in August-September, September-October or October-November.

DISCUSSION

Habitat and Relative Abundance. *Didelphis marsupialis* is a versatile, widespread and abundant small mammal characterized by its broad diet, short generation time, high reproductive potential, nomadic mobility, and being a habitat generalist. All these features make the opossum a good colonizing species in accordance to the attributes of invader species (Ehrlich, 1989). Perhaps, that is why it might be found anywhere in the mosaic of habitat patches in the urban greenspaces of CMA. It might occur almost in every habitat type throughout Venezuela, except at high elevation and deserts (Handley 1976).

The relative abundance of the opossum in other Venezuelan environments (O'Connell 1979, Cabello-Vilchez 1982, Cordero 1983) is lower than the abundance recorded in this study. Cordero (1983, 1984a) pointed out that opossum populations show seasonal fluctuations increasing during the wet season and decreasing in the dry season in a lowland mature tropical humid forest from Barlovento Region, nearly 100 Km E Caracas City. He reported numbers per 100 TN ranging from 0.44 in March 1982 to 1.03 in

July 1982. A monthly mean of 2214 TN was set from December 1981 to May 1983 in a 26 ha trapping grid, with a 30 m interval between trap stations. Relative abundance seasonal fluctuations are unknown throughout the year in urban environments. Assuming that those fluctuations follow the same pattern as in natural environments, I would expect more opossum reservoirs of trypanosomiasis to be present in the wet season. Generally, insect abundance increases during the rainy season (Wolda 1978a,b), meaning that more insect vectors would also be available. Should this be the case, the alleged epidemiological menace existing at CMA would even be greater in the wet season. However, information on the population interactions among opossum, insect vectors (*Panstrongylus geniculatus*) and humans is needed to validate this assumption.

Table 5. Food items of the opossum, by sex, in terms of percentages of volume (V) and frequency (F).

Food Items	Males N=20		Females N=15	
	% V	% F	% V	% F
ANIMALS	36.3	45.8	72.7	63.0
Mammalia	17.8	5.8	38.0	7.4
Aves	3.2	5.8	11.5	7.4
Reptilia	1.6	2.8		
Insecta	10.2	22.8	10.9	29.7
Mollusca	2.9	5.8	5.9	3.7
Chilopoda			0.1	3.7
Annelida	0.6	2.8	3.3	7.4
Carrion			3.9	3.7
PLANTS	43.0	34.3	9.1	14.8
Fruits	7.5	8.5	7.7	7.4
Plant remains	26.5	25.8	1.4	7.4
MISCELLANEOUS	1.8	8.5	9.6	11.1
Particulate Material	27.9	11.4	8.6	11.1

Cabello-Vilchez (1982) reported a mean of 3.28 of opossums per 100 TN, ranging from 2.07 to 5.45 for a highland agricultural landscape (mosaic of grassland for cattle ranching, streams, and patches of forest) at the Andes Region, Mérida. Seven transects were randomly selected to set live traps in the edge habitat. Trapping effort was on average 303 TN per month and the distance between trap stations was 15 m.

Probably, differences in field protocol, timing of trapping, habitat types, and weather patterns might account for these contrasting results. Obviously, a tropical humid forest is quite different from urban and agricultural landscapes. However, urban and

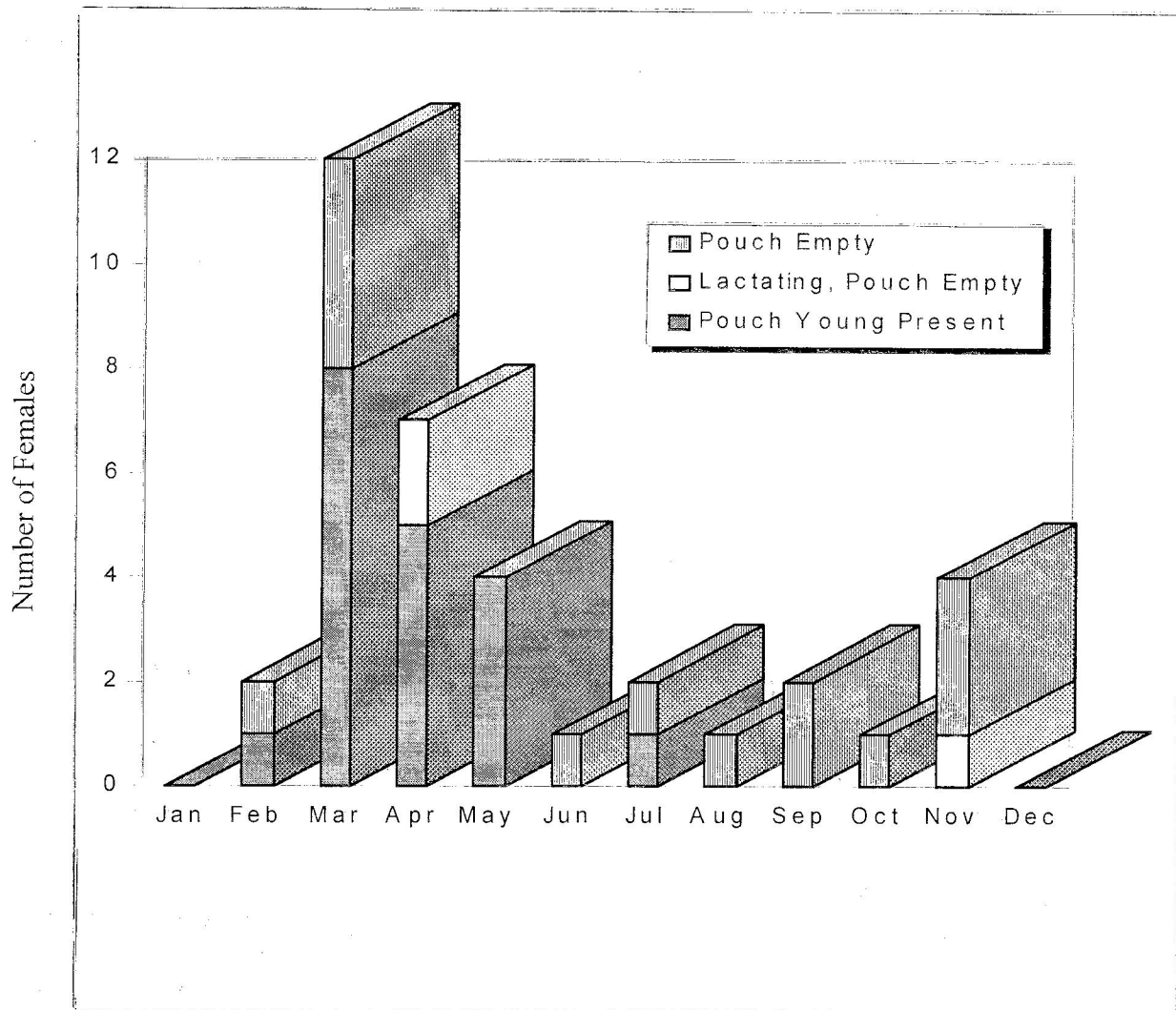


Figure 2. Reproductive conditions of adult female opossums (*Didelphis marsupialis*) at Caracas Metropolitan Area, Northern Venezuela.

agricultural landscapes share features as reduction of natural communities to fragments and habitat islands, and continual disturbance by human activities (Goldstein-Golding 1991). Edge communities are developed in both types of landscapes. In this sense, both my study area and Cabello-Vilchez's (1982) study site share similarities. Also, trapping was conducted in the edge communities in both studies. Perhaps, this could explain why the numbers of opossums per 100 TN recorded for these two landscapes are closer. Likewise, the additional food items offered in the urbanized environments and the absence or few predators in urban areas might also explain the success of opossums in urban greenspaces. Additionally, the natural protec-

ted areas around the city are a source of continuous influx of opossums to urban greenspaces.

Body Size. Tyndale-Biscoe and MacKenzie (1976) recorded a close correlation between body weight and dental age groups for an opossum population inhabiting an agricultural landscape (mixture of cultivated fields and extensive natural savannas broken by patches of gallery forest or palm swamps in the 'llanos' (plains) of eastern Colombia. Also, Cordero (unpublished data) found the same relationship for opossum populations from a tropical humid forest at Barlovento Region, Miranda. This study result on body weight by dental age groups concurs with their findings.

Table 6. Young opossums collected in urbanized environments at Caracas Metropolitan Area by sex and dental age group. Coll = Collection, Nbr = Number, AgeGrp = Age Group. Birth and weaning are the approximate dates of birth and weaning of pouch youngs. F = Female, M = Male.

Date of Coll.	Nbr Young	Sex	AgeGrp	Birth	Weaning
11 March 1982	1	F	III	25 Aug 81	30 Nov 1981
17 March 1984	1	F	I	10 Dec 83	
19 March 1982	1	F	I	12 Dec 81	
19 March 1984	1	F	I	12 Dec 83	
20 June 1984	1	M	I	15 Mar 84	
25 June 1982	1	M	II	2 Feb 82	10 May 1982
2 July 1983	1	?	I	26 Mar 83	
11 July 1982	1	M	II	18 Feb 82	16 May 1982
15 July 1982	1	M	III	2 Jan 82	9 Apr 1982
19 July 1982	1	M	III	6 Jan 82	13 Apr 1982
15 September 1983	1	F	I	19 Jun 83	
8 October 1981	1	M	III	28 Mar 81	3 Jul 1981
29 October 1984	2	F	II	8 Jun 84	13 Sep 1984
29 October 1984	1	M	II	8 Jun 84	13 Sep 1984
9 November 1982	2	M	II	19 Jun 82	24 Sep 1982
23 November 1983	1	F	II	3 Jul 83	8 Oct 1983
8 December 1983	1	M	II	18 Jul 82	23 Oct 1983

Cordero (1986) reported significant differences (t-test, $P < 0.05$) in body weight and total length by dental age groups and sex between rural and urban opossums from Barlovento Region and CMA, respectively. He also pointed out that on average opossums from urban areas are larger than their rural counterparts in northern Venezuela. The average maximum body weight recorded for 8 male opossums by myself at Barlovento Region was 1897.9 g ($S=154.1$), ranging from 1600 to 2050, whereas the mean body weight for adult males reported by Cabello-Vilchez (1982) was 1851g ($S=64$). In this study, I recorded an average maximum body weight of 2290.7 g ($S= 384.3$) for 10 male opossums, ranging from 1655 to 2847.5. Tyndale-Biscoe and MacKenzie (1976) recorded a maximum body weight of 1700 g for an adult male (age group VII). These contrasting results suggest that habitat feature as food quantity and quality might be affecting body size. Robinson and Redford (1989) made a projection of the effects of food quality and quantity on Neotropical forest mammal species body mass. They pointed out that in this

projection body mass appears to be positively related to quality when food quantity is constant, and positively to food quantity when food quality is constant.

Similarities on body weights were found between the wet and dry seasons within each urban and suburban area, suggesting that the seasonality of the environment does not affect the maintenance and growth of opossum populations in the urban landscape. The same results were found when comparing body weights between the areas in the wet season. However, on average opossums are heavier in suburban areas in the dry season. Assuming that food quantity availability is similar in both areas, probably food quality might be more limiting for opossum in the urban area during the dry season.

Likewise, one could argue that those similarities and differences in body mass could be considered an artifact of small sample size. The only case where that situation could be considered a problem

is the eight adult opossums examined during the wet season in the urban area.

Feeding Habits. The dietary data gathered in this study indicated that opossum is an opportunist omnivorous that feeds on whatever food item is available in urbanized environments. During the wet season, it tends to behave mainly as a carnivorous or insectivorous. However, in the dry season the diet is poorly known because a small number of stomachs content were analyzed.

The diet of *D. marsupialis* from Northern Venezuela was compared with findings on the feeding habits of the Virginian opossum (*D. virginiana*) from the United States of America in a previous paper (Cordero & Nicolas 1987). In the wet season, the number of food items consumed by opossum is larger than in the dry season. However, the difference is not as large as in the natural environments where the food resources are scanty in the dry season (Cordero & Nicolas 1992).

In urbanized environments, the opossum have access to additional food items, as human food remains mixed with garbage and the frequent presence of house rats, cats, and insects around garbage cans and dumpsters, which are not available in natural environments. Probably, those additional resources might account for the smaller seasonal difference in the number of food items taken by the opossum in CMA. The stomach of an opossum collected within Caracas City, after this study was completed, was completely full with food remains. Additionally, 119 species of edible fruits producing trees are a source of available food for opossums in an environment with few mammalian competitors.

The Virginian opossum forage on garbage, Norway rats (*Rattus norvegicus*) and house cats (*Felis domestica*) in urban environments at Portland City, Oregon (Hopkins & Forbes 1980) and on house cats in Missouri (Reynolds 1945), United States of America (USA). Also, in urbanized environments road-kills of birds and mammals (rat, cat, dog, and opossum) are often sighted in streets, roads, and free way corridors, providing an additional food source as carrion for the opossum in CMA. The opossum as a predator

is incapable of preying on small mammals that move faster as rats or are better equipped to defense themselves from an attack as cats. Probably, *Didelphis* is not an efficient predator of mammals in the wild (McManus 1970). Since none insect larvae were found together with rats or cats remains in stomach contents they were not reported as carrion.

Chickens (*Gallus* sp.) comprised the most important avian food item eaten by the opossum in CMA, but they are present in low percentage by volume. In the USA, chickens are present in low percentage in the diet of *D. virginiana* (Reynolds 1945, Taube 1947, Wiseman & Hendrickson 1950, Sandidge 1953). In spite of this situation, *Didelphis* is not considered a predator of domestic fowl.

Mollusks, chilopods and annelids were consumed in low percentage by volume and frequency of occurrence in the wet season. Mollusks and annelids tend to increase their activity on the soil surface during rainy days (personal observation). Probably, mollusk and annelids consumption throughout the year relates to rainfall as reported by Hopkins and Forbes (1980) for urban environments. These authors reported that, in terms of volume, mollusks (10%) and annelids (9.0%) are more important than diplopods, which are only present as traces in opossum stomach contents.

Although the opossum is not considered an efficient predator of mammals or chickens, it may play an important sanitation role by preying on repulsive invertebrates as slugs, centipedes, and cockroaches and eating roadkills carcasses.

The opossum forages on fruits and insects mostly in the wet season at CMA, probably because those food items are more abundant during that period. Fructification occurs throughout the year in tropical forests with peaks of fruit abundance in the drought-rainfall transition and wet season (Frankie *et al.* 1974, Croat 1975, Foster 1985). Insect abundance changes seasonally but increases in the wet season (Wolda 1978a,b).

Ripened fruits comprise nearly 50% of *D. marsupialis* diet in natural and suburban environments in French Guiana, whereas the

remaining 50% are made up of small mammals, amphibians, invertebrates, and carrion (Atramentowicz 1988). At CMA, fruits comprise 6.1% by volume and 12% in frequency of occurrence of the opossum dietary composition.

It is likely that fruit consumption varies in respond to its availability throughout the year, habitat type and sucesional status. Fruit production periods vary throughout the year among forest types in French Guiana. In primary forests, fruit production is more variable, the period of lower fruit availability is longer and most marked and the size of the harvest of most trees is larger in relation to secondary forests (Julien-Laferrière & Atramentowicz 1990).

Breeding Activity. The reproductive pattern of the opossum is consistent throughout the year in Northern Venezuela (Cordero 1983, 1984b). The onset of the breeding season begins in January-February (Cordero 1983, 1984b) or in February-March (O'Connell 1979) in the lowlands and highlands of Barlovento Region, respectively. In the highland llanos of Guárico and Portuguesa breeding begins in February-March (O'Connell 1979, Telford *et al.* 1979). Breeding activity begins in March in the highland Andes Region, Mérida (Cabello 1982). Reproductive activity seems to be rather variable at CMA, probably because the field data is a pool of breeding females collected in different years, from February 1980 to April 1985.

Didelphis marsupialis might produce 2 or 3 litters annually with a mean litter size ranging from 4.5 to 7.5 young in tropical America (Davis 1945, Biggers & Creed 1965 cited in Biggers 1966, Fleming 1973, Tyndale-Biscoe & MacKenzie 1976, Telford *et al.* 1979, O'Connell 1979, Cabello-Vilchez 1982, Cordero 1983, 1984b, Julien-

Laferrière & Atramentowicz 1990). My data on the breeding pattern of the opossum at CMA concur with these findings. Probably, the availability of natural forest areas around the city, fragments of forest patches and greenspaces within the urban areas, food resources, few predators, and a stable climate are responsible for the opossum success at CMA. Hopkins and Forbes (1979) compared the breeding activity pattern of *D. virginiana* from urban environments of Portland City, Oregon and several natural environments in the USA and found similar results. They concluded that it is likely that a combination of a mild climate and an urban environment favor growth and reproduction of Virginia opossum.

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Appendix 1. Dental Age Groups for *DIDELPHIS MARSUPIALIS* in Northern Venezuela.

Tooth Eruption	Wear	Age Group	Age (months)
dP3 M1	0	I	3.0 - 3.5
dP3 M2	0	II	4.5 - 5.0
dP3 M3	0	III	6.2 - 6.7
P3 M3	0	IV	7.9 - 8.7
P3 M4	0	V	10.9 - 11.7
P3 M4	P3 M1-2	VI	12.8 - 14.1
P3 M4	P3 M3-4	VII	> 16.1

Source: G. A. Cordero (Unpublished data)

Appendix 2. Opossums collected in urban and suburban environments of Caracas Metropolitan Area, Northern Venezuela. Spec = number of specimens; RK = roadkills; LT = live-trapping; HC = hand catch. IZT = Instituto de Zoología Tropical.

Location	Spec	Method of Collection		
		RK	LT	HC
Urban Environments				
Bello Monte	16	7	9	
Gardens of IZT	11		5	6
Las Acacias	4	3	1	
Country Club	3	3		
San Bernardino	3		3	
Alta Florida	3	3		
Las Mercedes	2	2		
El Paraiso	1	1		
Altamira	1		1	
El Márquez	1		1	
Mariperez	1	1		
Cumbres de Curumo	1	1		
Los Dos Caminos	1		1	
Totals	48	21	21	6
Suburban Environments				
San Antonio de Los Altos	18	16		2
Outskirts of Los Teques	10		9	1
Los Guayabitos	7	1	4	2
La Mariposa	4	4		
Laguneta de La Montaña	4		4	
San José de Los Altos	3	3		
San Diego	3	3		
Caricuaa Zoo	3		3	
Oripoto	2	2		
Los Anaucos	2	2		
Baruta	2	2		
Sartenejas	1	1		
Potrerito	1	1		
El Laurel	1	1		
El Hatillo	1	1		
La Trinidad	1	1		
Totals	63	38	20	5