NOT ALL SIGMODONTINE RODENTS IN THE SUGARCANE FIELDS IN COASTAL VERACRUZ, MEXICO, ARE PESTS

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ABSTRACT: Rats and mice have traditionally been considered one of the most important pests of sugarcane. However, "control" campaigns are rarely specific to the target species, and can have an affect on local wildlife, in particular non-pest rodent species. The objective of this study was to distinguish between rodent species that are pests and those that are not, and to identify patterns of food utilization by the rodents in the sugarcane crop complex. Within the crop complex, subsistence crops like maize, sorghum, rice, and bananas, which are grown alongside the sugarcane, are also subject to rodent damage. Six native rodent species were trapped in the Papaloapan River Basin of the State of Veracruz; the cotton rat (*Sigmodon hispidus*), the rice rate (*Oryzomys couesi*), the small rice rat (*O. chapmani*), the white footed mouse (*Peromyscus leucopus*), the golden mouse (*Reithrodontomys sumichrasti*), and the pigmy mouse (*Baiomys musculus*). In a stomach content analysis, the major food components for the cotton rat, the rice rat and the small rice rat were sugarcane (4.9 to 30.1%), seed (2.7 to 22.9%), and vegetation (0.9 to 29.8%); while for the golden mouse and the pigmy mouse the stomach content was almost exclusively seed (98 to 100%). The authors consider the first three species to be pests of the sugarcane crop complex, while the last two species are not.

KEY WORDS: rodents, sugarcane pests, non-pest species, Veracruz

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INTRODUCTION

Rodents have traditionally been considered one of the most important pests in the agricultural areas of the Papaloapan Basin in Veracruz, México, affecting such diverse crops as sugarcane, rice, corn and sorghum (Reiss 1976). Among the pest species are the pocket gophers (*Orthogeomys hispidus*) (Family: Geomyidae), the cotton rat (*Sigmodon hispidus*), the rice rat (*Oryzomys couesi*), and the small rice rat (*O. chapmani*). Farmers also consider small rodents such as the pigmy mouse (*Baiomys musculus*) as species that cause damage to crops. Carrasco and Abarca (1962) refer to the following species as crop pests, particularly in the sugar cane of México: *Sigmodon hispidus toltecus*, *Sigmodon. hispidus. major*, *Peromyscus leucopus texanus*, *Peromyscus. boylii levipes*, *Peromyscus. latirostris*, *Oryzomys couesi acuaticus*, *Liomys irroratus*, and *Reithrodontomys fulvescens*.

The Papaloapan Basin contains an extensive sugarcane monoculture that has been in existence for at least 40 years. During this time, certain rodent species have acquired a pest status, and the present traditional rodent control strategies have been developed. However, there are concerns regarding the effectiveness of these traditional control strategies, in particular, with regard to ineffective damage surveillance, delay between identification of damage and treatment, and the use of inappropriate rodenticides such as warfarin and zinc phosphide. Where such compounds are used extensively, and in particular where the poisons are applied using aircraft, there is a concern that non-target species may be adversely affected (Hudson, Tucker and Haegele 1984; Janda and Bosseova 1984).

The objective of this study was to identify and separate the target rodent pest species from the non-target species, and to identify patterns of food utilization by the rodents in the sugarcane crop complex.

MATERIALS AND METHODS

Study Site

This study was undertaken in the State of Veracruz, where sugarcane is the major crop, representing 70% of the cultivated area and responsible for 28% of the country's total sugar production. The study site is situated between La Tinaja and Cd. Alemán (18°08'to 18°20'W, 95°55' to 96°20'N) and the sugar mill is at Tres Valles. The site is approximately 40 m above sea level and has a total area of 22,000 hectares.

The climate is predominantly subhumid and hot, with monthly rainfall in the range of 12.5 to 470 mm, an average annual precipitation of 2026 mm, and a mean annual humidity of 82.5%. There are two major clearly defined seasons: a rainy season (May to October), with an average rainfall of 1829.2 mm, and a dry season (November to April) with an average rainfall of 196.9 mm.

The crop complex of the Papaloapan Basin is dominated by sugarcane, interspersed with a mosaic of other crops, including maize, sorghum, rice, banana and mango, as well as grasslands and other uncultivated areas. Abandoned fields are widely distributed over the whole area. The sugarcane is burnt by the farmers prior to harvest to facilitate cutting and transportation. Thus, during harvest time, extensive areas are systematically cleared of vegetation.

Maize, sorghum, rice and bananas are crops grown during the rainy season. Maize is a subsistence crop and covers a low percentage of the cultivated area in the region, while sorghum is a highly profitable crop. Rice is

grown in extensive areas, often alternating with the sugarcane. Harvest time for the rice is at the end of the rainy season (late October and November). Cattle raising is also an important agricultural practice in the region.

Sampling of Rodents

Four areas were identified in the study site (A, B, C and D), and within each area four sub-areas were marked out, each consisting of the interface between the sugarcane crop and adjacent crop vegetation.

Rodents were trapped each month between May 1994 and April 1995, using large snap traps, baited with fresh sugarcane. At each sub-area, the traps were set in two approximately straight lines, one in the sugarcane and one in the adjacent crop. Each line consisted of 40 traps set at 10 m intervals. On each trapping event, traps were set overnight between 1800 hrs and 0500 hrs the next day, over a three-day period.

Upon capture, each rodent was identified and classed as adult or immature, according to its weight and length. Biometric measurements recorded include total length, vertebrate tail length, hind foot length, ear length, weight and sex. Female reproductive status, and if pregnant, the number of embryos present was also recorded.

Stomach Content Analysis

Traps were checked early in the morning (0500 hrs) to safeguard stomach contents and to avoid damage to the animals by carnivorous ants. Stomachs were removed, preserved in 70% ethanol, and returned to the laboratory for processing. The examination of the stomach content was performed in a Petri dish using a dissecting microscope (14x magnification).

Sugarcane Cycle in the Area

In this area, sugarcane is planted from December until the end of May. From May to November the average age of the sugarcane increases from 4 to 12 months. This time period also corresponds with cane processing at the Mill. Vehicle access into the plantations probably restricts milling activity at other times of the year. However, harvest of the sugarcane is performed when the cane has a high sucrose content, and this is determined analytically within the laboratories at the Mill.

Plant Cover

A number of plant species were found growing either in association with the crop plants, in uncultivated areas or in grasslands. Such species included: *Rottboellia exaltata*, *R. cochinchinensis*, *Panicum maximum*, *Panicum bulbosum*, *Paspalum fasciculatum*, and *P. conjugatum*, *Setaria geniculata*, *Echinochloa colonum*, *Eleusine indica*, *Schizachyrium brevifolius*, *Poa pratensis*, *Sorghum halapense*, *Rhynchelytrum roseum*, *Digitaria sanguinalis* (Poaceae), various ferns, vines such as *Ipomoea purpurea*, ground tomatoes *Physalis angulata*, and *Solanum nigrum*, *Parthenium* sp., and various sedges, among them *Cyperus rotundus*, *Dactylis glomerata*, and *Cynodon dactylon*. Probably the most abundant plants were the touch sensitive *Mimosa pudica* and *Mimosa ivisa*, and the most troublesome weed in the area was the Kelly grass (*Rottboellia cochinchinensis*) to be found as an invader in all habitats.

Data Analysis

For each rodent species collected, the percentage of each category of food in the stomach was calculated. The data was analyzed independently over three periods of four months that were considered to reflect distinct growing phases of the sugarcane and prevailing climatic conditions (Table 1).

Data analysis was performed using SAS Version 6.11 for Windows, by Analysis of Variance, and by the Students T-Test.

RESULTS

Rodents of the Area

The six native species caught in the sampling area were:

cotton rat	*Sigmodon hispidus*
rice rat	*Oryzomys couesi*
small rice rat	*Oryzomys chapmani*
white-footed mouse	*Peromyscus leucopus*
golden mouse	*Reithrodontomys sumichrasti*
pigmy mouse	*Baiomys musculus*

Capture Success

The capture success of the six native rodent species caught in the study site from May 1994 to April 1995 are presented in Table 2. A total of 1,606 rodents were captured, of which over 72% were *Sigmodon hispidus*, 12.5% were *Oryzomys couesi*, and 9.2% were *Oryzomys chapmani*.

Apart from the capture of two specimens of *Baiomys musculus* in May 1994, the capture of each rodent species on a monthly basis is presented in Table 3. *Sigmodon hispidus* is seen to be the most prevalent rodent species in the study area for the whole of the study period. The number of animals trapped was stable between May and October 1994, but then increased between November 1994 and January 1995, and then decreased markedly in February 1995. There was evidence of a similar peak with both *O. cousei* and *O. chapmani*, although the magnitude was much less, reflecting the population size supported by this habitat.

Habitat Utilization

The percentage of each rodent species trapped in each vegetation type is shown in Table 3. The greatest proportion of each species were trapped in sugarcane, although this does in part reflect the greater trapping intensity in the sugarcane crop. Interestingly, for *S. hispidus*, uncultivated areas achieved a trapping success second only to sugarcane, probably indicating the importance of this habitat type for this species.

Diet

The results of the stomach contents analysis are as follows:

S. hispidus—sugarcane was found to be an important constituent in the diet, particularly between November and January, the maturing stages of the crop's growth (Table 4). Seeds and vegetation were also found to be important constituents of the diet.

O. cousei and *O. chapmani*—sugarcane was also an important dietary constituent, again particularly between November and January (Table 5). However, for *O.*

Table 1. Calendar periods of data analysis indicating climatic season and growth phase of the sugarcane.

Period	Calendar Months	Season	Sugarcane Cycle
1	May to August	Rainy	Early Growth
2	September to December	Intermediate	Late Growth
3	January to April	Drought	Harvest

Table 2. The capture success of the six native rodent species caught in the study site from May 1994 to April 1995.

Species	May to August	September to December	January to April	Total	%
Sigmodon hispidus	344	487	335	1,166	72.6
Oryzomys couesi	56	105	39	200	12.4
Oryzomys chapmani	47	65	36	148	9.2
Peromyscus leucopus	17	15	8	40	2.5
Reithrodontomys sumichrasti	30	13	8	51	3.2
Baiomys musculus	2	0	0	1	0.1

Table 3. Patterns of habitat selection for *S. Hispidus*, *O. couesi*, *O. chapmani*, *P. leucopus*, *R. sumichrasti*, and *B. musculus* within eight habitats.

Species	Sugarcane	Sorghum	Maize	Banana	Rice	Mangoes	Uncultivated Areas	Grazing Areas
S. hispidus	64.83	0.60	3.94	1.54	4.28	0.69	23.07	1.02
O. couesi	87.19	0.00	0.98	0.98	2.95	2.03	7.36	0.49
O. chapmani	77.70	0.67	2.70	0.00	4.05	2.07	12.83	0.00
P. leucopus	40.00	17.00	2.38	7.40	4.76	12.16	2.38	5.00
R. sumichrasti	66.66	11.76	15.68	5.88	0.00	0.00	0.00	0.00
B. musculus	0.00	0.00	0.12	0.00	0.00	0.00	0.00	0.00

Table 4. A comparison of the >50%< volume consumed by *S. hispidus*, *O. couesi*, *O. chapmani*, *P. leucopus*, *R. sumichrasti*, *B. musculus* in May 1994 to April 1995.

Species	Sugarcane <50% >50%	Seeds <50% >50%	Vegetation <50% >50%
S. hispidus	32.44 - 6.60	22.04 - 4.60	2.74 - 0.93
O. couesi	4.86 - 0.00	9.21 - 0.24	0.12 - 0.00
O. chapmani	2.40 - 0.06	6.03 - 0.31	0.18 - 0.00
P. leucopus	0.27 - 1.36	0.68 - 0.43	0.00 - 0.00
R. sumichrasti	0.00 - 0.00	2.98 - 0.06	0.12 - 0.00
B. musculus	0.00 - 0.00	0.00 - 0.12	0.00 - 0.00

Table 5. Seeds, sugarcane (Sc.), and vegetation (Veg.) consumption during the three four-month periods.

Species	May to August			September to December			January to April		
	Seeds	Sc.	Veg.	Seeds	Sc.	Veg.	Seeds	Sc.	Veg.
S. hispidus	8.20	6.91	1.80	10.20	14.30	0.62	3.60	11.30	0.31
O. couesi	3.23	0.00	0.12	4.85	1.68	0.00	1.12	0.18	0.00
O. chapmani	0.12	0.43	0.60	0.12	0.74	0.00	0.18	0.80	0.00
P. leucopus	0.37	0.24	0.06	0.12	0.12	0.00	0.18	0.00	0.00
R. sumichrasti	1.86	0.00	0.12	0.43	0.00	0.00	0.62	0.00	0.00
B. musculus	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00

cousei, seeds were an important dietary component over the whole study period, while for *O. chapmani*, invertebrates were an important dietary component.

P. leucopus—invertebrates and vegetation were important dietary components, while for *R. sumichrasti* and *B. musculus*, the diet was almost exclusively seeds.

DISCUSSION

It is thought that rodents can influence grassland ecosystems through their feeding habits (Golley 1975) with selective consumption of seeds influencing species composition and plant cover. It is thought that *Sigmodon hispidus* and both species of *Oryzomys* live in grasslands and fallow fields at times of the year when the crops are not providing an available food supply, moving into the sugarcane fields as the ripening season of sugarcane approaches, then leaving them after they damage the crop extensively. The other species of rodents generally stay in the fallow fields, where a great amount of food is to be found as well as insects. Probably as important as food, is the availability of refuges so common in the fallow fields.

The relationship between high rodent density and quality of habitats is positive. It was observed that sugarcane habitats were preferred specially by *S. hispidus*, *O. couesi*, and *O. chapmani*. Nevertheless, the uncultivated areas were also preferred first by *S. hispidus*, and second by *O. couesi* and *O. chapmani*. Glass and Slade (1980), Kincaid and Cameron (1985), Kincaid, Cameron and Carnes (1983), Lidicker, Wolf, Lidicker and Smith (1992), and Spencer and Cameron (1983) show that cotton rats occupy differing habitat associations during the different seasons. Cockburn (1981) and Taylor (1984) considered that alternate habitat occupancy may reflect preferences for or avoidance of particular forage species. Several studies suggest that hispid cotton rats select a mixture of dietary items from different habitat patches to balance their intake of nutrients (Kincaid and Cameron (1982, 1985), McMurry, Lochmiller, Boggs and Leslie (1994), and Randolph, Cameron and Wrazen (1991) suggest that dicot plants may be essential because they are richer in nutrients, energy, and water, and monocots provide a source of soluble carbohydrates and fiber, are more abundant, and have lower handling

cost. Protein and phosphorous are nutrients likely to limit reproduction of *S. hispidus* (Randolph, Cameron and McClure 1995). Farmers believe that in the middle and at the end of the dry season rodents use sugarcane as a source of water. Nutritionally, sugarcane is a poor food source for rodents as digestibility is extremely low (Garrison and Breidenstein 1970). The pith of sugar cane contains approximately 70% free water and 30% dry matter consisting of cellulose and sucrose. Crude protein represents only 1.2% and 2.2% in the pith and rind, respectively (Garrison and Breidenstein 1970). Conversely, the dominant weeds of the area can contain 10 to 20% of crude protein depending on the conditions under which they grow (Negus and Pinter 1966).

Svihla (1931) mentions that *O. couesi* and *chapmani*, under natural conditions, fed chiefly upon the seeds and succulent parts and sedges, and noted that each rice rat *O. palustris texanus* consumed 23.8% of its live weight per day. Meserve (1971), studying *Oryzomys longicaudatus* mentioned that this mouse, during the dry season (January to May), showed a strongly granivorous diet (proportion of seeds: 72.7%, of which more than two-thirds was grass and forb seeds). During the wet season they show a remarkable specialization of feeding on flowers, pollen and foliage (53.3%). The authors considered that *S. hispidus, O. couesi*, and *O. chapmani* are the only rodent pests in the sugarcrops in this area of México. It is important to mention that *P. leucopus* and *R. sumichrasti* are seed consumers, and sugarcane is rarely found in their stomach contents.

CONCLUSIONS

Due to the rare presence of sugarcane in their stomachs and the fact that they are rarely captured inside sugarcane fields, and due to the fact that they cannot open a mature sugarcane stalk because of the inherent hardness and thickness of the rind, it is concluded that *Peromyscus leucopus*, *Reithrodontomys umichrasti*, and *Baiomys taylori* (the smallest rodent of the continent), are not involved in the damage to sugarcane crops. The authors consider that *S. hispidus*, *O. couesi*, and *O. chapmani* are the major rodent pests of the sugarcane fields of this area of Veracruz. The minor rodent pest in the whole area is the hispid pocket gopher (*Orthogeomys hispidus*) rarely found in the sugarcane fields. Therefore, the authors suggest that rodent control campaigns based on the use of poison baits be directed to the target species.

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