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REPRODUCTIVE CHARACTERISTICS OF MERRIAM'S POCKET GOPHER (*PAPPOGEOMYS MERRIAMI MERRIAMI*) FROM HUITZILAC, MORELOS, MEXICO (RODENTIA: GEOMYIDAE)

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ABSTRACT—Reproductive data were obtained from 91 captures of *Pappogeomys merriami merriami* from Huitzilac, Morelos, México, from October 1980 to October 1981. Thirty percent of those captured were adult males, 47% were adult females, and 23% were juveniles. Female reproductive activity, defined as pregnancy or lactation, occurred primarily from October through March, but the potential for year-round reproduction was demonstrated. The mean sizes of the testes, seminal vesicles, and caudal epididymides of the males fluctuated during the year without a discernable pattern, but spermatozoa were present in all males captured year-round. Pregnant females were taken primarily during the dry season; however, juveniles were captured year-round.

The general features of reproduction in pocket gophers vary among different species, and also among different geographic areas occupied by a given species. Information pertaining to the breeding of the genus *Pappogeomys* is limited, especially for populations in the Valley of México. Information is especially limited for one taxon in this genus, *P. merriami merriami,* despite it being considered a major agricultural pest (Villa-R., 1953; Villa-C., 1989). Perusquia and Villa-C. (1982) described the estrous cycle of captive animals. Santillán (1978) indicated that females reproduce year-round in the Ixtaccihuatl and Popocatepetl regions, with an average of three embryos per female. Villa-C. (1984) recorded pregnant and lactating *P. m. merriami* in all months of the year in the state of Chalco, México, with most pregnancies occurring from May to October (wet season) and averaging two embryos per female.

Life histories of many other species of pocket gophers have been extensively studied (Miller, 1946; Howard and Childs, 1959; Hansen, 1960; Loeb, 1990), especially if they are considered important pests in agriculture or forestry (Luce et al., 1981; Tilman, 1983; Hobbs and Mooney, 1985; M. R. Case, in litt.). Knowledge of breeding activity, especially the breeding seasons, is a prerequisite to efficient population management (Miller, 1946). Pocket gophers are considered an important agricultural pest in the Mexican Valley (Villa-R., 1953; Villa-C., 1989). Effective and efficient control requires a thorough understanding of the ecology and biology of the pocket gopher, particularly its reproductive cycle. This paper provides information on the biology and reproductive features of *P. m. merriami.*

MATERIALS AND METHODS—The study was conducted at the border of the state of Morelos and the Distrito Federal, México 50 km (by road) S of Mexico City in Huitzilac, between parallels 19°01′45″ and 19°03′07″N and meridians 99°15′38″ and 99°16′32″W at 2,700 to 2,900 m in elevation. The general topography is gently sloping with poorly drained soils of volcanic origin. The climate is subhumid to humid. December to February are the coolest months and July is the warmest. Temperatures range between −3 and 18°C, rising to no more than 22°C in the warmest month. Annual precipitation is 1,000 to 1,500 mm, with high yearly variation (Garcia, 1973). October to February represent the dry season, followed by a prepluvial season from March to May, and a wet season from June to September. This highly disturbed area is characterized by weedy annuals such as grasses (*Cynodon* sp.) and a mixed conifer forest of evergreen oak (*Quercus crassipies*) and pines (*Pinus leiophyla, P. montezumae* and *P. pseudostrobus*), as well as crops like wild oats (*Avena fatua*), corn (*Zea mayz*), potatoes, beans (*Phaseolus* spp.), and some fruit trees.

TABLE 1—Summary data from 91 captures of *Pappogeomys merriami merriami*. All measurements are in mm. Months are numbered 1 to 12 from January to December.

	Year/season/month												
	1980			1981									
			Dry			Prepluvial			Wet				Dry
	10	11	12	1	2	3	4	5	6	7	8	9	10
Adult males													
Number caught	0	3	3	4	1	3	2	1	0	4	2	0	4
Length, seminal vesicle		9	10	9	6	10	10	6	6	9	9		10.5
Length, epididymis		20	22	12	13	22	24	13	13	13	10		22
Width, testes		22	21	28	12	26	22	12	16	26	24		29
Adult females													
Number caught	3	8	6	6	5	4	2	1	0	3	1	2	2
Number reproducing[1]	2	2	1	4	2	1	0	0	0	1	0	0	1
Length, ovaries[2]	4.2[3]	5.0	5.0	4.5	4.5		4.5			4.0	5.0	5.0	
Length, uterus[2]	30[3]	19	30	45	21		20			30	30	33	
Juveniles (number caught)													
Males	0	1	0	1	1	0	0	0	1	3	1	0	0
Females	2	1	0	1	0	1	3	0	0	2	0	2	1

[1] Reproducing females were either pregnant or lactating.
[2] Non-pregnant, non-lactating females.
[3] Combined October 1980 and 1981.

Pocket gophers were collected monthly from October 1980 through October 1981. Trapping began the first week of each month and continued for two weeks, using around 30 traps. Pocket gophers were captured by placing unbaited, leg-hold traps in burrow systems that showed signs of recent gopher activity. The animals were weighed and measured for total length, and their reproductive activity was determined. Animals were considered adults if they were sexually mature.

Males with epididymides containing large distinct tubules were classified as sexually mature and capable of reproducing, whereas those with small opaque epididymis were classified as nonreproductive (Tryon, 1947). Females were classified as lactating if the mammary glands showed development, and pregnant if they contained embryos. Females were considered sexually mature adults if the pubic symphysis had been reabsorbed (Hisaw, 1924). Weight and length measurements were taken on the ovary and uterus. The uterus was removed and examined microscopically for the presence of embryos. The crown-rump lengths of all embryos and fetuses were measured. Litter size was estimated from the numbers of embryos in the uterus. The weight and length of the testes, epididymis, and seminal glands were measured in the males, and histological smears were made to detect whether sperm were present.

RESULTS—91 pocket gophers were collected. Thirty percent ($n = 27$) of captured animals were adult males (Table 1), 47% were adult females ($n = 43$), 14% were juvenile females ($n = 13$), and 9% were juvenile males ($n = 8$). Mean weight for adult females was 676 g ($SE = 19$) versus 757 g ($SE = 25$) for adult males. Mean total body length for adult females was 346 mm ($SE = 3$) versus 360 mm ($SE = 4$) for adult males. Juveniles were trapped in each month except December and May (Table 1). Mean weight was 354 g ($SE = 25$) for juvenile females and 423 g ($SE = 40$) for juvenile males.

Table 1 presents the trapping results through the course of the year. Highest capture rates occurred November through January (dry season), reflecting higher populations, greater susceptibility to trapping, better trapping conditions, or a combination of these effects during this time. The observed male : female sex ratio (1:1.7) was significantly different from 1:1 ($\chi^2 = 3.657$, $d.f. = 1$, $P = 0.056$). The sex ratio for adults during the dry season (1:2, male : female) was not significantly different from that (1:1) in the wet season ($\chi^2 = 1.131$, $d.f. = 1$, $P = 0.288$). The ratio of adults to juveniles was 1:0.75 during the wet season and 1:0.47 during the dry season. Again, these ratios were not significantly different ($\chi^2 = 0.859$, $d.f. = 1$, $P = 0.354$).

The potential for year-round reproductive activity was indicated in all months (Table 1); however, most reproductive activity apparently occurred from October through March, with occasional activity at other times. Mean length of the ovaries did not vary substantially through the year (Table 1). Mean uterus length varied, but with no discernable pattern. Spermatozoa were present in all adult males examined, also indicating the potential for year-round reproductive activity. Mean sizes for the male reproductive measurements varied through the year, also without discernable pattern (Table 1).

We found 13 embryos, 6 fetuses, 1 neonate, and 2 resorptions. Crown to rump length ranged from 11 to 30 mm (n = 13) for embryos, 35 to 54 mm for fetuses (n = 6), and 61 mm (11.7 g) for the one neonate. Litter sizes in situ ranged from 1 to 3, with a mean of 1.5 (SE = 0.14).

DISCUSSION—Vaughan (1962) found a sex ratio of 1:1.3 (male : female) in *Geomys bursarius*. Similar ratios were found by Wood (1949), who reported a male : female ratio of 1:1.5 in *G. bursarius* in Texas, and by Wing (1960), who reported a ratio of 1:1.4 in *G. pinetis* in Florida. Villa-C. (1984) found a sex ratio of 1:1.3 in *P. t. tylorhinus* from the valley of México City. In the dry season, a greater proportion of the animals we captured were females, but this was not the case in the rainy season. Perhaps females were more active in repairing burrow openings or foraging and, therefore, were easier to trap in the dry season. Hansen (1960) suggested that the sex ratio between adults returns to 1:1 when the young have dispersed from the female's burrow. Miller (1946) also reported apparent shifts in the sex ratio at the times of the year when females were suckling young. However, in the present situation, suckling of young does not appear to explain why females were less likely to be captured in the rainy season, because our evidence (Table 1) indicates that females would be most likely to suckle their young in the dry season.

Environmental factors may affect the basic breeding cycle (e.g., Wood, 1949; King, 1927). Breeding begins at about the middle of March for *Thomomys talpoides* in Colorado, and extends to at least the middle of May (Hansen, 1960). Dixon (1929) and Scheffer (1938) asserted that pocket gophers of the genus *Thomomys* probably reproduce throughout the year in irrigated fields in central and southern California. Similarly, Miller (1946) reported reproduction in irrigated alfalfa fields throughout the year. Dixon (1929) suggested that the abundance of nutritious green food induced breeding in *T. bottae*. In Huitzilac we found that *P. m. merriami* have the potential to reproduce year-round. This potential is likely realized due to the constant availability of nutritious green forage in the different agricultural crops. Peak breeding occurred during the dry season when there is a flush of green vegetation from germination of the winter annuals.

Pregnant and lactating *P. m. merriami* were captured during a continuous period from October to March (dry season), and occasionally throughout the rest of the year. Spermatozoa were always present, so reproductive activity of adult males appeared less variable through the year than that for females. These findings indicate that *P. m. merriami* breeding has evolved so that most young are born when conditions are most favorable for the survival of mother and offspring, after winter rains have generated green food and tractable, moist soil for burrowing and nest building. During the rainy season, nests would be threatened with flooding.

As *P. m. merriami* is an important pest species in the area of our study, it is important to understand its breeding dynamics to optimize any damage reduction efforts, especially in Huitzilac, where the land owners typically attempt to control pocket gophers with hand-made traps, with only marginal success. While little is still known about pocket gopher invasion from surrounding areas, the greatest influx of dispersing young appears likely to occur in the prepluvial or wet season, although information is not available on the lactation period for this species.

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