INFLUENCE OF SEASON ON REPRODUCTIVE CHARACTERISTICS OF WOODCHUCKS IN VIRGINIA

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ABSTRACT

Reproductive characteristics of 110 woodchucks (Marmota monax) *were examined between 13 March and 30 November in 1974 and 1975. Ovulation rates averaged 4.73 in adult females examined between March to June. Less than 50 percent of yearlings ovulated during this period compared to 100 percent of adults. Preimplantation loss of embryos averaged 0.5 per pregnancy. Corpora lutea persisted until August in one female but was a reliable indicator of ovulation only until July. Placental scars persisted until September in one female. The peak of spermatogenesis seemed to occur earlier in adult males than in yearlings. Spermatogenesis were ceased in all males before June.*

The woodchuck (*Marmota monax*) has expanded its range and increased its population to the point that, in certain areas, it has become a serious pest to agricultural crops and farm equipment (Grizzell 1955, McDowell and Pillsbury 1959). As a result, control measures are required.

Trapping, shooting, fumigation and poisoning are all used to control woodchucks. More recently, interest in antifertility agents to limit pest populations has increased (Balser 1964, Linhart and Enders 1964, Harder and Peterle 1974, Oleyar and McGinnes 1974, Bell and Peterle 1975, Matschke 1975), because of the desirability of reducing natality rather than increasing mortality.

Since many chemosterilants have the potential to affect the reproductive cycle in both sexes (Jackson 1966), baseline data for all possible reproductive parameters of the species concerned is essential in evaluating the effectiveness of chemosterilants in inhibiting reproduction.

Hamilton (1934), Grizzell (1955), and Snyder and Christian (1960) provided considerable data on the reproductive characteristics of female woodchucks in New York, Maryland, and Pennsylvania, respectively. Christian et al. (1972) reported on the annual cycle of spermatogenesis in male woodchucks. Little has been done to delineate reproductive parameters of yearling woodchucks from those of adults.

The purpose of this study was to quantify reproductive aspects of woodchucks by age class in southwestern Virginia and to add to basic knowledge about spermatozoan output and hormone levels during the breeding season.

MATERIALS AND METHODS

Three study areas in southwestern Virginia were selected for collection of woodchucks: the Virginia Polytechnic Institute and State University (VPI&SU) Farm, the Radford Army Ammunition Plant near Radford, and the Carl Holcomb farm 1 km west of Blacksburg. All areas were similar in topography (rolling hills) and elevation (610-670 km). The VPI&SU Farm and the Holcomb farm were composed primarily of mixed agricultural cropland, while vegetation cover on the Radford Arsenal included broomsedge (*Andropogon virginicus*), blackberry (*Rubus* sp.) and pine (*Pinus* sp.) plantations.

Periodic surveys of woodchuck activity at den sites were conducted on the study areas during the months of February 1974 and 1975 in an attempt to determine approximate time of emergence from hibernation and the onset of breeding.

Woodchucks were collected during the periods 13 March to 20 November 1974-75 by trapping (22.8 x 30.5 x 91.4 cm wire-mesh Tomahawk live-traps) and by shooting with a .22 caliber rifle. Trapped animals were placed in a burlap bag and were sacrificed by cervical dislocation.

Immediately after sacrifice a 10 cc blood sample was obtained via heart puncture with a 18 ga needle attached to a 12 cc syringe. Blood samples were placed in a 15 cc test tube containing 15 mg ethylene-diaminetetraacetic acid (EDTA), capped with a rubber stopper, and placed on ice. Upon return to the laboratory, blood samples were centrifuged at 10 C and 2700 rpm for 10 minutes. Plasma was removed via pipette and placed in plastic Falcon tubes for freezing until needed later for hormone assays.

Reproductive tracts were removed from females and trimmed of extraneous tissue. Pairs of ovaries were weighed together, and numbers of corpora lutea were recorded. The uterus was separated at its junctions with the oviducts and the cervix, weighed, and placental scars were counted when present.

Spermatozoan Counts

Spermatozoan numbers were determined by a modification of the technique of Amann and Lambiase (1969). Testes were cut into fine pieces with scissors and homogenized in a blender at high speed for one minute in a saline (0.9 percent)—Triton-X (0.05 percent) solution at a dilution of 1 cc per 10 mg testis weight. Epididymides were cut into small pieces subjected to the same dilution, and homogenized for three minutes in a 40 ml Pyrex Tissue Grinder. Spermatozoa were counted from aliquots of the homogenate on an AO Spencer Hemacytometer and reported as spermatozoa per mg of tissue.

Hormone Assays

Blood plasma samples from males were analyzed for total androgen concentration, while those from females were assayed for estrogen and progesterone concentrations. Androgen levels were derived through a competitive protein binding procedure first described by Murphy (1964, 1968) and later modified by Schreck et al. (1972). Actual procedures utilized in this study follow those reported by Mirarchi (1975).

Plasma samples were assayed for total progestins by the competitive protein binding method described by Johansson (1970) as modified by Abler (1974). A radioimmunoassay developed by Dr. R. L. Butcher (Dept. of Obstetrics and Gynecology, West Virginia Medical Center, Morgantown, West Virginia) was used to assay plasma for estrogen. Exact procedures followed were those of Abler (1974), and due to the specificity of the antisera, estrogen concentrations obtained were essentially measures of estradiol 17-Beta.

RESULTS AND DISCUSSION

In 1974 the first sign of woodchuck emergence (fresh digging at the burrow opening) was noted on 13 February; in 1975 two woodchucks were observed in a pasture on 11 February. Considerable activity and den cleaning was evident by 20 February each year. According to Snyder and Christian (1960) adult male woodchucks emerge from hibernation first, followed a few days later by females and yearling males; breeding follows soon thereafter. Data by Snyder and Christian (1960) indicated a mean parturition date for Pennsylvania woodchucks of 10 April; this indicated an average conception date of

approximately 10 March as the gestation period is approximately 31 days (Hoyt and Hoyt 1950, Grizzell 1955).

A woodchuck, estimated to be 5-6 weeks old using Hamilton's (1934) criteria, was captured on May 1. At the latest, this particular animal was born on 24 March and, assuming a 31-day gestation, conception occurred approximately 21 February or earlier.

Two female woodchucks captured on 30 and 31 March each had placental scars which would indicate breeding approximately March 1, at the latest. One pregnant female was captured each of the following days: 29 March, 3 April, and 10 April. Embryos were estimated to be 8-10 days, 10-12 days, and 16-18 days, respectively. Breeding probably occurred during the third week of March in these three females.

Our limited data indicate that the mean breeding date in southwestern Virginia occurred no later than 10 March.

Of those females collected before mid-May adults had a greater number of ovulations and implantations and greater paired ovarian and uterine weights than yearlings (Table 1). Only 43 percent of the yearlings ovulated compared to 100 percent of adults ($P<0.01$, Chi square test). Differences in mean values for corpora lutea per female and corpora lutea per ovulated female reflect the fact that only 43 percent of yearlings ovulated. Similarly, differences between implantations per female and implantations per implanted female amplify the fact that not all yearlings ovulated.

Ova lost per implanted female, a measure of the number of ova that did not become implanted, was slightly greater for adults (0.50) than for yearlings (0.33). Ova loss also accounted for embryonic loss via resorptions, since placental scars were only counted if they were conspicuous and indicated a successful implantation.

Ovarian weights were highest in April but declined thereafter (Table 2). Data collected in June and later were analyzed without reference to age and all were considered adults. Uterine weights declined to low levels by August. Uteri of adult females regressed to lower weights in Fall than those of yearling females in Spring. Remnants of corpora lutea were still visible in some females in August but none were visible later than August. Placental scars were noted in some August and September females but were not evident in November females.

Reproductive hormone levels were variable for both adult and yearling females. Progesterone levels in adults were significantly higher ($P<0.05$) than levels in yearlings. Estrogen levels in adults tended to be higher than in yearling but differences were not significant. The wide variation in hormone concentrations of this time of the year was not unexpected, because the stage of the reproductive cycle also varied for individual animals because hormone levels normally change drastically during the active portion of the reproductive cycle.

Paired testes and paired epididymides weights were significantly ($P<0.05$) higher for adult males than yearling males (Table 3). As expected testicular and epididymal spermatozoan counts were lower for adults than yearlings. Christian et al. (1972) report that spermatogenesis in adult woodchucks is probably at its peak at the time that animals emerge from hibernation (mid-February). Testicular regression in both weight and spermatozoan production steadily regressed during the spring until no mature spermatozoa were found in the seminiferous tubules after 15 April. They further report that many yearling male woodchucks do not mature sexually until sometime after emergence from hibernation. As a result, mature spermatozoa may be found in some yearlings as late as May 31.

Testicular and epididymal spermatozoan numbers in yearlings was higher than in adults in April (Table 4). Only 6 of 13 yearlings had commenced spermatogenesis. These data tends to support the findings of Christian et al. (1972). In the present study a large number of animals were examined during the month of April, a time when many adult males had either very few or no mature spermatozoa. Only 3 of 14 adults had testicular spermatozoa and only 4 of 14 adults had epididymal spermatozoa. At the same time however, many yearling males were probably reaching the peak of spermatogenesis.

Data collected for June and later were analyzed without reference to age and all were considered "adult". Spermatogenesis ceased in all woodchucks by June and epididymal spermatozoa were resorbed or otherwise eliminated at this time. Weights of both testes and epididymides regressed considerably after July.

Table 1. Reproductive parameters of female woodchucks collected during the periods 13 March to 13 May, 1974-75 in southwestern Virginia.

	Mean (Sample size)	
Characteristic	*Yearling*	*Adult*
Corpora lutea	1.71(14)	4.50[a](6)
Corpora lutea per ovulated female	4.00(6)	4.50 (6)
Percentage that ovulated	43	100
Implantations	1.57(14)	4.00[a](6)
Implantations per implanted female	3.67(6)	4.00 (6)
Percentage that implanted	43	100
Ova lost per implanted female	0.33(6)	0.50 (6)
Paired ovarian weight (g)	0.13(14)	0.16[b](6)
Uterine weight (g)	1.28(12)	2.31[b](6)
Estrogen concentration (pg/ml)	46.18(9)	68.07 (3)
Progesterone concentration (ng/ml)	3.57(9)	10.73[a](3)

[a]Significantly different from yearlings at $P<0.05$ level.
[b]Significantly different from yearlings at $P<0.10$ level.

Table 2. Monthly variation in ovarian and uterine data of female woodchucks in southwestern Virginia.

		Paired Ovaries			*Uterus*		
Month	*Age*	*No.*	*Mean weight (±S.E.) (g)*	*Mean no. corpora lutea (±S.E.)*	*No.*	*Mean weight (±S.E.) (g)*	*Mean no. placenta scars (±S.E.)*
3	A[a]	1	0.108	4.00	1	4.416	4.00
	Y[a]	3	0.008(±0.02)	1.00(±1.00)	3	1.461(±0.81)	1.00(±1.0)
4	A	5	0.171(±0.03)	4.60(±0.51)	5	1.893(±0.33)	4.00(±0.45)
	Y	11	0.141(±0.03)	1.91(±0.71)	9	1.216(±0.32)	1.72(±0.66)
5	A	0					
	Y	0					
6	A	9	0.126(±0.03)	4.89(±0.82)	9	0.814(±0.14)	3.66(±0.83)
7	A	11	0.137(±0.01)	3.64(±0.97)	10	0.810(±0.12)	2.18(±0.86)
8	A	5	0.056(±0.01)	0.60(±0.60)	5	0.506(±0.10)	0.60(±0.60)
9	A	2	0.043(±0.01)	0.	2	0.531(±0.21)	2.50(±2.50)
10	A	0					
11	A	4	0.102(±0.06)	0	4	0.304(±0.08)	0

[a]A = adult, Y = yearling, distinction not made in June or later months.

Mean plasma androgen levels were similar for both adult and yearling male woodchucks (Table 3). Peak spermatogenesis and subsequent regression of the testes is apparently closely correlated with plasma androgen concentrations.

CONCLUSIONS

The data indicate that woodchucks have a relatively short breeding season and that reproductive activity of females is completed early in the year. Less than half of the yearling females examined ovulated and spermatogenesis was not evident in more than half the yearling males examined. Peak of spermatogenesis occurred later in yearlings than adult males but spermatogenesis ceased before June and testes and epididymides

Table 3. Reproductive parameters of male woodchucks collected during the periods 13 March to 13 May, 1974-75 in southwestern Virginia.

Characteristic	*Mean (sample size)*	
	Yearling	*Adult*
Paired testes weight (g)	3.40(16)	5.47[a] (14)
Paired epididymides weight (g)	0.56(16)	0.79[a] (14)
Right testis spermatozoan count (X 10^3)	2.55(16)	1.52 (14)
Right epididymis spermatozoan count (X 10^3)	4.45(16)	3.93 (14)
Plasma androgen concentration (ng/ml)	1.54(12)	1.57 (10)

[a]Significantly different from yearlings at $P<0.05$ level.

Table 4. Monthly differences in testes weights, epididymal weights, and spermatozoan concentrations of woodchucks in southwestern Virginia.

Month	*Age*	*Paired testis wt. (g)* N	*Paired testis wt. (g)* X±S.E.	*Paired epididymides weights (g)* N	*Paired epididymides weights (g)* X (±S.E.)	*Right testis sperm. nos. (X 10^3)* N	*Right testis sperm. nos. (X 10^3)* X (±S.E.)	*Right epididymis sperm. nos. (X 10^3)* N	*Right epididymis sperm. nos. (X 10^3)* X (±S.E.)
3	A[a]	2	5.61 (± 0.48)	2	1.03 (± 0.12)	2	8.44 (± 7.81)	2	21.88 (± 21.88)
	Y[a]	1	1.35	1	0.19	1	0	1	0
4	A	12	5.44 (± 0.53)	12	0.75 (± 0.05)	12	0.36 (± 0.22)	12	0.94 (± 0.47)
	Y	13	3.65 (± 0.51)	13	0.57 (± 0.04)	13	3.05 (± 1.27)	13	5.38 (± 3.35)
5	A	0							
	Y	2	2.77 (± 0.83)	2	0.64 (± 0.07)	2	0.63 (± 0.62)	2	0.63 (± 0.62)
6	A	3	5.40 (± 0.46)	2	0.25 (± 0.01)	2	0	2	0
7	A	7	3.92 (± 0.36)	3	0.18 (± 0.01)	3	0	3	0
8	A	6	0.69 (± 0.19)	4	0.09 (± 0.01)	4	0	4	0
9	A	5	0.58 (± 0.06)	5	0.07 (± 0.01)	5	0	5	0
10	A	6	0.88 (± 0.17)	5	0.08 (± 0.01)	5	0	5	0
11	A	2	0.71 (± 0.16)	2	0.06 (± 0.01)	2	0	2	0

[a]A = adults, Y = yearlings, distinction not made in June or later.

regressed after July in all males. Because of the short breeding season and early regression of spermatogenesis in males the woodchuck may be a suitable target species for attempts at chemosterilization.

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WOODCOCK ON NORTH CAROLINA WINTERING GROUNDS

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ABSTRACT

During the winters of 1974-75 and 1975-76, the regional distribution patterns of American woodcock (Philohela minor) *in North Carolina were determined from harvest and banding surveys. Woodcock were common transients in all regions of North Carolina but were common winter residents only in the central and eastern regions. Immatures were more abundant among birds collected in coastal counties than in interior counties, and males were disproportionately common in western counties. Woodcock were numerous in the vicinity of New Holland, Hyde County, and 341 were banded in 17 night-lighting trips. It appears that woodcock abundance patterns vary from western counties to eastern counties and that a split season may be needed to equitably distribute hunting opportunity. Excellent opportunities for wintering ground banding exist in northeastern North Carolina.*

In North Carolina there has been little interest in the sporting qualities of the woodcock. In a 1972-73 survey of North Carolina hunters (Hamilton 1974) the woodcock ranked only fourteenth among 15 game species in number of hunting enthusiasts. However, with more hunters taking advantage of the recreational opportunity afforded by woodcock over most of its range (Artmann 1976) specific information about the woodcock on southeastern wintering grounds is needed for effective management. In 1974, the authors initiated a five-year investigation of the woodcock in cooperation with the North Carolina Wildlife Resources Commission (NCWRC). This paper presents results of harvest and banding surveys during the winters of 1974-75 and 1975-76. The primary objective was to determine the regional distribution patterns of wintering woodcock.

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METHODS

The Study Areas

North Carolina extends across three physiographic regions which differ from one another in relief and climate. The Coastal Plain ranges in elevation from sea level to about 90 meters where it borders the Piedmont. Because of the low elevation and relatively flat terrain, many wide areas are covered by swamps, pocosin, and marshes; large tracts of bottomland forests occur along the floodplains of coastal rivers. In the Piedmont, terrain becomes increasingly rolling and bottomland forests are restricted to narrow strips along creeks and rivers. Elevations in the Mountains range from about 400 meters in the foothills of the Blue Ridge to 2,037 meters at the summit of Mt. Mitchell.