MICHIGAN DEPARTMENT OF CONSERVATION
Game Division

Report No. 2253
December 2, 1959

Use of Radiography (X-ray) in Deer Productivity Studies*

by

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This study explores the feasibility of determining pregnancy in live deer by means of radiographic examination. Veterinarians and others commonly use radiography for this purpose in domestic animals (Laing, 1955: Schnelle, 1954). We have been unable to find published reports of its use on deer, however. Our problem was not whether radiography was applicable to the detection of pregnancy in deer, but rather at what stage of gestation we could discern the fetuses. Calculation of fetus: doe ratios in live deer is of considerable value in experimental and field studies. We report here the need, validity, and technique for collecting such data.

Study Methods

Preliminary work on devising suitable methods for radiographic detection of pregnancy in deer began in early February, 1959. This phase consisted of radiographic examinations with a stationary high-energy X-ray machine to develop a technique, which was then modified for a low-energy portable machine available to us for field use. This work was done at the radiographic laboratory, College of Veterinary Medicine, Michigan State University, East Lansing, with accidentally killed deer. Following radiographic examination, we autopsied the deer and compared the number of fetuses with those detectable on the radiographs. We aged the fetuses by the method described by Armstrong (1950).

On April 16 the study shifted to the Cusino Wildlife Experiment Station, Shingleton, Michigan. At this date it was too late in the winter to live-trap wild deer and examine them with a portable X-ray machine as originally planned. However, we did make additional trial examinations with the machine on accidentally killed does collected earlier in the winter and held in a freezer for this purpose. Then we X-rayed captive experimental deer from April 17th to 27th, using only pregnant does. We determined pregnancy by palpating the flank region.

The machine used at Cusino was a General Electric Model F, type 4, portable unit. This machine operates on 115 volts at a maximum load of 15 amperes. In order to produce satisfactory radiographs, it was necessary to operate the machine at its maximum rated capacity. The kilovolt selector was in position three (approximately 60-65 kilovolts); the milliamperage was 15 and the exposure time

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A contribution from Federal Aid in Wildlife Restoration Project Michigan W-70-R, Region I Game Management Research; the Game Division Laboratory, Michigan Department of Conservation; and College of Veterinary Medicine, Michigan State University. Presented at the Midwest Wildlife Conference, at Minneapolis, Minnesota, December 7-9, 1959.

1.3 seconds at a 30-inch focal-film distance. The film-holder was a 14 x 17-inch Picker magnelite non-grid cassette with Patterson-DuPont Hi-Speed intensifying screens, and the film DuPont 508 X-tra fast medical film. We protected loaded cassettes from dirt and water during use by placing them in clear plastic bags. The exposed films were processed in Kodak X-ray developer and fixer solutions with a developing time of three minutes at 68°F.

We encountered little difficulty in holding deer in position for radiography. Most animals remained quiet during the short time needed to complete the work (Fig. 1). Clasping a hand over the deer's nostrils during the moment of exposures effectively interrupted heavy breathing in the more excitable animals. A general anesthetic (pentobarbital sodium) tested on a few deer also calmed them with reasonably satisfactory results. Narcosis had the added advantage of facilitating dental examination of the deer to determine their age.

Findings and Discussion

We X-rayed 36 deer, 17 dead and 19 alive. Radiographs taken at Cusino on 10 live deer were of poor quality for undetermined reasons and were not useable.

Fetuses in the dead does we X-rayed ranged from 66 to 150 days in age (Table 1). Mutilation of some accidentally killed does made some specimens difficult to study. Also, early radiographic trials at East Lansing were primarily for the purpose of developing technique, and not necessarily to ascertain pregnancy. Fetuses approximately 66 to 105 days in age were small, generally between 83-222 mm. crown to rump. Ossification of skeletons in very young fetuses was commonly insufficient for positive identification in radiographs. In many cases, however, portions of the skull, vertebral column, and legs were visible. We could identify twin fetuses even though the images overlapped.

Fetuses of 106-150 days gestation were generally large, approximately 223-367 mm. crown to rump. Ossification of most bones was relatively advanced, and skeletal structures readily recognized. In general, the older the fetus, the more easily we could determine pregnancy. Singletons were easier to appraise than twins. It is noteworthy, however, that we identified correctly a set of triplets approximately 106-111 days old.

The age of live fetuses X-rayed at Cusino varied from 133 to 153 days, well beyond the mid-point of pregnancy. We determined age by back-dating from parturition, assuming a gestation period of 200 days. Unfortunately, younger fetuses were not available. Fetuses 133-153 days old were generally large with fetal bones densely ossified. Teeth, ribs, and hooves shows readily in radiographs of good quality (Fig. 2).

Good radiographic quality depends upon the penetration of the body tissues by the X-rays. There is a direct correlation between the ability of X-rays to penetrate body tissues and the kilovoltage. The higher the operating kilovoltage the greater the penetrating ability of the X-rays produced. Therefore, a more powerful X-ray unit would be desirable. There is also an indirect relationship between kilovoltage and time. A higher operating kilovoltage would, within limits, permit reduction in exposure time, possibly as much as half. This would reduce the frequency of blurred radiographs caused by movement of the doe or fetus. However, as stated previously, we were able to control body motion of the doe. Even slightly blurred images in radiographs of good quality permitted detection of fetuses. In cases of uncertain diagnosis due to non-pregnancy, young age of fetus, movement, etc., it might be advisable to retain the deer in captivity and repeat the radiograph at a later date.

There is little reason to believe that the radiation dosage used was harmful to either does or fetuses. The exposure was about one-fifth of that of a normal film of the abdomen of a human (Michigan Department of Health, 1958).

Based on this study, pregnancy and number of young can be determined in live deer with considerable certainty from the mid-point (100th day) of gestation onward. Under ideal situations (image of fetus not obscured by structures in the doe, and good quality radiographs), fetal counts may be reasonably valid as early as the 66th day. Similar study is possible in the ewe from the 90th day onward (L. R. Wallace, quoted in Laing, 1955), where gestation ranges from about 144 to 152 days, depending upon the breed (Asdell, 1946).

Breeding season in most adult deer in Michigan normally occurs during the last half of November. Consequently, by February 1 most fetuses would be approximately 62-77 days in gestation, or approaching the lower age limit suitable for radiographic diagnosis. Radiographic examination of live deer beyond this date should result in useable productivity data, supplementing the meager information usually available from collection of road-killed specimens. This technique particularly applies to small study areas, where deer may be live-trapped during the winter yarding season. Fortunately it is easy to trap deer during the critical late winter period; hence, a reasonably large sample could be obtained.

Radiography proved to be useful in predicting the potential number of fawns to be born. As an illustration in the current work at Cusino, prenatal mortality was indicated in radiographs of two does, C-19 and C-21, on April 24 (Table 1). Autopsy of both deer on July 9 confirmed this suspicion and disclosed atrophic fetuses in one doe and abortion prior to full term in the other. There was the possibility that either or both atypical pregnancies might have gone undetected had radiographs not been taken.

We also contemplate use of radiography for a study of deer confined within a square mile of natural range at Cusino. Here we currently base productivity studies in the herd on capture of fawns during a protracted period after birth. The difference between potential (in utero) and observed (post-partum) fawn:doe ratios is important but not definitely known because ordinarily we are not able to detect pre- or postnatal fawn mortality. Radiographic study during the normal mid-winter examination of the herd can rectify this situation. That is, comparison of fetal and fawn counts would provide previously unattainable data on total fawn production and loss.

Radiographic diagnosis of pregnancy in deer is possible with reasonable ease and accuracy. We anticipate considerable use will be made of this method for appraising reproduction in deer.

Precautions

Since the effects of ionizing radiation, including X-rays, on body tissues are cumulative, permanent, and irreversible, it is of utmost importance that all personnel be adequately protected. Close adherence to rules of good radiographic technique will hold exposure of personnel to well within permissible dose levels

(U.S. Department of Commerce). Patterson (1959) recommended that the following rules be observed while making radiographic examinations: (1) wear lead-rubber aprons and gloves during all radiographic procedures; (2) use cones and cylinders to control the primary X-ray beam; (3) use cassettes with double intensifying screens; (4) use fast X-ray medical film; (5) since the intensity of the radiation varies inversely as the square of the distance from the source, stay as far as possible from the primary X-ray beam as the technique will permit; other precautions are (6) add at least 2 mm. of aluminum filtration to the inherent tube filtration; (7) monitor all personnel by use of film badges or similar devices; and (8) use only shock-proof and properly grounded equipment.

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LJV:LDF:pas

Table I
Validity of Deer Productivity Data
Determine by Radiography

Radiograph Serial No.	Date 1959	Number of Fetuses By Radiograph	By Autopsy	At Birth	Age in days	Remarks
Dead Does:						
L-61*	3/29	0	0			Non-pregnant yearling
L-13	2/22	0	1 ✓		61-65	Fetus not in situ
C-4	2/26	1	1		66-75	Fetus small, mutilated, indistinct
C-5	2/16	1	1		91-95	Fetus small but distinct
L-26	3/2	1	1		91-95	Fetus small, very faint image
L-19	2/19	1	1		96-105	Skull only distinct
L-18	2/19	2	2		96-105	Only 1 skull distinct
L-28	2/27	2	2		96-105	Only 1 fetus distinct, very faint image of twin
L-16	2/25	3	3		106-111	Triplet images distinct
L-59	3/25	2	2		111-120	One fetus distinct, twin slightly indistinct
C-6	4/2	2	2		111-120	Distinct skeletal structure visible
C-3	4/6	2	2		121-132	Do.
C-13	4/23	2	2		121-132	Do.
L-60	4/1	2	2		133-150	Do.
C-0	4/13	2	2		133-150	Do.
C-18	4/23	2	2		133-150	Do.
C-25	4/27	2	2		133-150	X-rayed alive, age from autopsy 5/13
Live Does:						
C-16	4/23	1		1	133	Slight movement, fetus indistinct
C-22	4/24	1		1	139	Fetus large and distinct
C-1	4/17	1		1	141	Do.
C-17	4/23	1		1	141	Slight movement, fetus indistinct
C-2	4/17	1		1	143	Do.
C-19	4/24	2	2		147	Abnormal pregnancy, see text
C-23	4/27	2		2	152	Fetuses large and distinct
C-15	4/23	1		1	153	Slight movement but distinct
C-21	4/24	2	2		?	Abnormal pregnancy, see text

* L--taken at East Lansing (M.S.U.)
C--taken at Shingleton (Cusino Wildlife Experiment Station)

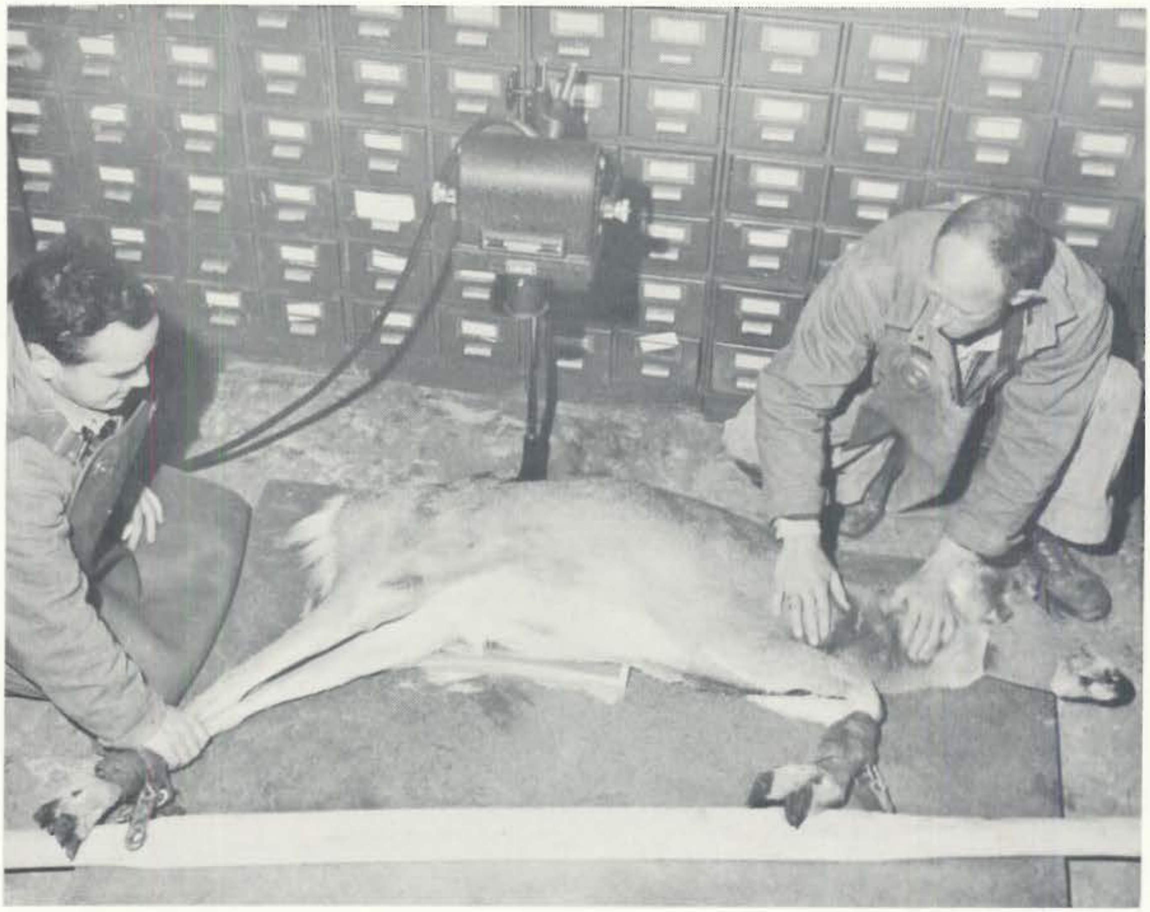

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Fig. 1. Positioning of deer and equipment used in radiographic study. Assistants are shielded from radiation by lead impregnated aprons. They should also wear lead impregnated gloves.

Fig. 2 Radiograph of a single fetus approximately 141 days in gestation. Note the high density of most skeletal structures.