THE PRACTICABILITY OF CHANGING BROAD BREASTED BRONZE TURKEY MALES IN INDIVIDUAL MALE BREEDING PENS

Thesis for the Degree of M. S.

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Cal J. Flegal

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by

Cal J. Flegal

AN ABSTRACT OF A THESIS

Submitted to
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ABSTRACT

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Any practice which would speed up the progress being made in the breeding of turkeys would be of great value to the turkey industry as a whole. This study was undertaken to determine the feasibility of changing male turkeys in individual male mated pens during a breeding season. In other experiments to determine the feasibility of changing turkey males during the breeding season, two or more varieties of turkeys were mated. In these tests, the same variety of turkeys was utilized. In the 1961 test, twenty-nine pedigreed Broad Breasted Bronze turkey hens, known to have a sex-linked recessive gene which could be used as a marker to identify resulting progeny, were mated to one type male. After fertility was established, male types were switched. Two types of Broad Breasted Bronze pedigreed males were used, those known to have a sex-linked recessive gene in their genetic makeup and those which were normal with respect to the sex-linked recessive gene. All offspring were pedigree hatched. One half of the females were allowed to mate naturally, the other half were artificially inseminated. Male types were switched four times in both pens.

The 1962 test was similar to the 1961 test except that natural mating only was used and only one shift in male types was made.

In the 1961 test, Broad Breasted Bronze females that were artificially inseminated began to produce offspring of the replacing type

male, following a shift in male types, sooner than females that were allowed to mate naturally. In the 1962 test in which only natural mating was utilized, Broad Breasted Bronze female turkeys began to produce offspring of the replacing type male, following a shift in male types, after about the same amount of time that the females in the 1961 test which were artificially inseminated had.

There was more overlapping of ensuing progeny following a shift in male types, from the artificially inseminated females in the 1961 test than from the females that were allowed to mate naturally in the 1961 or 1962 tests.

In the 1961 test, the first progeny of the replacing type male were produced by the artificially inseminated females on the second day following a shift in male types and the first progeny of the replacing type male were produced by the naturally mated females on the ninth day following a shift in male types. In the 1962 test, which utilized natural mating only, the first progeny of the replacing type male were produced on the third day following a shift in male types.

In the 1962 test it was possible to determine the total time, following a shift in male types, that progeny of the replaced type male were produced. The last progeny from the replaced type male hatched from an egg produced 42 days after the switch in male types.

Based upon this information and that reported by other investigators who utilized two or more varieties of turkeys in their experiments, a single change in Broad Breasted Bronze turkey breeder males during a breeding season seems feasible. Loss of paternal identity of offspring would be for a period of about four weeks. However, when utilizing

natural mating only, some females may not mate following the change of males and continue to produce progeny of the replaced male throughout the breeding season.

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INTRODUCTION

Despite the extensive expansion of the turkey industry in the last 15 years, turkey breeding today has progressed only to the point that chicken breeders had reached 15 to 20 years ago.

The pedigree breeding of chickens has been greatly enhanced by the practice of changing males in individual male mated pens one or more times during the breeding season with only a short loss of identity of the resulting offspring. This has allowed the testing of many more sires during one breeding season than was previously possible. As the normal turkey breeding season is of relatively short duration (usually six months or less), this same practice would be very advantageous to the turkey breeding industry if it could be used without subsequent loss of identity of progeny for an extended period.

Any practice or condition which would enable the turkey breeder to make more rapid advances would be of great value to the turkey industry as a whole. With this in mind and a sex-linked recessive condition known as vibrator reported by Coleman *et al.* (1960) in turkeys to use as a marker gene, experiments were conducted to determine the feasibility of changing males in individual male breeding pens during the breeding season. This was not possible within a variety of turkeys heretofore as no such marker gene had been available.

REVIEW OF LITERATURE

Most of the research in birds dealing with the onset and duration of fertility has utilized chickens of different breeds as the experimental animal. A lesser number of experiments have been conducted to determine the onset and duration of fertility in turkeys.

Curtis (1929), using White Plymouth Rock, Rhode Island Red, and White Leghorn chickens, determined that the onset of fertile egg production following a natural mating ranged from 24 hours to 7 days with 57.1 $\pm$ 2.6 hours as the average.

Using various varieties of turkeys, Lorenz (1950) obtained up to 11.4 percent fertility on the day following a single insemination. On the second day, fertility was close to, though perhaps not at, the maximum. Lorenz reported further that occasional fertile eggs appeared as long as 10 weeks after a single insemination. Hale (1955), using White Holland turkeys, determined that the average length of fertility resulting from natural matings was 43 days (7-62 days range). Crew (1926), working with White Leghorn females and males, determined that fertility lasted 12-21 days after removing males from pens and that the hatch of fertile eggs after the first week was poor. One female produced a fertile egg 32 days after the removal of the male.

Several experiments have been carried out to determine the feasibility of changing males in individual male mated pens during a breeding season. Crew (1926) used White Leghorn females mated with White Leghorn males in one pen and White Leghorn females mated with Redcap males in another pen. After fertility was established in both pens by the respective males, the males were changed to the opposite pen. When

the offspring hatched, a check was made of the comb type to determine the male parentage. From this test he concluded that the influence of the first sire disappeared in seven to ten days. The progeny resulting from the White Leghorn male replaced the progeny of the Redcap male in five days. The progeny resulting from the Redcap male replaced the progeny of the White Leghorn male in nine days. He stated that this could be due to the difference in sexual activity, the White Leghorn male being more active than the Redcap male.

Warren and Kilpatrick (1929), using natural matings, crossed Jersey Black Giant and Black Minorca females with Single Comb White Leghorn and Black Minorca males and determined that there was practically no overlapping of offspring. They concluded that only a 10-14 day lapse was needed for accurate identification of offspring following a shift in males.

Kosin and Wakely (1950) reported that when semen from Broad Breasted Bronze male turkeys was repeatedly (on five occasions in a five-week period) artificially inseminated into Beltsville Small White turkeys which had been mating with Beltsville Small White males, poults with white down continued to appear as long as eight weeks after removing the Beltsville Small White males. They concluded, in view of the short breeding season of the turkey, that sire substitutions in single male mated pens could not feasibly be made.

Harper and Parker (1952) mated Beltsville Small White females to Beltsville Small White, Broad Breasted Bronze, and Black males and Broad Breasted Bronze females to Broad Breasted Bronze, Black and Beltsville Small White males. From this experiment, Harper and Parker concluded that one double insemination (insemination on two successive

days) of semen from one variety of toms following previous artificial insemination of semen from another variety resulted in an overlap of offspring ranging from 24 - 58 percent. Whether insemination of semen from the replacing variety was made immediately or 11-14 days after insemination of semen of the replaced variety made little difference in the percent overlap. They concluded further that artificial insemination of Beltsville Small White and Broad Breasted Bronze turkey hens with semen from the reciprocal type males resulted in an 11 - 14 day loss of identity of progeny.

Payne and Kahrs (1961) artificially mated Broad Breasted Bronze turkey females to Broad Breasted Bronze and Slate turkey males. Also Broad White turkey females were artificially mated to Broad White and Broad Breasted Bronze turkey males. It was found that not all hens changed over at the same rate or at the same time. It was also found that fresh sperm in competition with stale sperm sired 71 percent of the poults hatched from eggs produced the second day after insemination.

MATERIALS AND METHODS

During the last week of October, 1960, twenty-nine pedigreed Broad Breasted Bronze female turkeys from the hatch of the previous spring were selected from the existing stock of the Michigan State University turkey breeding flock. They were removed from the range and placed in two breeder pens which were approximately 12' X 12' in size. These birds were known to have present in their genetic make-up the recessive sex-linked condition known as vibrator. At the same time, both normal (insofar as the vibrator character was concerned) and vibrator pedigreed males of the same variety and age were taken from range and placed in a pen containing males only. All birds received the same turkey breeder ration throughout the entire experiment.

In the second week of January, 1961, all males to be used in the experiment were placed on a 14-hour day consisting of natural day length supplemented by artificial light.

On the 6th of February, 1961, all females were placed on a 14-hour day with natural day light supplemented by artificial light. On the same date, two males were placed in the naturally mated pen.

Pen 1 contained 14 vibrator females and 2 males at all times throughout the experiment. No artificial insemination was employed in this pen. The males were either normal or vibrator at any given time (see appendix I). Pen 2 consisted of 15 vibrator females which were artificially inseminated using the method described by Burrows and Quinn (1937). Five-hundredths of a cubic centimeter of pooled semen from several males of either the normal or vibrator type was used according to the schedule seen on page 24 (in appendix I). All

females were inseminated within 30 minutes after the semen was collected. Changes of males or semen type were made simultaneously in pens 1 and 2.

Turkey trapnests were used in all pens. The eggs were gathered several times daily. Each egg was marked with pen number, hen number and date. The eggs were then recorded on a monthly trapnest record sheet. The eggs were set at two-week intervals. All eggs collected between settings were stored in the egg processing room at the Michigan State University Poultry Plant. Each egg was hatched in an individual pedigreed basket. Any egg on which the date was obviously marked incorrectly by the attendant was included in the results of the experiment only for computation of percent fertility and percent hatch of fertile eggs on the basis of individual pen totals. At 24 days of incubation, all eggs were candled and all apparent infertiles were discarded at this time. Some very early dead embryos could have been included with the apparent infertiles as no eggs were broken out.

The experiment was conducted the second year similar to the first year. In the fall of 1961 twenty-three pedigreed virgin females, all known to possess the vibrator gene in their genetic make-up, were placed in two pens; twelve in pen 3 and eleven in pen 4. Several pedigreed males, selected for good breeding characteristics, were placed in male pens at this same time. From this male pen, two males, known to be normal, insofar as the vibrator condition is concerned, were placed in pen 3 on the 19th of January, 1962. Two other males, known to be vibrators were placed in pen 4 on this same date. A portion of the females in both pens were already in production at this time.

Other procedures, such as feeding, collecting and storing of eggs, etc., were the same as for the first year of the experiment. The males

were switched only once during the experiment. On the 16th of February, 1962, the normal males in pen 3 and the vibrator males in pen 4 were removed and placed in a pen by themselves.

On the 23rd of February, 1962, the two normal males, which had been in pen 3, were placed in pen 4 and the two vibrator males which had been in pen 4, were placed in pen 3. The males remained in these respective pens for the remainder of the test period.

RESULTS - 1961 TEST

For the period that individual and pen records were kept during the 1961 test, a total of 1131 eggs were produced in the two pens. Of this total, 731 (64.63%) were fertile and 355 (48.56%) of the fertile eggs hatched.

The test period was broken up into five periods. The male and semen types used in each of the periods can be seen in Tables 1 and 2. For a complete description of the progeny which hatched, see Appendix I.

For the sake of brevity, a summary of the hatchability record of the eggs produced by the females in pens 1 and 2 can be seen in Tables 1 and 2.

It is possible that the results obtained in pen 1, which was naturally mated, could have been influenced by the mating habits of the turkey (see Hale, 1951) or the mating efficiency of the males (see Smyth and Leighton, 1953). In pen 1, possible examples of this are found in hens 401, 407, 408 and 410. All of these birds became fertile initially from mating with the vibrator males present in Period 1 prior to the first shift in males. In Period 2, which was 25 days in length and in which normal males were present, these females all switched over to the production of normal progeny. In Period 3, which was four days in length, and again in Period 5, which was 24 days long, vibrator males were present with these females for a total of 28 days. However, after Period 2, no vibrator progeny were produced by any of these females. Other females did not show these results.

Hen 404 initially became fertile in Period 1 with the vibrator males present and produced vibrator poults. In Period 2, both normal

Table 1. Summary of the Eggs Produced by the Hens in Pen 1*

Hen no.	Period 1 Vibrator male	Period 2 Normal male (25 days)	Period 3 Vibrator male (4 days)	Period 4 Normal male (7 days)	Period 5 Vibrator male (24 days)
401	DDD.V...VD	.VDI.VVD.IV.VVDI.N..NNNN.	.DND	D.NNNND	N.DNN.NDI..DINN...I.I..D
402	I..II.IIII	.III.I.II..III.ID.III..ID	I.D.	IINI.II	DI.IIII.II.I.I.....
403	.DV..D..D.	..IDI..D.DD.DD.DDDD...D..	....	DD.....	..D...DD.I.V.D..D...DD.I
404	...DD.VV.V	.DVDD.D.DDVD.D.IDDDDN....	NNDI	I.DI...	N.....ID.I.V...DV.I..DD.
405	...VDVV..V	.VDVV.V.V.....	....	..DNN.D N	N..NV..DNDDV.N..... N N
406	..I.III...	I.D.V..D.D.DDD.DD.DDD.DD,	....	.....	.....
407	IVV..II... VI	.IIII.I..IN.ND...DDD.DDN.	..ND	DN...N.	..N.N...D...ND..N..I..I. N
408	.D.IDD.VDV	DD.D...VN.D.NN.DID.N.DD.N	N.N.	DDN..DN	I.D..I.NN..I.....
409	.D..VDDIDD	IV..VDDVVI.VIIVII.ID.I.DI	...I	III.I.I	I.IIII.DDD.....
410	.....DDD..	V.VVD...V.V.DDNI.DDD.IDN.	.D..	D.D..N.	N.NDNN.DN..D.IN.D.I.....
411	.....	.D.....D..	....	.....	.....D....NN.....D...
413	.D.V..DD..	VVI....DNVD.V.DD.DNN..NNN V	...D	VVV.DVV	VVV.VDD..D.I..VVI.....D
414	VDD.D.VV..	DD.DV.....IIID.II..... I	....	.....	.....D..
415	.....DD	II..I.D.DDDID..D..I..DND.	....	.....	...N.....V....
Floor eggs	VIDDDDD... VIV D VVV IV DV	.D....VDNVNN..DDDN...D.VN DII V	NN.. D D	NDDNDD. D ID N	ND.IN.I.DI...DD..VIII.NI N N V D

* Period 1 is the ten days production prior to the first shift in males. Each space represents one day. A period (.) represents a day when no egg was produced.

D = Dead embryo resulted from the egg that day
I = Infertile egg produced that day
V = Vibrator poult produced that day
N = Normal poult produced that day

Two or more symbols on one day indicates that two or more eggs were marked with that date.

Table 2. Summary of the Eggs Produced by the Hens in Pen 2*

Hen no.	Period 1 Vibrator semen	Period 2 Normal semen (25 days)	Period 3 Vibrator semen (4 days)	Period 4 Normal semen (7 days)	Period 5 Vibrator semen (24 days)
412	..D.I.II.I	II.IINI.NNNNIN..IV.I.INDN	N.V.	DNDII.D	D.INN.....D.D
416	D.V.DD.D..	.N.I..DDDVV.VNDDI.N.....	....	.....	.....
419	...IIIII.I	.III....II..IIIDII..II.I.	II.I	III.II.	II.I.I.....
420	.VD..VVDV.	DI.DD.D.ND..NN.D.DD.DDDD.	DD.I	I.IDD.N	D.NDN.IDII.NVN.NN.NDDI.I D
422	.IIV..IIII	.IIII.III.II.I..IIIII.ID.	....	.....	.....D.....
423	.....	.....D.....	..I.	.....	.....
424	.VV.D.ID..	V..VD..D.D.IV..DD.IIDDIDI V	D....	.II..V.	I..I.I...I...ID.V.VV.DI.
425	.D..IIID.I	D..NN....D..NND.D..DD..N.	N.D.	...D.VN	.V.NDIVVD.DNNN.NVD.....
427	.....D	...I...VVVVVDDIIDIDID..II	....	.....	.....D.D..V...NVIIV.VI.
428	.DVV....D.	D.D.DVVNDD.VV.D.....	....	.....	.....
429	I.DDII....	.IIID.NNNDN...DD.DN.NN.ND	.VII	IDID.IV	..NVN...N.NVN.I.I.D.DD.D I
431	III.IIIII.	IIII.IIIIII.IIII...I.I.I. D	I.II	I..I..I	IIII.IIIIIIDDV.IV.....
Floor eggs	I.IIV.I.I. I II I I D V D	VII...V..V.VDIVVV...N..IN I N DI I	NINN	IV.II.I I I N	DN.NNINNI.V..DIIDIV.DI.D I II I

* Period 1 is the ten days production prior to the first shift in males. Each space represents one day. A period (.) represents a day when no egg was produced.

D = Dead embryo resulted from the egg that day
I = Infertile egg produced that day
V = Vibrator poult produced that day
N = Normal poult produced that day

Two or more symbols on one day indicates that two or more eggs were marked with that date.

and vibrator poults were produced. In Period 3, only normal poults were produced. No offspring were hatched in Period 4. Then in Period 5, both normal and vibrator poults were produced. Hen 405 initially became fertile with the vibrator males present in Period 1 and produced vibrator poults. In Period 2, only vibrator poults were produced. In Period 3, no poults were produced. In Period 4, only normal poults were produced, then in Period 5, both normal and vibrator poults were produced. This indicates that there was a wide variation in either the mating habits or mating efficiency of the turkeys involved. It appears from the results obtained in this test that it would be almost impossible to predict when all the progeny in a pen mating would be that of the replacing male following a shift in males where natural mating alone is employed.

The females that were artificially inseminated, in pen 2, began to produce poults of the replacing-type male following the initial shift in males much sooner than the females in pen 1, which were naturally mated. In pen 2, by the 10th day following the initial shift in males, five out of seven females, from which offspring were obtained, had produced poults of the replacing-type male. However, in pen 1, only two out of nine females, from which offspring were obtained, had produced progeny from the replacing-type male ten days after the initial shift in males.

In the present experiment, in comparing the naturally mated pen with the artificially inseminated pen, it can be seen that most of the hens that were artificially inseminated tended to produce both normal and vibrator poults throughout most of the test period which was not true of the hens that were naturally mated.

In the artificially inseminated pen, hen 412 produced both normal and vibrator poults in periods 2 and 3. Hen 416 produced normal and vibrator poults in Period 2. Hen 420, 427 and 429 produced normal and vibrator poults in Period 5. Hen 425 produced normal and vibrator poults in Periods 4 and 5.

The factors of mating efficiency and mating habits of the turkey were eliminated in the artificially inseminated hens and this could have effected the faster changeover of progeny and the greater overlapping of progeny following a shift in male types.

More overlapping of progeny was seen in the poults hatched from the eggs produced in pen 2, which was artificially inseminated only, than in the poults hatched from the eggs produced in pen 1, in which only natural mating was utilized. Seven females (412, 416, 420, 425, 427, 428 and 429) in pen 2 produced normal and vibrator poults on intermingled days. The earliest overlapping occurred on the second day after a switch in semen type and occurred as long as 18 days after a shift in semen type was made. From this test it could not be determined how long overlapping would occur as the semen type was switched four times during the test period so that overlapping of progeny in any successive period could have resulted from semen used in any of the preceding periods. Overlapping in Pen 1, where natural mating was used, occurred in only two females (405 and 413). The earliest overlapping occurred five days after a shift in males and occurred as long as 13 days after a shift in male types. The higher incidence of overlapping of progeny in the artificially inseminated pen could be due to the fact that both types of semen were present in a rather fresh state and not a stale state. For instance, it is known that when semen types were

switched in pen 2 the newest sperm from the previous semen type was not more than four days old if we assume the prior insemination to have been successful. It was not known when any of the females in pen 1 mated; however, if they followed the mating habits reported by Hale (1951 and 1954), the semen could have been as much as 34 days old. Hale (1955) determined that staleness of sperm had a sudden adverse effect on hatchability in turkey eggs. Any or all of these reasons could have been responsible for the greater incidence of overlapping of progeny which resulted from eggs produced in pen 2 as compared to the overlapping of progeny from eggs produced in pen 1. The poorer fertility in the artificially inseminated pen (pen 2) might have been the result of the inexperience of the inseminators, only one of which had had previous experience.

RESULTS - 1962 TEST

For the period that individual and pen records were kept during the 1962 test, a total of 544 eggs were produced in the two pens. Of this total, 295 (54.23%) were fertile and 176 (59.66%) of the fertile eggs hatched.

The test period was broken up into two periods utilizing natural mating only. The male types used in each period can be seen in Tables 3 and 4. For a complete description of the progeny which hatched, see Appendix II.

A summary of the eggs produced by the females in pens 3 and 4 can be seen in Tables 3 and 4.

In pen 3, the first progeny of the replacing-type male resulted from an egg produced three days after the switch in male types. The last progeny of the replaced male resulted from an egg produced 27 days subsequent to the shift in male types. In this pen, only two females laid eggs in the trapnests, one of which produced overlapping progeny. This female (hen 462) initially switched over to the replacing type male and then produced a poult of the replaced type male 19 days after the switch in male types.

In pen 4, the first progeny of the replacing-type male resulted from an egg produced three days after the switch in male types. The last progeny of the replaced male resulted from an egg produced 42 days subsequent to the shift in male types. Of the eight females which laid eggs in the turkey trapnests, seven females produced no overlapping progeny. The one female (hen 435) which produced overlapping of progeny did so only on one occasion, on the 11th day following the shift in males.

Table 3. Summary of the Eggs Produced by the Hens in Pen 3*

Hen no.	Period 1 N male used	Period 2 V male used
458	.....	.....NN.NINI..V..VVVI.VVV..V.I.D...II.I.I..VV
460	.....N..	.....
461	.....D.....	.....
462	.....N.....N...N.DN.....DID..I	..D.I.DVV..VVVVI.VN.D..DDVV.I..II..IIIII....II
464	.....N.	.....
Floor eggs	....NN.....NDNDDDNN.NINDNNDDDDNDN DDDN DDDINDDDNIID DD D DIDNDN D DD D ID I II I DN I	.DNDDIVIDNI.D.IIIIDIIVIIDDIDIDIIDIIDDDIIIIDIVD ND I D N IIIIDVV DIVIVIII I IID IIIIIVI II I V D DVD NI II I I D IIIVIII VI D V D V I V II I I I DI D I IV I I I VV I V V

* Hen 462 was in production prior to the start of the test. Each space represents one day. A period (.) represents a day when no egg was produced.

D = Dead embryo resulted from the egg that day.
I = Infertile egg produced that day.
V = Vibrator poult produced that day.
N = Normal poult produced that day.

Two or more symbols on one day indicates that two or more eggs were marked with that date.

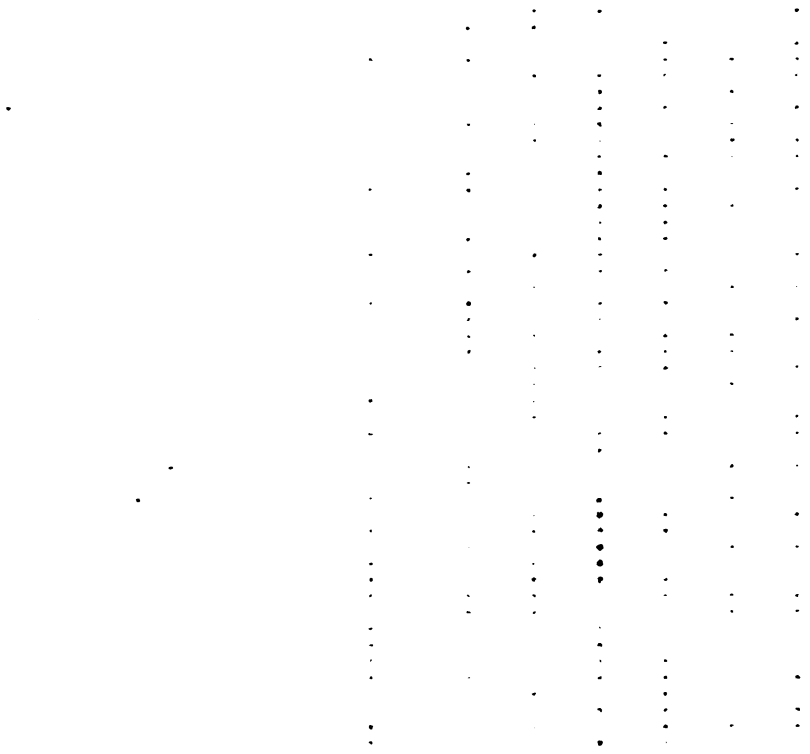
Table 4. Summary of the Eggs Produced by the Hens in Pen 4*

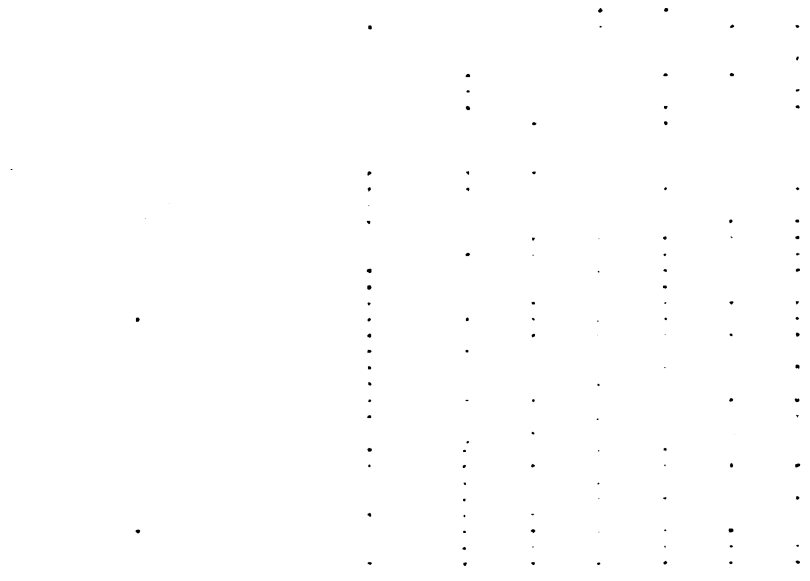
Hen no.	Period 1 V male used	Period 2 N male used
421	..II...II..I.I...I....D.DIII..I.I.I I	D..D.IND..NN.I..N.I..IN....D.I..ID.I..I.I...I. D
430	...VVI.VIV.VDD.V.VVI..DVVIIDII.II.V	D.IIIVII..VI.II.I.III..I..II.IIII.II...N.I.DNN D
432	.....DV.VII..I.IVV.	......I.I..IN..NNII..II...D.I.I....N.DI.I...IN
433	.....	.V.V.N..IIN..N..NN..VNNI.NN.NI..D....I....NNN. D
434	.....V.I.IDV...VD..VVV.IV.DIVIII. I	I.N.NINN....N..NNDII....N.ID.N..DI..I..NI..D.. D I
435	.....VI..D.V.VVD.DVV..IVV...VID	IVNN..IN..VD.NNN..NNNINN....I.N.II...N.NNN...I I
Floor eggs	.II.II..I.....VV....DDIVIIII.D DI D I	..ID....I...D.I.INN.D.IINDI.DI.III.IIDIIIV.IND IV I I ID I N I I II I N I I D D

* Hens 421 and 430 were in production prior to the start of the test. Each space represents one day. A period (.) represents a day when no egg was produced.

D = Dead Embryo resulted from the egg that day
I = Infertile egg produced that day
V = Vibrator poult produced that day
N = Normal poult produced that day

Two or more symbols on one day indicates that two or more eggs were marked with that date.





It is possible that the results in the 1962 test, in which both pens were naturally mated, could have been influenced by the mating habits of the turkey and/or the mating efficiency of the males. Examples of this are hens 421, 430, 432, 434, 435, and 462. All of these females became fertile initially from mating with the males present in Period 1 prior to the only reversal of males. In Period 2, after the males were reversed, all of these females switched over to the production of progeny of the replacing type male. However, the females began producing progeny of the replacing-type male at varying intervals of time following the reversal in males.

The first progeny of the replacing-type male, hatched from eggs produced three days following the shift in male types (hens 434 and 435). The last progeny of the replaced-type male hatched from an egg produced 40 days following the shift in male types (hen 430). All other hens, which produced eggs in the trapnests, changed over somewhere between these two extremes. It is obvious that hens 434 and 435 completed a mating with the replacing-type male soon after his introduction into the pen. However, hen 430, may not have mated or did not complete a mating with the replacing-type male for a much longer interval of time after his introduction into the pen.

DISCUSSION

In comparing the results of this experiment, the purpose of which was to determine the feasibility of changing turkey males in individual male mated pens during the breeding season, with prior experiments, it was found that a slower changeover in resulting progeny occurred in both the naturally mated and the artificially inseminated turkeys, following a shift in males, than Crew (1926) or Warren and Kilpatrick (1929) observed in chickens. There was also more overlapping of progeny from turkeys utilized in this experiment than that reported by Warren and Kilpatrick in their experiment with chickens.

In the present experiment, it was observed that following artificial insemination of Broad Breasted Bronze females (that were producing offspring from a given Broad Breasted Bronze male) with semen from another Broad Breasted Bronze male, identity of ensuing offspring was lost for a period greater than the 11 - 14 day period reported by Harper and Parker (1952).

The exact length of the period of paternal identity loss could not be determined in the first year of the experiment reported herein as the male types were shifted four times during the test period. In the second year, only one shift of males was made.

In the experiment herein reported, the females that were artificially inseminated did not all start producing progeny of the replacing type at the same time following a shift in male types. This is in agreement with the work of Payne and Kahrs (1961). However, the females in the present experiment did not produce as many poults of the replacing type male on the second day following a male shift as was

found by Payne and Kahrs. This possibly could be attributed to insemination techniques.

In the first year of this experiment, natural and artificial matings were utilized. In general, following a shift in male types, a greater time interval lag was observed in the naturally mated pen, as compared to the artificially mated pen, before progeny of the replacing type male were produced. This greater time interval lag in the naturally mated pen as compared to the artificially mated pen, could have been due to the mating habits of the turkey. Hale (1951) determined that the average interval between matings following a completed copulation was nine days (3 - 17 days range) and the average interval between matings following incomplete copulations, for the same hens, was seven days (2 - 12 days range). Hale (1954), using Broad Breasted Bronze and Beltsville Small White turkeys, observed that in the female turkey a successful mating occurred only about every other sex drive interval.

The slower changeover of progeny in the naturally mated pen as compared to that in the artificially inseminated pen could possibly have been attributed to the mating efficiency of the males. Using Jersey Buff turkeys, Smyth and Leighton (1953) observed that the female was responsible for initiating matings; however, a successful completion of the act depended on the male. Hale (1954), using Broad Breasted Bronze and Beltsville Small White turkeys, observed that males showed great individual variation in their ability to complete matings (12.5 - 97.5%) and low social rank reduced the males efficiency in multiple male pens.

In comparing the naturally mated pens of the 1962 test with the naturally mated pen of the 1961 test, progeny of the replacing type

male hatched much sooner after the shift in male types in the 1962 test. The time interval lag in the 1962 test, which used only natural mating, closely compares to the time interval lag obtained in the 1961 test in which artificial insemination was employed with respect to the speed of changeover of progeny to the replacing type male following a shift in male types. The shorter time interval lag in the 1962 test as compared to the naturally mated pen in the 1961 test could possibly have been due to increased sexual activity of the females and/or the males could have been more efficient in completing attempted matings.

Of the nine females from which pedigreed progeny were obtained in the naturally mated pen in the 1961 test, two produced overlapping progeny. This closely compares to the 1962 test in which two out of ten females from which pedigreed progeny were obtained produced overlapping progeny. The length of period of overlapping in the two tests was also closely related.

In the 1961 test, the male types and semen types were shifted four times. Therefore it was not possible to determine the total length of time semen from the replaced male could fertilize eggs following a shift in male types. In the 1962 test, only one shift in male types was made. The last progeny of the replaced type male was hatched from an egg produced 42 days subsequent to the shift in males. It will also be noted that only two poults of the replaced type male were hatched after the 19th day following the shift in males.

CONCLUSIONS

1. In the 1961 test, Broad Breasted Bronze female turkeys that were artificially inseminated began to produce offspring of the replacing type male, following a shift in male types, sooner than Broad Breasted Bronze females that were allowed to mate naturally.
2. In the 1962 test in which only natural mating was utilized, Broad Breasted Bronze female turkeys began to produce offspring of the replacing type male, following a shift in male types, after about the same amount of time that the females in the 1961 test which were artificially inseminated had.
3. There was more overlapping of ensuing progeny, following a shift in male types, from the artificially inseminated females in the 1961 test than from the females that were allowed to mate naturally in the 1961 or 1962 tests.
4. In the 1961 test, the first progeny of the replacing type male were produced by the artificially inseminated females on the second day following a shift in male types and the first progeny of the replacing type male were produced by the naturally mated females on the ninth day following a shift in male types. In the 1962 test in which only natural mating was utilized, the first progeny of the replacing type male were produced on the third day following a shift in male types.
5. In the 1962 test it was possible to determine the total time, following a shift in male types, that progeny of the replaced type male were produced. The last progeny from the replaced type male hatched from an egg produced 42 days after the switch in male types.

6. Based upon this information and that reported by other investigators who utilized two or more varieties of turkeys in their experiments, a single change in Broad Breasted Bronze turkey breeder males during a breeding season seems feasible. Loss of paternal identity of offspring would be for a period of about four weeks. However, when utilizing natural mating only, some females may not mate following the change of males and continue to produce progeny of the replaced male throughout the breeding season.

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APPENDIX I

The following is a complete hatching record of each hen in this experiment during the year 1961. All references to number of days refer to the total number of days following the switch in either semen or male type. All references to poults being hatched on a certain number of days following a shift in males or semen type means the poult resulted from the egg produced on that date. Any eggs that were pipped were not broken out but were included as dead embryos in figuring hatchability.

The following abbreviations will be used: V = vibrator, and N = normal. Information on eggs produced by individual hens will be given for each of five periods. Period 1 covered the time from the first egg to the first switch in either males or semen type. All females in pen 1 were exposed to vibrator males in Period 1. All females in pen 2 were inseminated with semen from vibrator males during Period 1. In Period 2, which was 25 days long, all females in pen 1 were subjected to two normal males while those in pen 2 were inseminated with semen from normal males. In Period 3, which was four days in length, all females in pen 1 were with two vibrator males and all females in pen 2 were inseminated with semen from vibrator males. During Period 4, which was seven days in length, all females in pen 1 were with two normal males and all females in pen 2 were inseminated with semen from normal males. In Period 5, which was 24 days in length, all females in pen 1 were with two vibrator males and all females in pen 2 were inseminated with semen from vibrator males.

Pen 1

Individual and pen records were kept for sixty days in this pen. A total of 593 eggs were produced. Four hundred and forty-one (74.36%) eggs were fertile. Two hundred and seven (46.94%) of the fertile eggs hatched. All 14 females in this pen produced eggs in the turkey trap-nests. This pen was naturally mated with two males in the pen at all times.

The following is a summary of the progeny produced by each female in pen 1.

Hen 401

Male type	
V	Period 1 - Fertility established. 4 V poults.
N	Period 2 - V poults on days 2, 6, 7, 11, 13, 14.
	N poults on days 18, 21, 22, 23, 24.
V	Period 3 - N poults on day 3.
N	Period 4 - N poults on days 3, 4, 5, 6.
V	Period 5 - N poults on days 1, 4, 5, 7, 14, 15.

Hen 402

N	Period 4 - N poults on day 3.

Hen 403

V	Period 1 - Fertility established. 2 V poults.
N	Period 2 - No poults produced.
V	Period 3 - No eggs produced.
N	Period 4 - No poults produced.
V	Period 5 - V poult on day 12.

Hen 404

V Period 1 - Fertility established. 3 V poults.

N Period 2 - V poults on days 3 and 11. N poult on day 21

V Period 3 - N poults on days 1 and 2.

N Period 4 - No poults produced.

V Period 5 - N poults on day 1. V poults on days 12 and 17.

Hen 405

V Period 1 - Fertility established. 6 V poults.

N Period 2 - V poults on days 2, 4, 5, 7, 9. No more eggs produced in trapnests.

V Period 3 - No eggs produced in trapnests.

N Period 4 - N poults on days 4, 5, 7.

V Period 5 - N poults on days 1 (2 poults), 4, 9, 12, 14. V poults on days 5 and 12.

Hen 406

V Period 1 - Fertility notestablished.

N Period 2 - V poult on day 4. No more poults in any of remaining periods.

Hen 407

V Period 1 - Fertility established. 3 V poults.

N Period 2 - N poults on days 11, 13 and 24.

V Period 3 - N poult on day 3.

N Period 4 - N poults on days 2 and 6.

V Period 5 - N poults on days 3, 5, 13, 14 and 17.

Hen 408

V Period 1 - Fertility established. 5 V poults.

N Period 2 - V poult on day 8. N poults on days 9, 13, 14, 20 and 25.

V Period 3 - N poults on days 1 and 3.

N Period 4 - N poults on days 3 and 7.

V Period 5 - N poults on days 8 and 9.

Hen 409

V Period 1 - Fertility established. 4 V poults.

N Period 2 - V poults on days 2, 5, 8, 9, 12 and 15. No more poults were hatched in any of the remaining periods.

Hen 410

V Period 1 - Fertility established. 1 V poult.

N Period 2 - V poults on days 1, 3, 4, 9 and 11. N poults on days 15 and 24.

V Period 3 - No poults in this period.

N Period 4 - N poult on day 6.

V Period 5 - N poults on days 1, 3, 5, 6, 9 and 15.

Hen 411

No poults hatched until Period 5, N poults on days 13 and 14.

Hen 413

V Period 1 - Fertility established. 1 V poult.

N Period 2 - V poults on days 1, 2, 10 and 13 (2 poults).

V Period 3 - No poults in this period.

N Period 4 - V poults on days 1, 2, 3, 6 and 7.

V Period 5 - V poults on days 1, 2, 3, 5, 15 and 16.

Hen 414

V Period 1 - Fertility established. 4 V poults.

N Period 2 - V poult on day 5. No more poults were hatched in any of the remaining periods.

Hen 415

V Period 1 - Fertility established. No poults hatched.

N Period 2 - N poult on day 23.

V Period 3 - No poults hatched.

N Period 4 - No poults hatched.

V Period 5 - N poult on day 4. V poult on day 20.

Floor eggs

V Period 1 - Fertility established. 11 V poults.

N Period 2 - V poults on days 7, 10, 16 and 24. N poults on days 9, 11, 12, 18 and 25.

V Period 3 - N poults on days 1 and 2.

N Period 4 - N poults on days 1, 4 and 5.

V Period 5 - N poults on days 1 (2 poults), 5, 9 and 23. V poults on day 18 (2 poults).

Pen 2

Individual and pen records were kept for 60 days in this pen. A total of 538 eggs were produced, 290 (53.90%) were fertile and 148 (51.03% of the fertile eggs) hatched. Thirteen of the 15 females produced eggs in the turkey trapnests. This pen was artificially inseminated throughout all periods. This was usually done twice weekly, on Tuesday and Friday. The insemination schedule was as follows:

Semen type

V Period 1 - All hens were inseminated 4 times. This period lasted from the first egg to March 6, 1961.

N Period 2 - All hens were inseminated on March 6th, 10th, 13th, 16th, 20th, 24th, 27th.

V Period 3 - All hens were inseminated on March 31st.

N Period 4 - All hens were inseminated on April 4th and 7th.

V Period 5 - All hens were inseminated on April 11th, 14th, 18th, 21st, 28th and May 2nd.

The following is a summary of the progeny produced by each female in pen 2.

Hen 412

Semen type

V Period 1 - Fertility established. No poults hatched.

N Period 2 - N poults on days 6, 9, 10, 11, 12, 14, 23 and 25. V poult on day 18.

V Period 3 - N poult on day 1. V poult on day 3.

N Period 4 - N poult on day 2.

V Period 5 - N poults on days 4 and 5. No more poults produced.

Hen 416

V Period 1 - Fertility established. 3 V poults.

N Period 2 - N poults on days 2, 14 and 19. V poults on days 10, 11 and 13. No more eggs produced in turkey trap-nests after 19th day of this period.

Hen 419

Only one dead embryo resulted (on day 16 of Period 2).

Hen 420

Semen type	
V	Period 1 - Fertility established. 5 V poults.
N	Period 2 - N poults on days 9, 13 and 14.
V	Period 3 - No poults hatched.
N	Period 4 - N poult on day 7.
V	Period 5 - N poults on days 3, 5, 12, 14, 16, 17 and 19. V poult on day 13.

Hen 422

V	Period 1 - Fertility established. One V poult. No more poults were produced in any of the remaining periods.

Hen 423

No poults hatched in any of the periods.

Hen 424

V	Period 1 - Fertility established. 2 V poults.
N	Period 2 - V poults on days 1, 4 (2 poults) and 13.
V	Period 3 - No poults hatched.
N	Period 4 - V poult on day 6.
V	Period 5 - V poults on days 17, 19 and 20.

Hen 425

V	Period 1 - Fertility established. No poults hatched.
N	Period 2 - N poults on days 4, 5, 13, 14 and 24.
V	Period 3 - N poult on day 1.
N	Period 4 - V poult on day 6. N poult on day 7.
V	Period 5 - V poults on days 2, 7, 8 and 17. N poults on days 4, 12, 13, 14 and 16.

Hen 427

V Period 1 - Fertility established. No poults hatched.

N Period 2 - V poults on days 8, 9, 10, 11, and 12.

V Period 3 - No eggs produced in turkey trapnests.

N Period 4 - No eggs produced in turkey trapnests.

V Period 5 - V poults on days 12, 17, 20 and 22. N poult on day 16.

Hen 428

V Period 1 - Fertility established. 2 V poults.

N Period 2 - V poults on days 6, 7, 12 and 13. One N poult on day 8. No further eggs were laid in the turkey trapnests in any of the periods.

Hen 429

V Period 1 - Fertility established. No poults hatched.

N Period 2 - N poults on days 7, 8, 9, 11, 19, 21, 22 and 24.

V Period 3 - V poult on day 2.

N Period 4 - V poult on day 7.

V Period 5 - N poults on days 3, 5, 9, 11, 13. V poults on days 4 and 12.

Hen 431

V Period 1 - Fertility established. No poults hatched.

N Period 2 - No poults hatched.

V Period 3 - No poults hatched.

N Period 4 - No poults hatched.

V Period 5 - V poults on day 14 and 17.

Hen 417

The only eggs produced by this hen in the turkey trapnests were not recorded as to the type of poults which hatched from the eggs.

Floor eggs

V Period 1 - Fertility established. 3 V poults.

N Period 2 - V poults on days 1, 6, 10, 12, 15, 16 and 17. N poults on days 7, 21 and 25.

V Period 3 - N poults on days 1, 3 and 4.

N Period 4 - V poult on day 2. N poult on day 5.

V Period 5 - N poults on days 2, 4, 5, 7 and 8. V poults on days 11 and 18.

APPENDIX II

The following is a complete hatching record of each hen in this experiment during the year 1962. All references to the number of days refer to the total number of days following the switch in male type. All references to poults being hatched on a certain number of days following a shift in male type means the poult resulted from the egg produced on that date.

It was observed that if any live, pipped poults were removed from the shell, they could readily be identified as being either normal or vibrator. During this 1962 test, all live, pipped poults were removed and identified and included as poults in tables 3 and 4. However, they were not included in the hatchability records as poults but were included as dead.

The following abbreviations will be used: V = vibrator and N = normal. Information on individual hens will be given for the two periods involved in the test. Period 1 covered the time from the first egg to the only switch in male types. All females in pen 3 were exposed to two normal males during Period 1. All females in pen 4 were exposed to two vibrator males during Period 1. In Period 2, all females in pen 3 were subjected to two vibrator males while all females in pen 4 were subjected to two normal males.

Pen 3

Individual and pen records were kept for 81 days in this pen. A total of 242 eggs were produced. One hundred and forty-five eggs were fertile. Seventy-four of the fertile eggs hatched. Five of the 12 females in this pen produced eggs in the turkey trapnests. Two males were present at all times.

The following is a summary of the progeny produced by the females in pen 3.

Hen 458

Male type	
N	Period 1 - No eggs produced in trapnest.
V	Period 2 - N poults on days 7, 8, 10, 12.
	V poults on days 16, 19, 20, 21, 24, 25, 26, 29, 45, 46.

Hen 460

N	Period 1 - Fertility established. 1 N poult.
V	Period 2 - No eggs produced in trapnests.

Hen 461

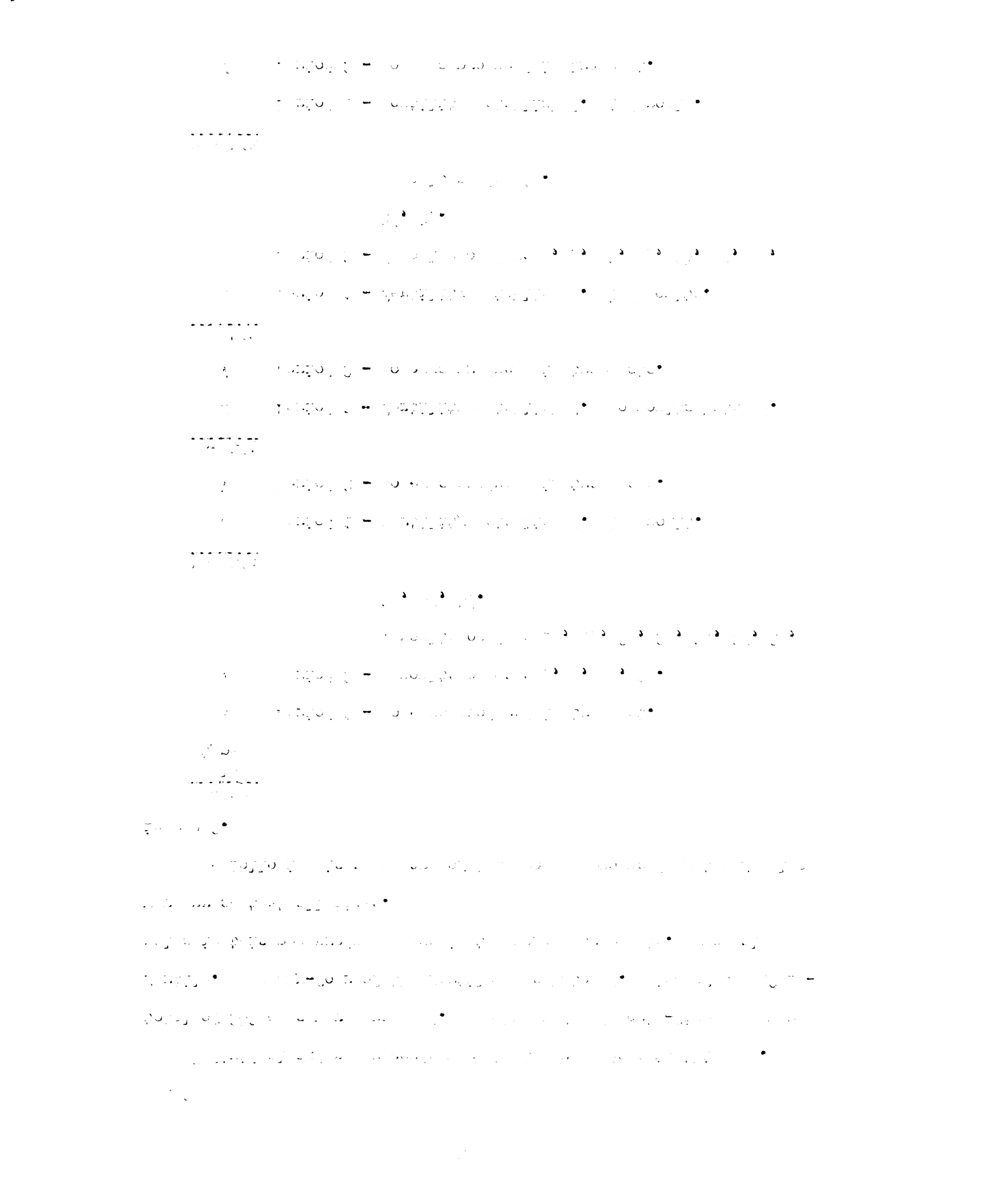
N	Period 1 - Fertility established. No poults hatched.
V	Period 2 - No eggs produced in trapnests.

Hen 462

N	Period 1 - Fertility established. 4 N poults.
V	Period 2 - V poults on days 8, 9, 12, 13, 14, 15, 18, 26, 27.
	N poult on day 19.

Hen 464

N	Period 1 - Fertility established. 1 N poult.
V	Period 2 - No eggs produced in trapnest.



Floor eggs

N Period 1 - Fertility established. 18 N poults.

V Period 2 - N poults on days 3 (2 poults), 10, 13, 27.
V poults on days 3, 7, 13 (2 poults), 17, 18, 19, 20, 21, 22, 26, 27, 28, 30 (2 poults), 31 (2 poults), 43, 45 (2 poults).

Pen 4

Individual and pen records were kept for 81 days in this pen. A total of 302 eggs were produced. One hundred and fifty (49.67%) eggs were fertile. One hundred and two (68.00%) of the fertile eggs hatched. Six of the 11 females in this pen produced eggs in the turkey trapnests. This pen was naturally mated with two males in the pen at all times.

The following is a summary of the progeny produced in pen 4.

Hen 421
Male type

V Period 1 - Fertility established. No poults hatched.

N Period 2 - N poults on days 7, 11, 12, 17, 23.

Hen 430

V Period 1 - Fertility established. 11 V poults.

N Period 2 - V poults on days 6, 11.
N poults on days 40, 45, 46.

Hen 432

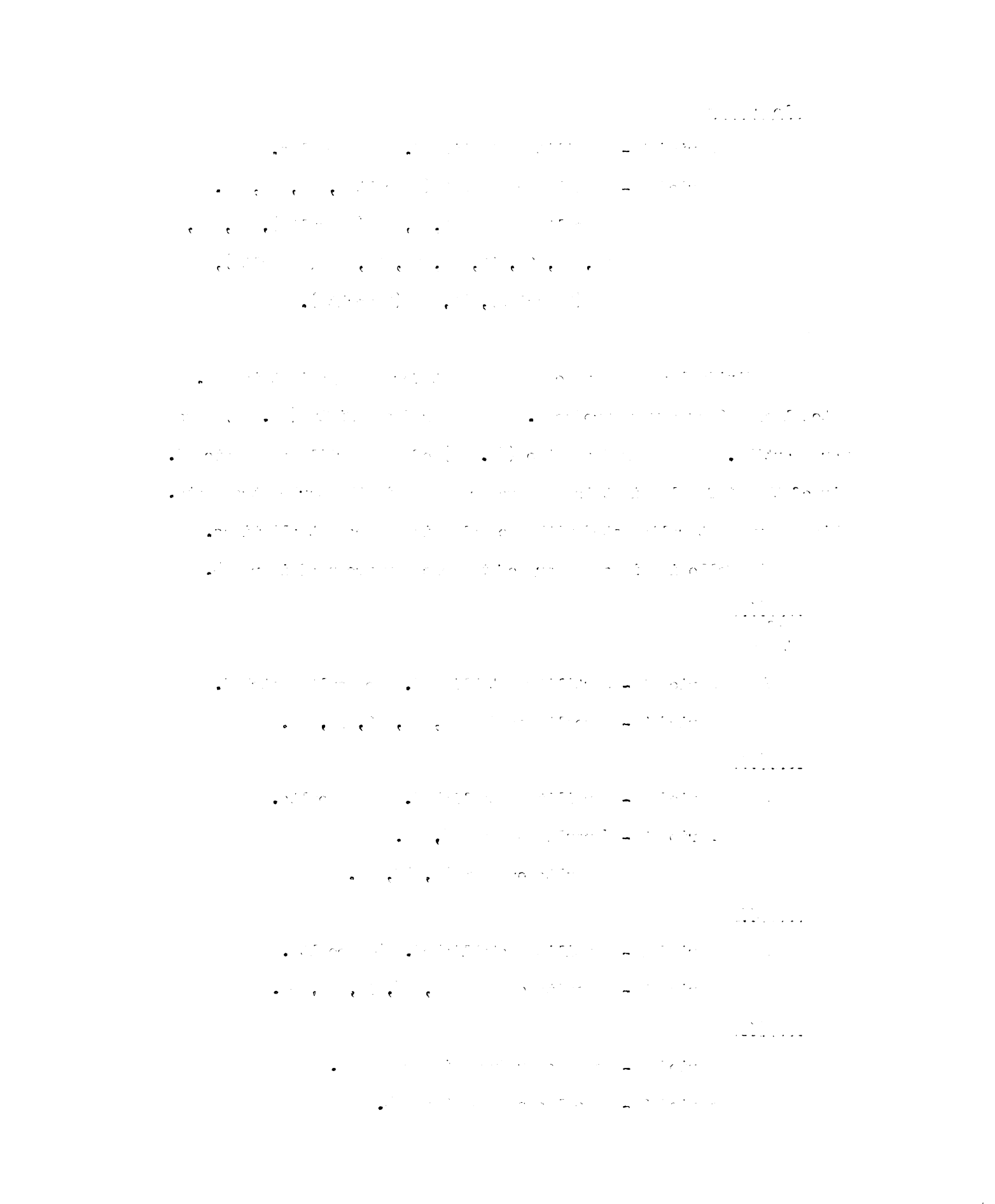
V Period 1 - Fertility established. 4 V poults.

N Period 2 - N poults on days 13, 16, 17, 36, 46.

Hen 433

V Period 1 - No eggs produced in trapnests.

N Period 2 - V poults on days 2 and 4.



Hen 433 (continued)

N Period 2 - N poults on days 6, 11, 14, 17, 18, 22, 23, 26, 27, 29, 43, 44, 45.

Hen 434

V Period 1 - Fertility established. 8 V poults.

N Period 2 - N poults on days 3, 5, 7, 8, 13, 16, 17, 25, 30, 40.

Hen 435

V Period 1 - Fertility established. 9 V poults.

N Period 2 - V poults on days 2, 11.
N poults on days 3, 4, 8, 14, 15, 16, 19, 20, 21, 23, 24, 31, 38, 40, 41, 42.

Floor eggs

V Period 1 - Fertility established. 3 V poults.

N Period 2 - V poults on days 4, 42.
N poults on days 15, 18, 19, 25, 26, 45.