THE SIGNIFICANCE OF CROP-GLAND ACTIVITY IN MOURNING DOVES DURING THE HUNTING SEASON IN VIRGINIA

by

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INTRODUCTION

The mourning dove (*Zenaidura macroura*) is a widely distributed species in North America. In addition to being a very highly popular game bird, the mourning dove also is an important non-game species because of its attractive appearance and because it nests freely in suburban areas. The Bureau of Sport Fisheries and Wildlife reports on the popularity of the mourning dove as a game species from statistics of hunter-harvested birds: 1942, 11 million; 1949, 15 million; 1955, 19 million; 1965, 41.9 million.

While dove harvests increased substantially, the indications are that these increases were due to increased hunting pressure rather than to population increases. In fact, analysis of call-count surveys (estimates of the breeding population densities) reveal slight but steady decreases in the breeding population.

Management of mourning doves in the United States consists, primarily, of regulating hunting seasons and bag limits to achieve a desirable harvest. Management is complicated by the highly mobile nature of the species and because of its migratory habits. The annual call-count surveys are used to estimate the breeding populations and the size of the breeding population is a prime input in setting the annual hunting regulations. Maximum harvest of doves depend on the size of the breeding flock so preservation of adequate breeding stocks is essential for ensuring subsequent maximum harvests. Also, setting the hunting season at a time which will avoid a serious conflict with nesting activity of birds will reduce the wastage of immature birds. A method for estimating possible wastage of immature birds due to the removal of parents by hunting would offer potential management benefits if this loss may be minimized by proper selection of the hunting season. Immature birds saved would later provide birds for hunting and for recruitment to the breeding population.

A unique aspect of the reproductive physiology of the family *Columbidae* is that all members nourish their young by the production and feeding of crop-milk (Levi 1941). This is a milk-like substance produced by the crop. The normal crop is a uniformly thin membranous structure. Towards the end of incubation, the walls of the crop thicken (up to twenty-fold increase). The thickened wall sloughs off layers of cells which constitute the caseinous "crop-milk" (Riddle and Bates 1939). This development of the crop is known to be under the influence of the pituitary hormone prolactin (Riddle, Bates, and Dykshorn 1932).

The development of the crop and production of crop-milk provides a unique system for studying post-hatching nesting activity in mourning doves. Anatomical changes in the crop of crop-milk producing birds are such that nest-tending birds may be readily distinguished by visual observation of their crops. The histological changes in the crop of crop-milk producing birds have been described for the pigeon (*Columba livia*, Dumont 1965) and the band-tailed pigeon (*Columba fasciata*, March and Sadleir 1970). The duration of crop-milk production activity and its associated anatomical changes in the crop wall of adults after hatching of young is not fully known for mourning doves. Laub (1956) showed that anatomical changes associated with crop-milk production were still present up to 14 days after hatching. It is probable that determination of the proportion of birds with active crops among those harvested by hunters will provide reliable estimates of the number of birds still tending young on nests at the time of death.

The present study was designed to determine the proportion of adult birds with crop-milk production activity shot at successive stages of the 1972 hunting season in Virginia. A preliminary study was conducted in 1971. In addition laboratory studies on mourning doves

(*Zenaidura macroura*) and pigeons (*Columba livia*) were conducted to estimate the rapidity of regression of the anatomical changes associated with crop-milk production following withdrawal of the hormone treatment used to induce the activity. This phase of the work was conducted in order to better understand the rate of disappearance of anatomical characteristics after cessation of crop-milk production.

LITERATURE REVIEW

Dove populations have been steadily declining over the last decade. Ruos (1970,1971) and Ruos and MacDonald (1970) have found downward trends in dove populations since 1958. The Eastern, Central, and Western Management Units vary as to the degree of decline but a nation-wide trend is evident. Regression analysis of the annual call-count survey data for 1959-1969 indicates a statistically significant downward trend of 1 percent per year in the Eastern Management Unit and 3 percent a year for the United States as a whole. Harris (1971) reports a continuation of this downward trend through regression analysis of the call-count data from 1961-1971. Mourning dove breeding populations decreased at an annual rate of 1 percent per year in the Eastern Management Unit, 2.5 percent in the Central Unit and 4.4 percent in the Western Unit. The estimates of Ruos (1971) essentially agree with similar estimates of Harris (1971).

Ruos and MacDonald (1970) provide data which suggests that hunting pressure increased substantially (31.5 percent) during the period 1965-1966 through 1967-1968. These data were based on a mail survey conducted in association with the Annual Waterfowl Mail Questionnaire

Survey and may have contained unknown biases. However, this survey provides strong indications that the demand for mourning doves as a game species is increasing. A similar increase in demand for dove hunting was noted by Preno and Labisky (1971) in Illinois. Statistics collected from Illinois hunters indicated approximately 50,000 resident small-game license holders hunted doves in 1949, but by the later 1960's the number of resident licensees hunting doves was slightly more than 100,000. Ruos and MacDonald (1970) found that the 31.5 percent increase in hunters resulted in a 28.9 percent increase in dove harvest. The increase in dove harvest was thus due mainly to an increase in hunter numbers.

As mentioned in the introduction section, all members of the *Columbidae* produce "crop-milk" (Levi 1941). This is a milk-like substances produced in the adult's crop and regurgitated into the young's mouth for nourishment. The normal crop is a uniformly thin membraneous structure somewhat transparent in appearance. Towards the end of egg incubation, the crop becomes opaque and has a somewhat rubbery texture. The thickened crop walls have a conspicuous increase in blood supply (Laub 1956). "The pavement epithelium undergoes rapid mitosis and becomes highly folded and, as hypertorophy progresses, the outer layers become pushed farther and farther away from the blood supply in the tunica propria and subsequently desquamate into the lumen of the crop" (Beams and Meyer 1931). These sloughed off cells constitute the crop-milk which is used to feed the nestlings. This development of the crop is known to be primarily under the influence of a single hormone, prolactin (Riddle et al. 1932).

The young of the mourning dove are helpless following hatching and require constant attention (Bent 1932). The diet of young doves consists initially of crop-milk but small seeds are mixed with the crop-milk as the nestlings increase in age (Hoffman and Lindsey 1972). Length of dependence of young doves on crop-milk has not been fully researched; however, studies by Hanson and Kossack (1963) reveal that by the time the young are 7 to 8 days of age, the activity of the crop gland is diminishing. Studies by Laub (1956) indicate that crop-milk production by adults ceased 6 to 8 days after the young are hatched. Moore (1940) showed that young are still receiving some crop-milk (up to 5 percent of food supply) up to 12 days after hatching. Laub (1956) reported that anatomical changes in the crop were still present up to at least 14 days after hatching.

This may indicate that the relatively small levels of production of crop-milk, from the point of view of proportion of its contribution to the total diet of young at the later stages after hatching, are associated with obvious anatomical changes in the crops of the adult birds.

The time of dependence of young doves on their parents for food is difficult to determine, but Dr. Roy E. Tomlinson (personal communication) indicates through general observation, that this period is 11 to 16 days after the young have left the nest. This is supported by evidence from Austin (1951) whos suggests that an average period of food dependence on parents is 14 days after leaving the nest.

The adult doves' crop development during the post-hatching period provides a useful means of studying the reproductive status of the birds. Little use has been made of this source of information in dove management. March and Sadleir (1970) studied crop activity in band-tailed pigeons in British Columbia and found that some birds shot during the hunting season in that area were feeding young. Thompson (1951) found that the number of doves feeding young during portions of the hunting season in the United States ran higher than 15 percent in some states. Studies of mourning doves in North

Carolina indicate that among specimens taken during September in each of the years 1939, 1940, and 1941, crop activity was present in 18, 23 and 26 percent respectively (Quay 1951). Hanson and Kossack (1963) found 38 percent of the hunters' kill in northeast Illinois had various degrees of crop development. Crop development was observed in 17.8 percent of hunter harvested doves in Tennessee (Hamm 1948) and in 6.0 to 6.8 percent of hunter-harvested doves during different seasons in Missouri (Korschgen 1955). Pearson and Moore (1939) found as high as 20 percent of the dove nests in Alabama were still functional in September. McClure (1950) reported significant differences in dove nesting periods and nesting success when comparing two states with no dove hunting season (Iowa and Nebraska) to California which had a relatively early dove season opening on September first. In Iowa, 29.1 percent of the doves did not leave the nest until after September first, and 20.2 percent of the young doves in Nebraska were fledged after September first. In comparison, California had only 5.8 percent of the young dove population fledged after September.

Caldwell (1957) found 42 percent of 36 adult doves shot in September in Michigan had "thickened" crop walls.

As he had observed that few birds seemed to be nesting in the area at the time of collection, he considered that the proportion of birds with crop thickening may not necessarily reflect the proportion of birds tending young. However, his sample size was of such a small size as to limit the ability to draw firm conclusions.

The late summer nesting of doves was found to be more successful (81 percent success) than early spring or summer nesting (Hanson and Kossack 1963). This higher success of late summer nests is presumably because of the better weather at this time of year. Heavy rains, high winds and temperature extremes are believed to be the major factors influencing nesting success earlier in the year (Hanson and Kossack 1963). The importance of minimizing conflicts between harvesting of doves and their nesting activity thus is readily discernable.

Mourning doves molt primary feathers from the wings in an orderly fashion (Swank 1950). The age of immature birds may be approximated from this fact (Swank 1955). In an analysis of juvenile mourning doves collected during the hunting season in Virginia, Sprunt (1957) provided evidence of young birds harvested which had hatched in September. Sprunt's estimate of 4 percent September-hatched doves was based on birds harvested in the latter part of October and may have been slightly biased because the removal of parent birds by hunting in September may have decreased the survival of young still being tended in nests.

Studies at Ohio State University (Laub 1956) indicated that upon removal of one of a nesting pair of adults, the other adult is incapable of successfully rearing two young if they are less than six or seven days old. In no case was a nest successful after an adult had been removed during egg incugation. This indicates that the taking of even one of a pair of nest-tending adult birds during an early hunting season would adversely influence the success of the nest and thus seriously conflict with recruitment of significant numbers of late-hatched birds.

Crop activity of the *Columbidae* is primarily under the control of the anterior pituitary hormone, prolactin (Riddle et al. 1932, Riddle and Bates 1939). The response of the crop wall of members of the *Columbidae* to prolactin is of such sensitivity that their response to this hormone is widely used in bioassays for prolactin (Bates et al. 1963). As little as 30 mg lyophilized anterior pituitary of cattle given in seven daily injections to pigeons have been used as a bioassay for pituitary prolactin (Rieser et al. 1968).

MATERIALS AND METHODS

The study was conducted in two separate investigations (1) A study of the proportion of doves shot during the hunting season which had evidence of crop-milk production activity, and (2) an investigation of the persistence of crop gland activity following its induction by exogenous prolactin.

Crop-milk Production Activity in Hunter-Harvested Doves

The investigation was conducted on doves harvested by hunters during the hunting seasons of 1971 and 1972. The collection of doves was made at Elm Hill Wildlife Management Area, Mecklenburg County, Virginia. Hunters were asked to donate carcasses of birds after the breasts were removed at the check station. The birds were separated by sex and age (adult or immature) and placed in 10 percent formalin for future detailed examination at the laboratory. Specimens were collected on the following dates: September 4, 1971; September 2, 1972; September 9, 1972; September 16, 1972; September 23, 1972, and December 23, 1972.

The following data were recorded for specimens examined in detail in the laboratory: sex of bird, age of bird, primary feather replacement, presence or absence of crop-milk production activity, weight of empty crop, weight of testes in males, weight of ovary in females, weight of oviduct in females, diameter of the three longest follicles in the ovary, and presence or absence of eggs in the reproductive tract of females. The development of crop-milk production activity was recorded as active, developing, regressing, or inactive. Crops were processed for histological examination and examined to confirm the development classification assigned at first examination. Comparisons were made based on histological examinations of crop-milk producing crops of other species of *Columbidae* (March and Sadleir 1970; Dumont 1965). Aging techniques used were those described by Swank (1950, 1955). Those birds with white edges on the wing covert feathers were considered juvenile. The pattern of primary feather replacement was used to estimate the age of juvenile birds (i.e. the time of hatching).

Persistence of Crop Activity Following Prolactin Injections

Ferel rock doves or pigeons (*Columbia livia*) were trapped from the wild and confined in laboratory cages. Following confinement for at least one month, birds were used in experiments to evaluate persistence of crop activity after prolactin injections. The study was conducted in two parts: one to estimate the approximate range of persistence, the other to identify more closely the duration of persistence of crop activity.

The prolactin source used to induce crop activity was secured from an extract of cattle anterior pituitary. Extracts were made by homogenizing fresh pituitaries in physiological saline (0.9 percent NaCl). The ratio of pituitary to saline in the homogenate was 50 mg anterior pituitary per 1 ml of saline. Following homogenization the homogenate was centrifuged and the supernatant recovered, subdivided in batches and frozen for later use.

Birds were given injections of the anterior pituitary extract at the following rates: mourning doves, 0.5 ml once daily for 5 days; pigeons, 1.0 ml once daily for 5 days. Injections were given intramuscularly in the pectoral muscle.

In Trial 1, birds were sacrificed at intervals of 1, 3, 5, 10, and 15 days after the last pituitary extract injection. The crops of birds were visually examined for development of the crop wall and presence of crop milk. Crops were dissected free and the empty crop weighed. A crop development score was given each crop on the basis of the visual examination. In Trial 2, birds were sacrificed at intervals of 1, 2, 3, 4, 5, 6, and 7 days after last pituitary extract injection. The crops of these were also examined as in Trial 1.

Number of birds used in this phase of the study were: Trial 1, 16 pigeons; Trial 2, 19 pigeons.

RESULTS

The collection of field data in the report depended in large measure on hunter success while in the wildlife management area. In 1971, relatively few birds were recovered on September 4 (82 adults). On September 2, 1972, 279 adult birds were recovered. Considerably fewer birds were recovered on subsequent sampling dates. This was primarily because of fewer hunters, although, there was also lower hunter success. The number of adult birds examined and the proportion of adult birds with anatomical features associated with crop-milk production activity are presented in Table 1. Among those birds collected on September 4, 1971, 12.5 percent had active crop glands while 8.4 percent had regressing crop glands.

Of those birds examined on September 2, 1972, 22.6 percent had active crops and 8.2 percent had regressing crops. The proportions of adults with active crops on September 9, 1972, September 16, 1972 and September 23, 1972 were 23.6 percent, 29.3 percent and 21.4 percent respectively. The number of adults examined on the later two dates was considerably less than on the earlier dates. There was a significant

Table 1. Crop-milk production activity in adult mourning doves collected from Elm Hill Wildlife Area, Mecklenburg County, Virginia in 1971 and 1972

Collection Date	Adults Examined (Number)	Active Crops (%)	Regressing Crops (%)	Total with Some Crop Activity (%)
1971, Sept. 4	82	12.5*	8.4	20.9
1972, Sept. 2	279	22.6	8.2	30.8
1972, Sept. 9	89	23.6	14.6	38.2
1972, Sept. 16	34	29.3	0.0	29.3
1972, Sept. 23	14	21.4	14.3	35.7
1972, Dec. 23	11	0	0	0

*Significantly different from September 2, 1972 ($P<0.05$, $X^2=4.20$, 1 d.f.)

difference ($P<0.05$, $X^2=4.200$, 1 d.f.) in the proportion of doves with active crops between September 4, 1971 and September 2, 1972. The proportion of doves with active or regressing crops on the above dates was not significantly different ($P<0.05$), but this difference approached significance ($P<0.10$, $X^2=3.23$, 1 d.f.). No evidence of crop-gland activity was present in doves harvested in December 1972. There was no evidence of crop-gland activity in immature birds. The data in Table 1 indicate that there was a substantial proportion of birds still raising young in September in each of the years studied, and that there appeared to be considerable differences between years in this activity.

Data on mean weights of crops of birds with active crop milk production, regressing and inactive crop development are presented in Table 2. The data indicates substantially heavier crop weight when there is crop milk production activity, and decline in crop weight when the anatomical changes were regressing. Significant differences ($P<0.001$) were observed between weights of active, regressing and inactive crop glands. Crop weights of immature birds were considerably lighter.

The possibility exists that crop weight could be used in addition to visual assessment of the crop as a diagnostic aid, thus eliminating the need for histological

Table 2. Mean crop weight of active, regressing and inactive crops of doves collected at Elm Hill Wildlife Area, Mecklenburg County, Virginia in 1972

	Active	Regressing	Inactive	All Adult	All Immature
No. Birds	97	39	292	356	128
Mean weight (g) (± S.D.)	3.50[a] (±1.26)	1.38[b] (±0.49)	0.87[c] (±0.26)	1.61 (±1.24)	0.65 (±0.18)
Range	0.94-7.24	0.55-2.79	0.33-1.62	0.46-7.24	0.33-1.39

(a,b,c) The means with different superscripts are significantly ($P<0.001$) different.

examination of crops for determination of crop activity. Data on the range of weights of crops classified as active, regressing or inactive are given in Table 3. It is clear from these data that a wide divergence in crop weights exist among birds with active crop glands. There is also considerable overlap in crop weight between those with different crop gland activity ratings. Consequently, though crop weights could be used to identify active crop glands above the 3.0 g level, below this level crop weight would not be useful in segregating active from regressing. Below the 2.0 g level, crop weight would not be useful in designating any category of crop gland activity among adult doves.

Data on ovarian activity are presented in Table 4. Birds collected in the first week of September in 1971 and in 1972 still had ovarian activity consistent with ovulation. Eggs were found in the oviducts of birds collected on September 4, 1971 and September 2, 1972. Birds with eggs in the oviduct represented 4.3 percent and 5.8 percent, respectively, of the adult females collected on the above dates. In addition, the collections of doves on September 4, 1971 and September 2, 1972 contained females that were considered to be likely to ovulate (i.e. had follicles greater than 10 mm diameter) had not they been killed. Eggs were not found in

Table 3. Distribution of crop weight for doves with active, regressive and inactive crops collected at Elm Hill Wildlife Area, Mecklenburg County, Virginia in 1972

Weight of Crop (g)	No. (percent) Each Weight Class Active	Regressing	Inactive
0.0-1.0	1 (1.22)	6 (17.65)	141 (57.55)
1.1-2.0	8 (9.76)	23 (67.65)	104 (42.45)
2.1-3.0	22 (26.83)	5 (14.71)	nil
3.1-4.0	24 (29.27)	nil	nil
4.1-5.0	17 (20.73)	nil	nil
5.1-6.0	8 (9.76)	nil	nil
6.1-7.0	1 (0.28)	nil	nil
7.1-8.0	1 (0.28)	nil	nil
	82 (100.00)	34 (100.00)	245 (100.00)

Table 4. Proportion of birds ovulating or likely to ovulate collected at Elm Hill Wildlife Area, Mecklenburg County, Virginia in 1971 and 1972

Date	No. Adult Females Examined	No. (%) With Follicles Greater Than 10 mm. Diameter in the Ovary	No. (%) With Eggs in Oviduct
Sept. 4, 1971	46	1 (2.17)	2 (4.34)
Sept. 2, 1972	103	2 (1.94)	6 (5.82)
Sept. 9, 1972	38	0	0
Sept. 16, 1972	13	0	0
Sept. 23, 1972	7	0	0
Dec. 23, 1972	3	0	0

oviducts of females collected later than September 2, 1972. Also, there was no evidence of well developed follicles (i.e. 10 mm diameter or greater) in adult females collected after September 2, 1972.

Analysis of primary feather replacement patterns was used to estimate the time of hatching of the immature birds harvested. Results of these esaminations are given in Table 5. The data indicate that the majority of immature birds harvested in 1972 were hatched later than mid-July. The lack of birds hatched in May and early-June probably is due to heavy losses of nests and nestlings due to hurricane Agnes. The data in Table 5 indicate that nesting activity was still continuing at high levels in late-August. The nature of the data precludes positive statements regarding September nesting activity as immature birds on nests are not exposed to hunter harvest. However, it could be inferred that, based on high levels of nesting activity in late August, nesting activity was still high in early September.

Data on gonad weights are presented in Table 6. In both adult male and female birds there was very wide variation in gonad weights. This may have indicated that regression of gonads may already have taken place in many birds at a time when substantial numbers of birds

Table 5. Estimated hatching dates of juvenile doves collected during the 1972 hunting season at Elm Hill Wildlife Area, Mecklenburg County, Virginia

Hatching Date		Number of Birds	Percent of Total
April	12-18	6	4.5
April	24-30	5	3.7
June	12-18	3	2.2
June	24-30	8	5.9
July	06-12	7	5.2
July	12-18	2	1.5
July	18-24	12	8.9
July	24-31	19	14.2
August	01-06	16	11.9
August	06-12	14	10.4
August	12-18	31	23.1
August	18-24	14	10.4
August	24-31	4	2.9
September	01-06	1	0.7

Table 6. Mean gonad weight (± S.D.) of doves collected at Elm Hill Wildlife Area, Mecklenburg County, Virginia in 1972

	Mature		Immature	
	Wt. mg	No. Birds	Wt. mg	No. Birds
Paired testes weight (mg)	227.13 ±200.64	234	5.78 ±3.79	63
Range	0.0027 - 0.7853		0.0016 - 0.0286	
Ovary weight	109.40 ±245.26	149	13.34 ±15.40	45
Range	0.0085 - 2.0216		0.0016 - 0.0708	

were still actively reproducing. Substantial differences in mean gonad weights also were evident between both male and female immature birds (Table 6).

Crop weights were indicative of anatomical changes in the crop gland (Table 2). Significant differences in mean crop weights were observed between active, regressing, and inactive crops. Data were examined to determine linear correlations between crop weight and gonad weights of adult male and female doves. The results of these examinations are presented in Table 7. The correlation coefficients between paired testes weight and crop weight and between ovary weight and crop weight were low. Thus, it seems that study of gonad weight, particularly of females, is unlikely to be useful in evaluating post-hatching nesting activity.

Mourning doves and feral pigeons were treated with cattle pituitary extract in attempts to induce crop milk production activity and to evaluate the persistence of anatomical changes after cessation of pituitary treatment. Initially, suitable dose levels had to be determined for mourning doves. Injections of 1 ml of the pituitary extract were unsuitable as they seemed to produce anaphylactic responses resulting in the death of several birds. Daily injections of 0.25 ml extract only induced crop activity in one of four doves. Later injections of

Table 7. Correlation coefficients between gonad weights and crop weights of doves collected at Elm Hill Wildlife Area, Mecklenburg County, Virginia in 1972

	Paired testes weight	Ovary weight
Crop weight	0.4828	0.0219
No. observations	195	132

0.5 ml were given without causing death of birds but crop milk production activity was not stimulated. This may have been due in part to the fact that these birds had previously been used in testing for suitable dose levels.

The data presented in Table 8 deal exclusively with observations made on pigeons. The results obtained suggest that observable morphological changes in the crop associated with prolactin treatment regress rapidly after cessation of prolactin treatment. In Trial 1, the results indicated that regression took place before day five, i.e. physical changes associated with crop milk production completely disappeared by the fifth day after cessation of the prolactin stimulus. A further study (Trial 2) was conducted to further delineate the duration of persistence of anatomical changes. Anatomical changes disappeared as early as two days after withdrawal of pituitary extract injections but, in some birds persisted as late as three and five days.

Table 8. Persistence of anatomical changes associated with crop milk production in feral pigeons after cessation of prolactin treatment

Day Sacrificed	No. Birds	No. With Anatomical Changes in Crop	Mean Crop Weight (g)
Trial 1.			
1	2	2	3.47
3	2	1	1.86
5	3	0	1.73
10	3	0	1.63
15	6	0	1.49
Trial 2.			
1	3	3	4.32
2	3	1	2.51
3	3	1	2.95
4	3	0	2.43
5	3	1	2.35
6	2	0	2.24
7	2	0	1.77

DISCUSSION

The relatively high frequency of active crops plus regressing crops indicates that a very high proportion of the adult birds were tending nests in September 1972 during the hunting season. The proportion was lower in 1971 and this may have been because of the relatively small sample size obtained in 1971. However, another explanation seems more likely as a severe interruption of the normal nesting activity took place in 1972 as a result of hurricane Agnes (June 19-23, 1972). Such a storm likely operated to eliminate substantial numbers of dove nests. Hanson and Kossack (1963) have stated that lowered success early in the breeding season is due primarily to the vagaries of the weather. Laub (1956) also indicated that adverse weather factors probably limited nest success. The data presented in this report based on estimates of hatching dates of immature birds by examination of primary replacement indicate that the hurricane played a major role in eliminating nests and/or reducing nestling survival at that time. The data presented tend to show a definite dimination in survival of young hatched about the time of the hurricane. Such dimination of success in nesting in the early part of the breeding season may have contributed to a higher proportion of birds tending nestlings during September. North Carolina data reported by Quay (1951) indicate considerable variation between years in the proportion of doves with active crop-milk production taken during the hunting season. Data for the years 1939, 1940 and 1941 indicated that 18 percent, 23 percent and 26 percent, respectively, of adults had active glandular crops. These variations may have been due in part to weather factors which may have caused variations in the number of birds which were tending nests at the time of the hunting season. The fact that differences between years may be substantial indicates that considerable study over a period of some years must be done in order to truly predict the effect of the timing of hunting season on the nesting activity and possible survival of the live hatched young doves.

The implications are that the loss of even one mourning dove parent may have a serious influence on the likelihood of success of the nest. The data provided by Laub (1956) indicate that a surviving parent is either unable or unwilling to continue hatching eggs after the loss of a nesting partner. This unwillingness or inability persists after young are hatched and no instance of a single surviving parent successfully raising a single young less than 4 days after hatching or a pair of nestlings less than 7 days after hatching. Consequently, removal of even one of the nesting pair during the early phases of raising of young is likely to eliminate the possibility of successful fledging of the young. The significance of a situation where the hunting season seriously conflicts with the nesting season (in terms of a high proportion of birds still raising young) is thus worthy of close examination, particularly because of the steadily reducing breeding population and increase in hunter demand for the mourning dove over the last decade.

The anatomical features associated with crop-milk production activity in crops of mourning doves have practical significance in determining the degree of nesting taking place in the early portion of the mourning dove hunting season. Caldwell (1957) examined the crops of mourning doves harvested in Michigan and found anatomical development of the crop-gland in 42 percent of 36 birds examined. Based on his knowledge of nesting activities in the area he considered that use of "crop thickening" probably over estimated the proportion of nesting doves. He cited other literature (Hopkins and Odum, 1953; Jenkins, 1955) which he felt supported his contention that presence of crop-gland development over estimated nesting activity. It was not clear that the data in the references cited (Hopkins and Odum, 1953; Jenkins, 1955) was collected simultaneously so valid comparisons were not necessarily made. Also, relatively small numbers of doves (79 adults) were studied by Jenkins and thus the data is of limited value. Caldwell (1957) based his observations on 56 adult doves harvested and again the small sample limits the value of the data. Thus, little real data exists on the persistance of anatomical changes in the crop gland of doves beyond the period of dependence of young birds. The data of Laub (1956) indicates that crop gland activity is still present 14 days after hatching. He did not study adults later than this stage. However, dependence of young persists for 11-16 days (i.e. 25-30 days after hatching) beyond this point (Tomlinson, personal communication). Young may survive with the assistance of one parent 14 days after hatching, but data on whether young of this age would survive without both parents are not available. It is possible that removal of parents may diminish survival prospects, even after young leave the nest, especially late in the breeding season.

In an attempt to better understand the regression of crop gland activity under laboratory conditions pigeons were induced to develop crop glands by treatment with pituitary extracts which contain prolactin. Crop activity should not persist without a stimulus such as crop milk production and feeding young. Exogenous prolactin can induce crop wall changes and cessation of prolactin treatment is the equivalent of withdrawal of the stimulus to maintain activity. Study of regression of the crop gland after withdrawal of pituitary injections in this experiment showed that regression is rapid in terms of disappearance of morphological features and in terms of crop weight. The above observation refers to pigeons only but serves to indicate a rapid regression after withdrawal of an activity-provoking stimulus.

SUMMARY AND CONCLUSIONS

A substantial proportion of adult doves collected during the hunting seasons of 1971 and 1972 had evidence of crop-gland activity consequently, the probability of conflict between nesting activity of doves and hunting is real and may well be the cause of substantial loss of immature birds. Because of the significant differences between proportions of doves with active crops on the opening days of the 1971 dove season (September 4) and the 1972 dove season (September 2) further study in other years is recommended to ascertain the normal range of the proportion of doves tending nests in September. The finding of female doves with eggs in the oviduct reinforces the conclusion that there is substantial numbers of birds tending nests in September.

Further observations on the rate of regression of anatomical changes in the crop-gland after cessation of crop-milk production are necessary in order to fully utilize data available from hunter harvested birds. The indications from the present work are that regression of visually observable changes and of weight of crop, is rapid following cessation of prolactin stimulation. Data from nest tending birds (especially those 14 to 30 days after hatching) are necessary to clarify whether the anatomical changes in the crop-gland persist after the young are independent of parents.

The use of parameters other than visual assessment and histological examination would be of benefit in game management. The weight of active crops could be used in segregation of active crops from inactive crops. In this report active crops were significantly heavier ($P<0.001$) than inactive or regressing crops. There was a slight overlap between active and inactive crops in actual values but, those crops of weight greater than 2.0 g could be identified as having crop-gland activity and a choice of crops of weight greater than 3.0 g would provide a conservative estimate, approximately 60 percent, of birds with active crops. Gonad weights would not likely yield valuable diagnostic information because in females the ovaries are relatively inactive during and immediately after hatching of young.

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THE SIGNIFICANCE OF CROP-GLAND ACTIVITY IN MOURNING DOVES DURING THE HUNTING SEASON IN VIRGINIA

by

Dwight Evans Guynn

(ABSTRACT)

Two investigations were conducted: (1) a study of the proportion of mourning doves (*Zenaidura macroura*) shot during the hunting season in Virginia which had evidence of crop-milk production activity, and (2) an investigation of the persistence of crop-gland activity following its induction by exogenous prolactin.

Mourning doves shot during the 1971 and 1972 hunting seasons at Elm Hill Wildlife Management Area, Mecklenburg County, Virginia were examined for crop-gland and gonad activity. Examination dates (numbers of adult doves in parentheses) were as follows: September 4, 1971 (82); September 2, 1972 (279); September 9, 1972 (89); September 16, 1972 (34); September 23, 1972 (14); and December 23, 1972 (11). The proportion of doves with active crops on the respective examination dates were as follows: 12.5 percent, 22.6 percent, 23.6 percent, 29.3 percent and nil, respectively,

on the above dates. Female doves with eggs in the oviduct represented 4.3 percent of those examined on September 4, 1971 and 5.8 percent of those examined on September 2, 1972. The results indicated that a substantial proportion of doves were engaged in nesting activity during the hunting season. Results of investigations of persistence of crop-milk production activity in pigeons (*Columba livia*) following prolactin injection indicate rapid regression of anatomical changes in the crop-gland following cessation of the injections.