A GROSS STUDY OF THE BURSA OF FABRICIUS AND COCK SPURS AS AGE INDICATORS IN THE RING-NECKED PHEASANT

BY J. P. LINDUSKA

Plate 11

THE accurate establishment of age groups of animals is an important phase of many ecological studies. In experimental management programs whose prime consideration is to measure yearly population trends, the ability to distinguish age classes has a special significance. It is often possible from an analysis of a fall population to make some evaluation of the extent of the previous spring and summer breeding and the subsequent survival of young.

In the case of game species, autumn hunting often results in the kill of a large percentage of the total population. Conservation officers' road blockades, managed hunting areas, etc., provide situations which make possible brief examination of significantly large numbers of these animals. Where techniques are available which permit rapid interpretation of various characters and conditions, considerable valuable information is obtainable from these sources.

At the Rose Lake Wildlife Experiment Station, Clinton County, Michigan, the Game Division has in progress a long-term study on the management of farm wildlife. On this area, extensive year-round observations culminate in a carefully measured and studied fall harvest of pheasants (*Phasianus colchicus torquatus*), rabbits (*Sylvilagus floridanus mearnsii*), and fox squirrels (*Sciurus niger rufiventer*) from 1500–2000 acres of farmland. The hunting is conducted under a managed plan which requires that all participants keep individual hunting records and submit all game taken to the station laboratory for examination. This system, in effect for two years, has made possible the examination of reasonably large samples of the several game species. As a result of these examinations and certain incidental studies, data have been obtained which have resulted in simplified methods for rapid age determination of pheasants by external means. These techniques utilize spur conditions in males, and the bursa of Fabricius in either sex.

The value of the bursa as a means of distinguishing adult from juvenile game birds was first recognized by Gower (1939). The technique as reported depended upon dissection for demonstration. It was consequently not suited to the rapid handling of a large series of dead birds and, of course, was not usable on living birds. As mentioned by Gower, these points constituted the principal limitations.

The increased spur length of cock pheasants, while generally recognized as being indicative of old birds, has apparently not been sufficiently investigated to establish its real value as a criterion of age.

The hunting-season data here compiled were obtained through the coöperative efforts of a number of former members of the Rose Lake staff to whom grateful acknowledgement is made. Of these, Charles T. Black, who supervised study of the 1940 hunting-season kill of pheasants, deserves special mention. Others who contributed to the study include Philip S. Baumgras and Warren W. Shapton in the 1940 hunting season, and Howard D. McGinley, Frank R. Martin, and Clare File in the 1941 season.

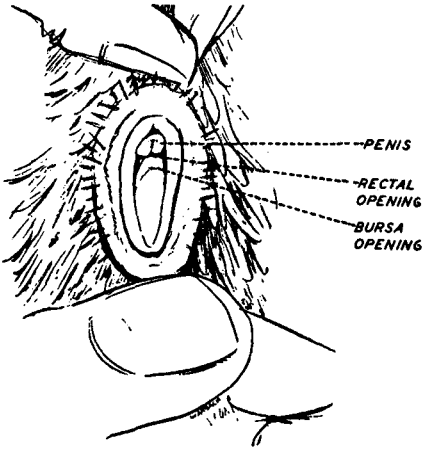
I wish particularly to thank Durward L. Allen, Biologist in charge of the Rose Lake Station, for his help and advice throughout the study. The work on game-farm birds was facilitated through the coöperation and interest of game-farm Superintendent Walter Van Dien and members of his staff. Assistance in making statistical computations was given by Miriam Geboo; the sketch shown in Text-figure 1 is by Oscar Warbach.

BURSA OF FABRICIUS

At its height of development in the pheasant, the bursa is a thick-walled, sac-like structure, approximately 20–30 mm. in length, and lying dorsal to, and at the extreme posterior end of, the large intestine. The full function of the organ is obscure; it has been recognized that the bursa consists largely of lymphoid tissue, and that it operates in a hematopoietic manner. However, various considerations point to it as being primarily of endocrine function. The fact that it exhibits its greatest development at the beginning of division of the sex cells and disappears coincident with sexual maturation (Jolly, 1915) makes it available as an age determiner. The structure, when present, may be easily and rapidly viewed in dead pheasants by making a lateral incision into the coelom at a point about half an inch behind the posterior margin of the cloacal fringe. Drawing the large intestine part way through the opening will then reveal the bursa. The works of Jolly (1915), Boyden (1922), and Gower (1939) give more detailed consideration to the structure.

Determining the age of pheasants without dissection is accomplished by probing the bursa through its opening, which is located on the dorsal median surface of the cloaca (Text-fig. 1). Until some familiarity with the exact position of the opening is obtained, its location in dead birds will be facilitated if the lateral walls of the cloaca are slit and the posterior margin laid back (Plate 11, left

figure). As an instrument for probing, particularly in living birds, an 8-penny nail on which the point has been rounded, has been found entirely satisfactory. Since, as will be shown later, an instance may occasionally arise in which an approximation of the extent of the bursa is desirable, calibrating the nail at 5 mm. intervals is convenient.



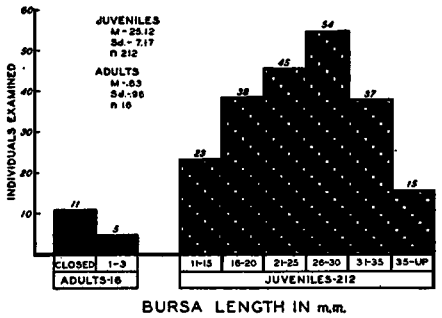
TEXT-FIGURE 1.—Ventral view showing the dorsal wall of the cloaca. The bursa opening lies just posterior to the rectal aperture. Sketch is from a live bird in breeding condition. The penis (anterior) is inconspicuous except during the breeding period. Compare with Plate 11 (left figure).

OBSERVATIONS ON WILD BIRDS

In the period September, 1940, to June, 1942, nearly 2000 individual pheasants were available for examination and study. Of these, 1353 were fall-shot cock birds examined on conservation officers' blockades; 403 were fall cocks shot on the Rose Lake controlled hunting area and examined in the station laboratory; and nearly 200 others were available from live-trapping operations.

As one result of these examinations it was noted that the cloacal opening of the bursa is present in all young of the year. However, this in itself was found not to be a completely reliable indication of juvenility in fall birds since nearly one-third of the adult cocks (over one year old) examined during the hunting season also had a vestige of the bursa persisting with a plainly visible opening. Confirmation of age in these individuals was at the time made by dissecting for the bursa proper. Over two-thirds of the autumn adults had the opening entirely sealed and nearly 90 per cent of the juveniles examined had a bursa measurement of over 16 mm. (Text-fig. 2).

Consequently, in the fall most adults are immediately recognizable by the lack of a bursa opening in the cloaca, whereas all juveniles are characterized by the presence of this same aperture. In the few atypical individuals that have been examined, a workable margin still remained which allowed accurate aging by measurement. In adults in which the bursa opening persisted, the bursa remnant was extremely short, measuring 3 mm. or less, whereas no juveniles were observed in the fall having a bursa shorter than 10 mm., and most had bursa measurements of 16–40 mm.



TEXT-FIGURE 2.—Frequency distribution of 228 bursa measurements obtained from cock pheasants shot in the 1941 hunting season and examined at the Rose Lake Wildlife Experiment Station laboratory. Standard deviations given above and those appearing elsewhere in the text or figures have been calculated from grouped series of measurements and are not adjusted.

STUDIES ON CAPTIVE PHEASANTS

In order to determine definitely the length of time during which the bursa is indicative of age, a series of examinations was made at approximately regular intervals on captive birds. These animals of known age were confined in open-range pens. Similar observations were made on a few wild-banded individuals recaught by live-trapping, and periodic autopsy of a limited number of others was also made to check the gross condition of the bursa and the reproductive system at various times of the year.

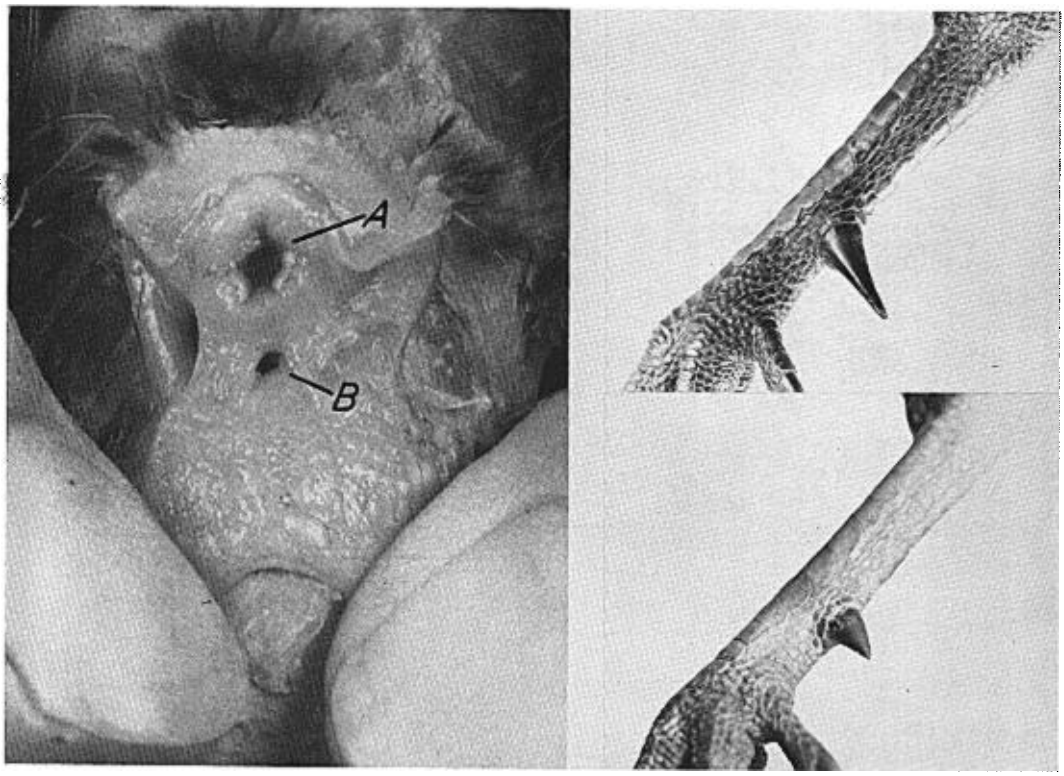
The captive birds used in the study were game-farm stock hatched in the spring of 1941. About sixty individuals of each sex were confined late in December, 1941, and monthly observations were made on most of these until May, 1942. The actual numbers examined and dates of examination are shown in Text-figure 2. The interval between examinations was extended to several weeks in order to preclude any possibility of the bursa remaining open as a result of

too frequent probing. That such did not occur is indicated by the fact that a new series of birds examined in early May showed practically the same condition as regards closure of the bursa as did the study group.

Due to differences in feed, activity, etc., there existed the possibility that the game-farm birds used in the study would not have developmental rates the same as wild birds. This was further suggested by the fact that evidences of sexual maturity were noted among the captives somewhat earlier than among wild birds. It is doubtful, however, that differences in the rate of bursa disappearance between captive and wild birds was appreciable. Sufficiently large numbers of wild-trapped birds were not available through the entire study to observe whether or not differences did exist, but in a series of thirty January hens taken by live-trapping, the average bursa measurement was found to be practically identical with that found for game-farm birds at about the same period.

The bursa proper was easily recognizable by dissection in early December pheasants (both wild and captive), but the structure could be distinguished only with difficulty in the few late January and early February captive specimens which were examined. The remnant of the bursa was at this later date membranous in appearance, and could be distinguished from surrounding mesenteries only by probing through the cloacal opening and following the path of the probe. On the basis of these examinations it appeared that, after early January, judging age solely by dissection for the bursa would require careful interpretation. Although recognition of the bursa proper was difficult in the few birds examined in January and early February, the membranous vestige and its opening into the cloaca continued evident by probing for another two to three months in most specimens. A series of monthly observations on captives for the period January to May, showed that the opening into the cloaca was still present in all birds in February. However, the length was found to be less than 5 mm. in a few cocks by the middle of January and in several hens by a month later.

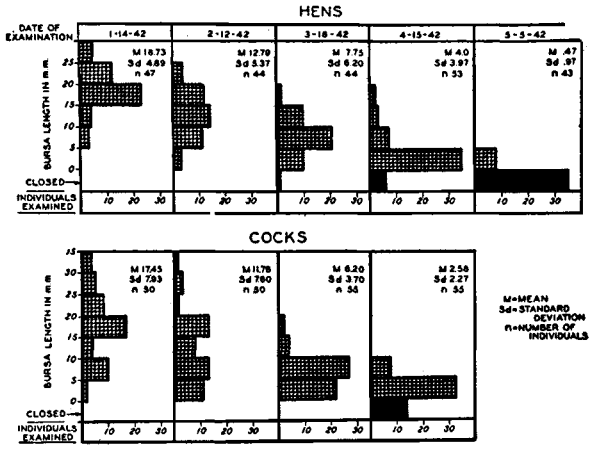
It was found (Text-fig. 2) that remnants of the bursa may persist in males over a year old, at least until the fall of their second year. Sufficient numbers of these old birds were not available for study to determine to what extent the bursa may close during the second winter. That it may remain open in some, however, was shown from the trapping record of cock E 9167. This wild bird, a juvenile of 1940, was first trapped and banded September 25, 1940. No subsequent



(*Left*) VENTRAL VIEW OF THE DORSAL WALL OF THE CLOACA IN A NON-BREEDING COCK PHEASANT. THE LATERAL WALLS HAVE BEEN SLIT AND THE POSTERIOR MARGIN LAID BACK. RECTAL OPENING IS AT A; BURSA OPENING AT B. (*Right, upper*) SPUR OF ADULT COCK (OVER ONE YEAR OLD) IN THE FALL. NOTE LENGTH, SHAPE, DARKNESS OF COLOR, AND HIGH GLOSS. (*Right, lower*) SPUR OF JUVENILE COCK (BIRD OF THE YEAR). THIS PHOTOGRAPH WAS TAKEN IN FEBRUARY AND SOME DARKENING OF THE SPUR IS ALREADY APPARENT.

handlings were made until April 9, 1942, when it was found that a vestige of the bursa still remained. The bird was a year and nine or ten months old at the time.

The persistence of the externally visible opening in old individuals undoubtedly is exceptional, but since a small percentage of juveniles can also be found in late winter in which the bursa has declined to a remnant, there exists a small group which cannot be distinguished on the basis of length of bursa alone. It was found (Text-fig. 3)

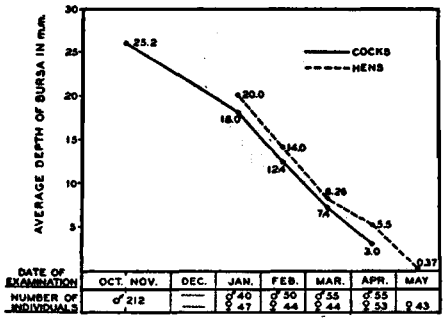


TEXT-FIGURE 3.—Distribution of bursa measurements of captive birds examined at approximately monthly intervals through winter and spring. Complete closure of the bursa was noted in some hens by mid-March and in cocks by mid-April.

that at least a portion of the bursa was still present in all yearling hens during February, and in all yearling cocks until March. Also, to the middle of March, a substantial majority of both sexes still had ducts over 5 mm. in length. From these notes it is indicated that in early spring most adults are characterized by a completely closed duct, and most of the yearlings by the presence of a bursa over 5 mm. in extent. Consequently, it should still be possible to distinguish most yearling birds from adults over a year old as late as March.

The average rate of closure of the bursa through winter and early spring appears as a uniform progression (Text-fig. 4). The banding of all animals at the first examination made it possible to follow the same process in individuals, and while a similar gradual shortening of the bursa was found for most birds, it was not true in all cases. A few exhibited extreme conditions of closing rapidly over a short period of time, while in others the bursa shortened comparatively

little over a two- or three-month period. In hens the bursa consistently averaged slightly longer than in cocks and the closure of this structure and its cloacal opening in females, while uniformly slower, was more complete. A July, 1942, examination of 1941 birds showed the cloacal opening of the bursa to be still present even though extremely shallow (less than 5 mm.) in six of twenty-five cocks, whereas a complete closure and healing over of the opening was noted in all twenty-five hens examined.

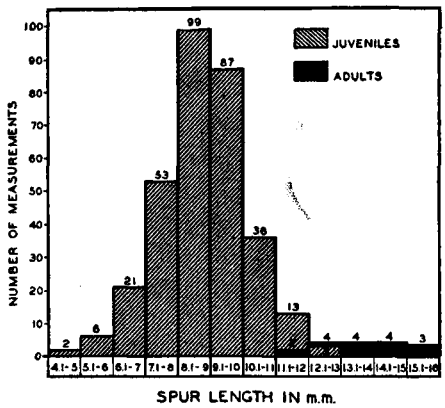


TEXT-FIGURE 4.—Average rate of closure of the bursa in both sexes. October–November, 1941, measurements were taken from fall-shot cocks; the January through May, 1942, measurements were from live captives.

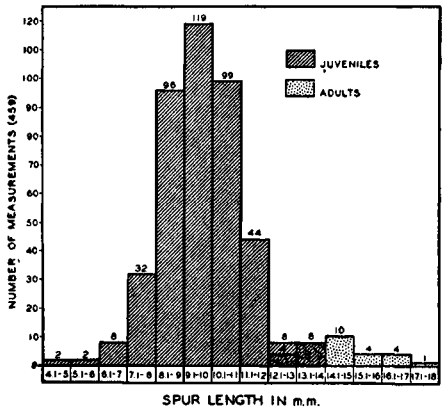
SPUR LENGTH IN COCKS

Although length, texture, and color of cock spurs are occasionally considered in estimating age of domestic fowls, the structure has apparently not been widely used in aging game birds. The following information, based on 796 spur measurements taken in the fall of the year, together with cursory examination of nearly 1400 additional fall-shot birds, indicates that spur length by itself is of value at this season, and when considered in connection with other spur characters, age distinctions are possible for most cocks in the autumn.

The general distribution of juvenile and adult spur lengths in the fall of the year is shown in Text-figures 5 and 6. Although there is some overlap between maximum juvenile lengths and minimum adult lengths, the nodes of the two groups are distinct and indicate that accurate age determination should be possible for many individuals on the basis of spur length alone. In the 1940 kill of cocks at Rose Lake, 88 per cent of the adult spur measurements were greater than 12 mm. and 95 per cent of the juvenile spurs were 11 mm. or less in length. The 1941 kill showed 87 per cent of all adult spurs to be over 13 mm., whereas 94 per cent of all spur measurements for young



TEXT-FIGURE 5.—Frequency distribution of adult and juvenile spur measurements in the fall of 1940. Overlap between maximum spur lengths of juveniles and minimum spur lengths of adults was found to be slight.



TEXT-FIGURE 6.—Frequency distribution of spur measurements taken from adult and juvenile cock birds shot in the fall of 1941.

birds were 12 mm. or under. Statistical analysis of this series of measurements for the two years showed the results to be highly significant. The average and extreme measurements of both age classes for two years are given in Table 1.

It can be shown statistically that on a curve of normal distribution, 99.7 per cent of all cases will fall within limits set by three standard deviations of the mean. Applying this to the groups of data shown in Table 1 (also Text-figs. 5 and 6) it is found that in 1940 the lower limit of adult spur measurements (three standard deviations

TABLE 1

AVERAGE AND EXTREME SPUR LENGTHS OF FALL-SHOT COCK PHEASANTS

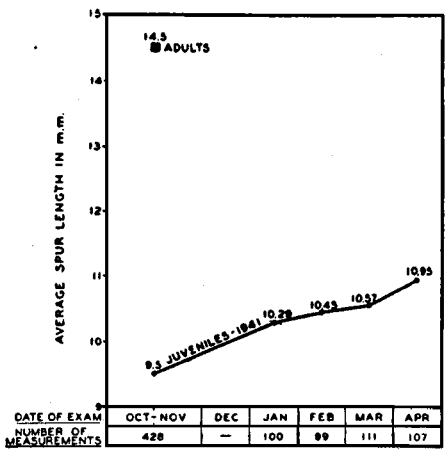
Year	*Age Class*	*Number of Measurements*	*Spur length in mm.*			*s. d.*
			Maximum	*Minimum*	*Mean*	
1940	Adult	17	15.9	11.0	13.6	1.32
	Juv.	320	12.3	4.3	8.9	1.36
1941	Adult	31	17.0	12.0	14.1	1.33
	Juv.	428	13.2	4.5	9.5	1.48

below the mean) is 9.74 mm. On the basis of the above series of measurements, 99.7 per cent of all adult spurs in an infinite sample would theoretically fall above the limits of 9.74 mm. The extreme upper limit of juvenile spur measurements is, on this same basis, found to be 12.88 mm. for an infinite sample. Since practically all adult spurs would be greater than 9.74 mm., it follows that any measurement below that would indicate a juvenile. All (99.7 per cent) of the juveniles in an infinite population should theoretically fall below the extreme length of 12.88 mm., and, conversely, any spur length falling above that point would be an adult. The zone encompassed by the lengths 9.74 mm. to 12.88 mm. would, statistically, nearly completely cover the overlap of age groups in an infinite population. A similar statistical manipulation of measurements, taken the year following, establishes the lower limit of adult spur lengths at 10.51 mm. and the upper limit of juvenile length at 14.14 mm. In this case, practically all individuals with spurs less than 10.51 mm. would be juveniles and all those over 14.14 mm., adults.

It is evident from the foregoing that cock birds in the fall of the year form mutually exclusive age groups on the basis of spur length alone. However, the differences in average length of spur found for the same age classes in the two years makes apparent a source of error that might be encountered in attempting to formulate indices by which age distinctions for all birds could be made in any given year. The rate and extent of spur development quite possibly are affected by geographical, and almost certainly by yearly climatic, differences. An example of the apparent effects of the latter is to be seen in the smaller average and extreme spur lengths recorded in 1940 (Text-figs. 5 and 6, and Table 1). Some factor or combination of factors which caused a slight postponement of nesting or considerable renesting in the summer of 1940 resulted in many unusually young juveniles being present on this area in the fall. Nu-

merous birds were examined in the fall of 1940 that had not completed the post-juvenal molt, whereas in the fall of 1941 nearly all cocks shot were in fully adult plumage. The presence of these younger birds in 1940 appears in this case to be reflected in the record of spur measurements for that year.

In addition to length alone, certain other characteristics of spur color and texture also serve well to help distinguish young and old males in the fall and early winter. The handling of a good series of animals in both age groups will show that aside from differences



TEXT-FIGURE 7.—Growth rate of juvenile spurs through the first winter. October–November measurements taken from fall-shot cocks; December through April figures from captives.

in length, practically all adult spurs are further characterized by being very dark in color, acutely pointed and sharp, often decurved, and with a hard, glossy surface (Plate 11, upper right figure). Juvenile males in the fall and through the winter have spurs that are most often straight along the edges, with points more obtuse, and with the surface (in the fall) much lighter in color and softer than in the adults, and without luster (Plate 11, lower right figure).

Studies on spur development, using a series of captive juvenile birds, indicated the process to be gradual with a possible slight acceleration of growth in early spring coincident with sexual maturation and mating (Text-fig. 7). By the middle of January the spurs of a few individuals had begun to assume the characteristic adult appearance, and by the latter part of April about half of them looked like adult spurs but had not reached the size found for the

average fall adult. As late as early May, over half of the birds studied could still be recognized as juveniles of the year previous on the basis of spur length. Thirty of fifty-four males handled at this time had spurs under 11 mm., or smaller than the shortest adult spur found in the fall of the two previous years.

SUMMARY

Methods for the fall aging of either living or dead pheasants by relatively simple means are described. An evaluation of these techniques which utilize the bursa of Fabricius in either sex, and the length and appearance of spurs in the males, can be summarized as follows:

The bursa of Fabricius was found to persist in all juvenile pheasants (birds of the year) into December. The occurrence of this structure indicates juvenility and its presence can be verified by probing through its opening in the dorsal median wall of the cloaca. The bursa is absent in all birds over one year old and in this study its absence was indicated in most adults by the fact that the former opening into the cloaca was completely grown over. Although the opening and a small vestige of the bursa were noted in a few old birds, these could easily be distinguished on the basis of the comparative lengths of the bursa remnant. In the fall of the year, adults in which the opening remained showed a bursa depth of 3 mm. or less, whereas probing revealed a bursa depth of over 16 mm. in 90 per cent of the juveniles and in none under 10 mm.

Monthly examinations of captive birds indicated that the bursa opening was still present in all juveniles in February. However, the length of the duct had been reduced to less than 5 mm. in a few cocks by January and a few hens by February. Consequently, a small minority of the juveniles had, by these dates, approached a condition similar to that found in fall adults. This condition would nullify attempts to make age determinations for a few birds after January by using this criterion alone.

The length, shape, texture, and color of spurs were observed to be sufficiently different between young and old birds in the fall to permit accurate aging of practically all cocks. Spur length in itself was found to serve as an indicator of age for many fall birds. Some overlap was found between a few minimum adult measurements and maximum juvenile measurements in both years of the study. Similarly, the average spur lengths for given age groups was found variable in different years. Consequently, age determination, using spur length alone, should be done with some circumspection and doubtful specimens checked by reference to other characters. Additional spur con-

ditions which were found to be distinctive for each age group, and which should be considered, are the shape, color, and texture.

It is our experience in Michigan that, as late as January, age recognition is possible for fully three-fourths of the cock birds by noting spur characters alone. The presumed ages of doubtful specimens may be easily verified by reference to the bursa, which can be probed through its opening into the cloaca. Aging of all hens was found possible into January, the juveniles being characterized by a bursa depth greater than 5 mm.

LITERATURE CITED

BOYDEN, EDWARD A.

1922. The development of the cloaca in birds, with special reference to the origin of the bursa of Fabricius, and the function of the urodael sinus, and the regular occurrence of a cloacal fenestra. Am. Jour. Anat., 30: 163–193.

GOWER, W. CARL

1939. The use of the bursa of Fabricius as an indication of age in game birds. Trans. Fourth N. Amer. Wildl. Conf.: 426–430.

JOLLY, T.

1915. La bourse de Fabricius et les organes lymphaepitheliaux. Arch. d'anat. Micr. T., 16: 363–547.

Game Division
Department of Conservation
Lansing, Michigan