ANNUAL WEIGHT CYCLES IN MALE AND FEMALE BOBWHITE QUAIL

JOHN L. ROSEBERRY AND W. D. KLIMSTRA

BODY weights of Bobwhite Quail (*Colinus virginianus*) during the fall and winter months have been recorded throughout most of the species' range but weight patterns during the spring and summer are, in general, poorly documented. Reported here are 1,672 weights of wild Bobwhites from southern Illinois obtained during all months of the year; these are analyzed by sex, age, and season; a growth curve for juvenile birds is also presented.

METHODS

Data were collected intermittently from October 1948 to January 1969 (Table 1). Approximately 80 per cent of the weights were obtained from live-trapped birds; the remainder were recorded from hunter harvests or collections made in conjunction with other studies. Over 86 per cent of the weights represent birds taken within an 8-mile radius of Carbondale; all collections were made within 65 miles of the city. When more than one weight of a retrapped individual was recorded during the same month, the average was used. All birds were weighed intact to the nearest 1.0 g.

Adults were segregated from young-of-the-year by color and appearance of primary coverts (Leopold, 1939; Haugen, 1957). Young birds that had not completed the postjuvenal molt were separated into weekly age classes using criteria of primary feather molt (Petrides and Nestler, 1952). Those that had completed the postjuvenal molt and were collected prior to mid-December were considered to be between 145 and 200 days old. For purposes of monthly comparisons, young birds are hereafter referred to as juveniles from the time of hatching through the first October of life and as subadults from November to the following July (prior to completion of the first postnuptial molt). Birds that had completed at least one breeding season are called adults.

FINDINGS

Growth rate of Bobwhites from 1 to 200 days old.—Figure 1 shows a growth curve based on the weights of 402 juvenile and subadult birds from 1 to approximately 200 days old. Growth was rapid and constant from 1 to about 74 days when a mean weight of 149.6 g was attained (83.4 per cent of maximum subadult weight). From 74 to 144 days weight gains continued, but more slowly with only a slight increase evident after 144 days. Thirty-three birds between 127 and 144 days old averaged 175.2 g while 39 birds between approximately 145 and 200 days old averaged 178.3 g, only 1.1 g less than the mean weight of 258 subadults during January and February. Our data indicated no consistent weight differences by sex among birds under 21 weeks old.

Adults vs. subadults.—Data on 847 birds collected from November through March showed 189 adults with a mean weight of 182.0 g to be sig-

TABLE 1

DATES AND LOCATIONS OF BOBWHITE WEIGHT COLLECTIONS IN SOUTHERN ILLINOIS, 1948–1969

Month	Year													
	1948[1]	1949[1]	1950[1]	1953[2]	1954[2]	1956[3]	1959[4]	1961[5]	1962[5]	1967[5]	1968[5]	1969[5]	Misc.[6]	Total
January		7	58	8	12	45				10	8	23	2	173
February		8	8		1	61				82			2	162
March		28		14	19	64				18	28		5	176
April		35		11	15			10			5		3	79
May				34	6			10	14		30		2	96
June				34	15			12	19	12	22			114
July				27	33			13	15	17	30			135
August				20	61			20	4	2	29			136
September					24			12		24	28		10	98
October	3	53		6	40			11		13	35		6	167
November	17	48					39	3		18	26			151
December	13	44					24			49	55			185
Total	33	223	66	154	226	170	63	91	52	245	296	23	30	1,672

[1] Live-trapped, Crab Orchard National Wildlife Refuge, Williamson County.

[2] Live-trapped, Carbondale Research Area, Jackson-Williamson counties.

[3] Shot, Massac, Union, Jackson, Williamson, Perry, Washington, and Marion counties.

[4] Shot, Williamson and Perry counties.

[5] Live-trapped, Southern Illinois University Farms, Jackson County (except for 96 shot during November–December, 1967 and 1968, Carbondale Research Area, Jackson-Williamson counties).

[6] Miscellaneous collections, mostly in Jackson County.

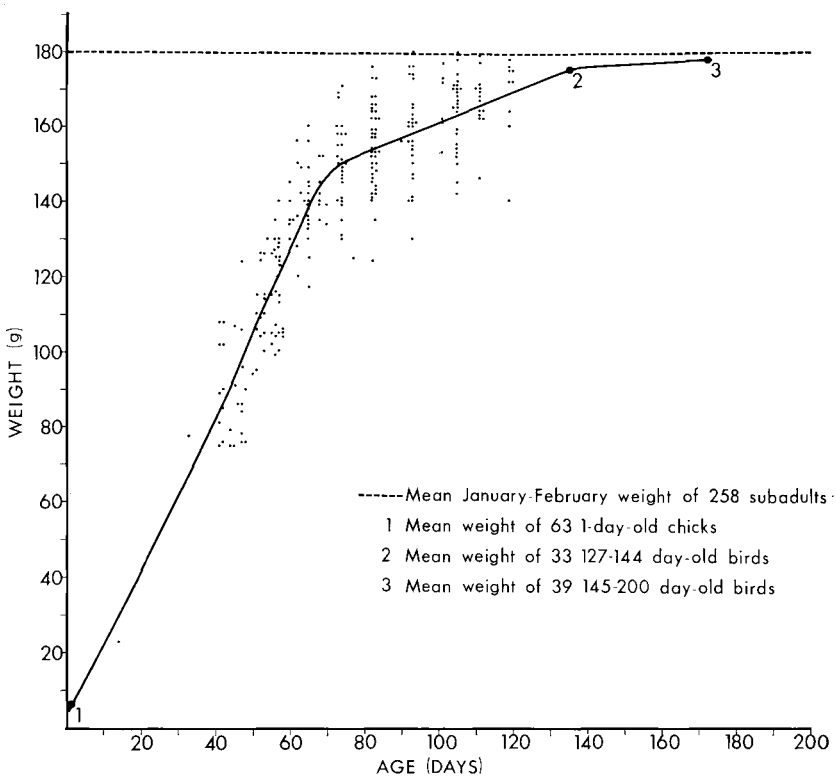

Figure 1. Growth rate of juvenile Bobwhites in southern Illinois.

nificantly heavier than 658 subadults, which average 177.2 g ($P < 0.001$). Mean weight of all birds during this period was 178.2 ± 0.52 g. Adult male weights ($\bar{x} = 181.2$ g, N = 106) were slightly but not significantly heavier than those of subadult males ($\bar{x} = 179.0$ g, N = 346). However 83 adult females averaged 183.0 g compared to 175.1 g for 312 subadult females; the difference is significant at the 0.001 level. Available data suggest that adults continue to outweigh subadults during the spring and summer. From April to August, 57 adult males averaged 164.5 g while 241 subadult males averaged 161.8 g; the difference approaches significance at the 0.05 level. Data are few and statistically insignificant for females during this period, but the mean weight of six adults was 188.5 g compared to 179.6 g for 42 subadults.

Seasonal weight patterns of males and females.—For the period November through March, adult females ($\bar{x} = 183.0$ g) were slightly but insignificantly heavier than adult males ($\bar{x} = 181.2$ g). However, subadult males

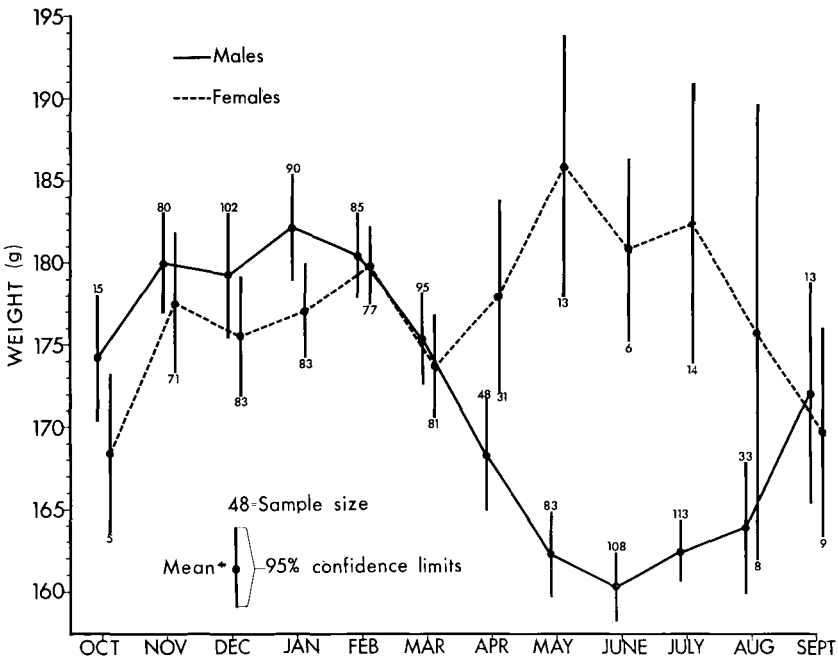

Figure 2. Average monthly weights of male and female Bobwhites in southern Illinois.

($\bar{x} = 179.0$ g) were significantly heavier ($P < 0.001$) than subadult females ($\bar{x} = 175.1$ g). Maximum weights recorded for each age and sex class during the study were as follows: adult male, 224 g; adult female, 221 g; subadult male, 221 g; and subadult female, 220 g.

Figure 2 illustrates monthly weight changes of a sample of 865 males and 481 females. When the weights of adults and subadults are pooled, males outweighed females during every month from September through March. Although monthly differences were significant only during January ($P < 0.025$), the combined data for all 7 months showed a significant difference ($P < 0.001$) between the mean weight of males (179.2 g) and females (176.6 g). During the breeding season (April–August), 72 females were significantly heavier ($P < 0.001$) with a mean weight of 180.4 g compared to only 162.8 g for 385 males.

Weight patterns of both sexes were essentially similar from October through March (Figure 2). The increase in weight from October to November was reflected by adults and did not result from the initial inclusion of subadults into the November sample. The mean weight of all birds was highest in February (180.3 g) but did not differ appreciably from the preceding 3 months. Both sexes experienced weight loss in March.

Beginning in April, weight patterns of the two sexes deviated. Males continued the weight decline begun in March and reached a low of 160.4 g in June. They increased gradually during July and August, then more rapidly from September to November when near maximum winter weights were achieved. Females reversed the weight loss suffered in March and gained rapidly throughout April, reaching a maximum weight of 186.1 g in May. Although sample sizes are not large, available data suggest that females maintained high weight levels until July with a sharp decline evident in August that continued through September. Similar to males, adult females resumed normal winter weights after a rapid gain from October to November.

DISCUSSION

Fall and winter weights.—Weight patterns of Bobwhites in southern Illinois exhibited the general tendency of most avian species to gain weight in late fall and maintain high levels throughout most of the winter, with males averaging somewhat heavier than females and adults heavier than subadults (Baldwin and Kendeigh, 1938). Our data confirm the findings of others (Perkins, 1952; Hamilton, 1957; Ripley, 1958; Robel and Linderman, 1966) that Bobwhites experience weight loss in late winter; this is thought to reflect the relatively low food supplies available then.

Weights recorded in southern Illinois during the nonbreeding season were heavier than similar collections from Georgia, South Carolina, and Florida (Stoddard, 1936) and Louisiana (Perkins, 1952) but lighter than samples from Kansas (Robinson, 1957; Robel and Linderman, 1966), Wisconsin (Buss et al., 1947; Kabat and Thompson, 1963), and Massachusetts (Ripley, 1958). They were essentially similar to those recorded in Indiana (Reeves, 1954) and only slightly lower than weights from Missouri (Hamilton, 1957). As expected, these data conform to the well-known positive relationship between latitude and size (in accordance with Bergmann's Rule) evident for many forms including the Bobwhite (Hamilton, 1957; Ripley, 1960; Robel and Linderman, 1966).

Breeding season weights.—Prior to our study, weight patterns of Bobwhites during the breeding season had not been documented adequately by published data. Robel and Linderman (1966) reported an increase in weights of females over males from March to April but their sample contained no data for the summer months. Stoddard (1936) found a similar trend as the breeding season approached but also lacked data for the summer. Perkins (1952) noted that mean weights of males were lower from May through August than during the nonbreeding season, but his data for females were too few to permit interpretation. Robinson (1957: 49), reporting on 230 September–March and 25 June–August weights, stated:

"Fully-grown bobwhites on the study area (Barber Co., Kansas) attain maximum size in mid-winter, and weigh the least in June and July." He noted that these weights tended to be inversely correlated with length of the photoperiod and concluded that they were related to sexual activity. Robinson failed to distinguish between males and females, but it is reasonable to assume that his use of hen-baited traps in summer resulted largely in the capture of males. Because, as shown by our data, the breeding season weight patterns of males and females are dissimilar, no interpretation of seasonal weight changes can be meaningful without segregation of the data by sex.

Concurrent with the April weight loss recorded for males, female weights increased (Figure 2). Similar gains noted in penned hen pheasants (*Phasianus colchicus*) prior to egg laying were attributable to increased weight of reproductive and digestive organs plus increased fat accumulations (Kirkpatrick, 1944; Breitenbach et al., 1963). Kabat et al. (1956) found that hen pheasants lost little weight during egg laying even though energy drains and the utilization of fat reserves were great. When incubation and molting began, weight declined rapidly since the birds had already depleted fat reserves and were utilizing protein. During this period, pheasants are subjected simultaneously to heat loss through the brood patch, an increased metabolic rate because of molting, and reduced food intake (Breitenbach and Meyer, 1959). Our data show that the summer weight pattern of Bobwhite hens is similar to that noted in hen pheasants, suggesting that the physiological basis for this pattern is also similar. It has been demonstrated that the annual weight curve of hen pheasants reflects their general vigor and condition (Kabat et al., 1956). Wagner (1957) believed that the generally poor condition of pheasant hens late in the breeding season was directly linked with heavy mortality in the wild during this time. Similarly, it seems likely that much of the summer mortality of Bobwhite hens might also be traced to a general decline in vigor associated with the physiological stresses of reproduction and molting. Kabat and Thompson (1963) reached similar conclusions although they lacked substantiative summer weight data. The mean loss of 8.7 per cent from highest to lowest monthly summer weights of female Bobwhites does not appear critical; but these data may not reflect maximum losses as they were obtained only from birds that had survived the breeding season.

Little is known about the physiological stresses incurred by breeding males. The early season weight loss shown by our study (Figure 2) has also been noted in other game birds (Kirkpatrick, 1944; Genelly, 1955). The seasonal occurrence of this weight loss suggests it may in some way reflect the stresses associated with fighting, courtship, and pairing. While the magnitude of loss from maximum to minimum weight levels is propor-

tionately similar for males and females, the decline is more gradual among males and it is doubtful if their vigor is as greatly reduced. This may be further evidenced by the fact that males begin regaining lost weight during the period of maximum summer temperatures (July and August) and continue throughout the postnuptial molt.

ACKNOWLEDGMENTS

We thank the following individuals who, at various times, assisted in the collection of data: Eugene E. Filer, Henry D. Crawley, Walter O. Stieglitz, Earle Stadelbacher, Grady L. Barnes, Ralph W. Dimmick, Jay L. Bergstrand, Thomas A. Jenssen, William H. Nesbitt, and David Urban. This paper is a contribution from Project No. 1: Bobwhite Quail Life History and Population Studies, Cooperative Wildlife Research Laboratory, Southern Illinois University.

SUMMARY

A total of 1,672 weights of wild Bobwhite Quail from southern Illinois were analyzed by sex, age, and season. Juveniles showed rapid and constant growth from 1 to about 74 days; weight gains continued but more slowly until about 21 weeks with only a slight increase evident thereafter. From November through March, 847 birds had a mean weight of 178.2 g; adult females averaged 183.0 g, adult males 181.2, subadult males 179.0, and subadult females 175.1. Mean monthly weights varied little during late fall and early winter but declined from February to March.

During the breeding season (April–August), females averaged 180.4 g and were significantly heavier than males (162.8 g). The summer weight pattern of females was apparently related to breeding activities as highest weights coincided with the egg-laying period and losses with brooding and the postnuptial molt. Males, in contrast, lost weight early in the breeding season but gained throughout late summer and fall. If weight changes are indicative of physical condition, then females would appear more susceptible to stress-related mortality during the summer than males.

LITERATURE CITED

BALDWIN, S. P., AND S. C. KENDEIGH. 1938. Variations in the weight of birds. Auk, 55: 416–467.

BREITENBACH, R. P., AND R. K. MEYER. 1959. Effect of incubation and brooding on fat, visceral weights and body weight of the hen pheasant (*Phasianus colchicus*). Poultry Sci., 38: 1014–1026.

BREITENBACH, R. P., C. L. NAGRA, AND R. K. MEYER. 1963. Effect of limited food intake on cyclic annual changes in Ring-necked Pheasant hens. J. Wildl. Mgmt., 27: 24–36.

BUSS, I. O., H. MATTISON, AND F. M. KOZLIK. 1947. The Bobwhite Quail in Dunn County, Wisconsin. Wisconsin Conserv. Bull., 12: 6–13.

GENELLY, R. E. 1955. Annual cycle in a population of California Quail. Condor, 57: 263–285.

HAMILTON, M. 1957. Weights of wild Bobwhites in central Missouri. Bird-Banding, 28: 222–228.

HAUGEN, A. O. 1957. Distinguishing juvenile from adult Bobwhite Quail. J. Wildl. Mgmt., 21: 29–32.

KABAT, C., AND D. R. THOMPSON. 1963. Wisconsin quail, 1834–1962, population dynamics and habitat management. Wisconsin Conserv. Dept., Tech. Bull. No. 30.

KABAT, C., R. K. MEYER, K. G. FLAKAS, AND R. L. HINE. 1956. Seasonal variation in stress resistance and survival in the hen pheasant. Wisconsin Conserv. Dept., Tech. Wildl. Bull. No. 13.

KIRKPATRICK, C. M. 1944. Body weights and organ measurements in relation to age and season in Ring-necked Pheasants. Anat. Record, 89: 175–194.

LEOPOLD, A. S. 1939. Age determination in quail. J. Wildl. Mgmt., 3: 261–265.

PERKINS, C. J. 1952. Seasonal weight fluctuations of Bobwhite Quail in southwest Louisiana. Unpublished M. S. thesis, Baton Rouge, Louisiana State Univ.

PETRIDES, G. A., AND R. B. NESTLER. 1952. Further notes on age determination in juvenile Bobwhite Quails. J. Wildl. Mgmt., 16:109–110.

REEVES, M. C. 1954. Bobwhite Quail investigation. Final Report. Indiana Dept. Conserv. P.-R., Project W-2-R. 151 pp., (mimeo).

RIPLEY, T. H. 1958. Ecology, population dynamics and management of the Bobwhite Quail, *Colinus virginianus marilandicus* (L.) in Massachusetts. Unpublished Ph.D. thesis, Blacksburg, Virginia Polytechnic Inst.

RIPLEY, T. H. 1960. Weights of Massachusetts quail and comparisons with other geographic samples for taxonomic significance. Auk, 77: 445–447.

ROBEL, R. J., AND S. A. LINDERMAN. 1966. Weight dynamics of unconfined Bobwhite Quail in Kansas. Trans. Kansas Acad. Sci., 69: 132–138.

ROBINSON, T. S. 1957. The ecology of Bobwhites in south-central Kansas. Univ. Kansas Mus. Nat. Hist. and Biol. Surv. of Kansas, Misc. Publ. No. 15.

STODDARD, H. L. 1936. The Bobwhite Quail, its habits, preservation and increase. New York, Chas. Scribner's Sons.

WAGNER, F. H. 1957. Late-summer mortality in the pheasant hen. Trans. North Amer. Wildl. Conf., 22: 301–315.

Cooperative Wildlife Research Laboratory, Southern Illinois University, Carbondale, Illinois 62901. Accepted 23 January 1970.