egg laying season has been reported by some investigators, but this reported rise is questioned by others(7). Estrogens will induce a rise in plasma calcium in male birds and in females during anestrus(3). The rise in plasma calcium of birds(3) during estrus is greater than increases found in vertebrates previously studied(1,2) but is still less than half the average concentration characteristic of these snakes.

As the eggs of viviparous snakes are not covered by a calcareous shell, it remains to be determined whether the estrous rise in calcium and magnesium represents a transport of these minerals to the developing follicles or whether the phenomenon is merely a physiologic response carried over from forms which used such inorganic material in egg shell formation. Follicles of birds develop in sequence and ovulation is at the rate of one egg/day or less. Viviparous snakes, unlike birds, develop large numbers of follicles simultaneously, reaching a maximum of 85(8). These follicles progress at approximately the same rate and are ovulated within a few minutes or at most a few hours of each other. The great metabolic demands of such large numbers of simultaneously developing follicles may be related to the greatly elevated protein, calcium and magnesium levels in the plasma of these snakes during estrus. The sharp decrease in these substances following ovulation probably is correlated with the uniform time of ovulation.

Summary. A marked increase in concentrations of calcium, magnesium and total protein occurs in plasma of female specimens of viviparous snakes during estrus. The magnitude of these estrous changes greatly exceeds any such data reported for other vertebrates. Following ovulation these plasma values rapidly fall to concentrations characteristic of nonestrous animals.

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Relationship of Blood Pressure to Mortality in Chickens.* (22457)

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Mortality losses in poultry flocks during the first laying year range from 20 to 40%. Autopsy reports indicate that 50% or more of these deaths result from non-specific disorders or undetermined causes(1-4). Whether or not any portion of the mortality was attributable to circulatory disturbances has not been ascertained. Sturkie, Weiss, and Ringer (5) previously determined systolic blood pressures on a large population of chickens, ranging in age from 10 to 54 months. At any age the pressures were widely distributed, but no attempt was made to relate the level of pressure to mortality, which is the object of this study.

Procedure. Arterial blood pressures were determined on hens hatched in 1950, 1952, and 1954 and on males in 1954 by an indirect method(6). Three consecutive determinations per bird were made at 7 to 10 months of

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TABLE I. Range of Systolic Blood Pressure for High, Median and Low Pressure Birds.

Pressure	♀ 1950	♀ 1952	♀ 1954	♂ 1954
	(Range in mm Hg)			
High	>141	>151	>176	>191
Median	121–140	130–150	146–175	161–190
Low	90–120	90–129	90–145	120–160
Mean	128.0	141.0	160	180

age and the values averaged. Records of mortality and egg production were kept until the birds were approximately 19 months of age. Thus, the records were based on a period of 9 to 12 months. The birds hatched in 1950 were of one strain of White Leghorns, but those hatched in 1952 comprised 3 strains (2 unrelated strains of White Leghorns, and one crossbred). The mean pressures and distribution of pressures for the 3 strains were not significantly different. The 1954 birds represented the first generation progeny of strains selected for high and low blood pressure. When birds of the 2 strains were pooled, the frequency distribution of pressures was similar to that for the 1950 and 1952 birds. Birds which died during the test period were autopsied by C. B. Hudson and D. C. Tudor of the Animal Pathology Department.

Results. Frequency distribution of blood pressure. The birds were divided into 3 blood pressure groups: high, median and low as shown in Table I. The increase in mean systolic pressure over the years reflects the effects of environment and aging. The 1954 birds were 3 months older than those of previous years when determinations were made, and we have shown(5) that blood pressure may increase significantly in this period of time. The data confirm our previous findings (5) that blood pressure is significantly higher in the male.

Table II shows the numbers and percentages of birds falling into each of the pressure groups. Pooled figures reveal that approximately 30% of the birds have high pressures, 30% low pressures and 40% median pressures.

Relationship of mortality to blood pressure. It is apparent that mortality (Fig. 1) has been consistently higher over the years in the hypotensive birds. Since in most groups the number of birds which died was less than 100, it was considered desirable to convert the percentage figures into angles in accordance with the formula: angle = arc sin $\sqrt{\text{percentage}}$ (Snedecor, 7). An analysis of variance revealed a statistically significant difference between the pressure groups (P = .04). Based upon standard errors, the differences between the hypotensive and other groups were significant, but not between the median and hypertensive birds.

Age at death. The mean ages at death were as follows: high pressure birds, 397 days; median pressure, 437 days; and low pressure, 426 days. An analysis of variance revealed the differences to be not statistically significant.

Cause of deaths. The cause of the higher mortality in the hypotensive birds could not be discerned from autopsies. The distribution of diseases and disorders was similar in the 3 groups.

Blood pressure and egg production. It appeared possible that because the hypotensive birds experienced a higher mortality, their reproductive performance (number of eggs laid) might be impaired. Thus, egg production of the birds dying and of those surviving the test period was compared with blood pressure. The mean numbers of eggs and standard errors for the high, median and low pressure birds were 189.6 ± 4.02, 197.6 ± 3.40, and 188.8 ± 5.04 respectively. The percentages of egg production (from first egg laid to death) were 45.8, 52.7, and 45.0 for the high, median and low pressure birds respectively. None of the differences was statistically significant.

TABLE II. Percentages of Birds Comprising High, Median and Low Pressure Groups.

Year	Total birds	High No.	High %	Median No.	Median %	Low No.	Low %
♀							
1950	50	13	26.0	17	34.0	20	40.0
1952	112	35	31.2	43	38.4	34	30.3
1954	155	43	27.7	68	43.9	44	28.4
Totals	317	91	28.7	128	40.4	98	30.9
♂							
1954	158	37	23.4	74	46.8	47	29.7

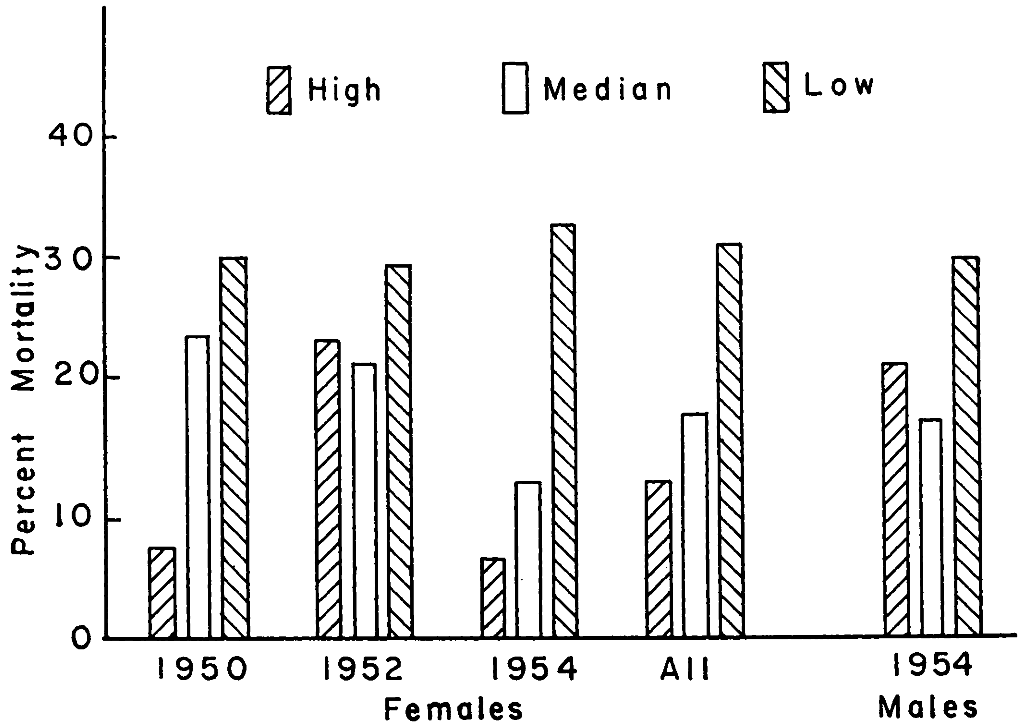

FIG. 1. Mortality to 19 mo of age of high, median and low blood pressure chickens. For numbers of birds involved, see Table II.

Discussion. The data reveal a significantly higher mortality in the hypotensive birds, but the hypertensive birds experienced no higher mortality than those with average or median pressures. Body weights and reproductive performance were not different among the pressure groups. That the cause of the higher mortality of the hypotensive birds could not be discerned from gross autopsies, is not surprising, since routine autopsies by poultry pathologists fail to account for an appreciable number of chicken deaths. More detailed studies involving the hemodynamical sequelae of hypotension and its effects, are required.

Summary. Systolic blood pressures were determined on adult chickens at 7 to 10 months of age in 1950, 1952 and 1954. Records of mortality and egg production were kept until the birds were approximately 19 months of age. The birds were divided into three pressure groups: high, median and low. Pooled figures for the three years show that approximately 30% of the birds had high pressure, 30% low pressure and 40% median pressure. The mortality in the hypotensive birds was nearly twice that of the other pressure groups. There were no significant differences in the body weights or egg production between birds of the groups. Gross autopsies did not reveal the cause of the higher mortality in the hypotensive birds.

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