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Pubic Spread Development and First Egg Lay in Japanese Quail[1]

D. G. Satterlee[2] and R. H. Marin[3]

Applied Animal Biotechnology Laboratories, Department of Animal Sciences, Louisiana Agricultural Experiment Station, Louisiana State University Agricultural Center, Louisiana State University, Baton Rouge, Louisiana 70803

Primary Audience: Researchers, Breeder Managers, Veterinarians.

SUMMARY

Measurement of the space between the pelvic ("pin") bones, also known as pubic spread (PS), is used to determine the state of sexual development of female broiler breeders. Herein, we examined PS at selected intervals before, during, and after puberty in Coturnix, an avian species often used for extrapolation of data to more valuable poultry stocks. The PS was determined using different sets of wooden applicator sticks joined together to represent fixed gauges of increasing widths. These gauges were placed between the pelvic pin bones of individual quail until the best fit was detected. Within a bird (n = 80), PS measurements were made at 15 different ages (beginning at 21 and ending at 84 d of age). A cubic relationship was found to exist between age and PS. The best-fit curve of this relationship showed that little development in PS was evident between 21 to 38 d (prepubescence), rapid and increasing development occurred between 38 to 59 d, and no further development occurred from 59 to 84 d of age (postpubescence). Regressions of PS with age at first egg showed that the optimum age range to make a PS measurement to predict the onset of egg lay was sometime during 49 to 52 d of age. The data demonstrate the usefulness of making pubic measurements in Japanese quail to evaluate sexual development and to predict the initiation of egg lay.

Key words: pubic spread, sexual development, Japanese quail

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DESCRIPTION OF PROBLEM

Many measures have been used in avian species to determine the state of female sexual development or predict the onset of egg lay. These include the determination of: body, abdominal fat pad, skin fat, breast, bursa, ovary, and oviductal weights; percentage body ash; oviductal, keel, and shank lengths; ovarian morphology; comb development, head size and scoring (by comb and wattle appearance) measures; degree of breast fleshing and pubic fat deposition; juvenile feather shed; blood hormonal measurements; sexual and other behaviors; and, pelvic or pin bone spacing, also known as pubic spread (PS) [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13]. These measures vary widely in their practical usefulness, which largely depends upon: the bird species studied; the magnitude of the predictive value of the variable to sexual maturity; whether the measurement is intended for research or industrial

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[2]To whom correspondence should be addressed: dsatterlee@agctr.lsu.edu.
[3]R. H. Marin is a career researcher of Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), Argentina.

use or both; identification of the time frame during which the measurement will adequately predict the bird's state of pubescence; whether the procedure is destructive or not; the relative speed, ease, and expense of the technique; and other factors.

If simple, inexpensive, and nondestructive testing is required, one of the easiest, most reliable, and predictive measures of the temporal degree of sexual maturity in broiler breeder hens, becoming increasingly more used in these stocks, is that of PS [7, 11, 14, 15]. Under normal conditions, the PS of breeder hens (measured in human finger widths; 1 finger = approximately [3/4] in. or 2 cm) ranges from being closed (0 fingers) at 84 to 91 d of age to about 3 fingers at the point of lay [14].

To our knowledge, the usefulness of making PS measures to determine the state of female sexual development and predict the onset of egg lay in Coturnix has not been determined. Japanese quail are not only an important agricultural species in many countries [16], but they are also considered to be a most useful model for the extrapolation of data to other, more commercially important poultry species, such as the domestic fowl [17, 18]. Thus, study of their reproductive activity serves 2 primary end-user groups, quail farmers and researchers. Obviously, in this species, measurements of comb and wattle characteristics would be impossible. Moreover, because of their small body size and precocious nature, measurements, such as blood hormone determinations, selected behaviors, keel and shank lengths, and palpation of breast fleshing, and pubic, would be, at best, more tedious, difficult, or stressful than PS assessments. Furthermore, judging by what is known in the chicken literature (see references cited above), measurement of these nondestructive characteristics of sexual development, other than PS, would likely be met with failure or would suffer from poor reliability if employed in Coturnix. Even simple BW measurements, which could be easily used in quail, are not known to be very reliable indicators of sexual development in chicken stocks. The simple fact is that the pin bones in any avian species must spread with age and sexual development in order to accommodate passage of a shelled egg at oviposition without breakage.

Thus, we wondered whether a method could be developed in quail that provided easy, rapid, and reliable measurement of PS with minimal distress to the bird. Such a measure would be of significant use to researchers who utilize this bird as a model particularly when quail are reared in groups and eggs cannot be assigned to a particular female of a given group. Obviously, the use of human fingers, as used in heavy hens to assess PS, would be contraindicated in Coturnix. Therefore, to mimic the fixed widths of an operator's fingers, at a greatly reduced scale, we constructed sets of wooden applicator sticks joined together to represent fixed gauges of increasing widths to measure PS in quail.

Herein, stick gauges were placed between the pubic pin bones of individual, developing female quail of various ages (from 21 to 84 d of age, spanning pre- and postphotostimulation) until the best fit was detected. The best-fit detection occurred when the applicator sticks could be seen pressing up against the insides of the pubic bones. When a best fit was achieved, within each of 80 birds at each of 15 time intervals, it was considered indicative of the PS of that quail at that time. The PS measures were regressed with age of measurement to assess the nature of sexual development. The PS measured at a given age was also regressed with age at first egg lay to determine the age when measurement of PS best predicts the initiation of oviposition.

MATERIALS AND METHODS

Birds and Husbandry

Female Japanese quail (*Coturnix japonica*) from a random bred population were studied. Egg incubation, chick brooding, feeding, and lighting procedures were similar to those described elsewhere [19] with the exception that chicks were brooded from d 1 in mixed-sex, mixed-line groups of approximately 100 within each of 2 compartments of 2 Model 2SD-12 Petersime brooder batteries [20] modified for quail. In order to maintain the identity of each bird, leg bands (placed on chicks at hatching) were replaced with permanent wing bands at 21 d of age.

At 28 d of age, quail were sexed by differences in plumage coloration, and 80 females were randomly selected and individually placed into Alternative Cage Design [21] quail layer cages. At this time, birds were switched to a breeder ration (21% CP; 2,750 kcal ME/kg), and feed and water were continued ad libitum. Upon housing in laying cages, birds were also subjected to a daily photostimulatory cycle of 14L:10D. Light intensity was approximately 280 lx during the lighted portion of the day with lights-on occurring at 0600 h daily. Daily maintenance and feeding chores were done at the same time each day (0800 h).

Variables Measured

Sets of wooden applicator sticks [22] were joined together to serve as fixed gauges of increasing widths. The gauges used an appropriate number of applicator sticks that, when glued together, represented increasing 1 stick (≅2.2 mm) incremental thickness from 4 (≅8.8 mm) to 13 (≅28.6 mm) sticks. These gauges were then placed between the pelvic pin bones of a given quail at a given test interval (see below) until the best fit was detected and recorded. The thickness of the best-fit stick gauge was considered to be that quail's PS.

The PS was measured at 15 selected intervals before, during the onset, and after puberty in each of the 80 females randomly selected for study. The PS was initially measured at 21 d of age and thereafter at 28, 31, 35, 38, 42, 45, 49, 52, 56, 59, 63, 70, 77, and 84 d of age. The age at which each hen laid her first egg (FIRST) was also recorded.

Statistical Procedures

Before conducting statistical analyses, the combined numbers of sticks in each stick gauge set were converted into an appropriate cumulative linear measure according to the formula: 1 stick = 2.2 mm. A best-fit curvilinear regression between age and PS was then determined. The PS measures at a given age were also regressed with FIRST to determine the age when measurement of PS best predicts the initiation of oviposition.

RESULTS AND DISCUSSION

Herein, we used wooden applicator stick gauges of increasing fixed widths to measure PS in Coturnix. This method provided an easy, rapid, inexpensive, nondestructive, and reliable measurement of sexual development that could be routinely applied with minimal distress to the bird.

The best-fit relationship between age and PS was found to be cubic ($PS = 22.4 - 0.99 \times d + 0.03 \times d^2 - 0.0002 \times d^3$; $r = 0.98, P < 0.0001$) (Figure 1). The sigmoid best-fit curve of this relationship showed 3 distinct periods of female sexual development: a prepubescence period (before 38 d of age; during which PS was minimal and stagnant); followed by a period of rapid sexual development (between 38 and 59 d of age during which PS increased linearly in anticipation of egg lay); followed by a postpubescent period (after 59 d of age during which PS became maximal and exhibited no further increases). The PS was also shown to accurately predict the onset of oviposition (see below). Therefore, the method should be of significant value to commercial producers that may be interested in monitoring the state of sexual development in their breeder flocks and researchers who utilize Japanese quail as a research model.

Regressions of PS with FIRST showed no significant correlations at 21, 28, 31 and 35 d of age (Table 1). Thereafter, there were significant correlations (ranging from $P < 0.01$ to $P < 0.00001$) at all ages that PS was measured. However, the r-values associated with each of these age-dependent relationships ranged from a low confidence of 0.29 and 0.42 at 38 and 42 d of age, respectively, to a much higher confidence of 0.59 to 0.71 between the ages of 45 to 70 d and back to a low confidence of 0.28 and 0.21 at 77 and 84 d of age, respectively. The earliest age range to make a meaningful PS measurement to predict the onset of egg lay with the greatest degree of confidence was sometime during 49 to 52 d of age [FIRST (d) = 89.64 − 1.63 × (PS at 49 d of age, mm), $r = 0.69$, $P < 0.00001$ and FIRST (d) = 97.98 − 1.93 × (PS at 52 d of age, mm), $r = 0.71$, $P < 0.00001$ (Table 1).] On d 50 and 51, approximately 20 and 30%, respectively, of the birds had initiated lay, and many of the residual hens initiated lay shortly thereafter. Thus, it may be argued that the measurement of PS sometime between 50 and 51 d of age (midway between

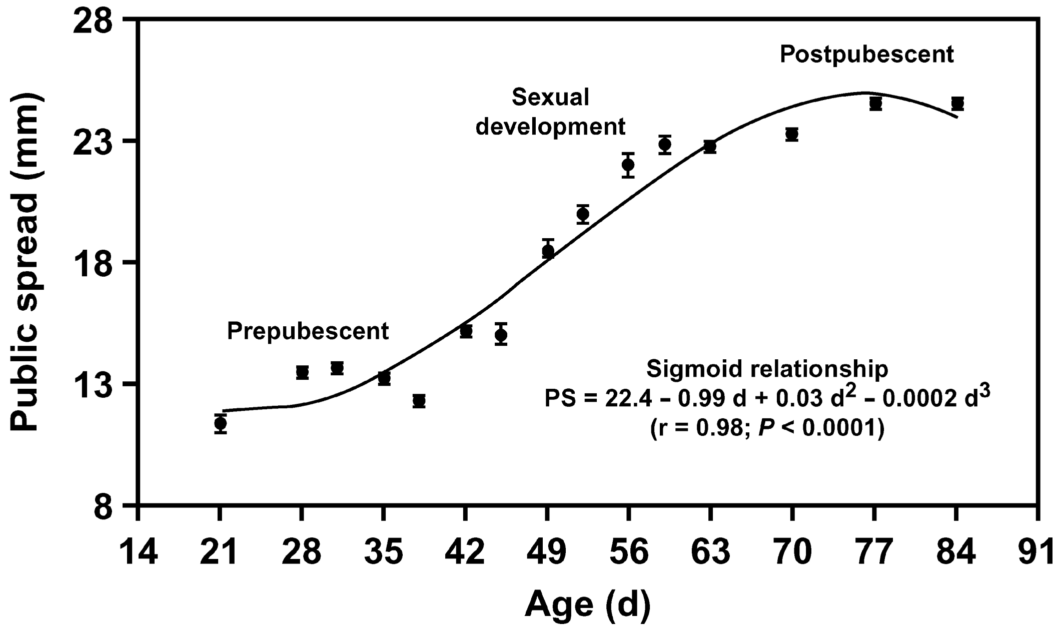

FIGURE 1. Pubic spread in Japanese quail from 21 to 84 d of age. Points plotted are means ± SE (vertical bars).

the 2 measured ages of 49 and 52 d) to predict FIRST may be foregone in lieu of simply waiting another 2 to 3 wk to determine the onset of egg lay by simple observation of each hen's first oviposition. However, by using the appropriate prediction equation in Table 1, simple substitution of the PS of any hen whose PS greatly lags behind the flock average allows one to immediately calculate how many days remain before that hen will likely achieve FIRST. This information could then be used to decide whether the affected bird should remain in the flock and be further observed to ensure egg lay is eventually initiated or removed.

TABLE 1. Regressions of pubic spread (PS) with age at first egg lay at selected intervals from 21 to 84 d of age in Japanese quail

Age (d)		r	*P*-value
21		0.19	0.09
28		0.16	0.16
31		0.07	0.37
35		0.19	0.09
38		0.29	0.00001
42		0.44	0.00001
45		0.59	0.00001
49	$\hat{Y} = 89.64 - 1.63^{A}$ (PS)	0.69	0.00001
52	$\hat{Y} = 97.98 - 1.93$ (PS)	0.71	0.00001
56		0.62	0.00001
59		0.61	0.00001
63		0.68	0.00001
70		0.65	0.00001
77		0.28	0.002
84		0.21	0.01

[A] $\hat{Y}$ = Predicted onset of egg lay (day).

The PS measurement could be useful in other ways as well. For example, like other poultry stocks, quail are more often than not reared in groups (flocks) in either colony cages or pens as opposed to housing them individually under these conditions. In such instances, the measurement of PS would be valuable when there is need to determine loafers (females not in lay) particularly at late stages of production for either research purposes or commercial culling. Reproductively inactive quail and chicken females are difficult to accurately identify from active egg layers based on their phenotypic appearance. Furthermore, it is well known that, in both egg-type and heavy chicken hens, as well as in quail [23], a small percentage of females never initiate egg lay, and others lay for a while and stop sometime during their reproductive cycle without ever starting to lay again. Such individuals would be expected to have greatly reduced PS. While

PS was not measured in the present study beyond 84 d of age, measurement of PS in aged quail hens (34 wk of age) in another study showed that 3 hens out of 96, who had ceased egg lay but had a previous history of lay, had PS resembling that typically found in undeveloped, prepubescent females: <18 mm [23].

In prepubescent broiler breeder hens, Fattori et al. [7] correlated PS with ovary and oviduct weights (indirect indicators of egg production) and found significant correlations of 0.66 and 0.71, respectively. Unfortunately, these workers did not make correlations between PS and direct measures of puberty, such as FIRST and age at 25 or 50% egg production. Nevertheless, since ovarian and oviductal weights are indicative of sexual development and egg lay, their data support the notion that PS is an excellent indicator of sexual development in heavy hens. Comparative studies evaluating the relationship between PS with direct measurements of egg production, such as FIRST, the average ages at 25 and 50% egg production, and total hen-day egg production during selected periods of lay in heavy hens, Leghorns, and Japanese quail, are currently underway in our laboratory.

CONCLUSIONS AND APPLICATIONS

1. Determination of PS in female Coturnix provided an easy, rapid, inexpensive, nondestructive, and reliable measurement of sexual development that could be routinely applied with minimal distress to the bird.
2. A cubic relationship was found to exist between age and PS; the best-fit curve of this relationship showed that little development in PS was evident between 21 to 38 d (prepubescence), rapid and increasing development occurred between 38 to 59 d, and no further development occurred thereafter (from 59 to 84 d of age; postpubescence).
3. The optimum age range to make a PS measurement to predict the onset of egg lay in Japanese quail was sometime during 49 to 52 d of age.

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