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A GUIDE TO AGE DETERMINATION OF BOBWHITE QUAIL EMBRYOS

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IDENTIFICATION of the various incubation stages of eggs is often necessary in avian nesting studies. This paper provides a descriptive and illustrative guide to age determination of bobwhite quail (*Colinus virginianus*) embryos. It supplements the work of Hanson (1954), who determined embryonic development by candling eggs, and of Essex (1952), whose descriptions and drawings of bobwhite embryos appeared in an unpublished thesis.

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Fig. 1 and 2 represent the chronological sequence of development of the bobwhite embryo. The brief descriptions of each daily stage are based on prominent external characteristics visible to the unaided eye.

Eggs were obtained from the Mount Vernon Game Farm, operated by the Illinois Department of Conservation, and incubated in a *Farm Master* incubator under standard incubating conditions (temperature 99.5° F., humidity 55%-60%). At least four eggs were examined at approximately the same hour each day of the incubation period. The embryo most representative of the mean degree of development each day was photographed and described. The embryo photographs were taken by Robert Hanzlik, a senior at Southern Illinois University. The nest photograph was taken by the senior author.

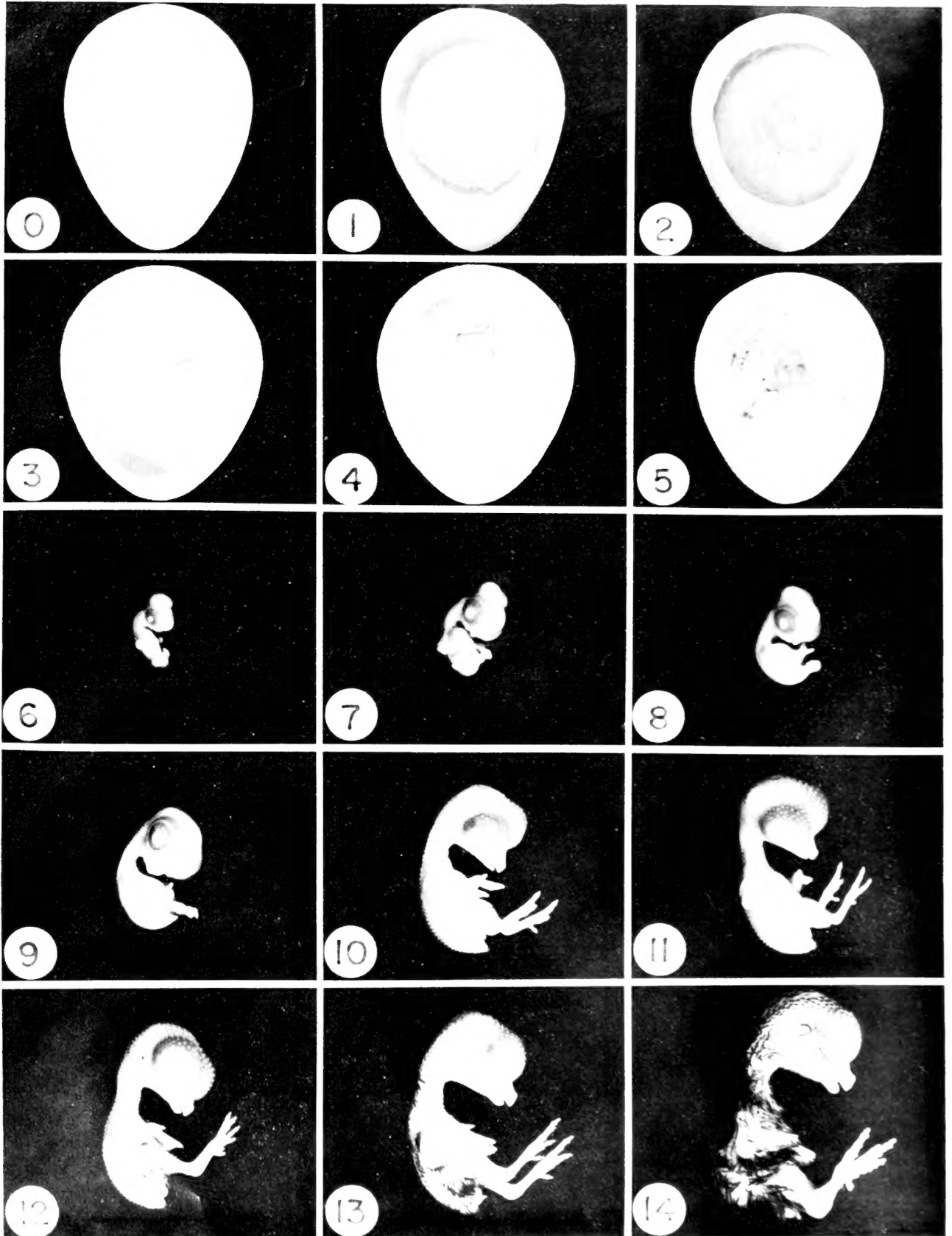


FIG. 1.—Stages of development of bobwhite embryos 0 through 14 days old.

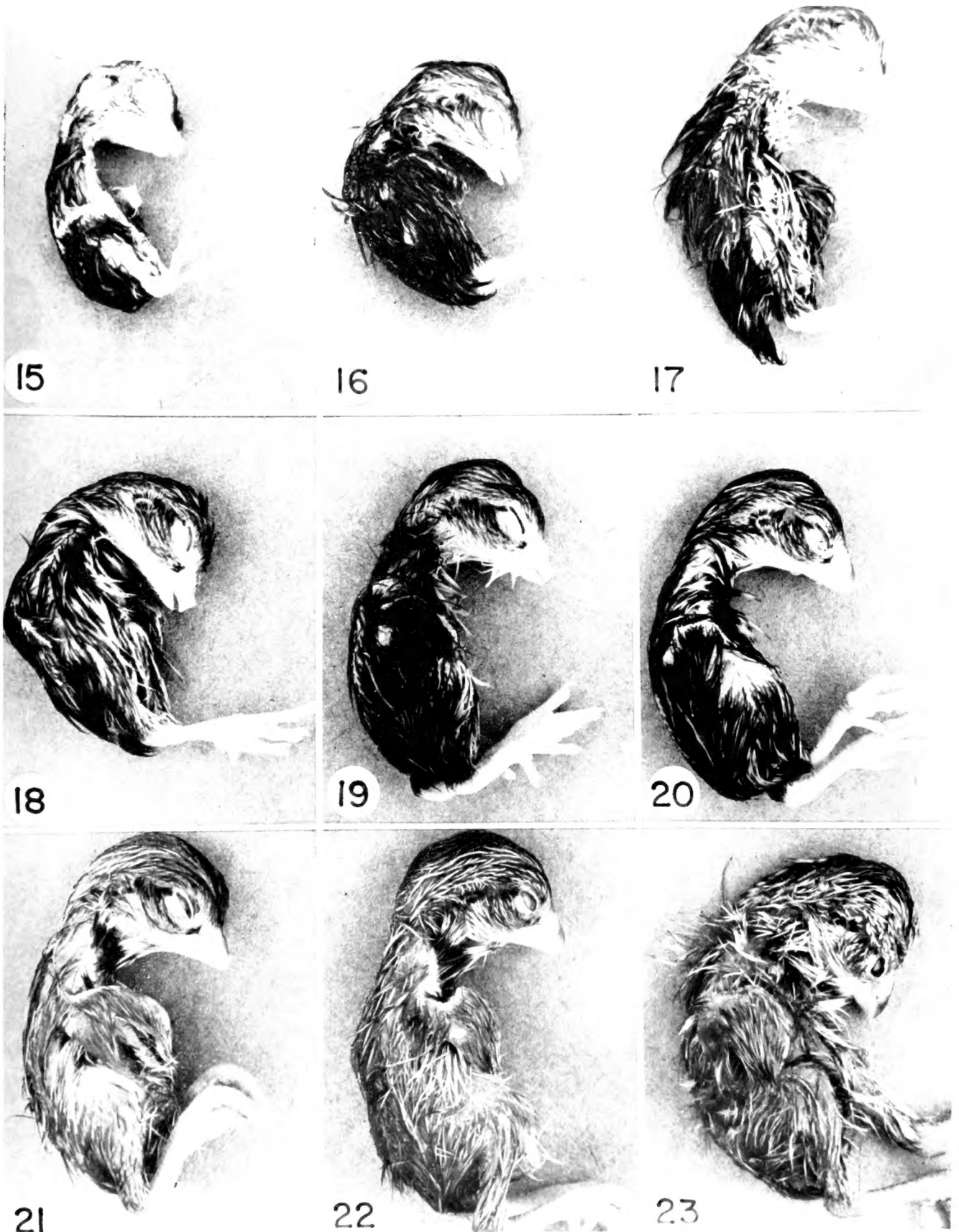


FIG. 2.—Stages of development of bobwhite embryos 15 through 23 days old.

Descriptions of Embryonic Development

- 0 Day (unincubated): Slightly cloudy area present on surface of yolk; blastoderm appearing as white opaque spot 2 mm in diameter in center of this cloudy area.
- 1 Day: Blastoderm resembling a bull's-eye about 10 mm in diameter with a small dark central spot surrounded alternately by lighter, darker, and lighter circular areas. Embryo proper and blood vessels not yet visible.
- 2 Days: Tiny blood vessels forming an irregular oval 8-10 mm in diameter, with unflexed embryo lying in clear area in the center; heartbeat not yet visible.
- 3 Days: Embryo, 5-6 mm long, lying transversely to longitudinal axis of egg; slightly arched and rotated to the right anteriorly. Heartbeat visible.
- 4 Days: C-shaped embryo lying on its left side; eye visible as dark pigmented spot 1 mm in diameter. Anterior limb buds discernible as small bumps. Choroid fissure and heartbeat evident.
- 5 Days: Embryo C-shaped and with prominent eye. Choroid fissure, cerebral hemispheres, and midbrain obvious; auditory openings barely visible. Limb buds appearing as flaplike structures 1 mm long. Allantois appearing as transparent structure, 3-4 mm in diameter, below lower limb bud.
- 6 Days: Eye about 2 mm in diameter; choroid fissure and auditory openings clearly visible. Cerebral hemispheres and midbrain conspicuous. Anterior limbs slightly flexed at elbow joint, posterior limbs covered by allantois, which appears as a spherical sac 5-6 mm in diameter.
- 7 Days: Embryo still C-shaped, with head nearly as large as body. Cerebral hemispheres and bilobed midbrain still conspicuous. Eyelids and upper mandible beginning to form. Forelimbs terminating in a broadened paddle. Long bones of anterior and posterior limbs visible as opaque white bars. Allantois covering entire embryo; heartbeat evident.
- 8 Days: Body and head nearly equal in size. Choroid fissure barely visible; iris visible and eyelids well formed. Knee and elbow joints flexed. Cerebral hemispheres less pronounced, but midbrain still prominent; upper mandible projecting from face. Heartbeat still visible.
- 9 Days: Center of each eye encircled by ring of white dots, nictitating membrane present. Cerebral hemispheres and midbrain much reduced; lower mandible well defined. First digit of each foot visible and wing alulae appearing as thumblike projections. Feather germs visible as band of white dots along center of back. Heartbeat barely discernible.
- 10 Days: Eyelids beginning to close over eyes. Alulae separated from manus and patagia formed. Digitation of feet well advanced. Dark feather papillae on back; feather tracts of head appearing as light dots. Mandibles assuming normal beak shape; egg tooth visible. Heartbeat no longer evident.
- 11 Days: Head more rounded but still large in proportion to body; choroid fissure no longer visible. Digitation of feet now complete; toes showing deposition of keratin at tips. Dark down feathers appearing on back, thigh, and tail. Cloacal opening visible.
- 12 Days: Feathers on back, thigh, tail, and scapular region darkly pigmented; those on back and thigh showing color differentiation. Feather germs on eyelids white. Keratinization of claws continuing; plantar pads beginning to form on feet.
- 13 Days: Dark feathers prominent on back, thigh, tail, and posterior edge of each wing. Feather germs encircling auditory openings dark. Scales beginning to form on legs and feet. Nostrils evident and eyelids closing to narrow slits.
- 14 Days: Feathering greatly advanced over that of previous stage; dark feathers around auditory opening appearing in the form of a semicircle. Inside edges of eyelids darkly pigmented. Dark band of feathers extending between auditory opening and eye.
- 15 Days: Eyelids virtually closed. Dark feathering around auditory opening a complete circle; feathers on breast long but colorless. Uropygeal gland showing feathered tab above opening. Serrated edge (labial grooves) apparent on lower mandible.
- 16 Days: Feathering on head greatly advanced over that of previous stage; breast feathers showing dark spots at base. Feathers brown on upper eyelids, white on lower. Cornified epidermis formed at tips of wing alulae.
- 17 Days: Embryo almost entirely covered by down feathers; uropygeal gland well hidden. Yolk intensely yellow in color. Eyelash structures apparent. Toenails well developed.
- 18 Days: Size of eyes appearing normal in relation to head. Yolk, wrapped around feet and legs of embryo, with a dark greenish tint. Yolk stalk and auditory openings plainly visible.
- 19 Days: Scaling of legs nearly complete. Auditory openings well hidden by feathers. Yolk being drawn into body; stalk no longer visible. Position of embryo as follows: lying on left side, with eye, ear, and bill visible; right leg bent so that foot is touching top of head; right wing in normal position at side. Epidermal tip on wing alula partly hidden by feathers.
- 20 Days: Embryo in following position: head rotated to right, and right wing shifted over head. Elbow joint still bare of feathers; periderm still covering egg tooth.
- 21 Days: Peridermal covering lost from beak. Back arched into pipping position, head covered by right wing; air cell punctured by bill, which is projecting from under right wing; pipping tooth nearly touching shell. Yolk concentrated around feet; embryo breathing when removed from egg.
- 22 Days: Upper mandible brownish. Yolk sac reduced to sphere 1 mm in diameter. Embryo able to open eyes when shell is removed; pipping commencing.
- 23 Days: Pipping completed; embryo emerging as hatched quail chick.

LITERATURE CITED

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