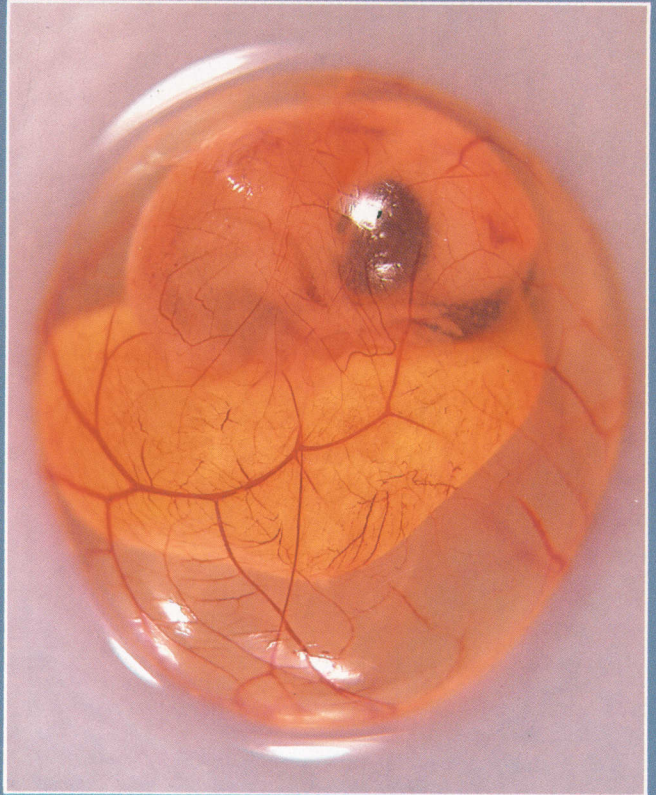




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Guide for Age Determination of Mourning Dove Embryos



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GUIDE FOR AGE DETERMINATION OF MOURNING DOVE EMBRYOS

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INTRODUCTION

IDENTIFICATION OF EMBRYONIC development stages can be useful in avian reproduction studies to estimate laying dates, predict hatching dates, or determine age at death. Embryo guides exist for the pheasant (*Phasianus colchicus*) (4), bobwhite quail (*Colinus virginianus*) (5,7), wild turkey (*Meleagris gallopavo*) (8), wood duck (*Aix sponsa*) (1,5), mallard (*Anas platyrhynchos*) (2,5), and giant Canada goose (*Branta canadensis maxima*) (3).

Descriptions useful for candling mourning dove (*Zenaida macroura*) eggs to determine embryonic development have been reported previously (6). Although candling has the advantage of not harming the embryo, accurate aging is difficult. This guide is intended to supplement previous candling descriptions and provide for more precise age determinations. Stages of mourning dove embryonic development from 1 to 14 days postlaying (PL) are described together with photographs, distinguishing characteristics, and measurements.

¹Graduate Assistants and Associate Professor, respectively, Department of Zoology-Entomology.

²This study was conducted under State Research Project #13-0048.

³Gratitude is extended to M.E. Lisano and W.D. Ivey for the use of laboratory facilities. W.M. Buerger aided in collecting samples.

MATERIALS AND METHODS

Eggs collected daily from a captive mourning dove breeding colony were incubated (Humidaire Incubator, Model 25, The Humidaire Incubator Co., New Madison, Ohio) at an average temperature of $99.5 \pm 0.5^\circ\text{F}$ and hygrometer reading of 85°F (approximately 55.5 percent relative humidity). Eggs containing known-aged, developing embryos were removed from the incubator between 5:00 and 6:00 p.m. daily. They were placed in a refrigerator to sacrifice and preserve the embryos until they were observed, measured, and photographed the following day. To facilitate observation, all photographs (except 1 to 3 days PL) were taken with the extra-embryonic membranes detached. Forty-one eggs were collected during the study.

Distinguishing characteristics were noted with the unaided eye except where magnification is specified in the following descriptions of embryonic development. Measurements in the table were made from 5 to 14 days PL to augment other aging criteria and included: (1) body length (from top of the head (crown) to the tail with bill perpendicular to the long plane of the body); (2) eyeball diameter (average of two measurements taken at right angles to each other); (3) maxilla length; and (4) tarsometatarsus length (proximal end of the tarsus to the end of the middle toe including the claw). At different stages of development, the embryo is persistently flexed and body length measurements may vary depending on how much the investigator stretches the specimen. The photographs in this guide (pages 6 and 7) were taken with the embryo fully extended and because of over-extension may occasionally depict measurements outside ranges given in the table. Thus, while the measurements may be beneficial, the descriptions of development are more reliable indicators of age.

DESCRIPTIONS OF EMBRYONIC DEVELOPMENT

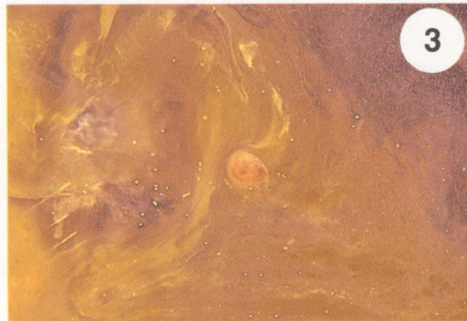
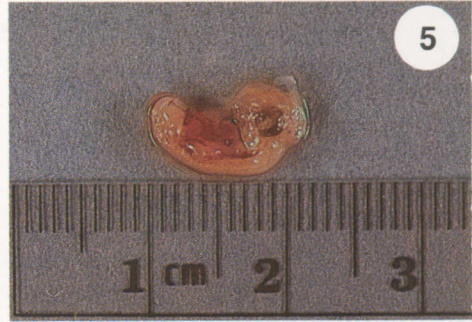
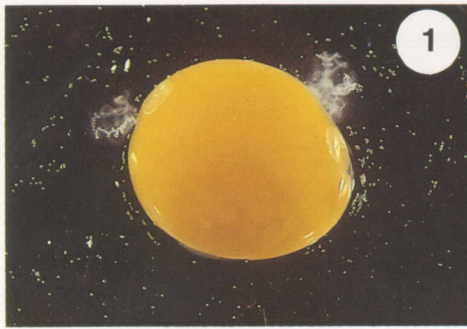
Day One

Egg can be opened with the yolk remaining intact. Chalaza extend from the yolk into the albumen at both poles. A protoplasmic disc having slight cell differentiation is present on the surface of the yolk.

MOURNING DOVE EMBRYO MEASUREMENTS FROM 5 TO 14 DAYS PL

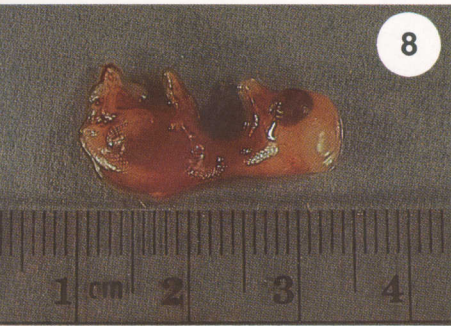
Time PL	Length			
	Body	Eyeball diameter	Maxilla	Tarso- meta- tarsus
	<i>mm</i>	<i>mm</i>	<i>mm</i>	<i>mm</i>
Day 5				
X	16.2	2.4		
SE .....	.7	.2	-- ¹	--
Range	15.0-17.4	2.0-2.7		
n	3	4		
Day 6				
X	20.6	4.1		
SE .....	.3	.2	--	--
Range	19.8-21.5	3.8-4.5		
n	4	4		
Day 7				
X	23.6	5.0	2.3	
SE .....	.8	.2	.1	--
Range	22.0-24.9	4.5-5.4	2.1-2.6	
n	3	4	3	
Day 8				
X	26.3	5.8	3.4	6.4
SE	1.1	.2	.1	.4
Range	24.0-29.2	5.4-6.4	3.3-3.5	5.5-7.0
n	4	4	3	3
Day 9				
X	29.7	6.3	4.4	7.9
SE .....	.7	.1	.2	.5
Range	27.7-31.0	6.1-6.5	4.1-4.8	6.5-8.9
n	4	4	4	4
Day 10				
X	34.2	6.9	4.9	9.3
SE .....	.3	.0	.2	.4
Range	33.2-35.0	6.8-7.0	4.1-5.5	8.3-10.6
n	5	5	5	5
Day 11				
X	40.6	7.5	5.9	11.9
SE	1.0	.0	.2	.0
Range	38.4-42.7	7.4-7.5	5.5-6.5	11.9-12.0
n	4	4	4	4
Day 12				
X	42.1	7.8	6.0	12.5
SE .....	.6	.1	.2	.2
Range	40.5-43.4	7.6-8.0	5.8-6.5	12.0-13.0
n	4	4	4	4
Day 13				
X	44.1	8.2	6.7	13.0
SE .....	.5	.1	.5	.6
Range	42.1-45.0	8.0-8.4	4.9-7.5	11.5-14.4
n	5	5	5	5
Day 14				
X	44.6	8.4	7.1	14.6
SE	2.8	.1	.1	1.2
Range	41.5-50.3	8.3-8.7	7.0-7.3	13.2-17.0
n	3	3	3	3

¹No values collected because of insufficient embryonic development.



Stages of mourning dove embryo development from 1 to 7 days postlaying.





Stages of mourning dove embryo development from 8 to 14 days postlaying.

Day Two

Embryo is white to translucent and difficult to distinguish with the unaided eye, but can be located by the slight vascularization in the egg yolk. Yolk breaks more readily upon opening the egg than at day 1. Amnion (fluid-filled sac around the embryo) is obvious and persistent. Cephalic flexion can be seen after careful dissection of the persistent extra-embryonic membranes. Brain region bends to the side of the primitive, vertical spinal cord.

Day Three

Yolk sac is extremely fragile. Embryo takes on a C-shape with cephalic and cervical flexion. Caudal flexion also is seen and the tail appears curled. The spinal cord has noticeable somites and can be seen from the hindbrain to the tail. Differentiation is occurring in the visceral region. Three bulges of the brain are evident and the mid-brain is prominent. The optic cup is beginning to become pigmented (dark gray). Wing and leg buds can be distinguished (10X power) as small flaps protruding from the body.

Day Four

Yolk sac is clearly vascularized. The allantois can be seen at the ventral-caudal end of the body. Embryo is strongly flexed so the pointed tail almost touches the head. Flexion is persistent and difficult to straighten.

Embryo is beginning to color, with the dorsal line and tail region taking on a cream tint; eye is pigmented; abdominal region appears red; and the edges of the embryo are still basically translucent. The spinal cord extends from the neck to tail with somites present predominantly at the caudal end. The lens inside the optic cup is easily seen. The midbrain is conspicuous. Wing and leg buds appear as small protuberances.

Day Five

Vascularization can be seen around the yolk as well as the allantois. Embryo has marked cephalic, cervical, and caudal flexion, but is not as compact as day 4. The embryo is predominantly cream-colored with a distinct midbrain bulge that appears translucent. The abdominal region is red and easily seen through the clear skin. The spinal cord can be seen to extend from the hindbrain to the tail and

slight somites appear in the neck and tail area. Tail is pointed but curls along the body. Early differentiation of the maxilla and mandible is occurring. The maxilla protrudes slightly (10X power) and wing and leg buds are evident with vascularization to these extremities visible.

Day Six

The embryo is C-shaped and the head is bent slightly to the side. Tail is pointed and projects beyond the body. Legs extend slightly beyond the tail. The ends of the legs are paddle-shaped and lobes can be seen for claw divisions (10X power). Wings are distinct with three segments visible. The maxilla appears as a small protuberance. The eyelids are beginning to cover a portion of the eyeball. The midbrain is prominent as a translucent bulge.

Day Seven

Yolk sac is heavily vascularized but resists tearing. The head is flexed sideways, now touching the wing. Wing and leg buds are distinct. The egg tooth is evident as a tiny white spot on the maxilla; the mandible is well defined.

Day Eight

The legs have digitation of the claws. The three segments of the wings are visible with the alulae obvious as projections from the manus. The maxilla is slightly longer than the mandible and egg teeth can be seen on the bill as small white spots. Eyelids cover about one-half of each eyeball. The embryo is basically cream-colored. The midbrain bulge is prominent but no longer translucent. Down tracts are beginning to form on the body and wings.

Day Nine

Embryo has pronounced cervical and slight caudal flexion. The neck is sharply bent at the junction with the body. Segments can be seen on the metatarsus. The alulae are distinct. The maxilla is solid cream with a white tip. Egg teeth are prominent on the bill. Two raised oval areas on the maxilla are beginning to develop into the nares. The eyelids cover about three-fourths of each eyeball, leaving an opening around the lens area. The body has a pink tint, but the extremities are cream-colored. The skin over the abdominal region

is translucent. Distinct organs and the soft keel can be seen in this region. The auditory opening is a subtle indentation in the skin covering the skull.

Day Ten

Embryonic waste appears as long white strands in the allantois. Embryo has a pronounced bend at the neck. The bill is facing the side and almost reaches the tail region in the natural flexed position. There is slight caudal flexion. Keratin tips on the toe digits appear white. The maxilla is cream-colored with a faint black stripe and white distal end. The egg teeth are obvious on the bill. The eyelids form an oval opening over the lens. The auditory opening is clearly visible. Down tracts are differentiating all over the body, giving the embryo a rough texture. Down papillae are forming (10X power).

Day Eleven

The yolk is slightly absorbed into the body causing the yolk sac to appear smaller. The embryo is sharply bent at the neck with the bill directed to the side of the body. Tips of the claws are distinctly white. Scale ridges can be seen on the legs (10X power). The oval ridges of the nares are easily seen on the maxilla. A dark stripe is present in front of the nares. The eyelid covers most of the eyeball. The opening over the lens of the eye ranges from a crescent to a slit. Down papillae are becoming evident, especially on the neck and back. Down is shorter on the head and dorsal surface of the eyes.

Day Twelve

Significant absorption of the yolk is evident. Caudal flexion of the embryo is slight. Scales are evident on the legs. The eyelids close to a small slit and in some specimens appear closed. Although the skin is still translucent, the back, neck, and head are cream to purple. The keel and some internal organs can be seen on the ventral side of the embryo. Down covers most of the body.

Day Thirteen

Development varies slightly at this stage. Some embryos show no signs of pipping while others are in the process of hatching. The embryo appears bent in half at the base of the neck. The head is

strongly flexed to the side and reaches the tail region. The yolk is largely absorbed, and the edges of the yolk sac are viscous. Most of the egg is fairly dry. Scales on the legs appear as ridges. The bill is dusky purple with a dark stripe beyond the nares. The white egg teeth are prominent. The eyeballs are not distinct bulges. The eyelids appear closed. The embryo is dark purple. The keel can be seen and is rigid. The brain still can be distinguished as a cream-colored lobe. Down is long and covers most of the body.

Day Fourteen

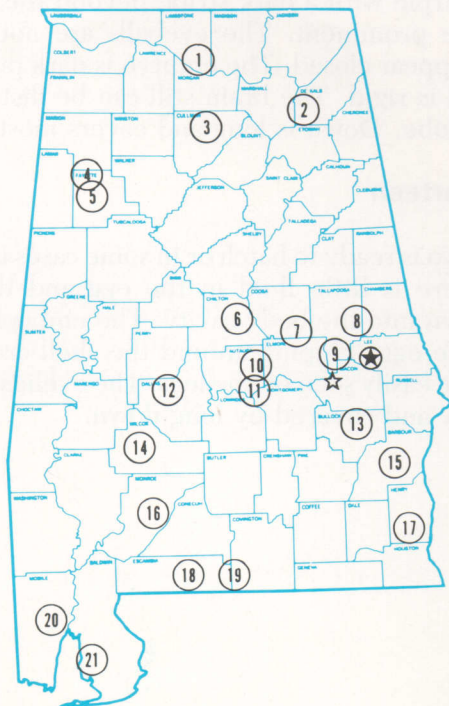
Embryo is ready to hatch or in some cases is already free from the egg. There is little fluid in the egg and the yolk sac is mostly withdrawn into the body cavity. The embryo is curled, just fitting inside the egg. Pipping around the shell creates a definite crack. Scales are easily seen on the legs. The eyelids are closed. Embryo is dark gray and covered by long down.

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- ☆ E. V. Smith Research Center, Shorter.

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2. Sand Mountain Substation, Crossville.
3. North Alabama Horticulture Substation, Cullman.
4. Upper Coastal Plain Substation, Winfield.
5. Forestry Unit, Fayette County.
6. Chilton Area Horticulture Substation, Clanton.
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