EFFECTS OF SIMULATED FLOODING ON ALLIGATOR EGGS

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Abstract: Alligator (*Alligator mississippiensis*) eggs were collected at four intervals during incubation and subjected to a single submergence to test the effects of flooding on hatchability. Treatments consisted of a 2-hour, 6-hour, 12-hour, and 48-hour submergence. Hatching success was significantly related to duration of immersion. Throughout incubation, eggs were not affected by 2 hours of flooding, but 48 hours of submergence produced total mortality.

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Alligators occur throughout the southeastern United States, but the majority of the population is confined to coastal marshes and swamps (Joanen 1974). Nest construction begins in early June; egg deposition usually commences in mid-June with eggs being encased inside a nest cavity. Hatching occurs in late summer.

Coastal areas are subjected to hurricanes which bring flood waters 30-35 km inland in a band 100-150 km wide. Hurricanes may occur from June through September in Louisiana. Heavy rains may also flood coastal marshes. Thus, alligator nests are subjected to flooding at any time during incubation.

Several authors have documented alligator nest losses due to flooding (Hines, et al. 1968, Joanen 1969, Fleming, et al. 1976). Floods damage nests more frequently than any other climatic factor. Losses are generally catastrophic and may exceed the subtle reduction in nesting effort caused by droughts (Joanen and McNease 1974).

This study was designed to determine the effects of flood duration on hatchability of alligator eggs. At various stages of incubation, alligator eggs were subjected to a simulated flood of variable duration.

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METHODS AND MATERIALS

Eggs used in this study were collected from the coastal marshes of Rockefeller Wildlife Refuge in southwest Louisiana. Joanen (1969) provided a thorough description of the study area. Five eggs were removed from each of the 8 nests on the following dates: 29 June, 20 July, 10 August, and 21 August 1976. These dates coincided with the first week of incubation, third week, sixth week, and eighth week. Four flooding treatments and a control were tested at four stages of incubation. The first test involved submerging the eggs for 2 hours, the second test 6 hours, the third test 12 hours, and finally a 48-hour submergence.

The 40 eggs picked up on each of 4 collection trips were marked as to up-right orientation, egg number, and nest number then packed in moist hay and transported to the laboratory. For each collection, 4 of 5 eggs collected from each nest were placed at random in containers filled with tap water 5 cm over the eggs. Upright orientation of all eggs was maintained. The remaining eggs served as a control and were placed directly in an incubator described by Joanen and McNease (1977). Eggs were removed from the water after 2, 6, 12, and 48 hours of submersion and placed in the incubator.

Young were removed from the incubators within 24 hours after hatching. Records were maintained on numbers hatched per treatment, date hatched, and collection dates. Unhatched eggs were opened and categorized as either fertile or infertile.

The data were analyzed as a 5 x 4 factorial arrangement of treatments in a randomized complete block design. Data were binomial; however, sufficient observations ($N = 135$) were taken to allow for a least squares analysis of variance. Specific comparisons were made using Tukey's w procedure to eliminate the influence of times of immersion and periods of incubation. A Kolmogorov-Smirnov 2-sample test was conducted to analyze hatching synchrony.

RESULTS AND DISCUSSION

Eggs in the controls and treatments began hatching after 65 days of incubation (24 August) and continued through the 95th day (23 September). However, 90 percent of hatching took place between the 65th and the 80th day of incubation, similar to hatchability reported by Joanen and McNease (1977). Except for the 48-hour submergence, the treatments had no adverse effect on hatching synchrony ($P > .05$). No significant difference was observed in percent hatch of eggs collected on the 4 dates ($P > .05$).

Duration of submergence was directly and significantly related to hatchability ($P < .01$). Using Tukey's w procedure it was found that the mean hatch of eggs in the control was not significantly different from 2-hour or 6-hour submergence ($P > .05$). Eggs submerged for 2 hours had hatching rates averaging 93 percent as did eggs in the control (Table 1). The hatchability of eggs flooded for 6 hours averaged 67 percent, 26 percent

Table 1. Hatchability of alligator eggs submerged for varying periods during incubation, Rockefeller Refuge, 1976.

Treatments	*Time of Collection (Week of Incubation)*	*Fertile Eggs per Treatment*	*Percent Hatched*	*Percent Hatched by Treatment*	*Percent Hatching Success Compared to Controls*
Control	1	7	86		–
	3	7	100		–
	6	7	86		–
	8	6	100	93	–
Two-hour Submergence	1	7	71		– 22
	3	8	100		+ 7
	6	7	100		+ 7
	8	6	100	93	+ 7
Six-hour Submergence	1	8	50		– 43
	3	8	62		– 30
	6	8	88		– 5
	8	6	67	67	– 26
Twelve-hour Submergence	1	8	50		– 43
	3	7	86		– 7
	6	7	0		–100
	8	2	0	34	–100
Forty-eight hour Submergence	1	8	0	34	–100
	1	8	0		–100
	6	7	0		–100
	8	4	0	0	–100

less than the control. Hatching of eggs in the controls and those submerged for 6 hours were significantly different from the mean hatch of eggs subjected to 12 hours and 48 hours of inundation ($P < .01$). All possible pairwise comparisons were tested also using Tukey's w procedure and are illustrated in Table 2. Hatchability of eggs flooded for 12

Table 2. Tukey's w procedure for comparisions of interactions of mean hatch of alligator eggs subjected to various durations of immersion in various weeks of incubation. Means followed by similar superscripts are statistically different ($P < 0.05$).

Periods of Collection	*Duration of Immersion*				
	Control	*2-hr.*	*6-hr.*	*12-hr.*	*48-hr.*
1	0.8571^{A^a}	0.7143^{E}	0.5000	0.5000	$0.0^{ABCDEFGHIJKL}$
3	1.0000^{B}	1.0000^{F}	0.6250^{I}	0.8571^{L}	$0.0^{ABCDEFGHJL}$
6	0.8571^{C}	1.0000^{G}	0.8750^{J}	$0.0^{ABCDEFGHJL}$	$0.0^{ABCDEFGHJL}$
8	1.0000^{D}	1.0000^{H}	0.6667^{K}	0.0^{BDEFGH}	$0.0^{ABCDFGHJL}$

hours during the first 30 days of incubation was comparable to the hatchability of the 6-hour treatment. Twelve hours of flooding in the remainder of incubation killed all embryos. Therefore, 12 hours of flooding appears to approximate tolerance of alligator eggs late in incubation. The longest period of flooding, 48 hours, killed all embryos except three and proved statistically lower for all stages of incubation. These three, considered atypical, hatched prematurely when submerged. Additional eggs were substituted to keep the numbers per treatment equal. When this happens in nature, the young are trapped in the egg cavity and drown.

In summary, alligator eggs in south Louisiana are subjected to periodic flooding throughout the incubation period. This study demonstrated that minor flooding can be tolerated; however, extended submergence for 12 hours or longer after the first 30 days of incubation produced total mortality.

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