PROCEEDINGS
of the
EIGHTH ANNUAL MEETING
WORLD MARICULTURE SOCIETY

Held at

San Jose, Costa Rica
January 9-13, 1977

Published by the

Louisiana State University
Division of Continuing Education

Through the academic direction of the

Louisiana State University
School of Forestry and Wildlife Management



# ARTIFICIAL INCUBATION OF ALLIGATOR EGGS AND POST HATCHING CULTURE IN CONTROLLED ENVIRONMENTAL CHAMBERS

Ted Joanen and Larry McNease[1]

## ABSTRACT

Operational procedures for environmental chambers and methods of handling alligator eggs were tested for three years to determine hatching success and to evaluate mortality factors. Eggs were collected from nests produced by captive and wild alligators no earlier than three weeks after laying and as late as five weeks.

Hatching success was determined for fourteen variables. The overall hatching rates for artificially incubated alligator eggs were greater than that reported for wild nests. Post hatching mortality was negligible under artificial conditions, averting high losses which occur in pens and especially in the wild.

## INTRODUCTION

This project was designed to evaluate artificial incubation techniques for alligator eggs and post hatching culture in controlled environmental chambers. Crocodilian culture has received considerable attention during recent years because of a generally declining worldwide population. Industry demand is strong for crocodilian leather although restrictions have been placed on harvest in the wild. In 1964, a pilot program was begun on Rockefeller Refuge to investigate the feasibility of rearing alligators in captivity. Culture operations included propagating adult alligators in enclosures, artificial hatching of eggs, and rearing the offspring in controlled environmental

[1]Louisiana Department of Wildlife and Fisheries, Grand Chenier, Louisiana 70643.

chambers (Joanen and McNease, 1971, 1974, 1975, 1976).

This report lists findings relating to methods of collecting eggs, transportation, incubation techniques, and post hatching culture. Studies by Chabreck (1971), Blake and Loveridge (1974), and Pooley (1971) investigated egg handling and methods of incubation.

## METHODS AND MATERIALS

### Egg Collection and Transportation

Alligator eggs were collected in the last week of July or early August, as late as the fifth week of incubation. This allowed uninterrupted early embryonic development. There is a bit of disagreement in the literature relative to optimum time of egg collection. Blake and Loveridge (1974) indicated that collection of eggs shortly after laying had a detrimental effect on hatching success as compared to late egg collections. Conversely, Pooley (1971) recommended early egg collection. Eggs were collected from wild nests and from nests produced by captive animals. A 132-liter metal container with a lid was used to transport the eggs from the field back to the laboratory. Approximately 25 to 30 cm of grass hay or nesting material was placed at the bottom of the can for insulation and protection. Eggs were marked and situated so as to preserve their original nest orientation while being transported in single layers covered with approximately 5-7 cm of nesting material. No attempts were made to segregate individual clutches, except for cultured eggs in 1974. Dented or slightly cracked eggs were incubated provided no leakage was apparent. The short trip from nest to incubator was smooth, therefore no special packaging was required.

### Incubation of Eggs

Environmental chambers, as described by Joanen and McNease (1976), were used for egg incubation. Temperatures were maintained at 28.8°C during the 1974 study and 28.6°C during 1975. Two tanks were used during 1976; one was maintained at 30.0°C and the other at 33.3°C.

All eggs were set in trays measuring 61 cm X 61 cm X 15 cm. Hardware fabric with 1.7 cm mesh was used on the top and bottom for air circulation. Trays were partitioned into two equal size compartments. Eggs were randomly selected in order not to bias test results. A minimum of three replications per treatment plus controls strengthened validity of results.

Egg trays were set approximately 7.5 cm above either the dry concrete tank floor or water. Small bricks or concrete blocks were situated under each corner of a tray so that air and humidity was free to exchange from below. Hay was aged for a year before being used as a nesting medium. This tended to reduce growth of undesirable fungii. A precautionary treatment of copper sulfate at a rate of 2 ppm was used as a fungicide.



Environmental chamber doors were opened once a week for check-up purposes until hatching commenced. If necessary, nesting media were moistened by spraying tap water on the nest boxes. Careful attention was given to maintaining clean chambers, properly operating data collection instruments, and checking conditions of eggs and nesting media.

Relative humidity averaged 92.4% in 1974 and 91.9% in 1975 throughout the period of artificial incubation.

A seven-day Taylor temperature recorder recorded water temperature of the chambers. A hair hygrograph recorded relative humidity approximately 7 cm above the water.

### Treatments

During the three-year study, 14 different treatments were tested. Tests included stacked, as would be found in a normal nesting situation, vs not stacked, laying one layer with eggs touching one another; inverted vs non-inverted (control); eggs collected from the wild vs eggs collected from captive breeding programs; oxygenated environmental chambers vs non-oxygenated chambers; eggs washed in dishwashing detergent vs non-washed; exposed eggs vs eggs covered with grass hay; and eggs set over water vs eggs set over dry concrete. The range of incubating temperatures was 28.6°-33.3°C.

### Hatching

Chambers were checked every second day once hatching began. Hatchlings were retained in their hatching trays for 24 hours, preferably under moist hay to restrain them. This allowed the animals to separate from the egg shell and time for the umbilical cord to break off. Next the newly hatched alligators were moved into brooder chambers to begin acclimation for intensive culture. The brooder chambers were adjacent to hatching chambers, therefore no special packing or moving precautions were implemented.

After all hatching was completed, the remaining eggs were opened and condition of eggs recorded. Eggs were categorized as either infertile or the age at mortality was estimated.

### Post Hatching Culture

Post hatching culture techniques developed during previous studies (Joanen and McNease, 1974, 1976) coupled with new developments during this study improved our efficiency for raising alligators. These techniques, aimed at attaining maximum growth and controlling mortality factors, were as follows. Ideally the young alligators should be separated into size groups with special emphasis on keeping the small and weaker individuals segregated. Environmental chambers should be thoroughly cleaned every second day to avoid infection of navel scars and to reduce pathogens. Drainage of compacted yolk material from the stomach was tried on obviously sick animals. A hypodermic syringe and needle were tools used to facilitate this task. Feeding trials were implemented on the 9th day of life, allowing for absorption of the egg

yolk. Finely ground fish with multi-purpose vitamin additives was placed near the water's edge and provided the best cost/benefit ratio of several foods tested. Fish must remain frozen until just prior to feeding, otherwise sickness will be induced.

The importance of cleanliness to the entire operation cannot be overstated. Unused food should be removed at least 3 or 4 hours after feeding and environmental chambers thoroughly cleaned to curtail disease-causing organisms.

Environmental chamber temperatures were adjusted to the desired setting (range 28.6°C-33.3°C for our different tests) by manipulating the thermostat controls. A continuous recording instrument verified environmental chamber temperatures and was used to calibrate thermostats.

## RESULTS

### Hatching Rates

The most notable difference detected during this investigation was the differential hatching rate for cultured as compared to wild eggs. The average hatching rate of 94% for 578 wild eggs greatly exceeded the 72% rate for 375 captive-produced eggs. Averages were for two years with infertile eggs excluded from analyses.

Hatchability averaged 99.4% for 270 fertile wild eggs for eight tests in 1975 (Table 1). The 1976 rate was a little lower, averaging 90.0% for 308 fertile eggs and six tests. Hatching rates for eggs produced by captive animals averaged 66.7% in 1974 for 270 fertile eggs for six treatments and 77.2% in 1975 for 105 fertile eggs (Table 1). Major emphasis was placed on collecting data on a per nest basis in 1974, therefore eggs were hatched according to clutch. Although different treatments were tested, hatchability varied so widely by clutch that it precluded detailed analysis by treatment.

No appreciable differences in hatchability were noted among the 14 treatments tested with the exception of a 13% decrease for stacked eggs, which indicates that alligator eggs lend themselves extremely well to artificial incubation. The simplest and most preferred incubation method involved setting a single layer of eggs under grass hay. Records were easier to keep for this treatment plus the hay kept hatchlings confined, reducing egg displacement and physical damage to eggs.

Hatching for an entire year's compliment of eggs extended over a three-week period. Wild eggs exhibited higher hatching rates earlier than did cultured eggs, reflecting the sporadic egg laying of cultured alligators (wild alligators exhibited a more unified effort). Weekly hatching rates for all treatments and years averaged 58.5%, 28.9%, and 12.6% for wild eggs and 10.0%, 58.5%, and 31.5% for cultured eggs for consecutive weeks.



Eggs washed with a mild dishwashing detergent (one tablespoon per liter of water) exhibited extended incubation periods. Unwashed eggs showed a 90% emergence during the first week of hatching for four different treatments while washed eggs showed only a 35% rate for the same period and treatments.

Mortality just prior to hatching was high for cultured eggs, especially in 1974 when 33% of the embryos died. Cultured eggs were inferior to those produced by wild alligators in terms of fertility rates and hatchability. Infertile eggs accounted for 25.4% from captive nests and 12.5% from the wild.

### Immediate Post Hatching Culture (0-10 Days)

Mortality was low during the first 10 days of life, ranging from 2 to 5% over the three year study. Death rates were reduced with each successive year of study, directly relating to knowledge gained in culture operations. Compacted yolks in a few weaker animals resulted in a few deaths. Drainage of compacted material was tried on an experimental basis, with encouraging results achieved for 5 alligators.

Careful attention must be given to keep stocking densities at a safe level; no more than one alligator per 0.07 $m^2$. Overcrowding will induce pile-ups and suffocations. Stocking density during this stage can be much higher than for the grow-out phases.

Temperatures were held at the 32.2-33.3°C range to speed up body functions and resulted in getting the young hatchlings on feed by the ninth or tenth day post hatch. Further study is warranted with temperature manipulation, as it may effect certain aspects of physiological development, specifically the reproductive system.

Initial food consumption was low but the important consideration was to get the young regimented to a feeding scheme just as quickly as possible.

### Culture After Tenth Day

Environmental chamber culture after the tenth day of life was basically one of maintaining stringently clean tanks, providing proper diets for maximum yield, providing adequate fresh water, and frequent inspections to diagnose problems or attributes of the program.

Stocking density should be adjusted within a month or two to a maximum rate of 0.12 $m^2$ per animal. After one year of growth, a minimum of 0.34 $m^2$ per animal must be furnished.

Food consumption during early life was extremely high, averaging 28% of their body weight per week. Food conversion (dry weight basis) was 77.1% during the first 2-1/2 months of life at 29.4°C. Joanen and McNease (1974) reported a 49.5% food conversion over a two-year period. Coulson et al. (1973) reported slightly lower conversion rates, ranging from 40% down to 25%, conversion rates being inversely proportional to age.

The first month in the feeding chambers should be considered an acclimation period, therefore careful attention should be given to every detail, especially in feeding and cleaning.

### Miscellaneous Problems

Care should be exercised to reduce pile-ups, best facilitated by partitioning each chamber into smaller units. Pile-ups cause suffocation, fighting, and physical abuse. Overcrowding was our most easily diagnosed problem and simplest to correct.

Gout can easily be caused by overfeeding. Once gout symptoms become evident, simple fasting will correct the problem.

No serious disease problems were encountered during the study. Occasionally animals went off feed for some unexplainable reason, perhaps due to minor changes in fish composition or to minor bacterial or viral infections.

Environmental chambers must be "climb proofed". Hatchlings are especially agile and will readily climb out of chambers and be lost.

Extreme care must be exercised in cleaning as young are very susceptible to bruising (damage) from too strong a water spray or striking with cleaning implements, or simply being mashed with pressure from hands or feet.

## DISCUSSION

Studies over the 1974-1976 alligator nesting seasons in southwest Louisiana indicated that alligator eggs can be very successfully artificially incubated. Especially encouraging results were achieved when eggs were picked up relatively late in their incubation period.

Artificial incubation is a very important facet of any full-fledged crocodilian farming operation. Assets of incubation include the aversion of natural egg losses due to predation, weather extremes and, especially in farm operations, competition for nest materials and destruction of nests by other alligators.

Hatching rates in the wild, deleting infertile eggs, averaged 57% for 154 nests followed for two years (Joanen, 1969). The obvious superiority of artificial incubation thus becomes very significant. Unpublished observations indicate considerable mortality occurs during the first year of life in the wild, a factor which can be practically eliminated under controlled conditions.

Careful consideration should be addressed to finding the cause for cultured eggs showing lower hatchability and fertility than those from the wild.

## LITERATURE CITED



Blake, D. K., and J. P. Loveridge. 1974. The role of commercial crocodile farming in crocodile conservation. Biological Conservation 8:261-272.

Chabreck, R. H. 1971. Alligator nest materials---moisture and temperature levels for hatching alligator eggs. In 14th Biennial Report, Louisiana Wildlife and Fisheries Commission. p. 73-74.

Coulson, T. D., R. A. Coulson, and T. Hernandez. 1973. Some observations on the growth of captive alligators. Zoologica 58(2):47-52.

Joanen, T. 1969. Nesting ecology of the alligator in Louisiana. In Proceedings Southeastern Association Game and Fish Commissioners Conference 23:141-151.

Joanen, T., and L. McNease. 1971. Propagation of the American alligator in captivity. In Proceedings Southeastern Association Game and Fish Commissioners Conference 25:106-116.

Joanen, T., and L. McNease. 1974. Propagation of immature American alligators in controlled environmental chambers. In Proceedings of AAZPA Regional Conference. p. 262-268.

Joanen, T., and L. McNease. 1975. Notes on the reproductive biology and captive propagation of the American alligator. In Proceedings Southeastern Association of Game and Fish Commissioners Conference 29:407-415.

Joanen, T., and L. McNease. 1976. Culture of immature American alligators in controlled environmental chambers. Proceedings 7th Annual Workshop World Mariculture Society 7:201-211.

Pooley, A. C. 1971. Crocodile rearing and restocking. Proceedings International Union for Conservation of Nature and Natural Resources, New Series 32, 104-130.

Table 1. Hatching rates for eggs produced by wild and captive alligators, 1975-1976.

| Treatment | Temperature (C) | Percent Hatch | Year | Egg Source |
|---|---|---|---|---|
| Stacked | 30.0 | 81.9 | 1976 | Wild |
| Not-Stacked | 30.0 | 86.7 | 1976 | Wild |
| Control* | 30.0 | 94.7 | 1976 | Wild |
| Control | 33.3 | 89.7 | 1976 | Wild |
| Inverted | 30.0 | 91.8 | 1976 | Wild |
| Inverted | 33.3 | 95.1 | 1976 | Wild |
| AVERAGE | | 90.0 | | |
| Ventilated-Washed-Wet | 28.6 | 100.0 | 1975 | Wild |
| Ventilated-Washed-Wet | 28.6 | 88.0 | 1975 | Captive |
| Ventilated-Washed-Dry | 28.6 | 95.0 | 1975 | Wild |
| Ventilated-Washed-Dry | 28.6 | 81.0 | 1975 | Captive |
| Ventilated-Unwashed-Wet | 28.6 | 100.0 | 1975 | Wild |
| Ventilated-Unwashed-Dry | 28.6 | 100.0 | 1975 | Wild |
| Oxygenated-Washed-Wet | 28.6 | 100.0 | 1975 | Wild |
| Oxygenated-Washed-Wet | 28.6 | 85.0 | 1975 | Captive |
| Oxygenated-Washed-Dry | 28.6 | 100.0 | 1975 | Wild |
| Oxygenated-Washed-Dry | 28.6 | 82.0 | 1975 | Captive |
| Oxygenated-Unwashed-Wet | 28.6 | 100.0 | 1975 | Wild |
| Oxygenated-Unwashed-Dry | 28.6 | 100.0 | 1975 | Wild |
| Oxygenated-Unwashed-Dry | 28.6 | 50.0 | 1975 | Captive |
| AVERAGE WILD | | 99.4 | | |
| AVERAGE CAPTIVE | | 77.2 | | |

*Under hay, original nest position.



Printed in the United States of America