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Culture of the American alligator

Alligator mississippiensis

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In 1959 Louisiana's Department of Wildlife and Fisheries initiated an intensive alligator *Alligator mississippiensis* management programme with the object of rebuilding and maintaining the State's alligator population at a figure capable of sustaining a closely regulated annual harvest. It was diverse in scope and involved diligent enforcement and legislative efforts, restocking of depleted areas, and extensive research. This paper reports on research concerning the propagation of the American alligator in captivity.

The research programme was in two main parts: a field study segment investigating basic life history and a culture programme which was based on the biological facts derived from field investigations. The alligator farming study demonstrated the feasibility of rearing alligators in captivity and reinforced the concept of culture as a viable source of animals for commercial and conservation purposes. We were able to study captive alligators and make observations that were impossible under field conditions, such as reproductive activities, stocking densities, food requirements and social order.

OBSERVATIONS IN THE WILD

Information gathered from telemetric investigations added valuable insight into habitat requirements of adult alligators (Joanen & McNease, 1970, 1972), and brought to light differences in habitat requirements by sex and by season of the year. Both sexes tend to gather in courting groups in deep water areas during the spring. During courtship ♀♀ were more social than ♂♂, but after mating the ♂♂ remained in the open water while ♀♀ moved to dense cover and small isolated ponds in the interior marshes to begin nest construction. Females generally remained in isolation in the marshes until the following spring when courtship once again brought them into open water.

Growth rates of wild alligators provided a base for evaluating growth under captive conditions. Food habit investigations showed that immature alligators (<1·8 m) consumed a large proportion of invertebrates whereas adults preyed heavily on vertebrates (Chabreck, 1971; Valentine *et al.*, 1972; McNease & Joanen, in press).

DESIGN OF ENCLOSURES FOR ADULTS

One important aspect of our culture study was the relationship between pen design and productivity. Early work (Joanen & McNease, 1971) concentrated mainly on the reproductive activities of the alligators and, although breeding occurred, the original pen layout was inadequate to achieve the level of productivity needed for a commercial farm-type operation. Our first five pens were 0·1 ha rectangles with a 70 : 30 water to land ratio. They contained a single pond 2·2 m deep with a small island in the centre. The spoil excavated from the water area formed a 4·9 m wide levee around the perimeter of the pen and served as a foundation for the fence. Natural vegetation invaded the area and provided cover and nesting material.

Because of the lack of habitat diversification, stocking rates were fixed at one ♂ to one ♀ (wild-caught) per pen. Efforts were made to stock more heavily, but social order prevailed and the dominant ♂ and ♀ either killed their competitors or forced them to flee. The problem with this type of culture was the large number of animals, especially ♂♂, that had to be maintained and the expense of housing each pair in separate pens.

Using data collected in recent field studies on habitat requirements, we constructed seven pens which incorporated social and environmental parameters into the design and allowed higher stocking densities. Thus three ♀♀ and one ♂ (wild-captured) could be maintained in one 0·2 ha area. Pen sizes varied from 0·1–0·8 ha, with a water to land ratio of about 20 : 80. A number of water areas were dispersed about the pen for isolation and a deep water courtship area for each pen was constructed by digging a rectangular pond 5–18 m wide × 30–38 m long × 1·8 m deep.

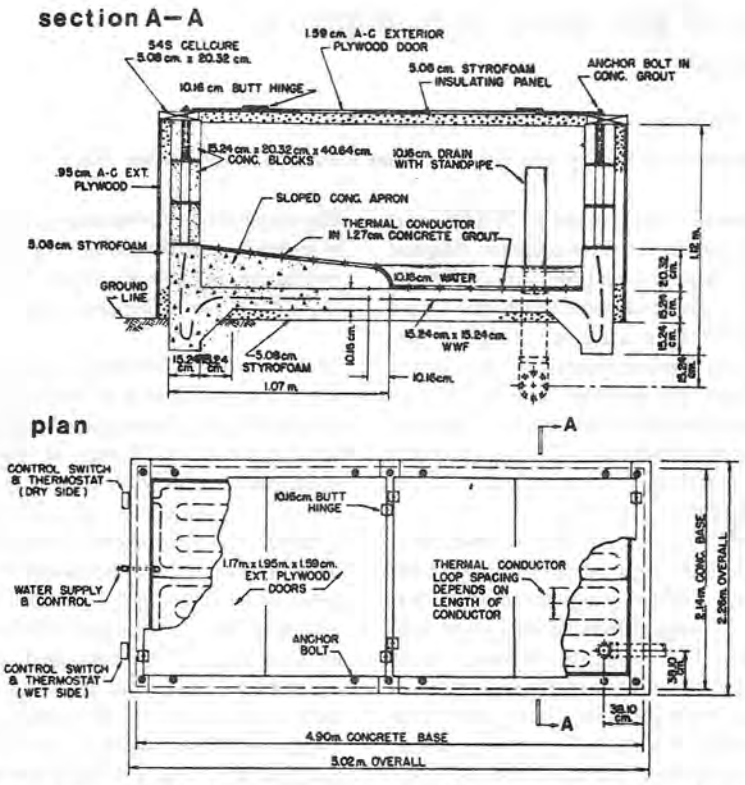

Fig. 1. Environmental chamber to house small American alligators *Alligator mississippiensis*.

The small 3 × 6 m isolation ponds, one per ♀, were dug adjacent to the courting pond. The largest number of ♀♀, and therefore ponds, in any one pen was six. Multiple stocking of wild adult ♂♂ proved impractical because the area needed to sustain two ♂♂ per pen was found to be four times greater than for one per pen.

No perimeter levees were constructed and the fences were set at ground level. This prevented the animals from escaping by burrowing under fence lines as had happened previously.

Feeding sites were established in all pens, usually near an area which was frequently used, such as loafing areas near a water hole. Trails were maintained to all feeding sites by light applications of herbicides and periodic mowings.

A deep fresh water well provided a dependable source of water to each pen.

HOUSING FOR JUVENILES

Three environmental chambers were used as brooders for alligators up to three years of age (Fig. 1). Water capacity was 530 litres with *c.* 10·4 m² surface area in each tank. Later a further six chambers were constructed with the following alterations: solid concrete walls instead of concrete blocks, the water area deepened by 5 cm and overall tank width increased by 91 cm (equal water and dry areas). Water capacity equalled 1136 litres, with *c.* 14·9 m² surface area per tank. A tin-roofed shed (top only; no sides) with skylights provided protection for the chambers (Joanen & McNease, 1974).

All nine tanks were heated by thermostatically controlled electrical thermal conductors. Water was supplied through a network of plastic and galvanised pipes from a 5 cm water well. Temperature recorders were used to monitor outside air temperature, and air and water temperatures inside two chambers. Partitions were installed in all chambers to reduce 'pile-ups' caused by the young alligators crowding into a particular spot.

PEN CULTURE STUDIES

Stocking rates: As in any farming operation, quality stock is a prerequisite to a productive programme. In our early farming endeavours wild-captured adults were the only stock available and were used until such time as we had cultured enough 'domesticated' alligators to serve as breeding stock.

Wild-captured alligators need approximately ten times more space than captive-bred alligators. Under the best pen conditions we were able to maintain five wild alligators per 0·4 ha. A commercial alligator farm in Louisiana was able to maintain 45 adult domesticated alligators per 0·4 ha with a nesting success ranging from 18–90% over a 13-year period.

Feeding methods and rations: Feeding began in March and terminated in October each year. Temperatures during the fast period were generally cool, averaging 15°C. January, the coldest month, averaged 8·5°C. Mean temperature for the active period was 26·5°C. A feeding rate corresponding to 8% body weight was given each week. The basic diet consisted of marine fish, primarily Atlantic croaker *Micropogon undulatus* supplemented with beef by-products from a commercial packing house. Diet additives such as vitamins and trace elements have been used and seem beneficial but this area deserves further study.

Growth rates: Annual growth rates under pen conditions for wild-captured alligators were inversely proportional to size class, ranging from 6·4 cm for the 1·83 m class to 1·8 cm for the 2·44 m class in ♀♀ and 13·2 cm for the 1·83 m class to 2·5 cm for the 3·05 m class in ♂♂. Weight gain of ♂♂ averaged 12·4, 11·3, and 8·9 kg per year for the 2·44, 2·74 and 3·05 m size classes. Females gained 5·3 and 8·5 kg per year for the 1·83 and 2·13 m size classes. Body condition of pen animals was superior to the wild counterparts. Care must be exercised not to overfeed.

REPRODUCTIVE EVENTS

Chronology of reproduction: Courtship activities generally began in early April with occasional light bellowing by both sexes. Bellowing and courtship displays gradually built up through the first week of June.

From late May throughout the first week of June courtship and copulation were intense, the ♀ ovulated, and the high point of spermatogenesis occurred. From the middle to the end of June the terminal end of the oviducts of all reproducing ♀♀ contained eggs with shells and deposition occurred. The time interval from ovulation to laying was three to three-and-a-half weeks. The average number of eggs per clutch was 39·5 (34 nests) over four successive nesting years.

The onset of sexual maturity occurred when the animals measured about 1·83 m. However, social order in ♂♂ favoured breeding by individuals in the 2·74 m and above size classes. All ♂♂ examined in the 1·83–3·96 m size classes were physiologically capable of reproduction. During 1969, ♂♂ produced sperm from 9 May to 20 June, a period of 43 days. Maximum gonadal development, hence sperm production, occurred from the last week in May through the first week in June.

Nesting in captivity: Age at first nesting was nine years ten months under pen conditions, the same as reported by McIlhenny for alligators in the wild (1935).

Egg deposition generally occurred from 12 June to the end of the first week of July. However, for any given year, nesting occurred within a two-week period and the time of nesting was directly related to air temperature, higher temperatures inducing earlier laying (Joanen, 1969). Average temperatures were 27 and 28°C respectively for June and July. Hatching was in late August and early September, after artificial incubation for about 65 days.

The overall nesting success rate was 49% for the period 1964–1975 (Joanen & McNease, 1971, 1975), using wild-captured stock.

Fertility rates: Fertility rates were determined from 11 nests produced during one nesting season. Of 358 eggs placed in incubators, 24·6% were found to be infertile. One ♂ serviced four ♀♀, the most recorded under captive conditions. These four ♀♀ produced 138 eggs of which 16% were infertile. Comparisons with wild nests, which demonstrated a 12·5% infertility rate, indicated a possible dietary deficiency in our captive stock.

Mortality and other problems: Fighting proved to be more detrimental to the well being of wild-captured alligators than diseases or other ailments. Stocking rates were critical, especially for ♂♂, and generally the low rates used were grossly inefficient when compared to stocking rates for 'domesticated' alligators.

ARTIFICIAL INCUBATION

Alligator eggs were collected from nests as late as the fifth week of incubation. There is disagreement in the literature on the optimum time of egg collection. Blake & Loveridge (1974) indicated that collection shortly after laying had a detrimental effect on hatching success compared to late egg collection. Conversely, Pooley (1971) and Chabreck (in press) recommended early egg collection. We found that turning the egg prior to the fourth week of incubation was harmful and reduced hatching success by as much as 45%. After the fourth week of incubation the eggs were not as susceptible to damage. Eggs, especially those picked up early in incubation, should be marked and so placed to preserve their original orientation in the nest while being transported. All eggs were carried in single layers covered top and bottom with *c.* 5–7 cm of nesting material (Joanen & McNease, in press).

Environmental chambers, as described by Joanen & McNease (1976), were used for incubation. Eggs were maintained at various temperatures ranging from 28–34°C but the best hatching success was obtained at 31–31·7°C. At 31°C the hatching rate was 18% better than at 29·4°C and 60% better than at 33·9°C.

The eggs were set in trays, measuring 61 × 61 × 15 cm, covered top and bottom with 1·7 cm mesh hardware fabric for air circulation. In all the tests hay was used as a nesting medium and the relative humidity was maintained at 90–92% throughout the incubation period. The trays were set on shelves *c.* 7·5 cm above either the dry concrete tank floor or water and the chambers were opened once a week for inspection until hatching commenced. If necessary, the hay was moistened by spraying tap water on the nestboxes.

Once hatching began the chambers were checked every second day. The hatchlings were retained in their hatching trays for at least 24 hours to allow time for them to separate from the shell and for the umbilical cord to break off.

The most notable difference detected during our studies was the hatching rate for cultured as compared to wild eggs, the 72% for 375 captive-produced eggs being markedly exceeded by the 94% for 578 wild eggs. In any one year hatching extended over a three-week period for the entire complement of eggs.

BROODER CHAMBERS

Ideally young alligators should be separated into size groups with special care taken to keep the smaller and weaker individuals segregated. Environmental chambers should be thoroughly cleaned every second day to avoid infection of navel scars and to reduce pathogens. Mortality was low during the first ten days after hatching, ranging from 2–5% over our three-year study. Careful attention must be given to keeping stocking densities at a safe level, i.e. no more than one alligator per 0·1 m^2. Overcrowding will induce pile-ups and suffocations. After hatching temperatures were held at around 32–33°C to speed up body functions with the result that the hatchlings could be induced to feed by the ninth or tenth day after hatching.

After the tenth day of life the environmental chamber culture was basically one of maintaining clean tanks and providing proper diets for maximum yield. Maximum stock density remained at 0·1 m^2 until one year of age when it was decreased to a minimum of 0·3 m^2 per animal. This allowed ample space for later growth. For maximum growth the temperatures of the environmental chambers were maintained at 29–30°C.

After evaluating various food sources over several years, we chose fish as the most practical diet for young alligators. It was the most economical feed available, being abundant and obtainable throughout the year, and easy to prepare. A multi-purpose vitamin premix supplement was given to correct the dietary deficiencies inherent in a diet of pure marine fish.

Feeding was not initiated until the ninth day of life to allow for absorption of the egg yolk. Initially food consumption was low, only 6% of body weight per week, but the important consideration was to get the young regimented to a feeding scheme as quickly as possible. Fish which had been ground up was given until the alligators

were around one year old when they had attained sufficient size to handle and digest chopped fish. Later, as soon as the animals were large enough to handle it, whole fish was given. Oily fish such as menhaden *Brevoortia patronus* was avoided as tests showed that these carried heavy loads of pesticides.

Feeding was carried out five days per week for the first year and three days per week thereafter (for example, Monday, Wednesday and Friday). A feeding rate corresponding to 25% body weight per week was adhered to for approximately the first year and thereafter was progressively decreased to about 18% at the end of the third year. After 36 consecutive months of feeding, the young outgrew their brooder facilities and were stocked into outside pens.

Alligators fed fish converted 49·5% of the food consumed (dry weight) into body mass over a two-and-a-half year period. Coulson *et al.* (1973) reported conversion rates of 40% up to one year of age and 25% from one to three years but this was probably based on wet weights.

At 33 months (i.e. after 26 months of intensive feeding) all animals averaged 19·4 kg and 160 cm with 10% of the alligators measuring more than 180 cm. The longest individual was 193 cm. After 12 months feeding (19 months of age) alligators fed fish averaged 106 cm total length and 4·02 kg body weight—a mean gain of 67·8 cm and 3·85 kg. Length-weight relationships (Joanen & McNease, 1976) were comparable with the findings of Coulson *et al.* (1973). Captive-reared alligators had a superior body condition to wild alligators, being 10% heavier per given length and twice the length of wild alligators of the same age (Coulson *et al.*, 1973).

Operating costs averaged about $20·00 per alligator up to 33 months of age. This figure included costs of electricity, feed, vitamins, medicines, and miscellaneous incidental supplies. Capital outlay and labour were not included because of the experimental design of our study.

DISEASE AND OTHER PROBLEMS

Care was exercised to reduce pile-ups, the best method being to partition each chamber into smaller units. Pile-ups caused suffocation, fighting and physical abuse. Overcrowding was our most easily diagnosed and simplest problem to correct.

Gout was caused by overfeeding; however, fasting for one week to ten days usually corrected the problem.

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

The environmental chambers must be 'climb proof'. Hatchlings were especially agile and readily climbed out of the chambers.

Our best survival rate was 99% for 156 alligators over a 33-month period. Fighting occurred occasionally, resulting in cuts on the tail, back and limbs, but was not considered a serious problem. High stocking densities exacerbated fighting.

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PRODUCT MENTIONED IN THE TEXT

Special experimental mixture 1369: multi-purpose vitamin premix manufactured by Syntext Agri Business Inc., Springfield, Missouri 65805, USA.

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