April 1990 *Asiatic Herpetological Research* Vol. 3, pp. 129-136

The Past and Present Situation of the Chinese Alligator

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Key Words: Reptilia, Crocodilia, Alligatoridae, *Alligator sinensis*, China, endangered species, history, conservation.

Introduction

The Chinese Alligator is one of 21 species of existing crocodilians in the world today. Their numbers have dwindled and their distribution is so narrow that it has aroused concern among experts, conservationists, and amateurs in wildlife at home and abroad. It is reported in foreign countries that the Chinese Alligator is an extinct animal in the wilderness. It has been placed on the list of endangered species by the International Union for the Conservation of Nature and Natural Resources. How did the Chinese Alligator live? How does it live now? This is a problem of worldwide attention.

Changes in the geographic distribution of the Chinese alligator

The fossils of the Chinese Alligator have been found in Taian and Yanzhou in Shandong Province, Maqian in Shanghai, Yuyao in Zhejiang Province, and Hexian in Anhui Province. In addition, some unidentified fossil alligators have been discovered on the south border of the Junggar Basin in Xinjiang Uygur Autonomous Region; Jiulengshan, Douan in Guangxi Zhuang Autonomous Region; Nanjing in Jiangsu Province; and Danxian in Hainan Province. These fossils reveal that the range of the Chinese Alligator extended from Taian, Shandong Province, to Yuyao, Zhejing Province during the Neolithic age of the Recent epoch. If the unidentified alligator fossils are included, the range during the late Eocene and the beginning of the Oligocene would have extended from Shanghai and Yuyao, Zhejiang Province in the east, as far west as Douan, Guangxi Zhuang Autonomous Region to the border of Hainan Island in the south, and to the Junggar Basin, Xinjiang Uygur Autonomous Region in the north.

According to ancient records which can be traced back to 3000 before present, the habitat of the Chinese Alligator was limited to the extensive lake and marshland of the middle-lower Yangtse River, along the banks of the Yangtse River from Shanghai to Jiangling City in Hubei Province, around Dongting Lake in southern Hubei and northern Hunan Provinces, including the extensive river network between the two provinces, and the Shaoxing, south of Hangzhou Bay in Zhejiang Province, approximately 28.5° - 32.5° N, 116.6° - 121.9° E. This range probable continued until the mid-19th century. However, in many regions, the Chinese Alligator became extinct. Reliable records show that they became extinct in the south of Hangzhou Bay in 1201 AD. A great number were killed around Nanjing in the 1870's. The bank of the Yangtse River frequently collapsed, and flooding occurred. It was thought that the alligators picked holes along the bank and caused the disasters. Thus, people killed a great deal of alligators, and drove them to extinction there.

The investigation in the 1950's revealed that the range of the Chinese Alligator stretched west from Pengze in Jiangxi Province, east to the west bank of Tai Lake, the north border of the Yangtse River, and south at the foot of Mt. Huang. To the north of Mt. Dongtianmu, 30.0° - 31.6° N, 118° - 120°E, the range has dwindled. Further supplementary investigations beginning in 1976 proved

that the range became smaller and was limited to ponds of a hilly region to the north of Mt. Huang, below 200 meters in elevation. There were a few individuals that extended northward along the riverside plain, and even as far as the Yangtse River, approx. 30.6° - 31.6° N, 118.0° - 119.6°E. Within this range, they are sparse. The present habitat of the species is mainly located in some villages in Xuancheng, Nanling, Jingxian, Wuhu, Langqi, and Guangde Counties in Anhui Province, and is also situated around a few villages in Anji and Changxing counties in Zhejiang Province, adjacent to the Anhui border. In 1983 the Chinese Alligator's Natural Refuge organized the research workers of several counties to make a survey and statistically estimated that the number of alligators was about 500. Among the 200 animals captured in part by the investigation, and in part by the Research Center of Chinese Alligator Reproduction, only 4.6% were immature, and 95.4% were older than 10 years of age. Thus, the age pyramid was inverted. Other recent investigations on alligator eggs found that the number of eggs has gradually declined in recent years. The Research Center of Chinese Alligator Reproduction obtained 270 eggs in 1982, 278 eggs in 1983, 154 eggs in 1984, and 85 eggs in 1985. The eggs have not only declined in quantity. They also rarely hatched normally. Thus, it is clear that the wild Chinese Alligator population is declining.

Reasons for the dwindling of the range and number of the Chinese Alligator

Climatic change

Fossil alligators were distributed in the Junggar Basin, Xinjiang Uygur Autonomous Region during the late Eocene to the Oligocene. In the Recent epoch, their range extended to the Yellow River. However, in our country it is recorded with reliable authority that there is no trace of them in these regions. This fact indicates that in some regions, the Chinese Alligator has long been extinct. Climatic variations are an important factor, and it is known that the worldwide climate became cold during ice-ages in the Quaternary period. According to information provided by Jiacheng Zhang, the greater ice-age of the Quaternary period in our country may be divided into six sub-ice-ages and six inter-ice-ages. The yearly average temperature of the inter-ice-ages was 3° - 6°C higher than that of the present, but the average yearly temperature of the sub-ice-ages was 6° - 12°C lower than that of the present. According to records in literature, in 903 BC and 897 BC, the Han River froze twice. In 366 AD, continuous freezing prevailed for three years on the surface of Bohai Bay from Changli to Yingkou. At that time, vehicles, horses, and troops 3000 to 40000 strong could pass over the ice surface. Carriages could pass over Taihu Lake when it was frozen in 1111 AD. The Chinese Alligator is an animal that is adapted to warm weather and not to cold. Late hibernation is an important period, then the reproductive organs develop. At low temperatures, reproduction cannot proceed normally. The hatching stage is about one month, and requires a temperature of about 30°C. If it is lower than 28°C, the young can hardly hatch. Thus it is certain that it is difficult for the Chinese Alligator to proliferate in chilly regions. They can only occupy the area south of the Yangtse River because there is a cool climate to the north.

Habitat destruction, the most important factor

The Chinese Alligator likes to live in water habitats such as ditches, ponds, reservoirs, etc. These habitats accumulate water year-round. These provide a mild and damp climate. Grass and trees grow luxuriantly, and numerous species of animals are common. This environment enables the Chinese Alligator to not only procure food, build holes, and mate in the water, but also to build nests and produce offspring on land. In the course of thousands of years, it was here that people reclaimed wasteland and built water conservation projects. Artificially cultivated plants were grown instead of natural vegetation. The alligator's holes

and nest-sites were destroyed extensively. All of this resulted in reduction of range and population size. We have investigated the habitat of the Chinese Alligator in the villages of Wanchun and Yitai, and the town of Qingshuihe on the outskirts of Wuhu. At present, there is level and open terrain with a vast extent of farmland, numerous villages, and well-developed roadways. The Shuiyang River lies to the east, flowing westward where it meets the Yangtse River. The Chinese Alligator is extinct in this region, which was altered radically about 80 years ago. Beach used to stretch for tens of miles along both sides of the Qingyi and Shuiyang Rivers. When the tide ebbed, reeds and other plants were exposed, providing habitat for many varieties of animals. When the tide was at flood, alligators were common on remote beaches in sparsely-inhabited areas. From the late 16th to the early 20th centuries, people from the north of the Yangtse River moved into this area, and began to cultivate an increasing amount of beach land.

The Wanchun Embankment was built in 1904. When a dam was being built, alligators were common around the flooded plain. When a dam was completed, they still inhabited ponds, pools, and ditches within the dam. As the alligators dug holes and built dens, they often destroyed the dam, flooding seedlings, and endangering fish and ducks. Peasants made a point of hunting Chinese Alligators whenever they were discovered, and the number of individuals living in the embankment has declined. However, on the plain that had once been flooded, where the Shuiyang and the western Qingyi rivers meet, a great number of Chinese Alligators survived. In 1927, people began to build a dam at this spot. The Yitai Embankment was completed in 1931. Farmland and villages replaced the beach. Within the memory of the former generation, "Chinese Alligators could be heard roaring everywhere in summer -as much as frogs are heard croaking- echoing the whole neighborhood". It was here in 1935 that Z. D. Xiao conducted a study and described the state of the Chinese Alligator. There were a number of the animals in this region then. C. G. Zhu (1951-1956) made an investigation in the same region and only discovered alligators in Wuhu. This region was a desolate beach then. In 1954 I captured one alligator and made it onto a specimen. It has been preserved in the Department of Biology, Anhui Normal University. In 1959, the Wanchun floodgate was built to irrigate farmland. In the meantime, people built a complete set of engineering equipment and an irrigation canal. All Chinese Alligators were dug out and killed. The area became farmland, and the habitat of the Chinese Alligator was destroyed. A large-scale drive to eradicate the blood fluke was launched in 1958. A large amount of sodium pentachlorophenate was applied to the river basin. The last alligator at Yitai Village was poisoned. During the twenty-odd years that followed, Chinese Alligators and their sign were not found. The Qingshuihe River is only an example. Other locations met the same fate but in various degrees. People have multiplied considerably in the present range of the Chinese Alligator. They weeded all corners to get brushwood burnt. When alligators began to build nests and hatch eggs, sufficient weeds were needed. The weeds grew less and less, and in 1984 only one alligator deprived of a nest was captured by a peasant.

Due to the fact that vegetation was destroyed, the areas of water in reserve had sharply dropped, and the area of wasteland to reclaim had greatly increased. The ponds and ditches that have never dried in history show frequent droughts at present. Moreover, because the forests have disappeared, soil and water cannot be conserved. There are rivers that flow into the Yangtse River (e.g. the Qingyi, Shuiyang, and Zhang rivers) whose beds have risen 1-2 meters in height, and have frequently flooded. Flood and drought have rendered the alligator's livelihood exceedingly difficult. When habitats incurred drought and flood, the alligator had to move away from the dry land or the submerged holes and look for habitat elsewhere. They were often captured or killed during the process of moving.

Excessive, indiscriminate capture or slaughter

Chinese Alligators are often killed because they consume fish, ducklings, and small geese, and damage dams by digging holes. Thus they damage things that are of immediate benefit to people. Another significant factor is that the alligator supplies edible meat, useful skin, and medicinal materials. So, excessive and indiscriminate capture and slaughter has not been rare in the past, and remains common in the present day. For example, *Guoxianjiayou*, a book written during the reign of Jiajing in the Ming Dynasty, records:

The bank of the upper Yangtse River near Nanjing often collapsed during the early years of the Ming Dynasty. It was due to this reason that the Chinese Alligators had herein drilled holes. It was reported that there was an old fisherman who had once said: 'Roast dogs were used as bait, put a hook; by raising the bait, you trapped alligators'.

The above record was not mentioned in the history of the middle Ming Dynasty, which verified the fact that after excessive harvesting during the early years of the Ming Dynasty, Chinese Alligators living in the Nanjing area had become very scarce. The *Classical Chinese Materia Medica*, written by S. Z. Li, recorded the medicinal value of Chinese Alligators, and their meat was served as favorite dishes at wedding feasts. All these serve to verify that catching alligators was in great vogue at that time. After going through the great disaster of catching and killing during the Ming Dynasty, the alligator's population was reduced, and its range dwindled rapidly. During the Qing Dynasty, the government began to divide land into regions to provide cattle ranches for the Mandarin. For example, Wanchun Dan in Wuhu district was an area of land reserved for cattle ranches. People were forbidden to plough or sow in such land so that wild grass could grow densely. Such reservations gave alligators fine conditions for prolific reproduction. But the custom of killing alligators continued.. Peasants not only caught alligators by using fish hooks, but developed a new device of string bows set around the burrows. As soon as the alligators emerged, they were trapped.

Application of large amounts of chemical fertilizers and insecticides in the field

Alligators feed on snails, mother-of-pearl, shrimp, aquatic insects, fish, frogs, turtles, birds, and small mammals. Among these, aquatic animals are their chief food. Since a great quantity of chemical fertilizers and insecticides have been applied to farmland in recent years, the growth of the fish, shrimp, and mothers-of-pearl is affected when the polluted water flows into ponds. So, the decrease of natural food has greatly influenced the reproductive success and survival capacity of alligators. It is common for young alligators to die during the winter season due to insufficiency of food.

Protection and captive breeding of the Chinese Alligator

In order to ensure the survival of the Chinese Alligator, the Forestry Department of the China National Government, and the Anhui Provincial Government have taken two measures.

1. Conservation

The first measure (in 1980) was to set up natural conservation effort for the species. The main goal was the protection and enlargement of the existing Chinese Alligator population and the protection of their habitat. Thus, a unit of leadership was established in the project which covers five counties with their respective species-protection work units. Reported here is the conservation effort:

In order to observe and investigate the location and population size of the species, the conservation workers in each county employ identical approaches. They inquire with the local folks, explore caves, and calculate statistics using headlamps. Every possible water habitat is examined. Since alligators have stationary territories, observation in the field is convenient. A

stock of information resulted from the project, and provided valuable data for the development of the species.

Through legislative measures, the National Government has ruled that the Chinese Alligator is a first-class rare animal to be conserved and protected. Hunting is not allowed. According to Item 130 of the National Offense Law, those who break hunting regulations by hunting in a restricted region, during a restricted period, by forbidden means, or harm rare animals, will be sentenced to two years in prison, or be subject to a heavy penalty. These regulations are strictly enforced by the police, who exercise their mission to keep the dignity of the law.

It is openly advocated that the Chinese Alligator is one of China's rare and valuable animals, and belongs to our national resources. Local folks are enlightened and therefore change their view of the Chinese Alligator as a harmful species. Folks are also made to recognize the great significance of the Chinese Alligator in academic research and its considerable economic benefits. Thus, everyone begins to be concerned about the species, and protects it. The provincial and local governments also post notices to inform the public that protection of the Chinese Alligator is rewarded, while the killing of the species is punished.

A full consideration of spatial and temporal factors strengthens the effectiveness of the conservation effort. Because the alligators presently have a fragmented distribution, their conservation is negatively affected by overcrowded human habitats with their large stretches of farmland and weaving highways. Considering these factors, many conservations stations are set up in the conservation area. If alligators are spotted in their caves, a conservation station is immediately set up with someone (usually a local farmer) who is responsible for the station and is paid from a special fund from the National Forestry Department. As the conservation station, no one is allowed to use chemicals, to cut grass, or to ravage the alligator nests and eggs. Consequently, the alligators in the conservation area enjoy proper protection. In some areas, alligators obtain the necessary conditions for reproduction, such as in Xuancheng, Nanling, and Jingxian counties, where in the past two years, alligators have been seen nesting, laying eggs, and hatching young. The alligator population in these areas is recovering and increasing in size.

2. Research

In order to achieve the rapid and effective recovery of the Chinese Alligator population, the second measure taken by the Forestry Department and the Anhui Provincial Government was to set up the Anhui Research Center of Chinese Alligator Reproduction in close cooperation with the Department of Biology, Anhui Normal University. Here, a thorough study of the ecology of the species has been made. This has resulted in a systematic theory to be applied to captive breeding and artificial reproduction. Currently, the artificial incubation of Chinese Alligator eggs, and the raising of the young alligators has had much success. Details are reported as follows:

Pen construction. A pen for alligators should be located in quiet marshy areas with appropriate temperatures and rich sources of food. After the location in decided, pens must be constructed with walls of brick, stone and cement. The height of the walls should be over two meters. When the rainy season comes, the walls may by surrounded by standing water, so the foundation should by 1.5 m below ground level, so as to keep the alligators from escaping by digging. The pen pond should be planted with trees and bushes, making it possible for the alligators to nest under the cover of vegetation. The land should be scattered with wild seeds to provide the necessary grass for nesting. The depth of the pond water should be kept at 0.5 m or more. Within the pond, small islands are built, where the alligators can enjoy sunshine.

Captive breeding. Captive breeding efforts

must take into account such biological factors as sexual maturity, courtship, copulation, nesting, and hatching. At different stages of growth, alligators have different requirements as to the quality and quantity of food. At sexual maturity, alligators need many kinds of substances, so food should be prepared with variety. During courtship and copulation, when they are stimulated by sexual hormones, both males and females are very active, and will often fight for a sexual partner. Males and females should be grouped on a ratio of one male with three to five females. The water depth should meet the requirements of activity and copulation. For constructing nests, large quantities of grass should be provided in the reproduction areas, so as to provide sufficient nesting materials for the gravid females, and to prevent fighting, harmful interactions, and decrease in egg deposition. During the entire period of reproduction, female alligators must be kept in extreme quiet in order for them to perform. As the alligator's appetite is slightly decreased by the process of reproduction, feeding should be monitored. After egg deposition, alligators begin to eat more, and the usual level of feeding is resumed. Overfeeding is to be avoided, lest the alligators gain too much fat, which affects their health and lowers reproductive productivity. During the winter, more care should be given, and all alligators who have not entered their caves before hibernation should be captured and sent to artificial hibernation chambers.

Egg deposition of captive alligators. Given the above requirements, captive alligators can lay eggs normally. The adult captive alligators we bred laid 264 eggs in 1983, 503 eggs in 1984, 809 eggs in 1985, 801 eggs in 1986, 1045 eggs in 1987, and 1219 eggs in 1988.

Artificial incubation of alligator eggs

Construction of incubation chambers

The incubation of alligator eggs requires high temperature and humidity. In constructing incubation chambers, enough emphasis should be placed on temperature and means of raising temperature. The surface of the chamber walls should be waterproof. The walls and floor should allow for cleaning readily. The incubation chambers at he Chinese Alligator Research Center have a double glass roof, and a double glass wall that faces south. Temperature is controlled by the temperature-controller. The incubation chambers should not be too spacious, so as to save energy and allow for easy control.

Equipment for incubation

Make a round egg collector and a square incubator which can let water go through at the bottom, to keep the eggs from being suffocated by the standing water at the bottom. Plants which can help stabilize temperature and humidity, and allow for ventilation, best serve as the filling of the incubator. The research center finds that moss is a very good filling material. The search is continuing for better fillings. The chamber temperature is generally controlled and monitored by means of electricity.

Techniques of incubation

1) Immediate collection of alligator eggs is required, as too many alligators in the reproduction area can possibly get the eggs crushed if not collected in time.

2) Egg collectors are used in collecting eggs. Quick action is required, and attention is to be given to the natural order of the eggs. The alligator eggs are stacked in baskets according to their natural order, and are sent to the incubation chambers immediately. Try to avoid shaking as much as possible in carrying the eggs.

3) Incubators and incubation chambers should be kept clean and be adequately sterilized to avoid bacterial or viral infections.

4) Alligator eggs are often in multilayer order when discovered in the wild. Artificial incubation requires monolayer arrangement.

5) Incubation temperature should be maintained at about 31°C. Humidity for the first four weeks is 95%. Use 85-95% humidity for the rest of the incubation period.

Raising young alligators

The mortality of young alligators is high in the first year, thus the key to breeding is the successful raising these juveniles.

Construction of cages

Cages for young alligators have requirements identical to those of the incubation chambers, as well as ventilation, sunlight, and adequate water and drainage.

Methods of raising hatchlings

The time between pipping and breakdown of the shell varies from a little over an hour, to two to three days. Hatchlings slow in liberating themselves are often poor in health, so they should be taken good care of. The hatchling has a crack 1.3-1.5 cm long in the vent in which some unconsumed yolk remains. This continues to provide sustenance for the hatchling, which needs no food during its early infancy. When to feed the hatchlings is still being studied. The newly-hatched alligators can be kept in the cage with enough area of water and dry sand and stone for the alligator to move about freely. Water supply and sanitary conditions are a significant factor in survival rate. Consequently, daily cleaning is required to remove food remains and excrement. When the hatchlings need to be fed, some *Oryzias latipes* can be thrown into the cage alive. Hatchlings in dry areas can be fed with fish meat in a small saucer, or with artificially-prepared food. Hatchlings are especially greedy; however, too much food can give rise to gout. If hatchlings are found in low spirits, tired of eating, or suffering from paralysis of the legs (a symptom of gout), feeding should be stopped immediately.

Soon after the hatchlings liberate themselves from the shell, the weather gets cool, which could reduce their appetite. Now, the temperature should be raised. The temperature in the cage must be maintained at approximately 31°C. The hatchlings will recover their appetite and will gain weight rapidly. In fine weather when the temperature rises to its normal level, hatchlings should be given more of a chance to enjoy sunshine. Individual differences in growth rate will be evident by now, and the young alligators should be grouped accordingly. In the area around the cages it is desirable to keep quiet, cut down human interference, reduce the possibility of infection by pathogens, and to reduce the possibility of predation on the alligators by mice. When the young alligators grow as weighty as 40 g, they can be sent into hibernation. Two or three days before hibernation, feeding is stopped so as to avoid diseases and ailment caused by food left in the digestive canal when temperature is lowered. It is desirable to reduce the temperature gradually until all food is completely digested. Temperature should be lowered by 2-3°C each time. Below 20°C, a larger decrease is allowable. 10°C is the proper hibernation temperature. Hibernation chambers can be set up underground, at a temperature of 10-12°C, and at 80% humidity. Late in hibernation, bowls of fresh water are supplied for the young alligators.

To conclude, our breeding techniques generally agree with the natural growth of young alligators in the wild. Consequently, the population rises year by year. The number of surviving captive-bred Chinese Alligators is as follows: 66 in 1982, 77 in 1983, 117 in 1984, 300 in 1985, 450 in 1986, and 975 in 1987.

Acknowledgments

I thank Prof. Ermi Zhao for his kind help in correcting this paper.

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