

Chinese Crocodile Lizard

Chinese crocodile lizard (*Shinisaurus crocodilurus*) information, care and breeding.

By Ernst G. Hofmann

Habitually secretive and unique in morphology and behavior, the Chinese crocodile lizard, after its discovery in 1928, sank into oblivion for 23 years. Professor Shin, of Sun Yat-sen University, collected the Chinese crocodile lizard at one of his student field trips to the Guilin region in the mountainous part of Guangxi (Kwangsi) Province. Asian herpetology was in its infancy at this time. The discovery of the Chinese crocodile lizard, with a tail like a crocodile, must have been quite a surprise. Shortly thereafter, several specimens reached the noted German herpetologist Ernst Ahl, who described the find as a new species, genus and family, christening the Chinese crocodile lizard, *Shinisaurus crocodilurus*, in honor of its discoverer, Shin. This established the family Shinisauridae, at least for the time being.

Semiaquatic, the Chinese crocodile lizard is able to submerge and remain motionless or move around underwater for long periods of time, entailing a drastic reduction of respiratory rate.

Photo by Steve Cooper In 1932, the highly regarded biologist Baron Franz Nopcsa speculated placing *Shinisaurus* with the Bornean earless monitor *Lanthanotus* since no ear openings are present in the Chinese crocodile lizard. Tsang How Fan, also a Professor of Sun Yat-sen University, observed the Chinese crocodile lizard in the field in 1931 and published observations on its diet of mollusks, tadpoles and fish. McDowell and Bogert (1954) carried out intensive anatomical studies and placed *Shinisaurus* with *Xenosaurus* in the family Xenosauridae. Linking the trans-Pacific distribution of the two forms could only be based on the continental drift theory. *Shinisaurus* differs from *Xenosaurus* in its characteristic way of transforming its scale surface structure during ontogeny, a phenomenon never described for any other lizard species (Harvey, 1993). Zhang (1991), Zhao and Adler (1993) reverted *Shinisaurus crocodilurus* to be the only species and genus in its own family, Shinisauridae.

Description

Male Chinese crocodile lizards average 16 inches in total length, with females being slightly smaller. On the head, the scales are plated, with ridged scales behind the eyes. From neck to tail base, the lateral scales are beadlike, interspersed with knobby scales.

Dorsally, four rows of distinctly high-ridged, oval-shaped osteoderms merge with two sharply keeled rows of scales from the tail base to the tip of the tail. The latter characteristic prompted the common name "crocodile lizard." Ventrally, the scales are flat, plated and arranged in transverse rows. Coloration is variable within sexes, with males generally more colorful than females. Some male Chinese crocodile lizards are strikingly clad with brilliant orange flanks and throat, occasionally the bright colors reach into the entire lateral part of the head. Colors intensify during the breeding season. In general, dorsal colors of various shades of brown from head to tail dominate in both sexes. Ventral colors vary from yellowish tan to light orange. Newborn shinisaurs are uniformly deep brown, with a light tan snout and forehead.

Stomach contents from Chinese crocodile lizards in the wild showed tadpoles, a variety of insects and a considerable amount of caterpillars, as well as dragonfly larvae. Food intake per week in adults is 10 percent of body mass, in gravid female Chinese crocodile lizards it rises to 41 percent, reaching 57 percent in juveniles (Fan, 1931; Zhang, 1985; Shen & Lee, 1987).

Habitat and Behavior

Chinese crocodile lizards inhabit small ponds (3 to 5 feet in diameter) and slow-running rivulets within the eroded karst mountains, also known as "Mogots," south of Guilin (Kueilin), Guangxi (Kwangsi) Province. These sugar loaf-shaped limestone formations rise abruptly from the western edge of the South China plain. The bizarre rock formations of the Mogots are covered with dense vegetation consisting of shrubs interspersed with low trees. In summer, air temperatures peak at 102 degrees Fahrenheit (38 degrees Celsius). Winter temperatures as low as 29 degrees Fahrenheit (-4 degrees Celsius) are not uncommon. At an altitude of 650 feet (200 meters) to 2,500 feet (760 meters), sharply contrasting day-night temperatures prevail. With a mean annual rainfall of 80 inches (2,000 millimeters) (Zhang 1991), the region has a reputation for being shrouded in an almost constant mist.

Usually only one Chinese crocodile lizard individual inhabits a pond. The dense vegetation with tree branches overhanging the waterholes provide the preferred shade and sleeping places. Shinisaurs spend long periods of time out of the water, frequently remaining motionless for hours in a "metabolic pause," suspending response to any surrounding stimuli. To no

surprise, the indigenous people call shinisaur "the lizard of great sleepiness" (Grzimek, 1975). Observations of the Chinese crocodile lizard remaining immobile for hours, occasionally for days, led to the belief that it could cure insomnia. This traditional medicinal use has most likely been going on for hundreds of years.

Semiaquatic, the Chinese crocodile lizard is able to submerge and remain motionless or move around underwater for long periods of time, entailing a drastic reduction of respiratory rate. This shut-down mechanism could aid in calorie conservation, an adaptation to the region's trend of sudden cooling (Sprackland, 1989). Hibernation begins in November when water temperatures drop below 60 degrees Fahrenheit (15 degrees Celsius) and ends in March with the warming of the ponds. During the winter months the southern latitude sunshine, occasionally burning off the mist, stimulates brief activity periods. Mating takes place in August. Females have been reported to give birth from April to May; usually two to seven young are born (Zhang, 1985).

Husbandry

When I spotted a Chinese crocodile lizard in a local pet shop in 1987, I was instantly captivated. The storekeeper, whom I knew since his teens, sold it to me for just \$25 knowing only that it was a semi-aquatic lizard from Asia. Arriving at home with my prize lizard, I searched for information, which resulted in only two very brief descriptions of this species, one in Grzimek's Animal Life Encyclopedia (1975), the other in Living Reptiles of the World (Schmidt & Inger, 1957). No information on captive care was available, perhaps for a good reason-most of the imports did not survive in captivity very long at that time. In continuing my search for information on care in captivity, I contacted my reptile keeper friends at the Bronx Zoo. From them I learned that a small group of crocodile lizards were kept in an off-exhibit setup in aquariums at a water depth of 2 inches, with just a rock placed in the tank for them to get out of the water. No information on feeding was available. Consequently, I was left with the challenging task to find ways and means to make this rare lizard survive in my collection.

I never advocated simplistic and unattractive setups, even in my very first attempts to care for reptiles in captivity, back at 1931 in Vienna, Austria. In those days I was guided by perhaps the most comprehensive publication on this subject, W. Klingelhoefter's Terrarienkunde, (Herpetoculture). The methods described were labor- and space-effective technologies for husbandry and reproduction.

Consequently, I started by setting up a preliminary semi-aquatic, natural habitat vivarium, 36 inches long, 14 inches deep and 14 inches high. One third of the enclosure's floor space was cut out to accommodate a plastic basin to provide 2.5-inch-deep water. I hooked up a Dynaflo filter unit for water purification. The remaining space was arranged with a layer of garden soil and dry leaf litter, several well secured rocks, large pieces of bark as hiding places and a branch hung over the pool for basking. One 20-watt Vitalite fluorescent bulb served for illumination. A 75-watt thermostatically controlled spotlight provided radiant heat for basking. Shortly after placing the crocodile lizard in its vivarium, I offered full-grown crickets, earthworms, mealworms and a variety of seasonally available insects, all of which were taken eagerly. Three- to 5-day-old mice and earthworms became its favored food, on which it would sometimes over-indulge resulting in regurgitation several hours later. This was quite contrary to a number of reports that shinisaur refused to eat and eventually died.

The donation of three wild-caught female Chinese crocodile lizards and one male Chinese crocodile lizard allowed me the opportunity to breed this fascinating lizard. In the years following my first acquisition, information on natural history and reports of occasionally successful breeding became available, spurring a more holistic approach to the involvement in *Shinisaurus* husbandry.

I reasoned that the natural habitat could be more closely simulated by housing the shinisaur in "solar-vivariums," indoor-outdoor enclosures I built in the early 1960s to provide optimal daylight exposure for lizards. Most of my Solar-Vivariums are permanently attached to selected windows with east, south and west exposures, throughout the entire house. The exterior section of a solar vivarium protrudes out of the window. The sides can be solid, the front facing the outside is covered with window screening or 1/4-inch wire mesh. Hinged on top, is a liftable frame covered with two layers of Saran Wrap, which allows 60 percent of UVA and UVB to enter the enclosure. I chose east- and west-oriented basement windows. Keeping the Saran Wrap covers open from late May to mid September provide moderate daytime temperatures and the entry of cool night air. Part of the interior section contains a 2-foot diameter pool with a water circulation and sprinkle-aerator system, directing the return water flow to create a simulated rivulet. The oxygen-enriched water assures sound sanitary conditions, although frequent water changes are necessary during the feeding season. The shinisaur's habit of defecating only in water helps to keep the vivarium clean.

When the cold season approaches, the interior parts of solar vivariums are sealed off from the exterior sections with General Electric greenhouse cover material (GE Thermoclear), in addition to the Saran Wrap covers, to assure maximum insulation. From October through the middle of April, the lizards remain dormant in a substrate of slightly moist leaf litter

under pieces of bark. Supplementary heating, to compensate for outdoor temperatures below 30 degrees Fahrenheit (-3 degrees Celsius), is provided by low wattage, thermostatically controlled, forced hot-air heaters, maintaining a temperature of 55 degrees Fahrenheit (16 degrees Celsius).

Propagation

On April 20, 1991, I observed the first courtship (contrary to August mating observed in the wild). The male Chinese crocodile lizard approached the female Chinese crocodile lizard with vertical head bobbing. After a short chase, the female lowered her head, signaling her readiness for mating. The male secured the female with a holding bite at her nape, simultaneously grabbing the female's tail base with both hind legs to lift her vent. Copulation lasted for 18 minutes, but has been recorded for as long as 90 minutes. Later observations of courtship behavior showed non-receptive females voraciously fighting off the males, occasionally resulting in serious bites. In one instance a male was seriously injured by a female biting his front leg. Only my intervening force on the female's mouth to open it led to the release of the gripping bite. Injuries require careful treatment. The aquatic behavior of the lizards delays the healing process, making them susceptible to infections. It is therefore advisable to keep an injured shinisaur in a dry, or at least only slightly moist, environment. The application of New-Skin Liquid Bandage to treat superficial wounds, is very beneficial in preventing infections.

Sex identification is to a great extent still unreliable and can be quite confusing in the Chinese crocodile lizard. In some individuals the typical red or orange colors indicating a male are coinciding with the recently established theory of the head's length-width-height proportions (Maegdefrau, 1997). One of my females, that gave birth twice, showed typical male orange markings. On the other hand, an individual lacking any orange markings turned out to be a male, confirmed by post-mortem examination.

The individually distinct lateral "facial" patterns in shinisaurs, which develop gradually as the lizards mature, should be used to identify individuals. Sequential close-up photography, at intervals of three to five months until maturity, is a practical way to record these markings. The identification of individuals is essential for managed breeding, studbook recording and gene pool exchange. The lizards' behavior, remaining motionless for long periods of time, makes photographing very easy.

Gestation periods of eight to 12 months are the norm, with one ultrasound confirmed record of 14 months (Maegdefrau & Schildger, 1993). Prior to obtaining this information, a female that I observed mating was gravid for 383 days, which caused me to be concerned about her being overdue in dropping the young. I consulted my veterinarian, Terry Morrison, who suggested the injection of Oxytocin to induce birth, under her supervision. I administered 0.01cc subcaudally, with no forthcoming result after one hour. The second dose was increased to 0.02cc. Forty-seven minutes later the first young was born. With the female resting in the pool, birth was instantaneous and so was the swimming of the newborn, crossing the pool and coming to rest on a rock. Twenty-three minutes later, the second young was born in the same manner. After the second 0.02cc dose failed to promote any further births, Terry decided to x-ray the female to find out if there were any more fetuses present. The result clearly showed three remaining fetuses. Eleven days later all three young were born naturally. The entire litter developed normally into adulthood.

The intervention revealed interesting and valuable facts, but most likely was unnecessary. In some litters there were occasional stillbirths. The largest litter of 11 neonates with no stillbirths, but very small young, occurred in October 1996. All but three refused to feed on their own. Forced feeding was of no avail, and all of them slowly withered away. With the record of a gravid female weighing 250 grams giving birth to 15 young (Maegdefrau, Schmidt, 1997), it can be assumed that the reason for their demise was too large a litter for a female weighing only 185 grams.

Gravid female Chinese crocodile lizards occasionally bask under the heat lamp, preferring only the peripheral warmth of the beam. Considerable time is spent in the pools and streams at water temperatures between 68 degrees Fahrenheit (19 degrees Celsius) and 80 degrees Fahrenheit (27 degrees Celsius). At the time of early imports, several gravid females died during gestation (Andy Snyder, pers. comm.) as a result of the belief that crocodile lizards should be kept entirely aquatic, with constant low water temperatures. I frequently observe gravid and non-gravid females, as well as males, hiding under bark or rocks for several weeks at any time within their activity cycle.

In the wild, mating is reported to take place in late summer (Zhang, 1985). In my own collection, within the past seven years I have observed three out of five matings in early spring. Two of the three spring matings were among wild-caught specimens. More recorded data of mating and giving birth in the wild could perhaps lead to an explanation of the time shift in captive mating. However, a gradual cooling down to temperatures of 60 degrees Fahrenheit (15 degrees Celsius) for three to four months is essential for successful breeding in captivity.

On March 2, 1992, five neonate Chinese crocodile lizards were found. Three were resting on rocks around the pool and

two were motionless in the pool. I removed the birth membrane from the two apparently stillborn and placed them in a screen-covered petri dish to confirm their condition. (A zoo-born shinisaur thought to be dead was placed in a container to be preserved, with the process delayed for two days, it was found very much alive [Sprackland, 1989]. Unfortunately, my two neonates showed no signs of life after 52 hours.)

In order to provide sound sanitary conditions and controlled feeding it is best to rear the young in plastic shoeboxes, replacing the lids with 1U8-inch screening for UV exposure. Vitalight bulbs placed 12 inches above the containers will suffice. Water at a depth of 1 inch with a flat stone as resting place works well. Small crickets, mealworms and earthworms are accepted by most neonates several days after birth, although some individuals refuse to catch their prey. When picked up, neonates always open their mouths in an attempt to bite. In doing so, individuals that do not feed on their own, can easily be fed by hand. I experienced the same phenomenon with most of the following litters. In one instance the entire litter of six behaved in the same manner. Eventually all individuals did feed on their own and developed normally to adulthood. Newborns average 3.5 inches (89 millimeters) to 5.5 inches (140 millimeters) in total length. Captive-raised shinisaur grow considerably faster. The weight of 6-month-old captive-born shinisaur averages 16 grams, as compared to a 7-gram average weight in wild-born specimens (Zhang, 1991, Maegdefrau, 1997).

The most likely reason for the more rapid growth of Chinese crocodile lizards in captivity is a considerably richer food supply and higher temperatures, especially during the winter months. As the young develop into the juvenile state, the bright tan snout color fades away and pattern marks as well as color variations become apparent. Based on my own records of breeding F3 generations, sexual maturity is reached in two to three years. I estimate longevity to be well over 10 years. The oldest individual in my breeding colony, the imported adult male I purchased in 1987, could be more than 15 years old, based on the estimated growth rate in the wild.

Discussion

I can say that in working with Chinese crocodile lizards, the devoted effort is well rewarded. The gentle and tolerant nature of shinisaur allows one to imitate their natural habitat, without their disturbing the setups. Their cryptic behavior, manifested by disappearing into preferred hiding niches, in some instances for several weeks, is rewarded when they reappear and wait patiently to be fed. Most individuals are well tempered, but the docility can be misleading. "Shinis," as I call them for short, can inflict painful gripping bites if hand fed. The best way to feed earthworms, crickets, superworms, etc. is by dropping them in the water basin. The lizards can easily find them, whereas on land the insects can take cover and not be found. If handling is necessary, a firm grip behind the head is a safe way to pick them up. It is best to keep male Chinese crocodile lizards in separate vivaria unless kept in very large setups with extensive, elaborate and secure hiding places. Even visual contact between males kept in separate vivaria provokes vigorous head bobbing. I have kept several male Chinese crocodile lizards temporarily with Chinese water dragons, *Physignathus cocincinus*, and green basilisks, *Basiliscus plumifrons*, without any problems, but there is always the risk of food competition, which could lead to injuries. With females, the additional risk is that if a female is gravid and drops her young, the newborn could easily fall prey to cagemates. Communal housing led to the observation of Chinese crocodile lizards feeding on cat food offered to the other lizards. A report by Gritis (1991) reports a female shinisaur feeding on strawberries and bananas. The unique biology and habits of *Shinisaurus crocodilurus* are somewhat matched by the noteworthy obscurities and tragedies besieging the species and some of the humans involved in its research. There is the "christening" by the German herpetologist Ernst Ahl in 1930, who joined Hitler's army, never to return. The reexamination in 1932 by the flamboyant Baron Nopcsa, whose gaudy lifestyle ended in killing his lover and then shooting himself. Then there was the lack of any research during China's 23 years of unrest. Last but not least is this sleepy saurian's habitat: the peculiar Mogots, sculptured by rain about 70 million years ago. These forested pinnacles are enveloped in an almost constant veil of fog, surrounded by the meandering streams and rivulets so often seen in Chinese paintings.

Status and Conservation

The natural habitat of the Chinese crocodile lizard is under attack by extensive deforestation, causing the streams and ponds in which the lizards thrive to dry out. The loss of ground cover makes them vulnerable to predation by birds, mammals and humans. In 1978, an estimated total population of 5,500 shinisaur within four localities was recorded. By 1991, only three localities of considerable smaller dimensions remained, with an estimated total population of 2,500 individuals (Zhang, 1985; 1991). The "rediscovery" of this lizard after more than 50 years was most likely triggered by commercial interest. Shinisaur were rarely seen in private collections and zoos. Very small numbers appeared on the pet market with four digit price tags. Suddenly, in 1986, there was an increase in exports from China. In 1990, German conservation authorities requested that *Shinisaurus crocodilurus* be placed under CITES regulation in Appendix 2. From that time on, virtually no imports of wild-caught specimens occurred in Europe or the United States. With next to none appearing on the herp market and reports of disturbing trends concerning populations in the wild, there is a great deal of uncertainty surrounding the species' present condition.

In 1996, the Lizard Advisory Group established long-term goals: (1) to improve the status and reproduction of rare and

endangered lizards in North American collections; (2) to encourage the need and opportunity for captive-breeding programs; (3) to establish a worldwide network of field, zoo and conservation biologists and provide a forum through which this network can communicate. *Shinisaurus crocodilurus* was placed in the high priority category to establish sustainable captive populations. This action prompted the publication of a regional studbook for the Chinese crocodile lizard in June 1995 by Andy Snider, curator of reptiles, Detroit Zoo. An updated Five-Year Action Plan for Lizards, in conjunction with the formalization of "Population Management Plans" and "A Preliminary Assessment of the Wild Populations of *Shinisaurus crocodilurus*" was submitted to the American Zoo Aquarium Association for funding. Private breeders are urged to follow institutions by entering their *Shinisaurus crocodilurus* stock in the studbook, to support the population management plan. Hopefully this effort will be expanded to international participation.

As for the populations in the wild, the status is quite uncertain because of the Chinese crocodile lizard's cryptic behavior and the rugged terrain of its habitat. Its existence, known only for 70 years, is shrouded in its three minuscule habitats with a total area of approximately 80 square miles. This monotypic saurian could face a dramatic decline in numbers due to the serious threats by the indigenous human population.

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