

The Discovery of *Mauremys iversoni*-like Turtles at a Turtle Farm in Hainan Province, China: The Counterfeit Golden Coin

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Abstract.— During a visit to a turtle farm in Hainan Province, we discovered turtles that closely resemble *Mauremys iversoni*. The *Mauremys iversoni*-like turtles at the turtle farm were intentionally produced hybrids of two commonly reared species, *Mauremys mutica* and *Cuora trifasciata*. According to the turtle farmer, the intentional production of hybrids between these two turtles is a common practice. The hybrids fetch extremely high prices (~1000 USD/kg) since they are sold as *Cuora trifasciata*, the “golden coin” turtle, to unsuspecting buyers. We suggest, but cannot prove, that all *Mauremys iversoni*-like turtles might be turtle farm hybrids. This hypothesis could explain all of the available evidence and could alleviate a lot of the confusion surrounding this species unusual geographical distribution, sudden appearance in the pet trade, as well as its variable morphology.

Key words.— Turtles, Bataguridae, Geoemydidae, *Mauremys*, *Cuora trifasciata*, *Mauremys iversoni*, China, Hainan, hybrids, turtle farm

Introduction

Mauremys iversoni Pritchard and McCord 1991 is one of ten new Chinese chelonians described from specimens purchased through the pet trade since 1987. From the beginning, our knowledge of this species' geographical distribution has been fraught with confusion. The type specimen of *Mauremys iversoni* (UF 71866; institutional abbreviations follow Leviton et al., 1985) and 19 other individuals are reported to have come from Fujian province (Fig. 1a), but eight additional specimens from a locality in Guizhou (over 1000 km away) were also reported (Fig. 1b). Pritchard and McCord (1991) propose two hypotheses to explain this disjunct distribution: 1) The distribution is (or was) continuous between these localities; 2) One of the localities (perhaps the type locality) is the result of turtles being relocated by traveling Buddhists.

An additional wrinkle is provided by Iverson and McCord (1994) who suggest that the type series of *Mauremys* “*guangxiensis*” (=“*Clemmys guangxiensis*” Qin 1992) from Guangxi (Fig. 1c) is actually a composite of *Mauremys mutica* and *Mauremys iversoni*-like specimens. However, some differences between the *M.* “*guangxiensis*” *iversoni*-like specimens, the Guizhou *M. iversoni* specimens, and the Fujian *M. iversoni* specimens have been noted (Pritchard and McCord, 1991; Iverson and McCord, 1994). The result is the occurrence of different-looking *M. iversoni*-like turtles from three disparate

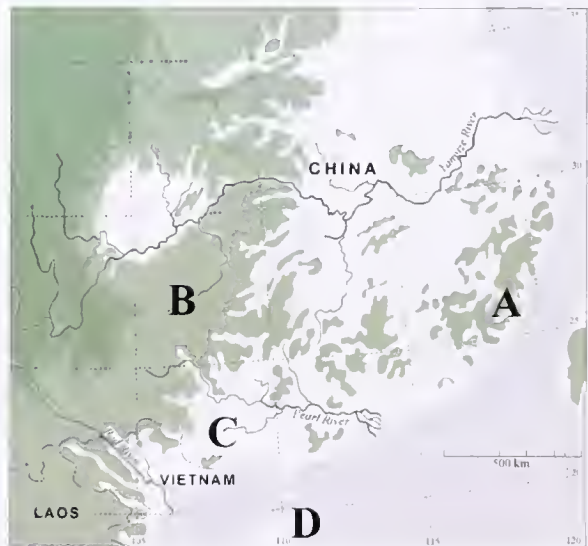


Figure 1. The reported localities of *Mauremys iversoni*-like turtles in China: A) Type locality, Nanping, Fujian Province (Pritchard and McCord, 1991); B) Kweiyang, Guizhou Province (Pritchard and McCord, 1991); C) Nanning, Guangxi Province (Qin, 1992); D) Tunchang, Hainan Province (This study).

regions in China between the years of 1986 and 1991 (Fig. 1). Based on observations from a breeding facility located on Hainan Island (Fig. 1d), we propose a third hypothesis that might explain all of the available data and possibly alleviate much of the confusion: All *Mauremys iversoni*-like turtles are the result of the



Figure 2. An intentionally produced hybrid from a Chinese turtle farm (MVZ 230475) that closely resembles *Mauremys iversoni*. Photo by JFP.

hybridization of *Mauremys mutica* and *Cuora trifasciata* in captivity.

Chinese turtle farms

The role of turtle farms in the Asian turtle trade is often overlooked. The primary reason for this is the secrecy of the turtle farmers themselves. Despite our ignorance, the practice of farming turtles in China is a widespread, lucrative endeavor. As far back as 1991, Zhou and Zhou report that *Cuora trifasciata* is being

bred "everywhere". In the past ten years, the number of turtle farms is rumored to have increased dramatically. Although it is not possible to provide exact numbers, there are estimated to be at least ten breeding facilities on Hainan alone. In an attempt to assess the impact of this burgeoning business to the Asian turtle trade, one of us (HS) has gained access to a large turtle farm in Tunchang, Hainan province (Fig. 1d) from 1996 to the present. This paper represents the second report of this effort (see also Shi and Parham, 2001).

According to the owner of the turtle farm, the Tunchang breeding facility was first established in 1983. The foundation of its breeding stock came from dozens of wild collected *Cuora trifasciata*, *Mauremys mutica*, and *Ocadia sinensis* from Hainan as well as additional specimens from a farm in Guangdong that was established in 1978. It currently houses an estimated 15,000+ geoemydids. Early on, the number of breeding ponds and turtles was limited and the establishment of breeding stocks proceeded without clear aim. Almost all the local species of turtles were collected from the field or bought from villagers and often kept in the same pond or enclosure.

In November of 1999, the authors visited a smaller facility that included several indoor breeding ponds.



Figure 3. A comparison of *Mauremys iversoni* plastra from the type description with turtle farm hybrids and putative parental species: A) *Mauremys mutica* from a turtle farm in Tunchang, Hainan Province (MVZ 230477); B-D) *Mauremys iversoni* from the type description. They are either from Fujian or Guizhou Province; E-F) Intentionally produced hybrids from a turtle farm in Tunchang, Hainan Province; G) *Mauremys iversoni* from the type description. It is either from Fujian or Guizhou Province; H) An intentionally produced hybrid from a turtle farm in Tunchang, Hainan Province (MVZ 130475); I) *Cuora trifasciata* from Tai Pin, central Hainan Province (MVZ 23932); J) *Cuora trifasciata* from the pet trade (MVZ 230636). Photos by JFP [a,e-f,h-j] and Pritchard and McCord (1991)[b-d,g].

Although numerous species were observed, *Mauremys mutica* and *Cuora trifasciata* were the most abundant. Many of the *C. trifasciata* were kept separately, but one pond included *C. trifasciata*, *M. mutica*, and even a *Chelydra serpentina*. When asked if any of the turtles ever hybridized, the workers of the farm produced several animals that closely resembled *Mauremys iversoni*. One of these hybrids, a subadult male, was procured as a voucher (MVZ 230475; Fig. 2, 3h). JFP was given permission to photograph two other hybrids (Fig. 3e,f).

The turtle farm hybrids

As with the three previously reported incidences of *M. iversoni* (Fujian, Guizhou, and Guangxi), there are some differences in the Hainan farm specimens. Unfortunately, it is difficult to understand these differences because of inconsistencies in the reporting of previous measurements, small sample sizes, and the fact the most important specimens remain in private hands. For example, Pritchard and McCord (1991) present bivariate plots of measurements for adult *Mauremys iversoni*, but inexplicably include only five of the adult males. It is not stated from which locality (Fujian or Guizhou) these specimens are from or why the measurements of all 10 of the adult males from Fujian (the type locality) are not included. Table 1 of Pritchard and McCord includes 10 shell measurements for all the specimens, but excludes the two measurements (the interpectoral length [IPL] and the interanal length [IAN]) that would have allowed the type series to be included in the bivariate plot. Iverson and McCord (1994) perform a more detailed study of variation within East Asian *Mauremys*, but do not present the raw data and only include one specimen of Guizhou *Mauremys iversoni* (no voucher).

The relevant shell measurements of MVZ 230475 are as follows: IAN= 1.4 cm, IPL= 1.1 cm, CL= 11.4 cm, IAN/CL= .1228, IPL/CL=.096. MVZ 230475 is a juvenile and smaller than three specimens excluded from the adult category by Pritchard and McCord (1991). Bearing this consideration, a comparison shows that the morphology of MVZ 230475 is unlike the type series of *Mauremys iversoni*, and apparently unlike the other *Mauremys*. It is uncertain what the variation between and among the *Mauremys iversoni* series (from Guizhou and Fujian) is fully represented by the polygon in Pritchard and McCord (1991). Since the relevant scale ratios from their entire series, including the subadult specimens, are not reported, we are forced to rely on the close phenetic similarity between the turtle farm hybrids and *M. iversoni* for our conclusions. It is important to emphasize that if



Figure 4. *Cuora trifasciata* from a Chinese turtle farm showing light head coloration. Photo by HS.

all *M. iversoni* are turtle farm hybrids, then we should expect them to have an extremely variable morphology, especially if they are the result of separate hybridogenic events. This pattern is borne out by the previously reported *M. iversoni*-like turtles (Pritchard and McCord, 1991; Qin, 1992; Iverson and McCord, 1994).

In terms of coloration, MVZ 230475 and the hybrids photographed at the Tunchang turtle farm closely resemble *Mauremys iversoni*. The head coloration of MVZ 230475 is lighter than that of the specimen figured by Pritchard and McCord (1991), but a variation in head coloration in *Mauremys iversoni* was noted by Fritz and Obst (1999). MVZ 230475 is almost identical to the lighter individual figured in that work. The variable head coloration in *M. iversoni* can be linked to the variation in *C. trifasciata*. For, while most *C. trifasciata* have dark postorbital markings, *C. trifasciata* with light head coloration are known (Fig. 4), especially in turtle farms. Pritchard and McCord (1991) state that *M. iversoni* can be distinguished from *M. mutica* by a horseshoe-shaped coalescence of blotches from the pectorals to the anals (with the open end anterior). Although they state that this pattern is not found in *Mauremys mutica*, Zhou and Zhou (1991, p. 38) illustrate a *M. mutica* (locality not stated) with this this plastral pattern. Later, Iverson and McCord (1994) illustrate a *M. mutica* from Taiwan (FMNH 127181) that also has a clear horseshoe-shaped coalescence of blotches. Even without this character, *M. iversoni* can be distinguished from *M. mutica* by its more rounded anterior lobe that lacks a prominent gular projection. Furthermore, many *M. iversoni* specimens, including some of the type series

of *M. iversoni* and the Hainan farm hybrids (Fig. 3b-f) have transverse trending blotches on the pectorals, a feature not known to occur in *Mauremys*, but common in juveniles of *C. trifasciata*.

The variation among the figured specimens in the type description is extreme (Fig. 3b-d,g). It is not stated whether these specimens are from Fujian or Guizhou. Comparisons of the plastral figures from Pritchard and McCord (1991) with the specimens from the Tunchang farm show that the latter specimens lie within the range of variation of *M. iversoni*. The most notable differences are that one (Fig. 3e) has more irregularly shaped plastral blotches and MVZ 230475 (Fig. 3h) has only a narrow, light, central figure on the plastron. Perhaps the most important feature to be noted is that no two specimens look alike. In the type description, Pritchard and McCord (1991) describe the plastral pigmentation as "very variable in intensity", but it is unclear whether the figured specimens represent the most typical patterns of *Mauremys iversoni* or the entire range of variation.

Luckily, there are three characters of *M. iversoni* that clearly set it apart from other East Asian *Mauremys*: 1) its olive or yellow head, 2) rounded end of anterior lobe of the plastron and 3) red coloration on the underside of the limbs. Until the description of *Mauremys iversoni*, the red coloration of the limbs was a diagnostic characteristic of *C. trifasciata*. The light head coloration and rounded lobe are also reminiscent of *C. trifasciata*. Furthermore, in *Mauremys iversoni* the sulcus between the humeral and abdominal scutes lies closer to the hyo/hypoplastral suture than it does in other *Mauremys*. An alignment of this sulcus with the junction of these bones is a character shared by *C. trifasciata* and other taxa with a kinetic plastron. In other words, the morphology of *Mauremys iversoni* is intermediate between *C. trifasciata* and *M. mutica*, and therefore consistent with a hybrid origin. A detailed comparison of the mitochondrial DNA and allozymes of this specimen and other pet trade "species" is currently under way (Parham et al., 2000; in prep.).

Discussion

During our joint visit to the Tunchang turtle farm, the workers stated that production of *Mauremys iversoni*-like turtles was the result of infrequent, accidental hybridization events. Since that time, the owner of the farm has confided that the intentional production of *C. trifasciata* X *M. mutica* hybrids is a common practice undertaken by several turtle farmers. Because practitioners of Chinese traditional medicine claim that *C. trifasciata* has many medicinal proper-

ties, and recently it has also been suggested that it has the ability to cure cancer, it is highly valued. As a result, it is often called the "golden coin" turtle. The price of turtles is determined by their weight. In the year 2000, 1 kg of *M. mutica* sold for approximately 100-120 yuan (~15 USD) whereas 1 kg of *C. trifasciata* sold for 6,000-8,000 yuan (~1000 USD). According to the turtle farmer, it is possible to sell the hybrids of *C. trifasciata* and *M. mutica* as pure *C. trifasciata* since, to the untrained eye, these species closely resemble one another, especially in the yellow coloration of the head. The confusion of these two forms should not be surprising since Timmins and Khounbolin (1999) report that even people familiar with *C. trifasciata* have mistakenly identified juvenile *M. mutica* as this species. Therefore, it is possible to produce and sell large numbers of counterfeit "golden coins" to unsuspecting buyers without having to obtain large numbers of adult *Cuora trifasciata*.

The high degree of phenetic similarity between the *C. trifasciata* X *M. mutica* hybrids from Hainan and the *M. iversoni*-like turtles reported from Fujian, Guizhou and Guangxi strongly suggests that all of these animals may be the product of accidental or intentional hybridization in turtle farms. This hypothesis explains the unusual morphology, its sudden appearance in the pet trade, absence in historical collections, and the confusion surrounding the distribution of this taxon. The timing of the discovery of these turtles shortly follows the increased demand for *Cuora trifasciata* as a reputed cure for cancer (van Dijk et al., 2000). This increased demand may have initiated the establishment of numerous turtle breeding facilities that led to the production of *Mauremys iversoni*-like turtles.

We stress that the practice of housing and breeding several species of chelonians in a single enclosure or pond is probably not restricted to the Tunchang farm alone. If the establishment of other facilities mirrors the one on Hainan, the sudden appearance of new and unusual turtles in the pet trade would be expected. The ability of turtles to hybridize is well documented (Fritz and Baur, 1994; Fritz, 1995). Certain species, such as *Mauremys pritchardi* McCord 1997, have already been implicated as possible hybrids (Artnier et al., 1998). Others, such as *Sacalia pseudocellata* Iverson and McCord 1992, *Ocadia glyphistoma* McCord and Iverson 1994, and *Ocadia phillipeni* McCord and Iverson 1992 are known from a paltry number of specimens which might be indicative of an accidental production in a turtle farm (van Dijk, 2000; Lau and Shi, 2000). It is probably not a coincidence that many of the newly described species (*O. phil-*

lipeni, *S. pseudocellata*, and *M. iversoni*) can be distinguished from their congeners by characters found in the commonly reared and highly valued *C. trifasciata*. Studies of the DNA of the holotypes of these species, compared with multiple, field-collected, vouchered specimens of established species from known localities, could easily determine the validity of these taxa.

Conclusions

It is uncertain whether all of the reported collection data from the pet trade, such as the distributional data for *Mauremys iversoni* are actual or fabricated. The rest of the available evidence strongly suggests, but does not prove, that all *M. iversoni*-like turtles could have a turtle farm origin. Parham and Li (1999) openly question the Yunnan locality of *Cuora pani* that was provided by the same pet dealer credited with collecting the original *Mauremys iversoni* series. The high prices that unusual turtles with locality data can fetch from turtle fanciers could serve as incentive to fabricate collection data. Furthermore, there is also incentive to hide the true locality as a trade secret, especially if the locality is a Chinese turtle farm. Of course, given the current scarcity of turtles in Asia it is difficult to prove that a locality is in error or whether the turtles have been extirpated. Verified distribution data for rare chelonians (e.g., Iverson, 1992) are critical to understanding their current and historical status. False localities unnecessarily complicate our meager understanding of turtle distributions. In light of the confusion surrounding pet trade data, we recommend that workers should treat them with utmost caution until they are supported by evidence that is more reliable.

Given the seemingly uncontrollable Asian Turtle Crisis, determining which species are valid evolutionary lineages and which are turtle farm hybrids is important. Otherwise, crucial resources could be wasted on invalid taxa. For example, the Red data Book of Endangered Animals (Wang, 1998) suggests that Fujian and Guizhou provinces protect *M. iversoni* and that surveys and ecological studies should be performed in order to determine the proper conservation strategies. We concur with van Dijk's (2000) assertion that researchers should make the investigations on the validity of the pet trade species a priority so that the limited resources for conservation can be directed towards established taxa that are undergoing unimagined, precipitous declines.

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