CONSERVATION BIOLOGY OF FRESHWATER TURTLES AND TORTOISES

A Compilation Project of the IUCN/SSC Tortoise and Freshwater Turtle Specialist Group

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Cuora zhoui Zhao *in* Zhao, Zhou, and Ye 1990 –
Zhou's Box Turtle

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Cuora zhoui Zhao *in* Zhao, Zhou, and Ye 1990 – Zhou's Box Turtle

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Summary. – Zhou's Box Turtle, *Cuora zhoui* (family Geoemydidae), and its synonym, *Cuora pallidicephala*, were both described in the early 1990s from trade specimens purchased in southern Chinese food markets. The animals were claimed to have come from small areas of highland streams in southwestern Guangxi and southeastern Yunnan provinces in China, respectively. However, the species' native range remains unknown, although suspected to have been a very small area of occupancy in the mountainous highland regions along the border between Guangxi and Yunnan, China, and northern Vietnam, from which it may already be extirpated. No specimens have ever been documented in the wild, and since it has been exploited for the pet trade and may also have been consumed locally, the species may well already be Extinct in the Wild. It is one of the most morphologically distinctive members of its genus and has been validated genetically, thereby disputing any speculation of hybrid origin. It is a medium-sized freshwater turtle (straight-line midline carapace length reaches 170 mm in males and 223 mm in females). Our knowledge of the natural history of this species is based entirely on captive studies. Mating occurs in spring and fall, but only a single clutch of 1–8 eggs (typically 2–4, 10–26 g each) is laid each year, usually in June or July; incubation takes 65–125 days. The species has temperature-dependent sex determination, with males produced only at colder temperatures.

Distribution. – Presumably China, Vietnam; however, actually Unknown, but suspected to occur along the border between China and Vietnam, and likely to be native to both countries.

Synonymy. – *Cuora zhoui* Zhao *in* Zhao, Zhou, and Ye 1990, *Cuora pallidicephala* McCord and Iverson 1991, *Pyxiclemmys zhoui*.

Subspecies. – None recognized.

Status. – IUCN Red List (2024): Critically Endangered (CR A1d+2d) (assessed 2000); TFTSG Provisional Red List: Critically Endangered (CR, assessed 2011); CITES Appendix II (since 2000); EUCR: Appendix B (since 2000); China Red Data Book: Data Deficient (assessed 1998); Class II of China's Nationally Protected animals since 1988 (as all Cuora species considered native to China); China Species Red List (assessed 2004, 2016): Critically Endangered.

Taxonomy. — *Cuora zhoui* was first recognized as a distinct species by McCord in 1989, based upon specimens exported from China through the Hong Kong pet trade by O. Shiu. Its distinctiveness was confirmed morphometrically by Iverson in late 1989. A description of the species was prepared and submitted for publication in March 1990. It was accepted for publication in December 1990, but published a full year later, in December 1991 (McCord and Iverson 1991) as *Cuora pallidicephala*; type locality: "reported to have been collected at "Wuting" [= Wuding: 25º26'N, 102°21'E] or "Yuanmow" [=Yuanmou: 25°41'N, 101°54'E], Yunnan Province, China"; holotype: UF 77230; paratype: UF 77253.

In the meantime, in April 1990, Zhou of the Nanjing Turtle Museum purchased two specimens, a male and a female, of this species in the market of Pingxiang, Guangxi Province, China. A month later (May 1990) another female specimen was purchased in the market of Nanning, Guangxi Zhuang Autonomous Region, China. Those specimens were deposited with Zhao, who prepared a description of the species (Zhao et al. 1990), and published it four months later as *Cuora zhoui* Zhao *in* Zhao, Zhou, and Ye 1990, preceding the description of the same taxon by McCord and Iverson (1991).

In the book *From Water onto Land* edited by Zhao (1990), the article "A new Chinese box turtle (Testudinata: Emydidae) – *Cuora zhoui",* authored by Zhao, Zhou, and Ye (Zhao et al. 1990), the species was officially described as *Cuora zhoui.* However, in the sentence naming the species within this publication, it was given as "*Cuora*

Figure 1. Adult female *Cuora zhoui,* in captivity, originally probably from southern Guangxi, China, or northern Vietnam. Photo by Torsten Blanck.

zhoui Zhao sp. nov.", suggesting that Zhao was the sole describer to name this species, and as such the attribution for naming the species would not be "Zhao, Zhou, and Ye 1990", but rather "Zhao 1990", or more correctly "Zhao *in* Zhao, Zhou, and Ye 1990". All three citation styles have been used in the literature, but since it was explicitly repeated in the latter way by Zhao and Adler (1993) as well as by many others (e.g., Fritz and Havaš 2007; TCC 2011; TTWG 2021), we follow this attribution: Zhao *in* Zhao, Zhou, and Ye 1990.

Figure 2. Adult female *Cuora zhoui* holotype, originally NTM 9001, now CIB 119803. Photo by Ting Zhou.

Figure 3. Adult male *Cuora zhoui,* in captivity, described as *Cuora pallidicephala*. Photo by John B. Iverson.

Figure 4. Captive-bred adult female *Cuora zhoui,* 233 mm SCL, showing multiple narrow growth lines. Photos by Torsten Blanck.

Cuora zhoui was named in honor of Jiufa Zhou, the father of Ting Zhou and founder of the Nanjing Turtle Museum (NTM). The type series included NTM 9001 (holotype), an adult female that was alive at the time of description in 1990, but died in 2023, and has been donated to the Chengdu Institute of Biology (CIB), catalogued as CIB 119803; NTM 9002 (allotype), an adult male; and NTM 9003, an adult female (paratype); the latter two are since 2021 deposited in the Naturhistorisches Museum Wien (NHMW) 41293 (1 and 2) (NHMW 2021). The type locality was listed as "the market of Nanning, Guangxi Zhuang Autonomous Region", China.

Cuora pallidicephala is an objective junior synonym of *C. zhoui*. Despite there being two descriptions of the same taxon, a precise field location is not available for any of the specimens, as all were purchased from local persons or in markets. Subsequent searches in native habitat regions near the type localities have not been successful in locating any specimens in the wild (Blanck 2013). The generic allocation of this species to *Cuora* has been generally accepted and comparisons with all congeners were discussed by McCord and Iverson (1991), although Vetter and van Dijk (2006) placed the species in *Pyxiclemmys*.

During the emerging concern in the early 2000s that many newly described Asian turtle species might be hybrids, the question arose as to whether this species might also be of hybrid origin, which could have explained its rarity (compare Artner 1999; Meier 2002). Several authors (see Iverson et al. 2001) speculated that it might be a hybrid of *Cuora pani* (Song 1984) or *Cuora amboinensis* (Riche *in* Daudin 1801) with *Mauremys mutica* (Cantor 1842) or its currently synonymized taxon, *Annamemys grochovskiae* (Dao 1957), with which the species shares some characteristics (Iverson et al. 2001; Meier 2002; H. Artner, pers. comm. to Meier). Farm surveys in southern China (Blanck 2007; Zhou et al. 2008a,b) by Zhou, Li,

Figure 5. Adult female *Cuora zhoui,* in captivity. Photo by Torsten Blanck.

Figure 6. Adult male *Cuora zhoui,* in captivity, described as *Cuora pallidicephala*. Photo by John B. Iverson.

Figure 7. Sexual dimorphism in *Cuora zhoui*: smaller male on left, larger female on right. Photo by Torsten Blanck.

and Blanck (pers. obs.) found no *Cuora zhoui*-like specimens, while many other true hybrids between other taxa were found in abundance (Zhou et al. 2008a,b; Blanck 2013; Blanck and Zhou, pers. obs.). Furthermore, hybrids of *Mauremys mutica* x *Cuora pani* as well as *Mauremys annamensi*s (Siebenrock 1903) x *Cuora amboinensis* have since been produced in captivity and do not look at all like *C. zhoui* and also do not possess a plastral hinge (Fritz and Mendau 2002; Blanck 2006; Meier and Langner 2018; Blanck, McCord, and Zhou, pers. obs.). Subsequent genetic analysis has shown that *C. zhoui* is not a hybrid (Honda et al. 2002; Parham et al. 2004; Spinks et al. 2004, 2012; Stuart and Parham 2004; He et al. 2007; Spinks and Shaffer 2007; Tiedemann et al. 2014; Thomson et al. 2021).

The phylogenetic placement of *C. zhoui* within the genus *Cuora* has varied across the genetic analyses cited above, depending on which markers were used. Based on only three specimens, Spinks and Shaffer (2007) found two genetically divergent subclades of *C. zhoui* when examining mitochondrial DNA, but those clades were not supported with combined mitochondrial and nuclear DNA. In addition, the three specimens they analyzed were neither morphologically nor phenotypically distinguishable from one another (Blanck and Meier, pers. obs.), but they might have originated from two separate populations. In general, some phenotypic variation in head and carapace coloration exists among known specimens, which needs further evaluation (see below).

The most comprehensive genomic analysis to date is that of Thomson et al. (2021), based on 15 nuclear genes. This analysis placed *C. zhoui* as sister to *Cuora yunnanensis* (Boulenger 1906) (see also Spinks et al. 2012), and that clade as sister to one including *Cuora trifasciata* (Bell 1825), *Cuora aurocapitata* (Luo and Zong 1988), *Cuora pani* (Song 1984), *Cuora mccordi* (Ernst 1988), *Cuora flavomarginata* (Gray 1863), and likely also *Cuora cyclornata* (Blanck et al. 2006), which the authors did not include in their study, but which was assessed by Tiedemann et al. (2014) with similar conclusions.

As for all members of the genus *Cuora*, the karyotype of *C. zhoui* consists of 2n = 52 chromosomes, sharing a similar topology of rDNA loci and telomeric repeats (Clemente et al. 2021).

Description. — *Cuora zhoui* is a medium-sized turtle, with males reaching 150 to 170 mm (mean 162 mm, *n*=6) in straight-line midline carapace length (SCL), weighing 500 to 850 g, and females reaching 150 to 223 mm SCL (mean 171 mm, *n*=22), weighing 630 to 1500 g (McCord and Iverson 1991; Fritz and Obst 1998; Meier, 2000a,b, 2002; Lee and Levine 2004; Bonin et al. 2006; Zhou 2006; Wang 2008; Lee and MacGregor 2008; TCC 2011, 2018; Meier and Langner 2018; Meier et al. 2019; Blanck, Meier, McCord, and Zhou, pers. obs.).

The carapace is elliptical, moderately domed (shell height averages 39% of SCL), with three low keels, widest near the junction of marginals 8 and 9 (maximum carapace width averages 69% of SCL), with straight sides, and a slightly flared, smooth-edged, or slightly serrated (in juveniles) posterior margin. The carapace surface in adults is smooth and lacks growth annuli. All vertebrals are wider than long and the low median keel is most pronounced on the first, fourth, and fifth vertebrals.

The maximum plastron length (PL) is equal to or slightly shorter than the SCL. The plastron is slightly upturned anteriorly, with a transverse hinge between the pectoral and the abdominal scutes (but not apparent until reaching an SCL of 8–10 cm), and the anterior plastral lobe is shorter than the posterior lobe (anterior lobe length averages 43% of PL). The width of the plastral forelobe at the level of the junction of the humero-pectoral seam and the lateral plastral margin averages 127% of the plastral

Figure 8. Captive-bred hatchling *Cuora zhoui*. Photos by Torsten Blanck.

forelobe length. The width of the plastral hindlobe (at the lateral junction of the abdominal-femoral seam) averages 103% of the maximum length of the plastral hindlobe. The plastral hindlobe has a shallow anal notch. The bridge is moderate in length, averaging 29% of the SCL. The axillary scutes are reduced or absent and a single inguinal scute is present on each bridge. The typical plastral formula is: pect > abd > anal > gul > fem > hum. The intergular seam length averages 87% of the interabdominal seam length and 87% of the interpectoral seam length. The interfemoral seam length averages 61% of the interanal seam length. The interanal seam is present and complete.

The head is narrow with the upper jaw slightly to strongly hooked, especially in males, and with obvious small tubercles located dorsal to the angle of the jaw and anterior to the tympanum. In juveniles, the head is very pointed. Males have a slightly concave plastron (flat in females), their carapace is usually darker than in females and they have larger, thicker tails than females, with the vent posterior to the carapace margin in males while anterior to it in females.

The carapace is chestnut brown to almost uniformly black in adults; often with black radiations on brownish

Figure 9. Captive-bred hatchling *Cuora zhoui*. Photos by Torsten Blanck.

ground. The carapace of hatchlings is dark brown to black, as is the very pointed head and the soft parts (Lee and Levine 2004; Lee and MacGregor 2008, Blanck and Meier, pers. obs.). The throat is white, similar to C. *yunnanensis* (Zhou et al. 2008c), but lacking the dark spots that are always present in *C.yunnanensis* (Blanck 2005). During the first year, the color of the carapace changes to a lighter brown and then usually begins to darken again with growth (Blanck and Meier, pers. obs.).

Generally a black triangular area is found on the ventral anterolateral margin of marginals 1–4 and 8–12, although sometimes the entire ventral surface of the marginals is washed with black; marginals 5–7 are mostly black ventrally. The adult plastron is mostly black (rarely brown), with central oblong, triangular, or irregular yellow figures of varying size found on the medial aspect of at least the pectoral and abdominal, often the femoral, and very rarely the humeral scutes, that may be connected to each other or well separated, somewhat resembling a fir tree in shape. Occasionally, a small yellow spot, separated from the triangular central patch is present on each pectoral scute, retained from the juvenile pattern. The lateral margins of the pectorals, femorals, and anals are yellow.

The central figure of the juvenile plastral pattern usually forms a yellowish to orange stripe extending along the interfemoral, interabdominal, and interpectoral seams with an additional, separated, rounded lighter area in the center of each pectoral scute (sometimes still present in adults). Blanck and Meier (pers. obs.) have on rare occasions hatched specimens which showed a completely black plastron and one female produced juveniles with a yellow central pattern covering nearly the entire pectoral, abdominal, and femoral scutes. The posterior anal scutes, and the lateral margins of the femoral, humeral and gular scutes are also orange-yellowish, covering a larger area of the scute than in adults. This light pattern somewhat resembles a smiling face, and changes after about two years of age into the adult pattern (Lee and MacGregor 2008; Blanck, pers. obs.). The adult black plastral pattern fades to a dark brown and the yellow shape loses clarity in old specimens. The bridge is black, with a small yellow area where it meets the hinge.

The dorsal head of adults is cream-white to uniformly yellowish-olive green or olive brown; and is olive to dark brown, to nearly black in juveniles. A black-bordered, narrow, yellow line originates at the lateral nostrils, passes to the anterior orbit, and continues posteriorly from the caudal orbit to where it fades completely near the dorsal rim of the tympanum. One or two faint yellowish lines, most prominent in juveniles, often fading with age, may be present directly behind the eyes extending to above the tympanum and often a small yellow spot is present behind the eye in juveniles, showing a close similarity to its sister species, *C. yunnanensis*. An olive to black line

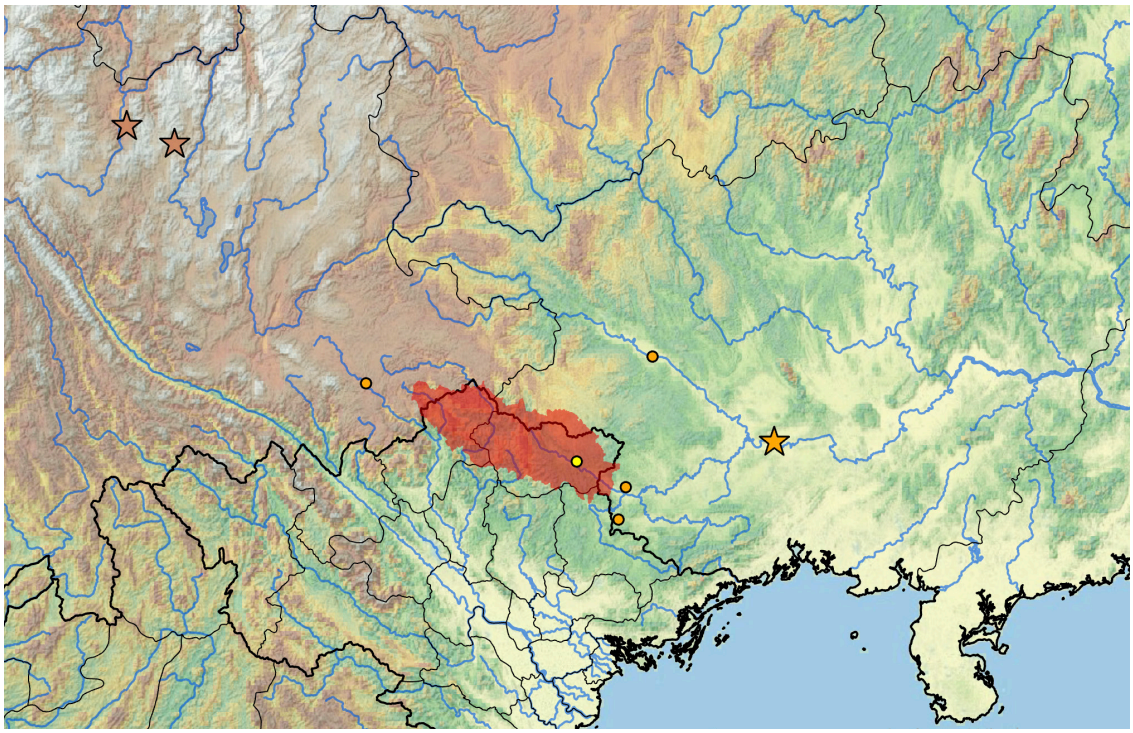

Figure 10. Presumed possible historical distribution of *Cuora zhoui* in China (Guangxi and Yunnan) and Vietnam (TTWG 2021). Yellow dot = possible occurrence record of native population; orange dots = market specimens; stars = type localities (food markets) (orange = *C. zhoui* holotype; brown = *C. pallidicephala* syntypes); colored shading = presumed historical indigenous range. Estimated distribution is based on fine-scaled GIS-defined level 12 HUCs (hydrologic unit compartments).

may extend from the lower jaw to the tympanum. The jaws are cream colored. The tomia, tympani, chin, and ventral neck are uniformly cream to yellow or cream to salmon. The iris is yellow to greenish and the irregularly shaped pupil (round in all closely related species) is crossed by a black bar. Two faint salmon stripes may be present along the lateral neck.

The forelimbs are dark olive-green laterally, washed with salmon medially, especially in males, but black in juveniles; the hindlimbs are dark olive dorsally and yellow ventrally, with some salmon wash on the ventral feet in adults, but black in juveniles. Soft parts are yellow, with some salmon wash at the base of the neck and onto the dorsum of the forelegs in adults and black in juveniles. The tail is cream-yellow ventrally, black dorsally, with indistinct lighter dorsolateral lines on each side in adults and black in juveniles. The species can be easily distinguished from its sister species *C. yunnanensis* by the described plastral pattern, the uniformly yellow chin pattern, and the lighter colored head pattern.

Distribution. — *Cuora zhoui* is the only recognized turtle species without a verified native distribution record, despite intense field surveys by various researchers over the last four decades. All reports, including the ones in the original description (Zhao et al. 1990; McCord and Iverson 1991) were based on market specimens purchased from the trade and thus the original collection data are unavailable.

The designated type locality of *Cuora zhoui*, as stated above, was a market in Nanning, but specimens were also obtained at a market in Pingxiang, both situated in Guangxi province, China. Pingxiang is located along the China-Vietnam border and acts as an important trade entry port for wild-caught animals from Vietnam into China, while Nanning, the capital of China's autonomous Guangxi province, located in the center of the province, has been an important trade hub for animals coming from all surrounding Chinese provinces as well as from Vietnam for many decades (Li and Li 1996, 1997, 1998; Li et al. 1996; Lehr 1997; Fritz and Obst 1998; Blanck, 2013; Guangzhou turtle dealers, pers. comm.; M. Tang, pers. comm.; Blanck and Zhou, pers. obs.). Subsequent frequent surveys in the Pingxiang markets starting in the mid 1990s into the 2010s were unable to record any *C. zhoui* (Artner, 1999; Blanck 2013; P. Petras, pers. comm.; H. Artner and N. Strauss, pers. comm. to Meier; Blanck and Zhou, pers. obs.), whereas specimens were available in Nanning as well as in Guangzhou (being brought there from Nanning according to trader interviews). Guangzhou is the capital of China's autonomous Guangdong province, potentially the most important turtle trade hub in Asia, along with Hong Kong. *Cuora zhoui* was found there in small numbers in the late 1990s and early 2000s, notably in Qing Ping market (Petras, pers. comm.; R. De Bruin, pers. comm.; Artner, pers. comm.; Blanck and Zhou, pers. obs.).

It has long been speculated (Meier 2002, pers. comm.; Lee and MacGregor 2008; P.P. van Dijk, pers. comm.; Blanck 2013; Meier and Langner 2018; Meier et al. 2019; TTWG 2021) that *C. zhoui* offered in the markets of Pingxiang and Nanning might have originated in Vietnam, since Pingxiang is located very close to the Vietnamese border and lies directly on the wildlife trade route that extends from there into Nanning and on to Guangzhou and Hong Kong. In 2009, Blanck received photographic evidence from a Vietnamese trader from northern Vietnam, depicting a *C. zhoui*. Subsequent field surveys undertaken by Blanck in collaboration with CRES (University of Hanoi) and the Asian Turtle Program between 2013 and 2018 (Le 2013; Thong et al. 2017) yielded some positive data and identifications by locals in one specific site out of dozens throughout northern Vietnam visited, but did not result in any specimens being found. In early 2023, Blanck received data from a *C. zhoui* trader in Guangxi, China, who claimed to have collected several specimens in the 2000s from an area in the vicinity of one of the sites surveyed by Blanck and colleagues, which also provided good interview results. Further field research in this area is planned. We refrain from providing more detailed data for these localities for conservation reasons.

The type localities for *Cuora pallidicephala*, initially provided by the reptile trader O. Shiu (pers. comm.) to McCord in the late 1980s, namely Wuding and Yuanmou, are situated in the northern part of Chuxiong District in China's autonomous Yunnan province. Subsequent surveys in this region (Artner and Strauss, pers. comm. to Meier; Meier 2002; Zhang et al. 2008; D.Q. Rao, pers. comm.; Blanck and Zhou, pers. obs.) did not provide any evidence of this species, neither was it ever recorded in a market in Kunming, the capital of Yunnan province, which was intensely surveyed over the last four decades (Zhang et al. 2008; Petras, pers. comm.; Artner and Strauss, pers. comm.; Rao, pers. comm.; Blanck and Zhou, pers. obs.). However, its sister species, *C. yunnanensis* has been recorded from Chuxiong district just a few valleys away (Yang and Rao 2008); Rao, pers. comm.; P. Praschag, pers. comm.; Blanck, pers. obs.), and this species also appeared in the trade in Kunming city in the early 1900s and 2000s (Boulenger 1906; Zhou and Zhao 2004; Zhou 2005; Blanck 2005, Rao, pers. comm.; Blanck, pers. obs.) which *C. zhoui* never did. Li and Wang (1999) reported *C. yunnanensis* to have been observed in the Yunnan trade on a single occasion, with the source of origin given as Yunnan and Vietnam. Whether this record was indeed *C. yunnanensis*, which was believed to be extinct back then (Zhou 2005; Blanck 2005) or a misidentified *C. zhoui* or possibly another more common species, such as *C. couro* (Leschenault de la Tour *in* Schweigger, 1812), remains unverifiable due to lack of photographic evidence. He and Zhou (2002) listed *C. zhoui* as occurring in northern and northeastern Yunnan without providing any further evidence; Sun and Gao (2016, 2017) also listed it as occurring in Yunnan, again without any further data.

Figure 11. Suspected hillside habitats of *Cuora zhoui* in northern Vietnam. Photos by Torsten Blanck.

McCord and Joseph-Ouni (2002) listed the vicinities of Tiandong (west of Nanning, close to Yunnan and Vietnam) and Longzhou (close to Pingxiang, directly bordering Vietnam), both situated in Guangxi, China, based on newer information provided by Shiu (McCord, pers. comm.). Rumors of the occurrence of the species in Wenshan County, southeastern Yunnan, emerged from traders in China in the late 2000s (Blanck and Zhou, pers. comm.). Surveys so far have yielded no results from this area, nor from adjacent areas in Guangxi (KIZ 2016; Zhou, pers. obs.). Wang et al. (2022) again suggested

southeastern Yunnan as a possible area of distribution without providing further details, furthermore claiming that there were confirmed distribution records in adjacent provinces or neighboring countries, without providing references for this. In 2020, Blanck was informed by a Chinese turtle enthusiast that the species might occur in southwestern Yunnan. Field surveys are currently planned for this area, which is not very far from a rumored locality of its sister species, *C. yunnanensis*. Given the fact that *C. yunnanensis* was not recorded by scientists for one hundred years after its description (Zhou and Zhao 2004; Blanck 2005) and is known to only inhabit a very small and remote area in Yunnan (Yang and Rao 2008; Auer and Blanck 2019; Rao, pers. comm.; Praschag, pers. comm.; Blanck, pers. obs.), we cannot yet exclude these areas as possible native origins of the species. Further field work is clearly necessary.

Laos has also been mentioned as a possible area of origin (Meier 2002, 2005; Lee and MacGregor 2008), but this is unlikely in our view, as the trade routes from Laos run into Yunnan, mainly to Kunming City, rather than to Guangxi (Wang et al. 1996; Yang et al. 2000; Blanck, pers. obs.). However, Lehr (1997) showed that some trade routes might run from central Laos through Vietnam to Guangxi, China, but still no trade route from northern Laos through Vietnam into China is suggested. Recent field surveys in Laos have not yielded any *C. zhoui* (M. Auer, pers. comm.).

Meier (2000a, 2002) and Meier et al. (2019), as well as our observations of specimens of *C. zhoui* maintained in captivity, indicate that this species is tolerant of cool temperatures and sensitive to high temperatures, similar to *C. yunnanensis* (Zhou, pers. obs.). This suggests that it likely inhabits a cooler climate than would be expected in Guangxi, Laos, or lowland areas of Vietnam, but which does exist in Yunnan as well as in the mountainous highlands of northern Vietnam.

Habitat and Ecology. — Nothing is known about the natural history of *C. zhoui* in the wild, except that local people have reported that it was collected in and near highland streams, according to data provided by Shiu (pers. comm. to McCord and Iverson 1991). According to the locals interviewed in the Vietnam site surveyed by Le (2013), the species inhabits swamps and slow-moving streams in this highland area, similar to its sister species *C. yunnanensis* in Yunnan (Blanck, pers. comm.). The highland occurrence seems substantiated by the reports of Meier (2000a, 2002; Meier et al. 2019) and our observations that specimens in captivity are sensitive to water temperatures >30°C.

In captivity, *Cuora zhoui* is primarily to strictly carnivorous (Meier 1999, 2002; Lee and Levine 2004; Zhou 2006; Meier and Langner 2018; Meier et al. 2019; Blanck, Meier, Zhou, and McCord, pers. obs.). The species is primarily diurnal in captivity and is rarely seen basking in direct sunlight, but rather prefers hiding beneath leaves or moss, etc., and is highly aquatic, as reported by Meier in Fritz and Obst (1998), Meier (2000a, 2002), Meier and Langner (2018), Meier et al. (2019), and our personal observations. This aquatic preference corresponds with data obtained by interviewing locals during the Vietnam survey (Le 2013); contrary to Bonin et al. (2006), who claimed the species was more terrestrial, but provided no basis for that statement.

Population Status. — Nothing is known of the current status of this turtle in the wild, but it has to be considered either extremely rare or more likely already extirpated from the wild. Unfortunately, the mortality rate of traded specimens has been high. According to Shiu (pers. comm.), more than 90% of the specimens he imported into Hong Kong died shortly after arrival and did not do well in local tap water with its high chlorine content; he considered them very delicate to keep alive compared to other *Cuora* species he maintained. Similar observations were made upon arrival of specimens in Europe and the USA (Meier 2002; Blanck, Meier, and McCord, pers. obs.).

Breeding in captivity was unsuccessful in the early years of availability and still proves difficult compared to other *Cuora* species. Meier was the first to successfully breed this species in captivity in 1994 (Rogner 1995; Meier 1999, 2000a, 2002; Blanck 2013; Meier and Langner 2018; Meier et al. 2019) and is still doing so. Other breeders, such as Lee and Levine (2004; also Lee and MacGregor 2008) in the USA, Tang from Hong Kong (2004, pers. comm. to Blanck in 2005), and Wang from Beijing, China, in 2007 (Wang 2008) have also had limited breeding success in the past. The species was also bred by P. Valentin (pers. comm.) in 2008 and occasionally thereafter in Austria, as did a private keeper with a breeding group in South Carolina between 2011 and 2019 (Hagen 2015; C. Hagen, pers. comm.). The IZS (International Turtle Center) at the Allwetter Zoo Münster in Germany, under the charge, care and guidance of Meier, has successfully bred the species annually since 2005 (Meier and Langner 2018; Meier et al. 2019), being the only place in the world with regular breeding success for this species.

The total number of known live *C. zhoui* in captivity has been estimated several times over the last few decades (Table 1). In addition, Meier et al. (2011) estimated 15 wild-caught founders remained in USA captivity and reported 40 hatchlings bred in Europe, with 2.6.20 (m.f.j.) in the European Studbook (ESF) by that time. The TCC (2011, 2018) estimated >200 specimens had appeared in the trade between 1990 and 2010, with fewer than 200 existing in captivity over the years, reaching a low of 30 by 2011. According to data received from Shiu (pers. comm.) and his own data, Blanck (2013) reported that about 300 specimens appeared in the trade between 1985 and 2012, of which about 150 were exported to Europe, USA, and Japan. Meier and Langner (2018) and Meier

Table 1. Estimates of number of live *Cuora zhoui* in captivity in Europe, USA, Asia, and Global, including estimated number of wild-caught founders.

Europe	USA	Asia	Global	Founders	Source
	2		2	2	McCord and Iverson 1991
	2	30	32	32	Shiu, estimate for 1991
21	25-30		46-51		Meier 1999
70	70		140		Artner et al. 2001
30	30-40		30-70		Meier, estimate in 2002
	70		70		Lee and Levine 2004
			59		Zhou 2007
70	70		140		Lee and MacGregor 2008
			140		Meier, estimate in 2011
			108		Blanck 2013
			130-135	30	Meier and Langner 2019
		357	357		Hong et al. 2022 *
136-154	14	30	180-198	25-37	Present review

* based on government-declared permits, not on actual living specimens

et al. (2019) reported that 200–300 specimens were exported from Hong Kong to the USA, Europe, and Japan, of which about 30 survived to that date, in addition to nine captive-bred specimens in the USA and 90 captive-bred specimens in Europe.

According to our last international census, reaching out to all known and previous keepers of the species worldwide, a total of 180–198 specimens were alive as of September 2024 (Table 1). Of these, 25–37 were wild-caught founder specimens, and of these, three are females in USA, 10 (4.6) in Europe, a single female in Japan, and the remaining 12–24 in China. Ten captive-bred females, descendants of two wild-caught (now deceased) males mated with one wild caught female, and a captive-bred pair exist in USA. No captive offspring are known in China, but might occur among two or three keepers who we were unable to reach. More than 85% of the remaining captive offspring were hatched by Meier and the IZS Project in Germany, most of them managed within the European Studbook for the species. All IZS offspring are derived from only six wild-caught founders (three males and three females, of which two males and two females survive to date).

Successful F2 reproduction has been achieved in the IZS and the CCC (Cuora Conservation Center, Austria). While the total number existing in captivity today is promising, the genetic variability is not, since the reproducing stock has an extremely limited gene pool. The number of wild-caught founders has decreased by more than 40% within the last decade, and the lack of breeding success in USA and especially China, combined with the loss of specimens, is very worrisome.

There are also at least 43 preserved specimens of *C. zhoui* in public museum collections in Europe, USA, and China, and more than 40 specimens are held in private museum collections, with the largest number in both cases in USA (Blanck, pers. obs.).

It is not known whether geographic variation exists within the species, but it is possible, based upon some genetic studies (Spinks and Shaffer 2007) as well as morphologic variation noticed in specimens in the trade. During a short time span in the late 1990s and early 2000s, a small number of nearly fully white-headed specimens appeared in the trade. To our knowledge, no specimens of this color variety remain alive (Petras, pers. comm.; Tang, pers. comm.; Meier, McCord, and Blanck, pers. obs.).

Threats to Survival. — *Cuora zhoui* is likely at very high risk of extinction in the wild, due to a combination of its presumed highly restricted range, apparent rarity with a presumably very small historical global population, possible habitat destruction, indications that it was apparently consumed by local people (O. Shiu, pers. comm.), and that it has also been significantly exploited for the pet trade, perhaps already to the point of extirpation.

Prices for individuals in the 1990s were below 300€ (Meier in CITES 1999; O. Shiu, pers. comm.; Blanck, pers. obs.), 800–1000€ between 1997 and 2001 (Meier in CITES 1999, Zhou and Cheng 2002), and more than 3000€ per specimen in 2007 and 2008 (Blanck, pers. obs.). More recently, Sung and Fong (2018) reported market prices as high as $38,461 USD for a single *C. zhoui*.

Figure 12. Specimens of *Cuora zhoui* and *Mauremys nigricans* for sale at the Qing Ping Free Market, Guangzhou, Guangdong, China, in 1999. Photo by Petr Petras.

While it was more frequently seen in the pet trade in the early 1990s, even then only ~150 specimens appeared (O. Shiu, pers. comm.) and were generally exported via Hong Kong to Japan, Europe, and USA, suggesting that this species must have always been scarce and/or found in a very remote or restricted area. Behler (1997) and Barzyk (1999) claimed that no further specimens were seen in the markets for several years, yet between 2000 and 2008 about 20 more specimens were offered in the trade (Blanck, pers. obs.; Tang, pers. comm.). A turtle trader from Guangzhou interviewed by Blanck and Zhou in 2008 reported that he purchased a total of 50 to 60 specimens of *C. zhoui* in the Pingxiang markets between 1997 and 2006, with numbers decreasing from 10–15 specimens a year in 2002–2003 to 2–3 specimens a year in 2005–2006, no specimens in 2007, but three specimens again in 2008. According to this trader, the species was regularly smuggled from Vietnam mixed with shipments of *Mauremys* spp.

The last wild-caught specimen, an old adult female, appeared in the Chinese trade in late 2009 or early 2010 (Blanck 2013; TCC 2011, 2018; Blanck and Zhou, pers. obs.) and not in 2017–2018 as suggested in Meier and Langner (2018) and Meier et al. (2019); this was a miscommunication between Blanck and Meier. A wild-caught specimen was offered for sale in 2018 in China, though not freshly originating from the wild, but rather a long-term captive. Thus, the last verified record of a freshly wild-caught specimen dates back to 2009–2010. These data suggest that populations in the wild likely have collapsed and extirpation may be imminent or may have already occurred, and that the species may now be Extinct in the Wild.

Until details of the native distribution become available, we are unable to estimate the impact of habitat modification upon this species. However, since destruction of the environment is known throughout the presumed range, the species is probably also threatened by this factor (CITES 1999; Lau and Shi 2000).

A serious threat in captivity has recently been identified both at the Turtle Survival Center in South Carolina, USA (Hagen, pers. comm.) as well as in Europe (Meier, pers. obs.), in that several founders as well as captive offspring died without any prior notice, showing significant osteoporosis of the carapace, and according to Zoo Münster veterinarians, also tuberculosis (C. Ludwig, pers. comm.).

Conservation Measures Taken. — The species has been listed as Critically Endangered on the IUCN Red List since 2000 (ATTWG 2000), with an earlier Data Deficient assessment (TFTSG *in* Baillie and Groombridge 1996). The species has also been included in CITES Appendix II since 2000. These measures have in effect stopped the legal international trade, but the domestic pet trade in China and the illegal smuggling of turtles from Vietnam into China continues (Blanck and Zhou, pers. obs) and represents a major threat, should the species still persist in the wild.

One of the captive-bred males from the IZS was sent to the Turtle Survival Center (TSC) in South Carolina in 2017, in exchange for three captive-bred females (Meier and Langner 2018; Meier et al. 2019; Hagen, pers. comm.). Unfortunately, this male died in 2019 (Hagen, pers. comm.), leaving the collection in USA without a surviving male. Attempts are under way to send another captive bred male from the IZS to the TSC. This exchange introduced new genetic diversity into the European population. The IZS Project has created 15 new captive colonies of *C. zhoui* with other zoos and private breeders since 2005, and IZS bloodlines are represented in all European colonies (Meier and Langner 2018; Meier et al. 2019).

Conservation Measures Proposed. — Focused field surveys of appropriate areas in southern China and adjacent Vietnam are urgently required to hopefully identify the actual distribution of *C. zhoui* and assess its status in the wild, hopefully before it is too late. This was already proposed at the Gangkou *Cuora* Workshop in 2011 (Hagen and Blanck 2011; TCC 2011) and has been suggested by most subsequent authors (e.g., Meier et al. 2011, Blanck 2013; Meier and Langner 2018; Meier et al. 2019). Captive breeding efforts, monitored by appropriate studbooks, should also continue, expanding on an international level as already suggested by Hagen and Blanck (2011), Meier et al. (2011) and Blanck (2013). International collaboration between CITES offices in China, Europe, and USA is highly recommended as already mentioned by Blanck (2013). However, Chinese authorities have not yet permitted the export of specimens for breeding loans to the IZS, despite international support for this project. The long-term hope is that the native habitat of *C. zhoui* can eventually be identified and protected, and then be augmented or repatriated with captive-bred animals as warranted.

Captive Husbandry. — The species is quite delicate, shy, and very sensitive to water quality and temperatures >30°C (Meier 2000b, 2002; Blanck, Meier, and Zhou, pers. obs.). Blanck and Meier (pers. obs.) and Shiu (pers. comm.) have reported that water quality plays a very important role for the well-being of wild-caught specimens, more so than for other *Cuora* species. Keeping them in a group also stresses the animals, as does unsuitable enclosures with insufficient hiding places (Blanck, Zhou, and Meier, pers. obs.). Captive-bred specimens are less stressed and also adapt well to different water qualities and have good survival rates (Blanck, Zhou, and Meier, pers. obs.).

As reported by Meier (2000a, 2002, 2005; Meier and Langner 2018; Meier et al. 2019), Lee and MacGregor (2008), Lee (pers. comm. to Iverson), and Blanck (pers. obs.), the species occasionally buries itself on land under moss and plant material, where it may stay for several

days. This may happen during winter hibernation, as well as in summertime for thermoregulation, especially when the temperature exceeds 30°C. This behavior can sometimes also be observed shortly before nesting. The species rarely basks openly in the sun, in sharp contrast to all other *Cuora* species (Meier 2005; Meier and Langner 2018; Meier et al. 2019; pers. obs. by the authors.)

Individuals are very aggressive toward each other (especially the males) and are also stressed if other species are kept with them, according to Meier (2000a, 2002; and Meier and Langner 2018; Meier et al. 2019; Blanck, pers. obs.), and thus visual or physical barriers are important. Most other keepers maintain their specimens in groups or in pairs (Zhou 2006; Wang 2008; Lee and Levine 2004; Lee and MacGregor 2008).

Meier (2000b, 2002) maintains his specimens in pairs, but the male and female are separated by a pane of glass, that can be removed during the breeding season, in aquariums measuring 150–170 cm x 60 cm, including a land area of 40–60 x 60 cm, in a greenhouse throughout the year. Surplus specimens are maintained in separate aquaria measuring 80 x 40 cm; water depth is 20–25 cm.

Water plants (mainly *Pistia stratiotes*) are present in all aquaria, stabilizing the temperature and providing hiding places for the turtles. In Meier's private greenhouse (Meier 2000a, 2002), summer air temperatures can occasionally reach 45°C during daytime and drop to 25–29°C at night, while the water temperature never exceeds 30°C and usually varies between 26–29°C. The animals are hibernated inside their enclosures from November to February at temperatures of 4–10°C. At the IZS, the temperature is controlled via air conditioning and never exceeds 30°C, and winter temperatures vary between 9–14°C. During summer, the animals are fed 4–7 times a week, in spring 3–4 times a week, and in autumn 2–3 times a week, and shortly before and after the hibernation just once a week (Meier 2000a, 2002; Meier et al. 2019). This is also the case at the CCC.

In North Carolina (USA), Lee and Levine (2004) and Lee and MacGregor (2008) kept their adult pair in a greenhouse enclosure measuring 200 x 200 cm with a 100 liter plastic pond included, measuring 135 x 75 x 30 cm. Maximum summer temperatures reached 30°C and minimum winter temperatures 18°C. The terrestrial part of the enclosure was robust with plants and sphagnum moss. Direct sunlight reached the pond 2–3 hours a day. The male was kept separately for the first few months, but after that was kept together with the female and other geoemydid species in the enclosure. Both animals basked in the late afternoon hours. During the height of summer and winter, both animals estivated on land for several days or weeks.

According to Lin et al. (2002) *C. zhoui* fed at temperatures above 22°C and entered hibernation when temperatures dropped below 17°C. Zhou (2006) reported that the two specimens maintained by her were kept in an indoor enclosure in Nanjing, China, measuring 94 x 52 cm, from September–June, with a water level of 5–7 cm in winter, and 10–15 cm in spring and autumn. During the summer, the specimens resided in an outdoor enclosure measuring 78 x 42 cm with a water level of 10–15 cm. Specimens were most active at air temperatures between 25–32°C and reduced their activity at temperatures below 20°C, and entered hibernation at 10°C. Hibernation occurred from the end of October to early April with water temperatures of 2–16°C. At the IZS, in Meier's private collection, and the CCC, *C. zhoui* is active and even occasionally feeding and mating at temperatures as low as 10°C, and can tolerate hibernation temperatures as low as 4°C (Meier, pers. obs.).

Wang (2008) maintained a pair of *C. zhoui* in an indoor pond in Beijing, China, together with *C. pani, C. aurocapitata,* and *C. trifasciata.* Both specimens hibernated from November to March at 5–10°C. In Austria, Valentin (pers. comm.) keeps his specimens in a large greenhouse and maintains them separately in plastic tubs measuring 100 x 60 cm for males and 150 x 150 cm for females, at a water level of 15–20 cm, with an adjacent land area with 30 cm of substrate.

At the CCC greenhouse in Austria, each specimen is maintained individually in a Heissner Tub measuring 150 x 80 cm at a water level of 25 cm, covered with *Pistia* and other water plants. The land area measures 30 x 40 cm for males and 80 x 60 cm for females, and the substrate consists of a mix of sand, soil and cypress mulch, covered with a layer of sphagnum moss and a plant. Depending on each specimen's behavior, the male is either moved to the female's enclosure or vice versa for breeding attempts during short periods (30–180 minutes) in March or April and September or October around the equinox periods. Apart from the mating season, the animals are not moved and stay in their enclosure all year round. Summer air temperatures reach up to 35°C while water temperatures never exceed 30°C, and winter temperatures vary between 7–20°C according to the sunlight available, and hibernation usually lasts from mid November to late February, during which the animals do not feed but alternate between the water or hiding on land.

Zhao (1998) reported that the type specimens of *C. zhoui* lived indoors in shallow water for several years. McCord (pers. comm.) has maintained adults indoors, in aquaria, some in groups, others separated, in shallow water with small land areas on a carnivorous diet for 30 years, mainly consisting of "Trout Chow" Pellets, before loaning his remaining specimens to the Turtle Survival Center in South Carolina. His animals never produced any viable eggs.

In two private turtle farms in Guangdong, China, *C. zhoui* is maintained in shallow concrete outdoor ponds all year round. The animals are maintained in mixed groups,

and breeding has not occurred (Blanck and Zhou, pers. obs.).

A private facility in coastal South Carolina, USA, is the only known location where *C. zhoui* has been maintained all year round and subsequently reproduced outdoors. Turtles are kept in 200 x 200 cm earth bottom enclosures with two 190 liter Rubbermaid stock tanks (132 x 79 cm) sunk in the ground for pools. The tops of the pools are level with the ground surface and water is maintained at approximately 28 cm deep with secured ramps to climb in and out easily. The enclosures are completely enclosed with a wooden frame and wire mesh to prevent escape or predation. Up to 5 adult females are kept per enclosure.

Ambient air temperatures at this site can reach over 40°C in the summer and as low as -9°C during the winter. However, it is uncommon to have temperatures below 0°C in the winter. During the summer, shade is provided to prevent overheating. Hibernation takes place on land and in the water where turtles can move freely between the pools or a covered pile of leaves and the thermal buffer of ground soil. Ambient winter daytime temperatures are typically at least 10–15°C, and the turtles are occasionally active during the winter months.

Mating in captivity was observed from March to June as well as from September to October (Meier 2000a, 2002; Meier et al. 2019; Lee and MacGregor 2008; Wang 2008; Hagen, pers. comm.; Blanck, Zhou, and Meier, pers. obs.), mainly when the water temperature varies between 24–28°C according to Zhou (2006, pers. obs.). Mating duration was ~8 minutes according to Zhou (2006); Meier (pers obs.) observed that mating duration varies with the water temperature, usually taking 4–10 min at temperatures above 20°C, while up to 35 min at water temperatures of 10–12°C. The color of the male's head has been reported to change in late March in association with courtship (D. Lee, pers. comm. to Iverson), which has not been observed by other keepers (Meier and Blanck, pers. obs.).

While courting in the water, the male "chews" the water by opening and closing his mouth continuously and appears to smell the female's cloaca. The male also positions himself in front of the female, stretches his neck and swings his head side to side. This is quite similar to the courtship behavior of *C. trifasciata* (Meier 2000b), except the head swinging is less exertive in *C. zhoui*. After courting, the male tries to mount the female. If the female refuses, the male tries to bite her front limbs until she complies. Then the male grabs the female's neck with his mouth and the female moves into a submissive mating posture. In this position, the female stretches her neck upwards, protrudes the tail and remains still in this position for several minutes. The male clings to the female's shell with all four feet and shortly thereafter releases his bite and claws and falls/drops backwards for copulation. Soon after mating the female tries to free herself by dragging the male through the water.

Tang (pers. comm.) reported a case of mating on land, which was not yet been observed by any other keeper. Hagen (pers. comm.) observed a case of sperm retention, where a female that was last mated with a male the previous year, deposited a fertile clutch of eggs. This has not yet been observed by Blanck and Meier, their females requiring yearly mating to produce fertile eggs.

Successful reproduction has occurred in various assurance colonies. The results of these efforts are reviewed here. Oviposition was problematic initially, when humid warm sand was used, causing females to retain eggs for six or more weeks, and leading to the need to use oxytocin to induce oviposition (Meier 2000a, 2002; Meier and Langner 2018; Meier et al. 2019). Oviposition improved when 5–10 cm of sphagnum moss was added on top of the sand, under which the females hid, and then dug 4–12 cm deep nests in the substrate below (noted also by Blanck, pers. obs.). If females were provided with barren sand as nesting substrate, eggs were frequently deposited in the water, as noted by Meier (2000a, 2002), Meier and Langner (2018), and Meier et al. (2019). Lee (pers. comm. to Iverson) observed his female to bury completely in the substrate prior to digging a nest chamber. Lee and MacGregor (2008) stated that all egg depositions seem to occur close to or below plants (noted also by Blanck, pers. obs.).

The females in South Carolina dig a nesting chamber in the sandy soil up to 30 or more cm deep, depositing the eggs at the deepest point. On more than one occasion eggs have been deposited under the Rubbermaid pools more than 30 cm below the ground surface (Hagen, pers. comm.)

Following nesting, the female fills the nest chamber with her back feet and smooths the entire soil surface before returning to the water (Lee, pers. comm. to Iverson; Meier and Langner 2018, Meier et al. 2019, Blanck, pers. obs.).

Egg laying in captivity is reported to occur between May and August, with a peak in June and July (Meier 2000a, 2002; Meier and Langner 2018; Meier et al. 2019; Zhou 2006; Wang 2008; Valentin and Hagen, pers. comm.; Blanck, Meier, and Zhou, pers. obs.). In South Carolina, it has always occurred between 23 June and 8 July (Hagen, pers. comm.).

Clutch size ranges from 1–8 eggs (mean 3, n=12), but usually 2–4, with one clutch produced per year (Meier 2000a, 2002; Meier and Langner 2018; Meier et al. 2019; Lee and Levine 2004; Lee and MacGregor 2008; Zhou 2006; Wang 2008; Hagen, Valentin and Tang, pers. comm.; Meier and Blanck, pers. obs.), though some females do not reproduce every year (Meier et al. 2019; Meier and Blanck, pers. obs.) and the fertility and hatching rate is often well below 100% (Meier and Langner 2018, account authors, pers. obs.).

Eggs measure 40.0–49.6 mm x 21.0–25.1 mm, are hard shelled, and weigh 10–16 g (Meier 2000a, 2002; Meier

and Langner 2018; Meier et al. 2019; Lee and Levine 2004; Lee and MacGregor 2008; Zhou 2006; Wang 2008; Valentin and Tang, pers. comm.; Meier and Blanck, pers. obs.). Fertile eggs banded after two days (Meier 2000a, 2002; Lee and Levine 2004; Lee and MacGregor 2008; Wang 2008; Valentin and Tang, pers. comm.; Meier and Blanck, pers. obs.).

All successful breeders (Meier 2000a, 2002; Meier and Langner 2018; Meier et al. 2019; Lee and Levine 2004; Lee and MacGregor 2008; Wang 2008; Hagen, Valentin and Tang, pers. comm.; Meier and Blanck, pers. obs.) incubated the eggs in damp vermiculite at temperatures between 19–32°C, with hatching occurring after 65–125 days. Incubation at lower temperatures produces some males, especially at 19–20°C, according to Meier and Langner (2018) and Meier et al. (2019), but most captive hatchlings so far have been female (>95%), demonstrating that this species exhibits temperature-dependent sex determination of some sort. It is not yet fully understood how to hatch males at a constant temperature (Meier, pers. obs.). Incubation data suggest that the species may have a TSD II pattern of sex determination, i.e. above 25°C only females hatch, while below 19°C females can also be obtained (Meier, unpubl. data).

Hatchlings measure 31–42.5 mm SCL (mean 36 mm, *n*=12) and weigh 9–16 g (mean 14 g, *n*=12) (Lee and Levine 2004, Lee and MacGregor 2008; Wang 2008; Valentin and Tang, pers. comm.; Meier and Blanck, pers. obs.). At the IZS and Meier's private facility, they are raised in pairs or small groups in small aquaria measuring 30 x 20 cm, with a water level of 4–5 cm at a temperature of 20–27°C for the first few months. After that they are maintained separately to avoid aggression and tail biting. A piece of cork and floating oak leaves offers the chance to bask or hide. All hatchlings were hibernated for several weeks at 6–8°C. Lee raised his hatchlings in a 35 liter aquarium, with a water level of 0.5–2.5 cm at temperatures of 26–29°C (Lee and Levine 2004; Lee and MacGregor 2008). The juveniles spent 90% of their time under sphagnum moss. Two days after hatching the neonates started feeding. At the age of two years, they were kept at a water level of 9 cm and showed a 13% to 60% weight increase and 50–70% size increase per year. At the CCC, hatchlings are maintained separated from each other in tubs during the first year and are then transferred to larger enclosures. The water level is maintained at a level to entirely submerge the carapace. Pistia and other water plants as well as cork and leaves act as hiding places, below which the hatchlings hide most of the time. Basking has only rarely been observed. Neonates start feeding 1–2 days after hatching. Juveniles hibernate similar to adults in the same greenhouse.

Meier and Langner (2018) and Meier et al. (2019) reported that in captivity males mature after ca. 7 years at 145 mm SCL, but that females require 14 to over 20 years. Hagen (pers. comm.) reports that a captive-bred female in South Carolina laid her first clutch when 11 years old. In 2017, Blanck and Meier each produced the first F2 captive generation (Meier and Langner 2018; Meier et al. 2019; Blanck pers. obs., www.cuora.org).

Cuora zhoui is primarily carnivorous in captivity and some authors (Zhao 1998; Lin et al. 2002; Zhou 2006) have reported that no vegetarian matter is accepted; however, according to most keepers, bananas and papaya are consumed (Lee and Levine 2004; Lee and MacGregor 2008; Wang 2008; Valentin and Tang, pers. comm.; Meier and Blanck, pers. obs.). Schilde (2004) stated that dandelions were also consumed. A wide variety of animal matter, consisting of fish, pork (incl. organs), crustaceans, beef (incl. organs), chicken (incl. organs), clam meat, turtle pudding, pinky mice, insects, canned dog and cat food, snails and earthworms plus additional vitamins and calcium as well as duck, koi, and turtle pellets, are provided by various keepers (Zhao 1998; Meier 2000a, 2002; Meier and Langner 2018; Meier et al. 2019; Lin et al. 2002; Lee and Levine 2004; Lee and MacGregor 2008; Zhou 2006; Wang 2008; Valentin and Tang, pers. comm.; Meier and Blanck, pers. obs.). Food has been provided once a week (Wang 2008) to daily (Meier 2000a, 2002; Meier and Langner 2018; Meier et al. 2019), depending on the season, with a higher frequency in summer. Feeding has been observed both day and night. If offered on land, food is readily dragged into the water. Food swallowing occurs strictly in water. Juveniles feed on mealworms, mosquito larvae, chopped earthworms, pupae and insects as well as dried *Gammarus* crustaceans (Lee and MacGregor 2008; Meier and Langner 2018; Meier et al. 2019; Blanck, pers. obs.); fishfood pellets were not accepted in the beginning (Lee and MacGregor 2008). Meier et al. (2019) reported that their specimens fed and digested in water temperatures as low as 12°C, whereas Lin et al. (2002) and Zhou (2006) stated that animals stopped feeding at temperatures below 17–20°.

Current Research. — Field surveys are planned by some of the authors of this account to further investigate the above-mentioned reports from Yunnan and northern Vietnam concerning the occurrence of this species. This is urgently required before the species is forgotten by local natives in case it is already extirpated. To provide further possible evidence about their origin, isotopes studies on two deceased wild-caught specimens are currently under evaluation. Several Chinese and Vietnamese researchers are also currently evaluating possible surveys.

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