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Mauremys nigricans (Gray 1834) – Red-Necked Pond Turtle, Chinese Red-Necked Turtle, Kwangtung River Turtle, Black-Necked Pond Turtle

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Summary. – *Mauremys nigricans*, the Red-necked Pond Turtle (Family Geoemydidae), is known from montane streams in the Pearl River drainage of southern China, and may also occur in the Jinlong Jiang River drainage of southeastern China and the Red River drainage of Vietnam. All data on the natural history of *M. nigricans* are either highly dated or derived from captive specimens. The taxonomic status of *M. nigricans* was unclear for many years and, although now resolved at the species level, morphological variation within the species has not been investigated; hence, no subspecies are recognized. *Mauremys nigricans* is in urgent need of additional conservation measures because of its restricted range and escalating demand for the species by collectors. Management of captive stocks for future reintroductions may be crucial, as no surviving wild populations of *M. nigricans* are currently known, despite multiple recent field surveys for this species.

Distribution. – China, Vietnam (?). Guangdong and Guangxi Provinces, southern China; possibly Fujian and Hainan in China and/or northeastern Vietnam.

Synonymy. – *Emys nigricans* Gray 1834, *Clemmys nigricans*, *Damonia nigricans*, *Chinemys nigricans*, *Mauremys nigricans, Geoclemys kwangtungensis* Pope 1934, *Clemmys kwangtungensis*, *Chinemys kwangtungensis*, *Geoclemys palaeannamitica* Bourret 1941, *Chinemys palaeannamitica*.

Subspecies. – None currently recognized.

Status. – IUCN 2012 Red List: Endangered (EN A1d+2d) (assessed 2000); TFTSG Draft Red List: Critically Endangered; CITES: Appendix III (China).

Taxonomy. — *Mauremys nigricans* was first described as *Emys nigricans* by Gray (1834) based upon a specimen from "China prope [= near] Canton". In 1855 Gray erroneously synonymized this species with *Emys* (= *Mauremys*) *mutica,* which Cantor had described in 1842. Pope (1935) confirmed that the two taxa were not synonymous, but failed to realize that *Geoclemys kwangtungensis,* which he had described in 1934 based on a specimen from "Lofaoshan, Kwangtung [= Lofu Shan, Guangdong Province, China]", was the same as *M. nigricans*. Fang (1934) confirmed the distinction between *mutica* and *nigricans*, placed *nigricans* in the genus *Chinemys*, and suggested that *kwangtungensis* and *nigricans* were synonymous.

However, for the next 50 years, all authors reverted to Gray's classification, considering *mutica* and *nigricans* to be synonyms (and *kwangtungensis* a valid species). Zong and

Figure 1. Adult male *Mauremys nigricans* in captivity. Photo by Ben Anders.

Figure 2. Adult male (left) and female (right) *Mauremys nigricans* in captivity. Photo by Ben Anders, courtesy of Dennis Uhrig.

Ma (1985) reaffirmed that *nigricans* and *kwangtungensis* were synonymous, but recommended using the latter name. King and Burke (1989) reverted to Pope's (1935) classification of *mutica*, *nigricans,* and *kwangtungensis*. Iverson and McCord (1989) finally substantiated the validity of Fang's (1934) earlier conclusion: *Geoclemys kwangtungensis* is a junior synonym of *Chinemys* (= *Mauremys*) *nigricans,* and *M. mutica* is a separate, distinct species. They also clarified misidentifications in the literature resulting from failure to accept Fang's conclusions.

Morphological variation in color, pattern, and head width exists in this species, although no research has tested whether this represents phylogeographic structure, and no subspecies have been described. *Mauremys reevesii* is the closest living relative of *M. nigricans* (Spinks et al. 2004; Feldman and Parham 2004). The two species are separated by morphological (Fang 1934; Pope 1934) and molecular (Barth et al. 2002) characteristics, and are largely allopatric (Mell 1931).

Figure 3. Adult female *Mauremys nigricans* in captivity. Photo by Ben Anders, courtesy of Paul Vander Schouw.

Figure 4. Adult male *Mauremys nigricans* in captivity. Photo by John Iverson.

Description. — *Mauremys nigricans* displays strong sexual size dimorphism, with females larger than males. The largest available male museum specimen measures 185 mm straight carapace length (SCL), and the largest female 257 mm SCL. Artner (2009) measured a female at 280 mm SCL, and T. Blanck (pers. comm.) measured a female at 298 mm SCL.

The chestnut brown to black carapace is low-domed, has a single, obvious median keel with a pair of weak lateral keels (usually obliterated with age), an unserrated, unflared posterior margin, and moderately developed growth annuli in all but old specimens, which possess smooth scutes. Scute patterns are illustrated in Fang (1934).

Maximum plastron length is 85 to 95% of maximum carapace length. The plastron is relatively flat, unhinged, slightly upturned anteriorly, and has a rounded anal notch. The posterior plastral lobe is as broad as the anterior lobe

Figure 5. Hatchling *Mauremys nigricans* in captivity, showing plastral color variation. Photos by Ben Anders.

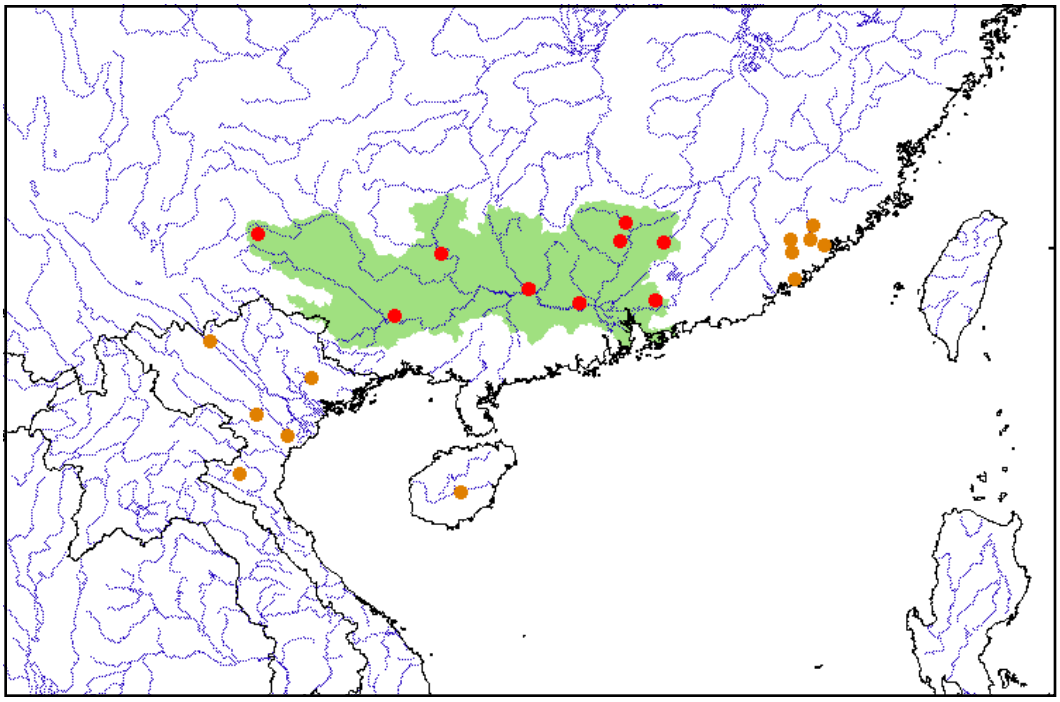

Figure 6. Distribution of *Mauremys nigricans* in southern China and possibly northern Vietnam in eastern Asia. Red dots = museum and literature occurrence records of native populations based on Iverson (1992), plus more recent and authors' data; brown dots = possible occurrence records representing unconfirmed localities, possibly of introduced market specimens; green shading = projected native distribution (now quite possibly largely extirpated) based on GIS-defined hydrologic unit compartments (HUCs) constructed around verified localities and then adding HUCs that connect known point localities in the same watershed or physiographic region, and similar habitats and elevations as verified HUCs (Buhlmann et al. 2009), and adjusted based on authors' data.

or nearly so, but distinctly narrower than the shell opening. The bridge is mostly brown to black and moderately long, averaging 32% of carapace length, each with a single, small axillary and a much larger inguinal scute. The commonest plastral formula is: abd>fem>pect>gul><anal>hum. The interpectoral seam length averages 2.4 (1.5–3.1) and 2.5 (2.1–3.6) times the interhumeral seam length in males and females, respectively. The interabdominal seam length averages 1.3 (1.1–1.4) and 1.2 (1.0–1.3) times the interfemoral seam length in males and females, respectively. The plastron is yellow to horn and irregularly marked with brown to black blotches, generally on the older portion of each scute (covering 10–100% of each scute, but least apparent in large females). The bridge and plastron may develop reticulate melanism in old males.

In hatchlings the carapace is rounded, slightly tricarinate, papillose and black, sometimes with a chestnut vertebral stripe; juveniles may develop chestnut radiating patterning on the vertebral and costal scutes. The hatchling plastron ranges from intense yellow through orange to red with irregular black spots (generally one or two per scute, but see Ipser [2011b, Fig. 17]), and dulls to the hues of those in

Figure 7. *Mauremys nigricans* plastra with various patterns. Photo by Ben Anders, courtesy of Paul Vander Schouw.

adults by approximately 8 months of age; hatchling plastral coloration is not a sex-specific trait (Anders 2010).

Skeletal morphology of *M. nigricans* was described by Bour (1980), who showed that the name *Chinemys palaeannamitica* Bourret (1941), based upon a single large skull from an archaeological site in northern Vietnam, is a synonym of this species. Pritchard (1994) examined Bour's description and compared skull morphology in *M. nigricans* to that of *M. megalocephala* – a macrocephalic morph of *M. reevesii* (Iverson et al. 1989).

The head of adult *M. nigricans* is typically large (macrocephalic in some old specimens), the broad jaws are not denticulate, the upper jaw is unhooked and lacks a medial notch, and the triturating surfaces are very wide and lack longitudinal ridges. The anterior part of the head is covered by a large, smooth shield on the crown and snout, and another shield covers the temporal area on each side. The skin of the posterior dorsal surface of the head is granular. The top of the head is uniform brown to dark gray or black. Fine cream to yellow vermiculations and several irregular, narrow, cream to yellow stripes adorn the tympanic region and extend laterally down the neck. The jaws and chin in males have varying amounts of cream to red over a black background, which is broken into largely vertical streaks; females have gray to black jaws, often with cream to yellow mottling on the proximal margins. The external tomia are horn or black. The throat generally sports irregular stripes of brown to black pigment interrupted by streaks of cream to red in males and cream to yellow (often a blotched pattern) in females. Head patterns are underdeveloped in hatchlings, starting as interrupted lateral stripes of cream to yellow, becoming more pronounced and complex with age in males and less so in females (in some females the cream to yellow pattern is obliterated with age).

The eye of hatchlings has a silver iris interrupted by a horizontal black bar, and darker (greenish gray to charcoal) sclera. The eye in females maintains this appearance (or becomes uniformly darker) through life, whereas that in males develops a pattern more homogenous with the intricate tympanal vermiculations – the sclera retain dark patches that become interspersed with cream to red mottling, although the iris remains silver with a black horizontal bar or darkens as in the female.

The anterior surface of the lower forearm is covered with many large, oblong scales. The exposed parts of the forelimbs and hind limbs are mostly dark brown or black, but may be mottled with cream or, in males, with red. The recessed areas of the skin are cream to yellow in females, and in males may be red. Hatchlings often have irregular red stripes or blotches on the soft parts around the plastron, which fade into cream or yellow in young female specimens at a rate similar to the change in plastral pigmentation. The tail is relatively long, dark brown to black, and has about twelve pairs of regular, smooth, squarish scales on its ventral side.

Breeding males develop vivid red suffusion in the cream to yellow areas of the soft parts. The marked color variations of *M. nigricans* were first described by Fang (1934) as phases. De Bruin (1988) considered the dichromatism to represent different (unnamed) subspecies. Color and pattern differences in *M. nigricans* were first attributed to sexual dichromatism by Iverson and McCord (1989), and its development in young specimens was described by de Bruin (1993).

Males are smaller than females and have longer tails that are proportionately wider at the base, with the vent at or beyond the posterior carapace margin in males and anterior to it in females. Hatchlings have long tapering tails as in other *Mauremys* species. Males mature by the time they reach 90 mm SCL (de Bruin 1993), and a female approximately 128 mm SCL produced a fertile clutch of eggs (D. Uhrig, pers. comm.). The odor of the musk produced by this turtle when disturbed is perhaps the most pungent of all geoemydid turtles and can be produced from the time of hatching (B. Hughes, pers. comm.).

Adult *M. nigricans* can be distinguished from all other geoemydid turtles by the combination of body size, typically large head, relatively large inguinal scute, lack of a medial notch in the upper jaw, usual presence of asymmetrical black blotches on the plastral scutes, relatively short interhumeral and interfemoral seams, relatively long interpectoral and interabdominal seams, mottled black to mostly black chin and neck, suffusion of red color on the head and soft parts of males, and the pungent musk produced. Hatchling *M. nigricans* can be distinguished from all other geoemydid hatchlings by the combination of black dorsal color, weakly tricarinate, papillose carapace, vivid yellow to red plastral color, irregular small to moderate black spot(s) on each plastral scute, cream to yellow vermiculations and irregular stripes on the tympanic region and throat, and the pungent musk produced.

The common name Red-necked Pond Turtle was implemented by Iverson (1985) and has been used in much of the subsequent literature on *M. nigricans*. This species is generally referred to as the Kwangtung River Turtle by turtle breeders and keepers in the United States, and the common names of Black-necked Pond Turtle and Watermelon Turtle are used in China. Another common name used for macrocephalic *M. nigricans* specimens is Dumbhead Turtle, which may be confusing since this name was also used for megacephalic *Chinemys (= Mauremys) reevesii* (i.e., *C. megalocephala* by Ernst and Barbour [1989]).

Distribution. — This species is known definitively only from affluents of the Pearl River drainage in Guangdong and Guangxi Provinces, People's Republic of China (Iverson 1992). Additionally, Cheng and Ting (1965) reported six

localities in the Jinlong Jiang River drainage in Fujian Province, China, which, however, remain unconfirmed, and could represent a different species or introduced specimens.

There are also several unsubstantiated reports of its occurrence in northern Vietnam (Klingelhöffer 1959; Felix 1965; Bonin et al. 2006), in addition to six specific localities provided by Nguyen et al. (2009), all of which remain unconfirmed. Five of these localities lie within the Red River drainage. Furthermore, the skull record for the synonymized species *Chinemys palaeannamitica* from northern Vietnam was found in a prehistoric human midden in the Red River drainage (Pritchard 1994), though it could have been transported to its point of discovery. Finally, a market specimen has been reported from Hainan Island (Zhou 1998), and a female specimen was recently collected from central Hainan (T. Blanck, pers. comm.), possibly representing a released market animal. Mounting evidence suggests that the species may currently range beyond the Pearl River basin, but whether those extralimital populations are natural or based on human introductions remains unclear.

Habitat and Ecology. —What little is known of the habitat occupied by this turtle has been drawn from reports by Mell (1922, 1929), who claimed it to be a highland species, inhabiting pools in montane streams strewn with granite boulders and partially to largely shaded by overhanging evergreen vegetation at elevations between 300–400 m. Water temperatures in August measured 16–17°C (Mell 1922). Interviews conducted since 2000 in villages adjacent to the described habitat of *M. nigricans* agree with these details, though it may inhabit streams up to 700 m elevation (T. Blanck, pers. comm.); it has not been reported from higher-order (larger) streams at low elevations. Bonin et al. (2006) stated that it occurs at altitudes up to 1200 m in water ranging from calm and mud-bottomed to clear and torrential, but neither data nor sources for this claim were provided.

Mell (1922) reported reduced activity in *M. nigricans* following substrate burrowing during November–December, and that the turtles reappeared in spring. This agrees with observations on captive specimens maintained outdoors at latitudes similar to those of their natural range (P. Vander Schouw, C. Hagen, and A. Luison, pers. comm.). Potentially sympatric turtle species based on range and habitat include *Cuora trifasciata*, *Sacalia* spp., and *Platysternon megacephalum*. Natural diet is unknown, although the enlarged head and expanded jaws in *M. nigricans* suggest mollusks and/or hard-shelled fruits may be an important component.

Reproductive behavior in *Mauremys nigricans* is only known from captive specimens, although Mell (1929) reported that a female laid two eggs—a fact that was generalized as standard clutch size in this species for many years (Pope 1935; Moll 1979; Pritchard 1979; Ernst and Barbour 1989). Courtship begins in the spring, coinciding with the male's red color intensifying. Upon recognizing a potential mate, the male pursues, overtakes and pivots to face the female, then rapidly and repeatedly extends and retracts its neck while faintly twitching its head. Artner (2009) reported that the female signals acceptance of the male's advances by withdrawing the forelimbs and extending the hind limbs such that the posterior of the shell and tail are elevated. The remainder of copulation can be aggressive, with the male repeatedly biting the back of the female's neck after mounting by gripping the rim of the female's anterior carapace, although Artner (2009) reported copulating males behaving in a more benign fashion, in which they released their grip of the female's carapace and were subsequently dragged behind her; he did, however, note aggressive behavior from the female at the conclusion of copulation via her use of the hind limbs to kick the male away from the cloacal region. De Bruin (1993) found older males (> 150 mm SCL) to be unsuccessful breeders, but this has not been reported elsewhere and is contrary to observations by Artner (2009).

Nesting for captive specimens in the northern hemisphere generally occurs from April through July (P. Vander Schouw, pers. comm.). Ewert (1979) recorded mean egg size as 51 x 27 mm. A large female (252 mm SCL) laid 7 eggs that averaged 44.8 x 27.2 mm (Iverson, unpubl. data). Mean egg size reported by Grosse et al. (2010) for five clutches was 39.1 x 22.6 mm, and mean egg mass was 11.9 g. This is the only species of turtle known to regularly dig paired nest holes and deposit eggs in both; holes are spaced 60–110 mm apart (Artner 2009; Grosse et al. 2010). Reported clutch size ranges from 1 to 13, with up to 4 clutches laid annually; mean clutch size and annual clutch rate for two females over 12 years was 5.4 and 3.3, respectively (Artner 2009). Incubation temperatures for successful development range from 25–31.5°C, with constant temperatures over 31.5°C proving fatal (Ewert et al. 2004; Artner 2009). Mean time to hatching reported by Artner (2009) was 59.4 days (n = 60, range = 50–75). *Mauremys nigricans* was tentatively shown to demonstrate temperature-dependent sex determination (TSD) type Ia, with only males produced at 25 and 27°C (Ewert et al. 2004), although the sample size was small.

Population Status. — Surveys conducted from 2007–09 examined presumed *M. nigricans* habitat in Guangdong and Guangxi Provinces including the localities reported by Iverson (1992), and although sympatric *Platysternon* and illegal turtle traps were located, no *M. nigricans* specimens were found (M. Lau, pers. comm.). This suggests possible extirpation of wild populations of the species across its known range. Additional recent surveys have turned up no specimens in the wild (B. Horne and T. Blanck, pers. comm.). The species is extirpated in the long-protected habitat of Dinghushan Reserve (from where Mell [1922] based his

description of the species), with the last known specimen reported during the 1960s (Li et al. 2009). No wild populations of *M. nigricans* are currently known to science.

Threats to Survival. — Zhou and Zhou (1991) stated that *M. nigricans* was rare. This species is vulnerable to extinction not only because of its restricted range, but also because it has become highly coveted by collectors. According to the Chinese turtle dealer O. Shiu (pers. comm.), this turtle was previously regularly offered for sale in Guangzhou (=Canton) markets. Recent surveys have shown *M. nigricans* to be rare in Guangzhou and Hong Kong markets and very high-priced when available, though a previous survey in 2000 suggested the turtle was easily collected in its habitat by trappers (T. Blanck, pers. comm.). Heavy collection over the past decade may have resulted in a rapid collapse of populations of this geographically limited species.

Current demand for *M. nigricans* appears high as suggested by a recent surge in internet prices commanded by captive bred hatchlings in Europe and the United States, although this trend could reflect demand from an international market. This species is not reported by locals to be valued as food (T. Blanck, pers. comm.; but see Zhao 1998; Lau and Shi 2000; Li et al. 2009) and was considered bycatch in traps set for *Cuora trifasciata* when Mell (1922) observed *M. nigricans* in the wild, although it is now a valued pet in China and Hong Kong (T. Blanck, pers. comm.).

An important concern is that *M. nigricans* is known to hybridize with five related species—*M. reevesii* (Zhou and Wang 2009), *M. japonica*, *M. mutica*, *M. sinensis* (P. Vander Schouw, pers. comm.), and *M. annamensis* (Ipser 2011b)—and purported to hybridize with at least one other, *Cuora amboinensis* (T. Blanck *in* Vetter and van Dijk 2006). All six of these naturally allopatric species have been traded in Southeast Asia (Blanck et al. 2009), such that their spread in the form of released pets into *M. nigricans* habitat could pose a genetic risk.

Not enough is known about the region in which *M. nigricans* occurs to assess the extent of habitat degradation and destruction and consequent effects on this species, although deforestation, hydroelectric plants, and stream liming are of concern (Lau and Shi 2000). If the species is indeed reliant on mollusks as an important dietary component, pollution could pose an indirect threat as it has done for other molluscivorous turtles (Vandewalle and Christiansen 1996).

Conservation Measures Taken. — The IUCN Red List of Threatened Species has listed the conservation status of *M. nigricans* as Endangered since 2000 (IUCN 2012). China listed the species under CITES Appendix III as of 2005 (CITES 2004) and included it among National Protected Terrestrial Wild Animals that are Beneficial, or with Important Economic and Scientific Research Values (ESIEMO 2002). Collection of *M. nigricans* from the wild is legally prohibited in China (Zhao 1998).

The IUCN Red List status of *M. nigricans* was provisionally uplisted to Critically Endangered by the IUCN Tortoise and Freshwater Turtle Specialist Group in 2011 (Turtle Taxonomy Working Group 2011) and the species was included among the world's top 40 most endangered tortoises and freshwater turtles in 2011 (Turtle Conservation Coalition 2011).

Conservation Measures Proposed. — Additional field surveys in southern China and northeastern Vietnam are needed to establish the current distribution of *M. nigricans*, such that active protection methods in the form of government patrolling or fencing habitat may be considered. Initiatives for educational outreach should also be investigated, particularly where populations of *M. nigricans* were historically found, since this may be a more practical option for safeguarding than government-mediated resources, although the market value of this species may nullify attempts to discourage local communities from collecting turtles.

Cooperative establishment of and exchange between zoological institution and private assurance colonies in Europe and the United States should be developed to promote maintenance of genetic diversity among captive stock, and collaboration with farms successfully producing *M. nigricans* in China should be explored. While present in some Chinese turtle farms (Zhao and Wang 2009), *M. nigricans* does not seem to be bred in particularly large numbers there or in Europe and the United States. However, the scale of farming *M. nigricans* is likely increasing in China, as suggested by recent research on watermold infections in the species in captivity (due to overcrowding of specimens in aquaculture; Fu et al. 2010; Chen et al. 2010).

Potential assurance colonies exist and the species consistently reproduces in captivity. The lack of known wild populations emphasizes the importance of captive breeding programs for this species' survival. To this end, a *M. nigricans* Taxon Management Proposal (TMP) (Anders 2010) was drafted for the Turtle Survival Alliance (TSA) to facilitate preservation of genetic diversity in assurance colonies and to recharge institutional interest in the species, since the American Zoo and Aquarium Association (AZA) and European Association of Zoos and Aquaria (EAZA) have discontinued their previous *M. nigricans* studbooks (D. Ferri and H. Zwartepoorte, pers. comm.). TSA should evaluate the cost of developing holdings of this species, since hatchlings produced by the private sector are generally sold and thus unlikely to be donated for developing assurance colonies. Genetic analyses of *M. nigricans* assurance colonies and the progenitors of these colonies, similar to those for *Cuora trifasciata* (Praschag 2009), are warranted, considering the species' within-sex morphological variability and the ability to hybridize. The TMP outlines options for restocking programs in China, provided that habitat meeting essential criteria is available and scientific coordination is possible.

The value placed on *M. nigricans* by humans suggests that conservation of wild populations will continue to present challenges (Courchamp et al. 2006) and may be possible only where there are resources to actively protect turtles from collection. The species has also recently been proposed for uplisting to CITES Appendix II, along with most other unlisted Geoemydidae (China and United States of America 2012).

Captive Husbandry. — The general maintenance of *M. nigricans* is similar to that of other semiaquatic geoemydids; personal experiences in its care and breeding are described by de Bruin (1988, 1993), Luison and Redaelli (2008), Artner (2009), and Ipser (2011a, 2011b).

Circadian rhythms in this species are confusing, as captives exhibit both diurnal (de Bruin 1988) and nocturnal (Artner 2009) behavior: juveniles will bask habitually, but adults often remain hidden by day and become active at night. Basking does not appear to be necessary for healthy growth in well-nourished specimens maintained in water > 20°C; growth is most rapid in water 27–30°C. If a basking site is provided, it need not exceed 40°C (de Bruin 1993). Adults respond well to a period of cooling. Artner (2009) provided winter air temperature not lower than 8°C for two months and experienced good breeding results from his captives. However, some outdoor colonies encounter fluctuating winter air temperatures down to -2°C or less and remain inactive for four months of the year, yet also breed well (P. Vander Schouw and A. Luison, pers. comm.).

Captive-bred specimens are tolerant of warmer water than many Southeast Asian species (to 30°C and warmer), and are not particularly sensitive to pH level or aqueous nitrogenous waste. However, they do appear to be sensitive to some tap water sources as suggested by the development of epithelial white cheesy growth on the soft parts, particularly in younger specimens. These lesions have been attributed to *Citrobacter* and commonly afflict captives of turtle species from Southeast Asian streams (T. Blanck, pers. comm.). *Saproglenia* causes damage to epithelial and brain tissue in *M. nigricans* (Fu et al. 2010), and Chen et al. (2010) identified antipathogenic effects from 20 of 55 Chinese herbal medicines on *Saproglenia* infection in this species. The scutes are not shed during growth and are highly resistant to abrasion – a possible adaptation to the species' rocky stream habitat – such that infection of the shell has not been reported.

Although interspecific aggression has not been noted in *M. nigricans* (de Bruin 1988; Artner 2009), intraspecific aggression can be problematic among captives, particularly in courting specimens (males abrade the necks of females when the sexes are confined together for prolonged periods) and in juveniles (tank mates demonstrate aggressive behavior and victims suffer nipped tails). Injuries are inflicted within and among the sexes, and can be severe to fatal. Thus, Artner's (2009) recommendation for maintaining the sexes of this species separately is justified. Colonies maintained in large outdoor pools do not necessarily exhibit the aggression found in colonies housed in smaller, closed quarters (P. Vander Schouw and D. Uhrig, pers. comm.). In contrast to the bold attitude demonstrated among conspecifics, *M. nigricans* is a rather withdrawn captive when kept with other species (Artner 2009). Many *M. nigricans* specimens do not develop a strong affinity to humans (demonstrated by other species such as *M. reevesii* in the form of excited, anticipatory feeding behavior), and all specimens appear to prefer enclosure provisions in which they may conceal themselves.

The natural diet of *M. nigricans* may be diverse (Zhou and Zhou 1991), but the broad jaws of this species suggest it is adapted for a diet of mollusks and/or hard-shelled fruits (both low in fat content), and food items for captives should be predominantly low in fat (≤ 5%), since this species is prone to obesity. A wide array of items is consumed by *M. nigricans*, including prepared fish/turtle pellets, invertebrates, fishes, fruits, and some plants, including algae. Predominantly carnivorous diets seem to be preferred, particularly by hatchlings.

Mauremys nigricans is long-lived. Ipser (2011b) maintained a female for 36 yrs (still living at the time of the publication), which he estimated to be 10–15 yrs old upon acquisition, i.e., at least ca. 46–51 yrs old. He estimated another female to be 100 yrs old, though the actual ages of his two specimens were unknown. A female acquired by D. Uhrig (pers. comm.) in 1986 as an adult (though not yet fully grown) was still living 25 yrs later. Slavens and Slavens (2000) reported a female acquired as an adult still living after 13 yrs.

Current Research. — *Mauremys nigricans* is being tested to confirm TSD type Ia and to establish the threshold temperature(s) for the benefit of assurance colony management (Anders 2010).

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LITERATURE CITED

Anders, B. 2010. Turtle Survival Alliance Taxon Management Proposal: Kwangtung river turtle; red-necked pond turtle (*Mauremys nigricans*). Fort Worth, Texas: Turtle Survival Alliance, 18 pp.

Artner, H. 2009. Successful breeding of the Chinese red-necked pond turtle *Mauremys* [*Chinemys*] *nigricans* (Gray, 1834). Emys 16(2):4–22.

Barth, D., Bernhard, D., Guicking, D., Stöcke, M., and Fritz, U.

2002. Is *Chinemys megalocephala* Fang, 1934 a valid species? New insights based on mitochondrial DNA sequence data. Salamandra 38(4):213–232.

Blanck, T., McCord, W.P., and Zhou, T. 2009. The Chinese Turtle Trade. Reptilia 66:52–59.

Bonin, F., Devaux, B., and Dupré, A. 2006. Turtles of the World. Baltimore, MD: Johns Hopkins University Press, 416 pp.

Bour, R. 1980. Position systématique de *Geoclemys paleannamitica* Bourret, 1941 (Reptilia-Testudines–Emydidae). Amphibia-Reptilia 1(2):149–159.

Cantor, T. 1842. General features of Chusan, with remarks on the flora and fauna of that island. Annals of the Magazine of Natural History (London) 11:481–493.

Chen, X.-Y., Xiao, H., and Fu, X.Y. 2010. Antibacterial activity of 55 Chinese herb medicines on *Saproglenia* in *Chinemys nigricans*. Journal of Anhui Agricultural Sciences 2010(33):18855–18857.

Cheng, C. and Ting, H.-P. 1965. A preliminary survey of turtles and tortoises from Fukien. Journal of Fukien Teachers College, Fuzhou 165(1):163–193.

China and United States of America. 2012. CITES CoP16 Prop. 32 - Inclusion of the following taxa of the Family Geoemydidae in Appendix II: *Cyclemys* spp., *Geoemyda japonica*, *G. spengleri*, *Hardella thurjii, Mauremys japonica, M. nigricans, Melanochelys trijuga, Morenia petersi, Sacalia bealei, S. quadriocellata*, and *Vijayachelys silvatica*, and adoption of a zero quota on wild specimens for commercial purposes for *Batagur borneoensis, B. trivittata, Cuora aurocapitata, C. flavomarginata, C. galbinifrons, C. mccordi, C. mouhotii, C. pani, C. trifasciata, C. yunnanensis, C. zhoui, Heosemys annandalii, H. depressa, Mauremys annamensis*, and *Orlitia borneensis*. Geneva: CITES Secretariat, 25 pp. www.cites.org/eng/cop/16/prop/E-CoP16-Prop-32.pdf.

CITES. 2004. Notification to the Parties No. 2004/074 concerning Appendix III. Geneva: CITES Secretariat, 2 pp. www.cites.org/eng/notif/2004/074.pdf.

Courchamp, F., Angulo, E., Rivalan, P., Hall, R.J., Signoret, L., Bull, L., and Meinard, Y. 2006. Rarity value and species extinction: the anthropogenic Allee effect. PLoS Biology 4(12):2405–2410.

De Bruin, R. 1988. Enige opmerkingen over de Kwangtung-moerasschildpad (*Chinemys kwangtungensis*). Lacerta 46(10/11):172–178.

De Bruin, R. 1993. De Kwangtung-moerasschildpad (*Chinemys nigricans*), kweek en ontwikkeling in het terrarium. Lacerta 51(2):42–46.

Endangered Species Import and Export Management Office of the People's Republic of China (ESIEMO). 2002. Identification Manual for Common Turtles and Tortoises. Beijing: China Forestry Publishing House, 174 pp.

Ernst, C.H. and Barbour, R.W. 1989. Turtles of the World. Washington, DC: Smithsonian Institution Press, 313 pp.

Ewert, M.A. 1979. The embryo and its egg: development and natural history. In: Harless, M. and Morlock, H. (Eds.). Turtles: Perspectives and Research. New York, NY: John Wiley and Sons, pp. 333–413.

Ewert, M.A., Etchberger, C.R. and Nelson, C.E. 2004. Turtle sex-determining modes and TSD patterns, and some TSD pattern correlates. In: Valenzuela, N. and Lance, V.A. (Eds.). Temperature-Dependent Sex Determination in Vertebrates. Washington, DC: Smithsonian Institution Press, pp. 21–32.

Fang, P.W. 1934. Notes on some chelonians of China. Sinensia 4:145–199.

Feldman, C.R. and Parham, J.F. 2004. Molecular systematics of old world stripe-necked turtles (Testudines: *Mauremys*). Asiatic Herpetological Research 10:28–37.

Felix, J. 1965. [Turtles of Vietnam](original in Czech). Ziva 13:227–229.

Fu, X.-Y., Chen, X.-Y., and Li, G.-S. 2010. Histopathological observation of *Chinemys nigricans* infected with *Saproglenia*. Journal of Anhui Agricultural Sciences 2010(22):12164–12165.

Gray, J.E. 1834. Characters of several new species of freshwater tortoises (*Emys*) from India and China. Proceedings of the Zoological Society of London 1834:53–54.

Gray, J.E. 1855. Catalogue of Shield Reptiles in the Collection of the British Museum. Part I. Testudinata (Tortoises). London: Taylor and Francis, 79 pp.

Grosse, A.M., Buhlmann, K.A., and Hagen, C. 2010. Nesting behavior of the red-necked pond turtle (*Mauremys* [*Chinemys*] *nigricans*) in captivity. Turtle Survival Alliance Magazine 2010, pp. 90–92.

Ipser, T. 2011a. *Mauremys nigricans*, Reaktionen zu den Artikeln im Heft 29. Sacalia 9(30):34–40.

Ipser, T. 2011b. Über Schildkröten und was einem sonst noch anhängt. Sacalia 9(31):6–56.

IUCN. 2012. IUCN Red List of Threatened Species. Version 2012.2. www.iucnredlist.org.

Iverson, J.B. 1985. Checklist of the Turtles of the World with English Common Names. Society for the Study of Amphibians and Reptiles, Herpetological Circulars 14:1–14.

Iverson, J.B. 1992. A Revised Checklist with Distribution Maps of the Turtles of the World. Richmond, IN: Privately published, 363 pp.

Iverson, J.B., Ernst, C.H., Gotte, S. and Lovich, J.E. 1989. The validity of *Chinemys megalocephala* (Testudines: Batagurinae). Copeia 1989(2):494–498.

Iverson, J.B. and McCord, W.P. 1989. The proper taxonomic allocations of *Emys nigricans* Gray, *Emys muticus* Cantor, and *Geoclemys kwangtungensis* Pope. Amphibia-Reptilia 10:23–33.

King, F.W. and Burke, R.L. 1989. Crocodilian, Tuatara, and Turtle Species of the World. A Taxonomic and Geographic Reference. Washington, DC: Association of Systematics Collections, 216 pp.

Klingelhöffer, W. 1959. Terrarienkunde. 4. Teil. Schlangen, Schildkröten, Panzereschen Reptilienzucht und ausführliches Sachregister. Stuttgart: Alfred Kernan Verlag, 379 pp.

Lau, M. and Shi, H. 2000. Conservation and trade of terrestrial and freshwater turtles and tortoises in the People's Republic of China. In: van Dijk, P.P., Stuart, B.L., and Rhodin, A.G.J. (Eds.). Asian Turtle Trade: Proceedings of a Workshop on Conservation and Trade of Freshwater Turtles and Tortoises in Asia. Chelonian Research Monographs, Number 2, pp. 30–38.

Li, Z.-C., Xiao, Z., Quing, N., Lu, W.-H., and Lazell, J. 2009. Amphibians and reptiles of Dinghushan in Guangdong Province, China's oldest nature reserve. IRCF Reptiles and Amphibians 16(3):131–151.

Luison, A. and Redaelli, S. 2008. Freshwater Turtles and Terrapins: The Complete Guide. Ravenna, Italy: TE s.n.c., 207 pp.

Mell, R. 1922. Beiträge zur Fauna sinica. I. Die Vertebraten Südchinas; Feldlisten und Feldnoten der Säuger, Vögel, Reptilien, Batrachier. Archiv für Naturgeschichte 88:1–134.

Mell, R. 1929. Beiträge zur Fauna sinica. IV. Grundzüge einer Ökologie der chinesischen Reptilien und einer herpetologischen Tiergeographe Chinas. Berlin, 282 pp.

Mell, R. 1929 (1931). The distribution of Chinese reptiles in relation to zoogeographical boundaries. Lingnan Science Journal, Canton 8:221–258.

Nguyen, V.S., Ho, T.C., and Nguyen, Q.T. 2009. Herpetofauna of Vietnam. Frankfurt am Main: Edition Chimaira, 768 pp.

Pope, C.H. 1934. A new emydid turtle of the genus *Geoclemys* from Kwangtung Province, China. American Museum Novitates 691:1–2.

Pope, C.H. 1935. Natural History of Central Asia. Vol. X. The Reptiles

of China. New York, NY: American Museum of Natural History, 604 pp.

Praschag, P. 2009. Golden coin box turtle genetics and implications for captive management in the U.S. Turtle Survival Alliance Magazine 2009, pp. 22–23.

Pritchard, P.C.H. 1979. Encyclopedia of Turtles. Neptune, NJ: T.F.H. Publications, 895 pp.

Pritchard, P.C.H. 1994. Comments on *Chinemys palaeannamitica* and certain other chelonian taxa based upon material from archaeological sites. Chelonian Conservation and Biology 1:131–137.

Slavens, F. and Slavens, K. 2000. Reptiles and Amphibians in Captivity, Breeding–Longevity and Inventory Current January 1, 1999. Seattle, Washington: Slaveware, 400 pp.

Spinks, P.Q., Shaffer, H.B., Iverson, J.B., and McCord, W.P. 2004. Phylogenetic hypotheses for the turtle family Geoemydidae. Molecular Phylogenetics and Evolution 32:164–182.

Turtle Conservation Coalition [Rhodin, A.G.J., Walde, A.D., Horne, B.D., van Dijk, P.P., Blanck, T., and Hudson, R. (Eds.)]. 2011. Turtles in Trouble: The World's 25+ Most Endangered Tortoises and Freshwater Turtles — 2011. Lunenburg, MA: IUCN/SSC Tortoise and Freshwater Turtle Specialist Group, Turtle Conservation Fund, Turtle Survival Alliance, Turtle Conservancy, Chelonian Research Foundation, Conservation International, Wildlife Conservation Society, and San Diego Zoo Global, 54 pp.

Turtle Taxonomy Working Group [van Dijk , P.P., Iverson, J.B., Shaffer, H.B., Bour, R., and Rhodin, A.G.J.]. 2011. Turtles of the world, 2011 update: annotated checklist of taxonomy, synonymy, distribution, and conservation status. In: Rhodin, A.G.J., Pritchard, P.C.H., van Dijk, P.P., Saumure, R.A., Buhlmann, K.A., Iverson, J.B., and Mittermeier, R.A. (Eds.). Conservation Biology of Freshwater Turtles and Tortoises: A Compilation Project of the IUCN/SSC Tortoise and Freshwater Turtle Specialist Group. Chelonian Research Monographs No. 5, pp. 000.165–000.242, doi:10.3854/ crm.5.000.checklist.v4.2011, http://www.iucn–tftsg.org/cbftt/.

Vandewalle, T.J. and Christiansen, J.L. 1996. A relationship between river modification and species richness of freshwater turtles in Iowa. Journal of the Iowa Academy of Science 103:1–8.

Vetter, H. and van Dijk, P.P. 2006. Turtles of the World, Vol. 4. Frankfurt am Main: Edition Chimaira, 160 pp.

Zhao, E. 1998. China Red Data Book of Endangered Animals: Amphibia and Reptilia. Beijing: Science Press, 330 pp.

Zhou, T. and Wang, W. 2009. Atlas of Turtles Farmed in China. Beijing: China Agriculture Press, 256 pp.

Zhou, J. and Zhou, T. 1991. Chinese Chelonians Illustrated. Jiangsu: Jiangsu Science and Technology Publishing House, Nanjing, 89 pp.

Zong, Y. and Ma, J. 1985. Studies on the genus *Chinemys* of China. Acta Herpetologica Sinica 4(3):234–238.

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