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Distribution, Natural History, and Exploitation of *Leucocephalon yuwonoi* in Central Sulawesi, Indonesia

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ABSTRACT. – The Sulawesi forest turtle, *Leucocephalon yuwonoi*, is Critically Endangered and exploited for the food and pet trade, but little is known of its ecology. We accompanied a group of commercial turtle collectors into the wild and obtained preliminary data on habitat, diet, and exploitation.

The Sulawesi forest turtle (*Leucocephalon yuwonoi*) is a poorly known species from central and northwestern Sulawesi, Indonesia. Initially described and named *Geoemyda yuwonoi* (McCord et al., 1995), Fritz and Obst (1996) later placed both *G. yuwonoi* and *G. depressa* in the genus *Heosemys*, concluding that morphological characters shared with *Geoemyda* species arose via homoplasy. Based on mitochondrial gene sequence variation and distinctive morphological characters, McCord et al. (2000) reassigned *H. yuwonoi* to the new monotypic genus *Leucocephalon*, and reported a close relationship with *Notochelys platynota*. In spite of a clearer understanding of taxonomic relationships, observations in the wild remain scant and little is known of the Sulawesi forest turtle's natural history and ecology (Platt et al., 2001; Innis, 2003).

The Sulawesi forest turtle is listed by IUCN as Critically Endangered (IUCN, 2004, www.redlist.org) and is a species of conservation concern. While visiting central Sulawesi in February 2002 we were given the opportunity to accompany commercial turtle collectors on one of their forays into the turtle's natural habitat. We also visited three commercial turtle holding facilities. Here we report habitat descriptions, behavior, and morphology of *L. yuwonoi*, as well as some insights into local commercial trade and possible conservation measures.

Methods. — Data were collected from 23 to 26 February 2002 in Donggala County, central Sulawesi, Indonesia. On the evening of 24 February 2002 we were permitted to accompany four commercial turtle collectors into the lowland forest of the Santigi region (00°35'N, 120°54'E) on a nocturnal search for *L. yuwonoi*. We searched a small stream and tributaries near the Kanggol River for 4.5 hours (1930 to 2400 hrs) and surveyed approximately 4 km of the stream.

Turtles were located and captured by hand by wading and searching in the stream bed. Midline carapace lengths (CL) and maximum carapace widths (CW) were recorded, as well as water and air temperatures.

We also visited temporary holding and dealer facilities where turtles were examined. Also, reptile dealers and local turtle collectors were interviewed for anecdotal information concerning their knowledge of *L. yuwonoi*.

Study Site. — The stream and small tributaries that we surveyed were clear and shallow, allowing high visibility by day and easy flashlight viewing at night. The stream averaged about 30 cm deep and 4 to 5 m wide. The small tributaries were only about 1 m wide, very shallow (< 10 cm), and heavily shaded by vegetation. Water and air temperatures ranged from 25.2 to 26.9°C and 25.0 to 27.2°C, respectively. The substrate of the stream was pebbles, gravel, and cobble sized stones with large slabs of protruding rock. Intermittent rock pools were encountered along the stream, averaging about 0.5–1 m in depth and 1 m in width. The stream and tributaries also contained some woody debris from the surrounding secondary growth forest. Along the tributaries surveyed, the slope of the surrounding forest banks generally ranged between 60 to 80° inclination. The maximum elevation of the area does not exceed 300 m (Platt et al., 2001). Our guides indicated that this was typical habitat for *L. yuwonoi* within its local range.

Results. — We encountered 4 *L. yuwonoi* in the stream and small tributaries between 2030 and 2345 hrs. Three of the four were found sleeping/resting at the bottom of rock pools. According to our guides, they can also be found in the deeper (30–50 cm) still-water sections of the stream channel. A juvenile (CL = 70 mm, CW = 70 mm) was found along the main stream channel, at a water depth of 35 cm, within some deadfall at the surface against the bank (Fig. 1). An adult female (CL = 210 mm, CW = 170 mm) was encountered along a small (< 2 m wide) tributary sleeping/resting at the bottom of a solid rock pool that was 1.5 m wide at a depth of 45 cm (Fig. 2). In addition, another adult female and an adult male (no morphometric data recorded) were found



Figure 1. Juvenile *Leucocephalon yuwonoi* as encountered in stream during nocturnal survey in Santigi, central Sulawesi.



Figure 2. Adult female *Leucocephalon yuwonoi* as encountered in stream during nocturnal survey in Santigi, central Sulawesi.



Figure 3. Adult *Leucocephalon yuwonoi* in holding facility in Palu, Sulawesi, awaiting shipment to Jakarta, Indonesia.



Figure 4. Captive adult male *Leucocephalon yuwonoi* displaying characteristic white head.

together in a different small (< 2 m wide) tributary in a pool 1 m wide at a depth of 60 cm. Both appeared to be sleeping/resting on the bottom of the pool approximately 20 cm apart.

We found fallen fruits (possibly *Artocarpus heterophyllus*) in the water that appeared to have turtle bites taken from them, but we did not observe turtles feeding. Also, the juvenile captured during our field survey defecated and the feces were found to contain insect parts, confirming juvenile carnivory as noted from captive observations (B. Bonner, *pers. comm.*; J. Vaughan, *pers. comm.*).

All four *L. yuwonoi* encountered were collected by our guides for commercial purposes. Another adult female *L. yuwonoi* was collected by a local villager from a different nearby stream on the same night, also for commercial reasons.

In addition to our field survey, we observed many *L. yuwonoi* in three commercial holding facilities throughout Donggala County. We visited a dealer's house and reptile-holding facility in Palu. There, we examined 25 juvenile and 48 adult *L. yuwonoi*, an adult male and female *Indotestudo forstenii*, and 1 adult male *Trachemys scripta elegans*. This dealer, as of 2002, was the principle organizer of the *L. yuwonoi* trade in central Sulawesi. He would apparently visit villages throughout the region once or twice a month to purchase turtles and other reptiles. Local collectors were paid 15,000 Rupiah (ca. \$1.50 US) per hatchling or juvenile and 40,000 Rupiah (ca. \$4.00 US) per adult *L. yuwonoi*, regardless of gender. Occasionally, village collectors would travel to Palu themselves and drop off their turtles. When enough turtles were stockpiled at the holding facility in Palu they were shipped to a commercial reptile farm in Jakarta where they would await distribution. The dealer in Palu was paid 50,000 Rupiah (ca. \$5.00 US) per juvenile and 150,000 Rupiah (ca. \$15.00 US) per adult by the proprietor of the reptile farm in Jakarta (approximate prices in 2002).

We observed 2 adult male *L. yuwonoi* (reportedly collected in a nearby forest stream) for sale at a local collector's house near the small village of Tinombo. We also observed an adult female *L. yuwonoi* and several *Cuora amboinensis* at a reptile dealer's house near the town of Santigi where a sign advertised the sale of *kura-kura* (Indonesian for freshwater turtles). This was the only location we visited in central Sulawesi where turtles and other reptiles were openly sold domestically (reportedly for pets or food).

In total, we observed 81 *L. yuwonoi* in transit at captive holding facilities throughout central Sulawesi. Unfortunately, we were unable to collect morphological data on these animals. All were said to be collected from December 2001 through February 2002. The overcrowded and unsanitary conditions of these facilities in which the turtles are held for weeks or months likely help explain the high mortality rate of some pet trade specimens (Fig. 3).

Discussion. — According to local commercial turtle collectors, literature reports, and our observations, the range of *L. yuwonoi* extends at least from the Santigi region in the north of Donggala County south to Lore Lindu National Park (Platt et al., 2001; Colijn, 2001; F. Taula, *pers. comm.*). We believe that the type specimens purchased by Frank Yuwono

in Gorontalo and Poso as reported by McCord et al. (1995) may have originated from within Donggala County.

As described by McCord et al. (1995), captives are excellent climbers, semi-aquatic, and herbivorous. Our field-work tends to agree with these observations. *Leucocephalon yuwonoi* must be an adept climber to cope with the rough, steep, and rocky terrain that surrounds the streams we surveyed. These turtles tend not to be found in the streams during daylight hours (local turtle collectors, *pers. comm.*). We and others familiar with the species believe that *L. yuwonoi* forage on *Ficus* spp. (figs) and other fallen fruits in the streams and surrounding forests (F. Yuwono, *pers. comm.*). Platt et al. (2001) noted that four unidentified fleshy fruits, possibly *Ficus* spp., were found in *L. yuwonoi* stool samples during their survey. According to Kinnaid et al. (1999) at least 37 fig species occur in north Sulawesi and are found in the highest densities reported for Southeast Asia (1163 individuals/km²). Several *Ficus* spp. bear fruit year round and the figs are especially rich in calcium and magnesium compared to other fruits in the region. The genus *Ficus* is reported to be the single most important food resource for Sulawesi's fruit-eating birds and mammals (Kinnaid et al., 1999).

Local commercial turtle collectors indicate hatchlings and juveniles are more aquatic and carnivorous than adults, eating aquatic larvae and insects, as well as other small aquatic prey. This coincides with captive observations by us and others (B. Bonner, *pers. comm.*; J. Vaughan, *pers. comm.*). Hatchlings and juveniles are also known to readily accept a wide variety of fruits and leaves in captivity (J. Vaughan, *pers. comm.*), and are likely to do the same in the wild. Local turtle collectors also claim that with 3 or 4 people searching it is common for them to find 5 or 6 *L. yuwonoi* per night. They have conducted hunts up to 8 times per month, throughout the year, in the same stream and as of 2002 claimed to find 5 or 6 turtles in a single night. They also stated that when the moon is bright or full, many turtles stay in the forest at night instead of entering the streams.

Conservation. — Previously, *L. yuwonoi* was legally managed by Indonesia as a fishery resource and not afforded any specific protective status (Samedi and Iskandar, 2000). In 2002 *L. yuwonoi* was assigned to CITES Appendix II in order to regulate international trade and listed as Critically Endangered by the IUCN Red List of Threatened Species. Also in 2002, based on Indonesia's quota system, no *L. yuwonoi* were permitted to be exported. However, some Indonesian exporters still held unused export permits from previous years, explaining why some *L. yuwonoi* were imported into the USA during 2002 (A. Weinberg, *pers. comm.*). Quotas for 2003 and 2004 were set at 100 animals for each year (www.cites.org). Additionally, because of the lack of proper species identification training of both export (D. Iskandar, *pers. comm.*) and import inspectors, as well as the phenotypic resemblance and close geographic proximity of *L. yuwonoi* to other turtles such as *Cyclemys* spp. and *Notochelys platynota*, some misidentified specimens are likely to be traded.

We recommend that more field studies are needed to better define the distribution and natural history of *L. yuwonoi*, especially for conservation applications. Captive observations of the reproductive biology of this species note that only one large (48–52 g) egg, occasionally two, is laid per clutch, with up to 3 clutches per year (Innis, 2003; B. Bonner, *pers. comm.*; J. Vaughan, *pers. comm.*). This reproductive strategy should be considered when determining protective status for this species. If *L. yuwonoi* generally lays one egg per clutch then any sustainable harvest of adults would be considered impossible (Congdon et al., 1993, 1994). *Leucocephalon yuwonoi* is endemic to Sulawesi and relatively accessible to local turtle collectors. We agree with Platt et al. (2001) that this species should be afforded the highest level of protection under Indonesian law.

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Genetic Analysis of Mitochondrial DNA Variation in Eastern and Western African Spurred Tortoises, *Geochelone sulcata*

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ABSTRACT. — Genetic analysis of mtDNA in the widespread African tortoise, *Geochelone sulcata*, revealed three closely related haplotypes, two of them specific to animals from, respectively, Sudan in the eastern range and Senegal in the west. One common haplotype was also found in animals from Sudan, Senegal, and Mali.

The African spurred tortoise, *Geochelone sulcata* (Miller, 1779) is the largest continental tortoise species, weighing up to 100 kg (Lambert, 1993). Its distribution ranges from Senegal in the west to Eritrea (Erythrea) in the east, which corresponds to a belt about 500 km wide across the sub-Saharan African continent (Loveridge and Williams, 1957; Iverson, 1992; Devaux, 2000a). Although considered common and abundant several decades ago, populations have declined since the early 1990s, and they are now highly fragmented (Fig. 1). Causes of decline are mostly related to the explosion of human population and domestic herds, with enhanced desertification triggered by severe droughts in the 1970s (Devaux, 2000a). *Geochelone sulcata* is now included in Appendix II of CITES and benefits from specific conservation program (Stubbs, 1989; Devaux, 1993).

The wide distribution of *G. sulcata* could possibly be associated with morphologic and genetic differences among populations. A study of size and weight relationships between animals from Sudan and Mali, from opposite ends of the