Conservation Biology of Freshwater Turtles and Tortoises:
A Compilation Project of the IUCN/SSC Tortoise and Freshwater Turtle Specialist Group
A.G.J. Rhodin, P.C.H. Pritchard, P.P. van Dijk, R.A. Saumure, K.A. Buhlmann, J.B. Iverson, and R.A. Mittermeier, Eds.
Chelonian Research Monographs (ISSN 1088-7105) No. 5, doi:10.3854/crm.5.026.maximiliani.v1.2009

Hydromedusa maximiliani (Mikan 1825) – Maximilian's Snake-Necked Turtle, Brazilian Snake-Necked Turtle

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Summary. – Maximilian's snake-necked turtle, *Hydromedusa maximiliani* (Family Chelidae), is a small freshwater turtle endemic to eastern and southeastern Brazil with a distribution associated with Atlantic rain forest mountainous regions. The species inhabits streams with clear, cold water and sandy or rocky bottoms within the primary forest above 600 m elevation. The species is common in some areas but human induced threats associated with demographic factors may have a negative impact on *H. maximiliani* populations inhabiting regions not encompassed by protected areas.

Distribution. – Brazil. Restricted to eastern and southeastern coastal mountainous regions, including southern Bahia, Espírito Santo, Minas Gerais, Rio de Janeiro, and São Paulo.

Synonymy. – *Emys maximiliani* Mikan 1825, *Chelodina maximiliani, Hydromedusa maximiliani, Hydraspis maximiliani, Chelodina flavilabris* Duméril and Bibron 1835, *Hydromedusa flavilabris, Hydromedusa subdepressa* Gray 1854, *Hydromedusa depressa* Gray 1856, *Hydromedusa bankae* Giebel 1866.

Subspecies. – None recognized. Eastern populations have been genetically identified as a probable evolutionarily significant unit.

Status. – IUCN 2008 Red List: Vulnerable (VU B1+2cd) (assessed 1996, needs updating); CITES: Not Listed; Brazil: Listed regionally in São Paulo (Vulnerable), Minas Gerais (Vulnerable), and Espírito Santo (Vulnerable).

Taxonomy. — The species was originally described as *Emys maximiliani* by Mikan (1825) and first assigned to the genus *Hydromedusa* by Wagler (1830). Three subsequently described taxa (*Chelodina flavilabris* Duméril and Bibron 1835, *Hydromedusa subdepressa* Gray 1854 [= *Hydromedusa depressa* Gray 1856], and *Hydromedusa bankae* Giebel 1866) have been synonymized with *H. maximiliani*. No subspecies are recognized, but at least one

Figure 1. Adult female *Hydromedusa maximiliani*, Parque Estadual Carlos Botelho, São Paulo State, southeastern Brazil, July 2006. Photo by Franco L. Souza.

Figure 2. Juvenile *Hydromedusa maximiliani* carapace and plastron, Parque Estadual Carlos Botelho, São Paulo State, southeastern Brazil, September 2004. Photos by Franco L. Souza.

evolutionarily significant unit (ESU) has been genetically identified for the population inhabiting the eastern part of the range in São Paulo (Souza et al. 2003).

Description. — *Hydromedusa maximiliani* is a small freshwater turtle with adult straight-line carapace length (CL) ranging from 100–200 mm and mass from 120–520 g. There is evident sexual dimorphism with males having greater carapace, plastron, and tail length, and greater mass than females. Males also exhibit plastral concavity; whereas females have a relatively flat plastron (Souza 1995a; Souza and Abe 1997a).

Adults have an oval-shaped carapace. Its color varies from dark to light brown, or dark gray, with or without vermiculations. Black spots can be present on the marginal scutes of some individuals. The plastron is yellowish or cream colored. The head is of moderate size, with a small protrusive snout. The jaws are yellowish. Several conspicuous spine tubercles are present on the neck but barbels are not present on the chin. The head, neck, and limbs are gray or olive green dorsally and cream colored ventrally. Limbs are flattened; the feet are webbed and possess four sharp claws. The iris is black.

Hatchlings (35–40 mm CL) and juveniles (CL ≤ 100 mm) differ in several morphological aspects from adults. Hatchlings and juveniles have a serrated carapace from the seventh marginal scute posteriorly (Souza 1995b). The plastron color of hatchlings can be completely black with a yellowish bridge, or yellowish with peripheral black spots. Juveniles can have a brownish plastron. The ventral side of the marginal scutes is yellowish, with black sutures in some animals. The maxilla and mandible are blackish or yellowish.

Distribution. — *Hydromedusa maximiliani* is endemic to eastern and southeastern Brazil (in parts of southern Bahia, Minas Gerais, Espírito Santo, Rio de Janeiro, and São Paulo), with a distribution always associated with mountainous Atlantic rain forest (Serra do Mar and Serra da Mantiqueira). The species typically inhabits streams within the primary forest above 600 m elevation (Iverson 1992; Argôlo and Freitas 2002; Souza 2005a). Island populations are found on Ilha Grande (Rio de Janeiro) and Ilha Bela (São Paulo). Ecological interactions may explain some local distribution patterns. When *H. maximiliani* is found in sympatry with *H. tectifera*, the former is only found in areas above 600 m. In contrast, in areas where *H. tectifera*

Figure 3. Adult female *Hydromedusa maximiliani*, Parque Estadual Carlos Botelho, São Paulo State, southeastern Brazil, July 2006. Photo by Franco L. Souza.

Figure 4. Hatchling *Hydromedusa maximiliani*, Parque Estadual Carlos Botelho, São Paulo State, southeastern Brazil, May 2008. Photos by Shirley Famelli.

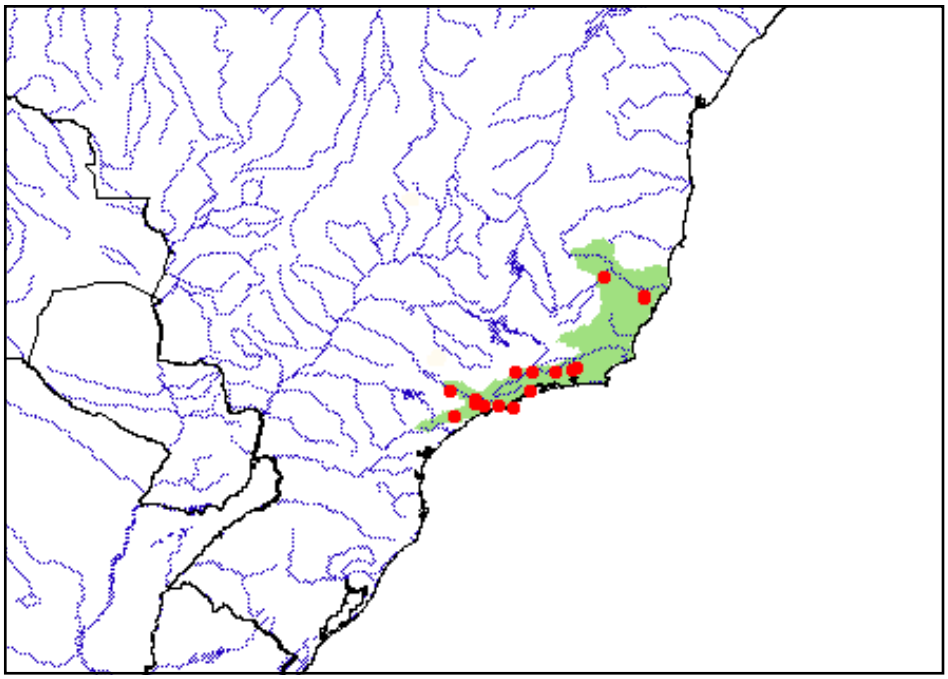

Figure 5. Distribution of *Hydromedusa maximiliani* in southeastern Brazil in South America. Red points = museum and literature occurrence records based on Iverson (1992) plus more recent and authors' data; green shading = projected distribution based on GIS-defined hydrologic unit compartments (HUCs) 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., unpubl. data), and adjusted based on authors' data.

is absent, *H. maximiliani* can be found in coastal rivers below 100 m (e.g., Ilha Bela) (Souza 2005b).

Habitat and Ecology. — *Hydromedusa maximiliani* inhabits shallow streams (depth 15–100 cm) with clear, cold water and sandy or rocky bottoms, normally with small waterfalls. This habitat may be topologically complex, with sequences of ridges and valleys each drained by river and stream systems. Little sunlight reaches the streams inhabited by this species because of the dense canopy, closed understory, and common broad-leaved plants along streams banks (Souza 1995a, 2005a; Souza and Abe 1998). Given the forest canopy and heavy understory, aerial basking is possible only in forest gaps along the stream course (Yamashita 1990; Souza and Martins 2006). Thus, this species is a thermoconformer, although body temperatures are frequently higher than the river water temperature (Souza and Martins 2006).

Resource and habitat partitioning occurs between individuals of different body sizes, and thus, colors. Adults are frequently found in streams, where their lighter color

Figure 6. Typical mountainous shallow running water habitat for *Hydromedusa maximiliani*, Parque Estadual Carlos Botelho, São Paulo State, southeastern Brazil. Photos July 2007 by Paulo L. Filho.

and flatter carapace make them resemble river stones. Juveniles frequently explore areas close to the shoreline; whereas hatchlings are normally found in areas with no flow, such as flooded areas along stream banks where dead leaves accumulate (Souza 2005a; Souza and Abe 1998).

The species dispersal rate is extremely low, with a mean daily displacement of only two meters. It is not uncommon to recapture a turtle at the same place that it was captured and marked 10 years earlier. Thus, the species can be classified as quite sedentary (Souza 1995a; Souza and Abe 1997a; Souza et al. 2002a, b). Activity levels are associated with environmental conditions, particularly rainfall and temperature. Many individuals may be found on hot humid days following a nighttime rainfall; whereas few are encountered after a sudden decrease in temperature. Long-term research at the same streams during different seasons (e.g., January and July) confirms the association between turtle activity and climatic conditions (Souza 1995a; Souza and Abe 1997a; Martins 2006).

Population density and biomass of *H. maximiliani* can be very high in some areas, reaching up to 190 turtles and 40 kg/ha of river. Some potential predators of the species include the jaguar (*Panthera onca*), puma (*Puma concolor*), crab-eating raccoon (*Procyon cancrivorous*), coati (*Nasua nasua*), and Neotropical otter (*Lontra longicaudis*).

Hydromedusa maximiliani is omnivorous, feeding on a diversity of aquatic invertebrates that it finds in streams, including small crustaceans such as shrimp and crabs, and insect larvae such as mayflies, dragonflies, caddisflies, stoneflies, beetles, and mosquitoes (Yamashita 1990; Guix et al. 1992; Souza 1995a; Souza and Abe 1995, 1997b, 1998; Novelli and Sousa 2006). The diet also includes terrestrial invertebrates that fall into the water, such as earthworms, cockroaches, crickets, termites, and spiders. The species will consume vertebrates such as small frogs, or carrion, as well. The diet can vary seasonally based on the availability of prey (Souza and Abe 1997b). Observations reveal that this turtle searches for food in areas of slow-moving water. Juveniles (50–120 mm CL) ingest more calcium-rich prey (e.g., crustaceans such as shrimp and crabs) than adults (Souza and Abe 1998). These differing diets of adults and juveniles may be related to species growth strategies.

Hydromedusa maximiliani exhibits a growth pattern similar to other turtle species, with decreasing growth rates associated with increasing body size (Martins and Souza 2008). Growth is slow, but significantly higher for juveniles than for adult males and females for both body size (3.7 mm/yr in plastron length for juveniles, approximately three times higher than in adults) and body mass (12.3 g/yr, approximately two times higher). Thus, the more pronounced growth and body mass gain for juveniles is consistent with the hypothesis that consumption of crustaceans during the juvenile life-history stage promotes relatively rapid growth in juveniles (Martins and Souza 2008). Models of growth patterns for *H. maximiliani* resulted in a mean estimated age at maturation of 14 yrs (11.6–16.6) for males and 9 yrs (5.7–11.9) for females and a life expectancy of approximately 100 yrs (Martins and Souza 2008).

The reproductive behavior of *H. maximiliani* has not been described in wild animals. In captive individuals, however, the courtship and mating behavior includes four stages: encounter, male aggression, pre-copulation, and copulation (Novelli and Sousa 2007). This reproductive behavior lasts approximately 25 min and is similar to that reported for other Chelidae, confirming the stereotypical mating behavior in these animals (Molina 1996; Souza 2004).

Evidence suggests that the species' reproductive season extends from September to January. It is during this period that the turtles can be most frequently captured, reflecting an increase in their activity (Yamashita 1990; Guix et al. 1992; Souza 1995a; Souza and Abe 1997a; Martins 2006; Costa 2009). Hatchlings (CL < 45 mm) are found in early September to January, coinciding with the beginning of the rainy season in certain parts of the species' range (e.g., São Paulo).

There is little information on the nests of this species. However, field observations suggest that females probably lay eggs among tree roots, or beneath fallen trees or leaf litter, in areas along river edges that are not flooded periodically. The few records indicate *H. maximiliani* clutches consist of 1–3 ellipsoidal eggs (41.5 × 22.5 mm) and the incubation period is estimated to be 250–300 days (Yamashita 1990; Guix et al. 2002; Souza 2004; Souza et al. 2006; Costa 2009).

Population Status. — The geographical range of the species is limited to a narrow area across the Atlantic rainforest mountainous regions, an area of extensive habitat fragmentation. Population size inferred for one local subpopulation was seemingly stable (Martins 2006; Martins and Souza 2009). The species can be considered common in some areas, but there is uncertainty as to whether or not this is a local phenomenon or if local subpopulations are abundant across the species' range. At a local scale, the species can be vulnerable. At a regional scale, however, this status is not met according to IUCN criteria.

Threats to Survival. — *Hydromedusa maximiliani* is associated with pristine Atlantic rainforest habitat but the species' range encompasses regions of intense development in eastern Brazil; one of the most endangered ecosystems in the world. Edge effects, as a result of extensive deforestation, would probably affect this species severely (Souza and Martins 2006; Costa 2009). Demographical records are available only for a subpopulation in the southernmost corner of the species' range (Martins and Souza 2009). Clearly, more research is necessary.

The species has been exposed to several anthropogenic threats, including habitat loss and degradation due to agricultural practices, infrastructure development, human settlement, tourism and recreation, fires, as well as pollution of land and water. The association between stochastic (habitat fragmentation) and demographic (population

structure, growth) factors may have a negative impact on *H. maximiliani* populations inhabiting areas not encompassed by protected areas.

Conservation Measures Taken. — Throughout its range, several populations of *H. maximiliani* occur within protected areas, including Parque Estadual Carlos Botelho (São Paulo), Parque Estadual da Serra do Mar (São Paulo), Parque Estadual de Ilha Bela (São Paulo), Parque Estadual da Ilha Grande (Rio de Janeiro), and Parque Nacional do Caparaó (Espírito Santo and Minas Gerais). However, the species also inhabits areas with high exogenous pressures (including deforestation and pollution), suggesting that *H. maximiliani* could become increasingly vulnerable in the near future. The species has been classified as Vulnerable on the IUCN Red List since 1996, but needs updating.

Conservation Measures Proposed. — New protected areas should be created and others expanded as several Atlantic rainforest fragments can be found in areas of intense exogenous development and threats.

Captive Husbandry. — Unknown other than a description of captive courtship and reproduction (Novelli and Sousa 2007).

Current Research. — Current research by J. Bertoluci and collaborators is focused on the species' reproductive behavior using radiography, as well as dispersal using radiotelemetry. As little is known about *H. maximiliani* populations beyond the southernmost limit of the species' range, research should be conducted elsewhere, including island populations and in fragmented habitats.

Acknowledgments. — We are grateful to Shirley Famelli and Paulo L. Filho for providing photos. Universidade Federal de Mato Grosso do Sul and Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) contributed logistical support during part of the long term research project, and F.L. Souza thanks CNPq (306034/2008-5) for his research support.

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Citation Format for this Account:

Souza, F.L. and Martins, F.I. 2009. *Hydromedusa maximiliani* (Mikan 1825) – Maximilian's snake-necked turtle, Brazilian snake-necked turtle. 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. 026.1-026.6, doi:10.3854/crm.5.026.maximiliani.v1.2009, http://www.iucn-tftsg.org/cbftt/.