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Notes on the Distribution, Life History, and Exploitation of Turtles in Sulawesi, Indonesia, with Emphasis on *Indotestudo forstenii* and *Leucocephalon yuwonoi*

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The fauna of Sulawesi (formerly Celebes) is the most distinctive in Indonesia, with high levels of endemism among terrestrial mammals, amphibians, and invertebrates (Whitten et al., 1987). Three species of non-marine chelonians occur in Sulawesi: two endemic species, the Sulawesi tortoise (*Indotestudo forstenii*) and the Sulawesi forest turtle (*Leucocephalon yuwonoi*), and the widespread Malayan box turtle (*Cuora amboinensis*), (de Rooji, 1915; Iverson, 1992; McCord et al., 1995). However, the turtles of Sulawesi have received scant scientific attention and little is known about their distribution and life history. Such information is essential for planning effective conservation and resource management strategies (Das, 1997), especially in Sulawesi where remaining wildlife populations are threatened by commercial exploitation and habitat loss (Whitten et al., 1987; Myers, 1992; Lee, 1999). Habitat destruction is attributable to commercial logging, shifting and small-scale agriculture, plantation projects, and transmigration schemes (designed to resettle people from Java to other less populated islands), and deforestation rates in Sulawesi are among the highest in the world (Whitten et al., 1987; Myers, 1992). In this note we present field data on all three non-marine turtles of Sulawesi, *I. forstenii*, *L. yuwonoi*, and *C. amboinensis*.

The data we report here were collected as part of a survey to determine the status of the Sulawesi tortoise in the wild. Hoogmoed and Crumly (1984) synonymized *Indotestudo travancorica* from the Western Ghats of India with *I. forstenii*, considering the Sulawesi tortoises to have been introduced from India. As *I. forstenii* was described by Schlegel and Müller in 1844 and the Western Ghats tortoise by Boulenger in 1906, the name *I. forstenii* was applied according to the rules of nomenclature to both the Sulawesi and Western Ghats tortoises. Klemens and Amato (in prep.) consider the Indonesian and Indian populations quite distinct, based upon morphological and genetic variance, and Pritchard (2000) has separated them based on external characteristics, resurrecting *I. travancorica* as a separate species.

Methods and Study Site. — Fieldwork was conducted in Sulawesi from 6 to 27 October 1998. We interviewed turtle hunters, local buyers, and reptile exporters, and examined captive specimens. From 12 to 16 October we conducted a field survey of Cape Santigi (00°35'N, 120°54'E), a hill region along the southwest coast of the North Peninsula, approximately 240 km west of Gorontalo (Fig. 1).

Cape Santigi (Fig. 2) is characterized by volcanic soils (Whitten et al., 1987), supporting a low-canopy (< 15 m) forest with a dense understory of shrubs, vine thickets, and herbaceous plants. Numerous rock outcrops are scattered throughout the forest. Slopes range up to 70°, and maximum elevation does not exceed 300 m. Cape Santigi experiences a wet season extending from October through February, with a mean annual rainfall of 1500 to 2000 mm. The dry season is typified by up to six consecutive months with < 60 mm of rainfall (Whitten et al., 1987). Parts of Cape Santigi are devoted to a large transmigration project, and most of the lowland forest has been converted to rice fields.

All specimens were deposited in the American Museum of Natural History (AMNH) and voucher photographs at the Campbell Museum (CUSC), Clemson University. Mean values presented as ± 1 SD.

Indotestudo forstenii. — The Sulawesi tortoise occurs on Sulawesi and possibly the nearby island of Halmahera, and is the only tortoise (Testudinidae) found east of Wallace's Line (Hoogmoed and Crumly, 1984; Iverson, 1992). Extant populations of *I. forstenii* appear to be localized on Sulawesi, and information regarding life history, current distribution, and status is lacking (Groombridge, 1982; Ernst and Barbour, 1989). *Indotestudo forstenii* is considered one of the world's rarest tortoises, and until this study, only five museum specimens were available from Indonesia (Groombridge, 1982; Hoogmoed and Crumly, 1984; Iverson, 1992). One specimen is from Halmahera and four from Sulawesi, although only two of the latter have specific locality data (Table 1). These two specimens were collected prior to 1900 on the North Peninsula of Sulawesi (Fig. 1). Additionally, Groombridge (1982) reported a population near the Morowali Reserve in central Sulawesi (Fig. 1), where three wild tortoises and a village captive were observed. Locals considered the tortoise rare, and few had ever seen a specimen. *Indotestudo forstenii* is currently listed on Appendix II of CITES (King and Burke, 1989), and large numbers of living tortoises have been exported from Sulawesi during the past 10 to 15 years (Pritchard, 2000).

During this survey we examined 17 *I. forstenii*: eight living tortoises, three intact shells (AMNH 145099-101), and six preserved juvenile specimens (AMNH 145102-107). The living tortoises were held by reptile dealers in Palu (2) and Ujung Pandang (4), a private zoo in Bitung Village (1), and a fishing encampment on Cape Santigi (1). The six preserved juveniles were obtained from an exporter in Jakarta.

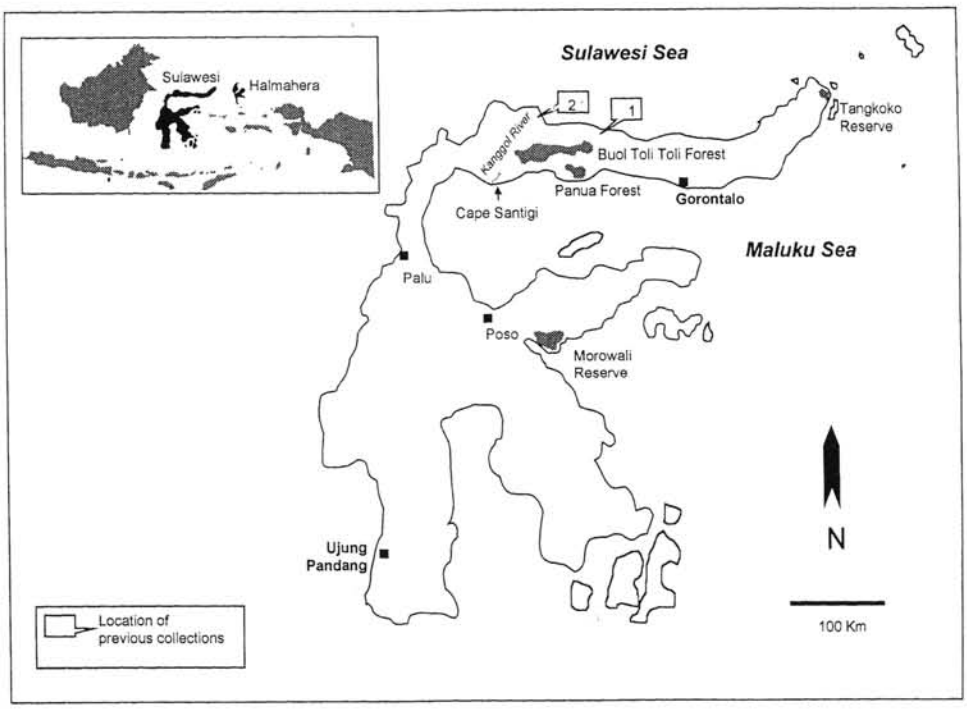

Figure 1. Map of Sulawesi, Indonesia showing localities mentioned in text. Numbers correspond to Table 1. Shaded regions denote protected areas.

We collected the shells on Cape Santigi. Our sample included seven males, four females, and six juveniles. Males were readily distinguished from females by the presence of a deep plastral concavity. Morphometric data are presented in Table 2. Mean female carapace length was slightly larger than that of males, but the largest tortoise we examined was a male. However, our small sample size precluded meaningful statistical comparisons. The humeral-pectoral seam length ratio of 10 adult specimens ranged from 1.68 to 2.35 (mean = 1.95 ± 0.2), within the range of variation reported by Pritchard (2000).

Previous authors stated that *I. forstenii* lacks a cervical scute (Smith, 1931; Pritchard, 1979), and this is the sole criterion currently used by the U.S. Fish and Wildlife Service (USFWS) to distinguish this species from *Indotestudo elongata*, a widespread species in Southeast Asia (S. Lieberman, Chief, Scientific Authority, USFWS, *pers. comm.*). However, cervical scutes were present on six (35.2%) of the tortoises we examined in Sulawesi, 26 of 29 (89.6%) tortoises in two shipments from Indonesia seized by the USFWS (Joseph Ventura, USFWS, *in litt.*), and five of nine (55.5%) Sulawesi tortoises examined by Pritchard (2000). Likewise, Hoogmoed and Crumly (1984) noted the presence of cervical scutes on "many" *Indotestudo forstenii* in a shipment originating from Indonesia, but speculated these were *I. elongata* "that became confused with Sulawesi specimens by pet traders." These data demonstrate that the absence of a cervical scute is an unreliable criterion for distinguishing *I. forstenii* from *I. elongata*.

We obtained a living tortoise and found three intact shells during field surveys of Cape Santigi. The living tortoise (CUSC 1660), captured in the hills surrounding a coastal fishing encampment, was being held for an animal buyer. Three shells (AMNH 140599-101) were found among rock outcrops on forested hillsides (Fig. 2). According to turtle hunters, *I. forstenii* are collected by searching crevices and rock overhangs. Based on the condition of the shells, two of the tortoises died within the past year. The third shell appeared older and weathering had caused the loss of most scutes. These shells were larger than most of the specimens originating in the wildlife trade examined by one of us (MWK). Cause of death could not be ascertained for any of the tortoises. A lack of shell damage suggested predators were not responsible, and moreover, few if any predators in Sulawesi are capable of killing an adult tortoise (Whitten et al., 1987). These tortoises may have succumbed to desiccation or starvation during the severe, prolonged El-Niño-related droughts of 1997 and 1998.

Although the hillside where the tortoise shells were found had not been recently burned, wildfires may be responsible for considerable mortality among *I. forstenii* populations in northern Sulawesi. Hunters and farmers interviewed on Cape Santigi reported finding large numbers (50+) of tortoise shells at other sites following drought-

Table 1. Museum specimens of the Sulawesi tortoise (*Indotestudo forstenii*) for which locality data are available. BMNH = Natural History Museum, London. Numbers in parentheses correspond to Fig. 1.

Museum number	Date	Location
BMNH 1872.4.6.116	1872	Boliahoeta [= Mount Boliahutu], near Salamatta, Celebes (1).
BMHN 1896.12.9.1	1896	Buol, North Celebes (2).

Table 2. Morphometric data (in mm and kg) from *Indotestudo forstenii* examined in Indonesia.

		n	Mean ± 1 SD	Range
Males	Midline carapace length	7	215 ± 50	150–272
	Maximum carapace width	7	157 ± 15	124–165
	Midline plastron length	7	174 ± 41	90–210
	Maximum plastron width	7	138 ± 12	115–150
	Mass (kg)	5	2.0 ± 0.4	1.3–2.6
Females	Midline carapace length	4	236 ± 11	230–254
	Maximum carapace width	4	156 ± 3	153–160
	Midline plastron length	4	181 ± 8	170–189
	Maximum plastron width	4	141 ± 3	138–146
	Mass (kg)	3	2.0 ± 0.1	1.9–2.2
Juveniles	Midline carapace length	6	80 ± 10	62–93
	Maximum carapace width	6	72 ± 7	58–79
	Midline plastron length	6	69 ± 9	51–77
	Maximum plastron width	6	62 ± 7	48–68

related wildfires in 1997. Wildfires, ignited by small-scale cultivators and loggers to clear land, are especially prevalent during El-Niño events (Kinnaird and O'Brien, 1998). While the area burned on Cape Santigi has not been determined, and effects on *I. forstenii* populations are speculative, dry season wildfires constitute a significant source of mortality for many chelonian populations (Thirakhupt and van Dijk, 1994; Chan-ard et al., 1996; Mitchell and Rhodin, 1996; Das, 1997).

Cape Santigi is approximately 105 km southwest of Buol, the nearest location where a specimen was collected in the 19th century (Table 1). According to reptile dealers that we interviewed, *I. forstenii* is restricted to the western region of the Northern Peninsula; all tortoises entering the trade originate from this area. These dealers were unaware of populations elsewhere in Sulawesi, including the Morowali Reserve. There is little evidence for the present-day occurrence of *I. forstenii* in the eastern region of the Northern Peninsula. The owner of a private zoo in Bitung Village, near Tangkoko Nature Reserve (01°36'N, 125°08' E) stated that an *I. forstenii* in the collection was captured locally and purchased from a hunter. However, we question this record as one of us (RJL) and other researchers with long experience in Tangkoko Nature Reserve (A. Cahill, M. Kinnaird, T. O'Brien, and J. Walker, *pers. comm.*) have never encountered *I. forstenii*. Populations of *I. forstenii* may be extirpated on Halmahera (F. Yuwono, *pers. comm.*).

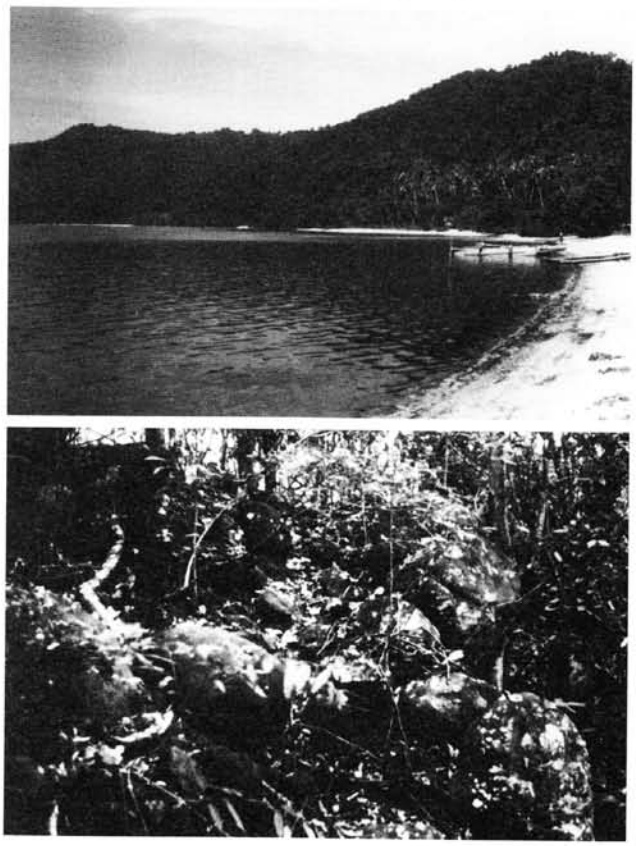

Figure 2. Cape Santigi, Sulawesi. **Above**: Forested hills where field surveys for *Indotestudo forstenii* were conducted from 12 to 16 October 1998. **Below**: Rock outcroppings inhabited by *Indotestudo forstenii*.

Exploitation of *I. forstenii* continues, although harvest levels are difficult to quantify. *Indotestudo forstenii* is classified by Indonesia as a "non-protected species" under the Conservation of Living Resources and Ecosystems Act of 1990 (No. 5), and export is permitted according to a quota system (Jenkins, 1995; Samedi and Iskandar, 2000). The original annual quota of 1500 was reduced to 400 in 1993, and 200 in 1994 (Jenkins, 1995), but apparently raised to 450 in 1998 (Samedi and Iskandar, 2000). However, our interviews indicated larger numbers of tortoises are actually being exported. Hunters stated up to 20 tortoises/day were collected in the past, and one dealer reported exporting 50 to 100 tortoises/month during recent (< 5) years. Juveniles are highly sought by the pet trade, while adults enter both pet and food markets. Adults are often reportedly exported to China scattered among large shipments of *Cuora amboinensis*.

In the absence of any baseline data on wild populations it is difficult to predict current demographic trends for *I. forstenii*. Local hunters believe tortoises are becoming increasingly more difficult to find, and current levels of harvest probably threaten the continued viability of *I. forstenii* populations. *Indotestudo forstenii* is particularly vulnerable to over-exploitation as extant populations are confined to restricted areas of northern and central Sulawesi, reproductive potential is low, and large numbers of adults, the most reproductively important age class, are apparently being aggressively harvested. A similar situation was reported in

Tanzania, where severe impacts to pancake tortoise (*Malacochersus tornieri*) populations resulted from over-collecting for the pet trade (Klemens and Moll, 1995). Life history traits of long-lived organisms such as tortoises severely constrain the ability of populations to respond successfully to chronic over-harvesting, and the concept of any significant level of sustainable yield is not applicable (Congdon et al., 1993). Furthermore, drought and catastrophic wildfires constitute additional sources of mortality, which may exacerbate the demographic effects of human over-harvesting on already depleted *I. forstenii* populations.

Leucocephalon yuwonoi. — The endemic Sulawesi forest turtle was recently described as *Geoemyda yuwonoi* on the basis of seven specimens purchased by Frank Yuwono at Gorontalo (McCord et al., 1995). An additional turtle was later purchased at Poso, in central Sulawesi (McCord et al., 1995). The species was subsequently reassigned to the monotypic genus *Leucocephalon* by McCord et al. (2000). Captives are excellent climbers, semi-aquatic, and herbivorous (McCord et al., 1995). Otherwise, nothing is known concerning the life history and ecology of *L. yuwonoi*.

On 14 October 1998 we located two specimens of *L. yuwonoi* during a nocturnal search along 1 km of a tributary creek of the Kanggol River (00°35'N, 120°54' E), approximately 220 km west of Gorontalo (Fig. 1). The creek is characterized by a rocky channel with abundant woody debris, and drains an area of second-growth forest. Occasional deep (≥ 1.0 m) pools were encountered, but water depth was generally less than 30 cm. Two adult males (CUSC 1657, 1686) were captured, photographed, and released. Both turtles were found moving on the bottom of shallow pools, and defecated immediately upon capture. The feces of one (CUSC 1657; CL = 237 mm) contained unidentified leaves and eight heretofore undescribed nematodes (*Falcaustra kutcheri*; Bursey et al., 2000); the other (CUSC 1686; CL = 230 mm) contained four unidentified fleshy fruits, possibly *Ficus* spp. These observations constitute the first report of *L. yuwonoi* in the wild.

Currently, *L. yuwonoi* is managed as a fishery resource and not afforded national protection status by Indonesian authorities (Samedi and Iskandar, 2000). *Leucocephalon yuwonoi* is collected for the food and pet trade, but we were unable to obtain quantitative estimates of this harvest. We examined two adults at a reptile dealer's compound in Palu, and two recently captured juveniles at a village on Cape Santigi. Villagers reported the recent sale of about 30 turtles, and our guide had captured and sold about 100 turtles during the past two years, all caught in the creek mentioned above. A dealer stated that *L. yuwonoi* are sold to restaurants in Palu. *Leucocephalon yuwonoi* is also exported commercially and has been found in the turtle markets of southern China (Salzberg, 1998; W.P. McCord, *in litt.*) and Hong Kong (M. Lau, *pers. comm.*). Although the ecological requirements of *L. yuwonoi* remain largely unknown, deforestation may likewise prove detrimental.

Cuora amboinensis. — The Malayan box turtle remains common in Sulawesi and large numbers are harvested annually. We observed about 130 turtles at the holding facilities of two exporters, and lesser numbers elsewhere. Most are opportunistically collected by farmers from flooded rice fields, ponds, and ditches. The ability of *C. amboinensis* to inhabit anthropogenically altered and created habitats, and the opportunistic rather than systematic collection practices may contribute to the continued abundance of this turtle (Shine et al., 1998). Annual export quotas were unlimited in 1990, but subsequently reduced to 90,000 (Samedi and Iskandar, 2000). However, enforcement is lax and quotas are routinely exceeded. According to several dealers, "two to three tons" (ca. 1800 to 2700 kg) of turtles, primarily *C. amboinensis*, are exported daily from Jakarta, most destined for food markets in southern China. Assuming an average body mass of 1.0 kg/turtle, this conservatively represents an annual harvest of 657,000 to 985,000 turtles. Although this harvest is distributed throughout Indonesia and not confined to Sulawesi, it surely constitutes a serious long-term threat to wild populations.

A *C. amboinensis* that we examined at a dealer's compound in Ujung Pandang represents a new maximum size record. The female turtle (CUSC 1658) weighed 2.5 kg and had a carapace length of 242 mm, exceeding the previously reported maximum size of 200 mm (Pritchard, 1979; Ernst and Barbour, 1989). Much of the posterior carapace was discolored, scutes were fused, and no sutures were evident, a description consistent with reports of fire damage to *Terrapene carolina* (Dodd et al., 1997).

Trachemys scripta elegans. — The red-eared slider is native to the southern United States, but numerous extra-limital populations, believed to originate from escaped or released pets, have become established in North America, Europe, Africa, and Asia (Luiselli et al., 1997). We found *T. scripta elegans* at dealer's compounds in Palu (CUSC 1659; CL = 122 mm) and Ujung Pandang (CUSC 1661; CL = 143 mm), both captured in nearby rice fields by farmers. Furthermore, these dealers report frequent purchases of this species from local villagers. *Trachemys scripta elegans* has not been previously reported from Sulawesi, but our observations suggest feral populations are present.

Conclusions. — Our limited study indicates commercial exploitation of turtles is occurring in Sulawesi at levels that are compromising the viability of wild populations. We consider *I. forstenii* as endangered in Sulawesi and thus throughout its range owing to its restricted distribution, the magnitude of the harvest, and systematic collection strategies which target adults. The declining catch-per-effort reported by turtle hunters is highly suggestive of an over-exploited population (Klemens and Moll, 1995). Thus, the conservation of *I. forstenii* should be accorded a very high priority. While there is clearly a need for additional field studies, without rapid implementation of protective measures, populations may disappear before even basic ecological studies can be completed. It is imperative to determine the status of *I. forstenii* in protected areas, especially Morowali

Reserve, where tortoises were last reported in the early 1980s, Pauna Nature Reserve, and the proposed Buol Toli Toli Protected Forest. Although the occurrence of *I. forstenii* in the latter two protected areas has yet to be confirmed, museum specimens were collected nearby, and these reserves might harbor significant populations, which would benefit from protection. Wildfire prevention and control measures should be incorporated into management plans for all protected areas inhabited by tortoises. Moreover, we recommend that Indonesian conservation authorities institute a moratorium on the harvest and export of *I. forstenii* pending the completion of status surveys. In addition, it is crucial that countries such as China, the United States, and the European Union suspend imports pending completion of a thorough status review of *I. forstenii* in Indonesia. Furthermore, due to its endangered status on Sulawesi and continuing exploitation by trade, *I. forstenii* should be considered for listing on Appendix I by CITES.

Further studies of the distribution and ecology of *L. yuwonoi* are also warranted. Anecdotal information we gathered suggests *L. yuwonoi* may occur at relatively high densities, and based on the few records available may be widely distributed in Sulawesi. The impact of current levels of exploitation is unknown. However, because *L. yuwonoi* is endemic to Sulawesi, we recommend the species be afforded national protection status (no utilization allowed without ministerial permission; Samedi and Iskandar, 2000). *Cuora amboinensis* remains common, but given the large number of turtles being exported for food to China, the long-term sustainability of this harvest is questionable.

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Kyphosis in a Musk Turtle (*Sternotherus odoratus*) from Ontario, Canada

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Kyphosis has been recorded in many turtle species and families (Lynn, 1937; Ernst, 1976; Plymale et al., 1978; Harding and Bloomer, 1979; Wilhoft, 1980; Rhodin et al., 1984; Stuart, 1996). The deformity has most often been reported for the genera *Apalone* and *Chrysemys* (Stuart, 1996). Nixon and Smith (1949) noted that kyphosis had been observed by Hartweg in the common musk turtle, *Sternotherus odoratus*, but no details were provided. Herein, I report an additional instance of kyphosis in *S. odoratus*.

A kyphotic adult male musk turtle (Fig. 1) was captured on 25 July 1984 at Big Clear Lake, Arden, Kennebec Township, Frontenac County, Ontario, Canada (44°44'28"N, 76°54'15"W). The specimen had the following maximum dimensions: carapace length = 114.5 mm, carapace width = 75.6 mm, plastral length = 87.3 mm, and the kyphotic shell height was 63.6 mm. Of 39 musk turtles (26 males, 13 females) captured at this site, only this specimen had kyphosis.

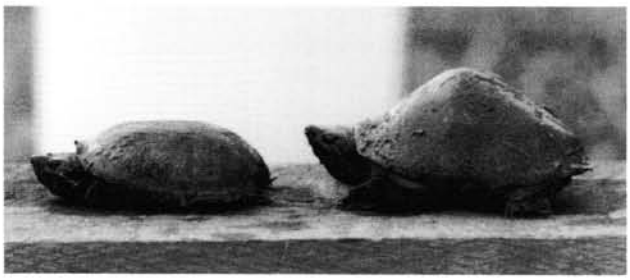

Figure 1. Normal (left) and kyphotic (right) *Sternotherus odoratus*.

Definitions and theories for the cause of kyphosis in turtles have been reviewed by Wilhoft (1980), Rhodin et al. (1984), and Stuart (1996). Kyphosis ("hump-back") is thought to be the result of a premature fusion of the vertebral elements of the vertebral column causing unequal growth rates of the various carapacial components. Such fusion may be brought about by environmental conditions to which eggs, embryos, and hatchlings are exposed. The opposite spinal deformity of lordosis ("sway-back") can be caused by a premature fusion of the dorsal elements of the vertebral column, while allowing continual growth of the ventral vertebral centra, as recorded in cases of infection causing neural synostosis and lordosis in sea turtles (Kochinsky et al., 1995). Neither kyphosis nor lordosis is common, with the overall incidence of spinal deformities calculated at about 0.1% in a sample of over 11,000 sea turtles (Rhodin et al., 1984).

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