

CONSERVATION BIOLOGY OF FRESHWATER TURTLES AND TORTOISES

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Geochelone elegans (Schoepff 1795) – Indian Star Tortoise, Star Tortoise

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SUMMARY. – The Indian Star Tortoise, *Geochelone elegans* (Family Testudinidae) is a medium-sized tortoise endemic to the Indian subcontinent. Typical straight carapace length (CL) of females is up to 32 cm, with males up to 26 cm, but females of greater than 50 cm CL are known. The species occurs in scrub forests, grasslands, and some coastal scrublands of arid and semi-arid regions throughout its range, but also commonly inhabits human-dominated landscapes, including agricultural fields, hedgerows, and plantations. *Geochelone elegans* is most active during the monsoon rains when it is known to forage and copulate throughout the day. Females typically produce two clutches annually, usually comprising 2–10 eggs per clutch. Generation time has been estimated to be about 10 years. Outside of the monsoon season the species is predominantly crepuscular, typically venturing out in early morning and late afternoon, hiding under bushes or tufts of grass throughout the rest of the day and night. The species is largely herbivorous, feeding on various grasses, herbaceous succulent vegetation, fruits, and fallen flowers. It is also known to scavenge on animal matter, including centipedes, insects, slugs, snails, excreta of dogs and birds, and carrion. The main current threats to the survival of *G. elegans* include illegal collection, habitat loss, and accidental killings, including road mortality. Illegal collection for the international wildlife trade is the most serious concern for the species. Numerically, *G. elegans* is the single most confiscated species of tortoise or freshwater turtle in the global illegal wildlife trade. While some small-scale captive breeding may be occurring at some zoos and with some private keepers, few of the offspring are traded internationally, and no large-scale commercial captive production facilities are known to exist. Future conservation efforts hinge on increased legal protection inside and outside of range states, including possible uplisting on to CITES Appendix I, cooperation between relevant enforcement bodies, and the implementation of human behavioral change initiatives focused on reducing consumer demand for this protected species.

DISTRIBUTION. – India, Pakistan, and Sri Lanka. Occurs in several disjunct populations in northwestern India and extreme southeastern Pakistan, southeastern and southern India, and Sri Lanka.

SYNONYMY. – *Testudo elegans* Schoepff 1795, *Chersine elegans*, *Peltastes stellatus elegans*, *Geochelone elegans*, *Geochelone elegans elegans*, *Testudo stellata* Schweigger 1812 (*nomen novum*), *Geochelone* (*Geochelone*) *stellata*, *Geochelone stellata*, *Peltastes stellatus*, *Testudo actinodes* Bell 1828, *Testudo actinoides* Bell in Gray 1844 (*nomen novum*), *Peltastes stellatus actinoides*, *Testudo megalopus* Blyth 1854, *Peltastes stellatus maura* Gray 1870, *Peltastes stellatus seba* Gray 1870.

SUBSPECIES. – None currently recognized.

STATUS. – IUCN 2018 Red List: Vulnerable (VU A4cd) (assessed 2016); CITES: Appendix II, as Testudinidae spp.; India: Wildlife Protection Act – Schedule IV (1972); Pakistan: Sindh Wildlife Protection Ordinance (1938) – Schedule II; Sri Lanka Fauna and Flora Ordinance (1993).

Taxonomy. – The Indian Star Tortoise, *Geochelone elegans*, family Testudinidae, was originally described as *Testudo elegans* (Schoepff 1795). Later, Schweigger (1812) described *Testudo stellata* based on the same specimens

and plate previously described and figured by Schoepff (1795) as *Testudo elegans* (TTWG 2017). Schweigger (1812) named *stellata* as a *nomen novum* because Schoepff (1795) had based his description of *elegans* partly on a



Figure 1. *Geochelone elegans*, adult female, from Gir Wildlife Sanctuary and National Park, Gujarat, India. Photo by R. Vyas.

Seba (1734) specimen that Schweigger concluded had been incorrectly identified, and he instead synonymized that figure under *Testudo rotunda* (TTWG 2017). Schweigger therefore coined a new name for Schoepff's species, renaming it *stellata* and stating: "Habitat in India orientali. (Schoepff. *sub falso nomine: test. elegans* Seb.)" (TTWG 2017). However, the description of *T. elegans* by Schoepff was nomenclaturally available, and therefore *T. stellata* Schweigger has the same type specimens as *T. elegans*, according to Article 72(e) of the ICZN Code, and thus becomes its objective junior synonym (TTWG 2017).

Later, Bell (1828) described *Testudo actinodes*, using the type locality "Africa" in error. Based on this description, Bell in Gray (1844) coined the name *Peltastes stellatus actinoides*, as a *nomen novum*, followed by the subspecies *Peltastes stellatus maura* and *Peltastes stellatus seba* (Gray 1870) (type localities unknown) all of which are now considered as subjective synonyms of *G. elegans* (TTWG 2017). Similarly,



Figure 2. Subadult *Geochelone elegans* from northeast Tamil Nadu, India. Photo by P.P. van Dijk.

Testudo megalopus (type locality not known) was described by Blyth (1854) based on a specimen registered as being collected from the streets of Calcutta (in West Bengal State, eastern India) and is also considered a subjective synonym of *G. elegans* (Das et al. 1998; TTWG 2017).

Loveridge and Williams (1957) restricted *Testudo* to five species of Palearctic tortoises, with those from other zoogeographic regions being assigned to different genera; many large-bodied tropical species, including *T. megalopus* were transferred to the genus *Geochelone*. Le et al. (2006) concluded that *Geochelone* was a polyphyletic genus with species distributed in four independent clades; *G. elegans* was placed in the *G. elegans* group that also included *G. platynota* and *G. sulcata* (a species now usually referred to the monotypic genus *Centrochelys*). Further analysis by Fritz and Bininda-Emonds (2007) has supported this grouping. The clade containing *G. elegans* is thought to have originated in Africa and later dispersed in Asia (Le et al. 2006).



Figure 3. Record size female *Geochelone elegans* (57.5 cm curved carapace length) from Sri Lanka. Photo by A. de Silva.



Figure 4. Adult female *Geochelone elegans* from Gujarat, India. Photo by N. D’Cruze.

No subspecies are recognized, but based on genetics, Gaur et al. (2006) identified three distinct allopatric populations (see Distribution) that may be worthy of taxonomic recognition. A size gradient exists from north (larger) to south (smaller) through peninsular India (Ernst and Barbour 1989). This is reversed in Sri Lanka where large individuals occur (Ernst and Barbour 1989; de Silva et al. 2017).

Description. — *Geochelone elegans* is a medium-sized tortoise with a straight carapace length (CL) of at least 15 cm for males but typically reaching up to 26 cm (Moll 1989; Fife 2007). Females are larger than males with a CL \geq 25 cm, but typically reaching 32 cm (Frazier 1987; Fife 2007). However, some larger female specimens are recorded as reaching up to 50.5 cm curved carapace length in India (Matz et al. 1971; Vyas 2011) and 57.5 cm curved carapace length in Sri Lanka (de Silva et al. 2017). Detailed descriptions are provided by Ernst and Barbour (1989), Moll (1989), Das (1995), and de Silva (2003).

The oval carapace is domed, with a very convex dorsal surface and abruptly descending sides. A deep cervical indentation is present, but no cervical scute. Posterior marginals are serrated and, in some, slightly upturned. Vertebrae are usually broader than long, although the first may be longer or as long as broad; the fifth is expanded. Well-defined growth annuli surround the raised vertebral and pleural areolae, causing the carapace to appear lumpy. There are usually 11 marginals on each side, and a single, undivided, downturned supracaudal scute.

The carapace is dark brown or black; a series of 6–12 yellow stripes radiate outward from the yellow or tan vertebral and pleural areolae. Each marginal has one to three yellow stripes beginning at a yellow spot in the lower posterior corner and extending upward towards the pleurals and vertebrae. Males typically have a supracaudal scute that is longer and more curved than females. Das (1995) reported that animals from the northwestern Indian population are less brightly colored than those from the southeastern Indian and Sri Lankan populations.

The well-developed plastron is slightly upturned anteriorly. Its forelobe is longer but narrower than the hind lobe, which bears a deep notch. The plastral formula is $abd > hum > gul > fem > pect > an$; the paired gulars are thickened but do not generally protrude anteriorly. The bridge is wide with single axillary and inguinal scutes of moderate size. The plastron and bridge are yellow with black radiations.

The head is moderate with a non-projecting snout and a weakly hooked, sometime bi- or tricuspid, upper jaw. A large prefrontal scale is divided longitudinally and followed by a single, rather narrow frontal scale that may extend forward to partially separate the two halves of the prefrontal. Other head scales are small. The head is yellow to tan with spotted brown or black jaws; limbs and tail are also yellow or tan with brown or black irregular spots.

The anterior surface of each forelimb is covered with large and small irregularly shaped to pointed protective scales in five to seven longitudinal rows. Several small to moderate conical tubercles occur on the thigh. The back legs



Figure 5. Hatchling *Geochelone elegans* from Sri Lanka. Photo by A. de Silva.



Figure 6. Hatchling *Geochelone elegans*. Photos by P. Praschag, Turtle Conservancy.

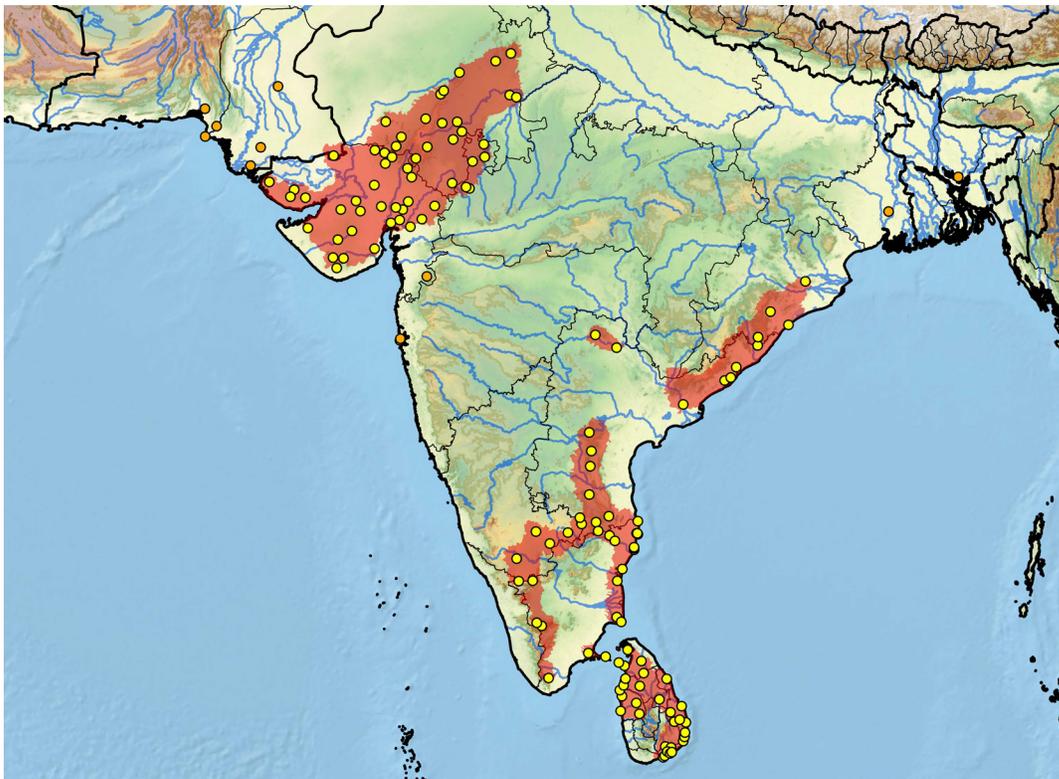


Figure 7. Distribution of *Geochelone elegans* in Pakistan, India, and Sri Lanka. Yellow dots = museum and literature occurrence records of native populations based on Iverson (1992) plus more recent and authors' data; orange dots = uncertain native or trade or introduced specimens; red shading = projected historic distribution. Distribution based on GIS-defined level 10 HUCs (hydrologic unit compartments) 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; TTWG 2017), and adjusted based on authors' subsequent data.

are typically short and strong (Fife 2007). The tail usually lacks an enlarged scale. Males have longer thicker tails than do females; females have larger and broader shells.

Geochelone elegans can be distinguished from other tortoises of the region by the combined carapacial pattern of light radiating lines on a dark background and plastral pattern of dark radiating lines on a light background (Moll 1989). Additional distinguishing characters include an undivided supracaudal scute, absence of a cervical scute, an entoplastron not crossed by the humeropectoral seam, and a relatively long trachea (Moll, 1989).

The Burmese Star Tortoise (*Geochelone platynota*) of Myanmar is the closest extant relative of *G. elegans*. Both have a star pattern on the carapace, but *G. elegans* differs by having more rays on the costals (eight or more), while *G. platynota* usually has six or seven rays on its costals. *Geochelone elegans* also differs by having asymmetric small distinct shields on the top of the head and radiating lines on the plastral scutes (juveniles have dark blotches) (Moll 1989).

Distribution. — *Geochelone elegans* is found in three broadly disjunct (and likely taxonomically recognizable; Frazier 1992; Jayson 1993; Das 1995; Gaur et al. 2006) areas of geographic occurrence in South Asia: (1) northwestern India (Gujarat, Rajasthan, and adjoining western part of Madhya

Pradesh) and adjoining extreme southeastern Pakistan (the Thar desert); (2) southern and southeastern areas of India, including Tamil Nadu, Kerala, southeastern Karnataka, Andhra Pradesh, Telangana, southern Chhattisgarh, and eastern Odisha (Orissa); and (3) the island of Sri Lanka and its small offshore islands (Minton 1966; Ernst and Barbour 1989; Moll 1989; Das 1991; Choudhury and Bhupathy 1993; Das 1995; Vyas and Parasharya 2000; de Silva 2003; Vyas 2005, 2010; de Silva and Vamberger 2016). Jayakar and Spurway (1966) cited a secondhand record for Bangladesh; however, that is probably not reflective of the natural distribution for *G. elegans* (Moll 1989).

Pakistan. — Records of *G. elegans* from Pakistan are few. Günther (1869) reported that a specimen was collected from Sindh after examining a collection of Indian reptiles received by the British Museum. A few specimens were obtained by Anderson and Minton (1963) from the Tharpakar Desert in extreme southeastern Sindh (Moll 1989). Khan (2006) stated that the species also occurs in southeastern Pakistan around Karachi and is commonly found in semi-domesticated conditions; it is likely that these are released trade specimens (TTWG 2017).

India. — In northwestern India, according to a literature report and survey by Frazier (1987) and Rao and Choudhury (1996), *G. elegans* has a wide distribution throughout

the Saurashtra and Kachchh peninsulas, North Gujarat, Ahmedabad, Chhota Udaipur and Vadodara districts. A survey by Vyas and Parasharya (2000) also confirmed the presence of *G. elegans* in 18 different districts within Gujarat, including Ahmedabad, Amreli, Anand, Banaskantha, Bhavnagar, Dahod, Devbhumi Dwarka, Gandhinagar, Gir Somnath, Jamnagar, Junagadh, Kheda, Kutch, Mahesana, Panchmahal, Rajkot, Sabarkantha, and Surendranagar. The species was not recorded in the districts south of the Narmada River (Vyas and Parasharya 2000), confirming earlier reports by Das (1995).

In Rajasthan, *G. elegans* was reported by Smith (1931) from Udaipur “east of the Aravalli range”, from an area near Jawai Bandh railway station on the western side of the Aravalli range (Prakash 1971), and at Erinpura, Jalore District by Bhupathy et al. (1994). In Madhya Pradesh, *G. elegans* was reported from Mandsapur (Gandhisagar Reservoir) by Vyas and Singh (2004), and from Sailana Wildlife Sanctuary by Vyas (2010).

In southeastern and southern India, Sethy et al. (2015) confirmed the presence of *G. elegans* in the District of Gajapati, Odisha. In Telangana, Srinivasulu and Srinivasulu (2002) reported *G. elegans* from the Deccan plateau between Godavari and Krishna rivers. Srinivasulu (2003) also reported *G. elegans* from within Kawal Wildlife Sanctuary in Adilabad District of the Godavari river belt; confirming prior survey work by Moll (1984). Anand et al. (2005) reported *G. elegans* from Chittoor and Madanpalle districts in Andhra Pradesh and Kolar District in Karnataka.

In Tamil Nadu, *G. elegans* has been reported from Mambakkam, Pudukottai, and Ramanad by Das (1991) and as occurring along the plateaus and plains east of the Ghats by Sharath (1997). The species has also been reported from within Point Calimere Wildlife Sanctuary by Alagar Rajan and Balasubramanian (1991), Mudumalai Wildlife Sanctuary (and surrounding areas of Masinagudi, Moyar, and Vazhathottam) by Bhupathy et al. (1994), Kalakad–Mundanthurai Tiger Reserve by Johnsingh (2001), and from the districts of Karaduva and Rameswaram by Anand et al. (2005). In Kerala, *G. elegans* has been reported from Chinnar Wildlife Sanctuary (Jayson 1993), a release site for confiscated specimens.

Sri Lanka. — The ancestral stock of *G. elegans* would have arrived to the island of Sri Lanka during periods when it was connected to the Indian subcontinent (de Silva et al. 2017). Here, the natural habitat of *G. elegans* is confined to the dry and arid climatic zones of the lowest, or the first penepain (sea level to 270 m) (de Silva et al. 2017). The dry zone constitutes approximately 65% of the island’s total land area (de Silva et al. 2017).

Tennent (1861) and Ferguson (1877) reported *G. elegans* in Puttalam and Chilaw in northwest Sri Lanka. Deraniyagala (1939) reported its presence in Udappuwa, close to Puttalam

and the island of Karaduva. Dattatri and Vijaya (1983) and Dattatri (1984) reported *G. elegans* in Yala and Wilpattu National Parks. The species has also been reported in the Mihintale Sanctuary by Jayawickrama et al. (2010), in Andigama by de Silva et al. (2000), in Batticola by Ahamed et al. (2004), and released captive specimens in Kandy by Ekanayake et al. (2004). More recently, *G. elegans* has been reported from an island off Kalpitiya lagoon by de Silva and Vamberger (2016) and from within Lunugamwehera National Park, Thanamalwila (de Silva et al. 2017).

Habitat and Ecology. — *Geochelone elegans* is a terrestrial species with a highly generalized habitat preference (Moll 1989; de Silva 2003). The species naturally inhabits

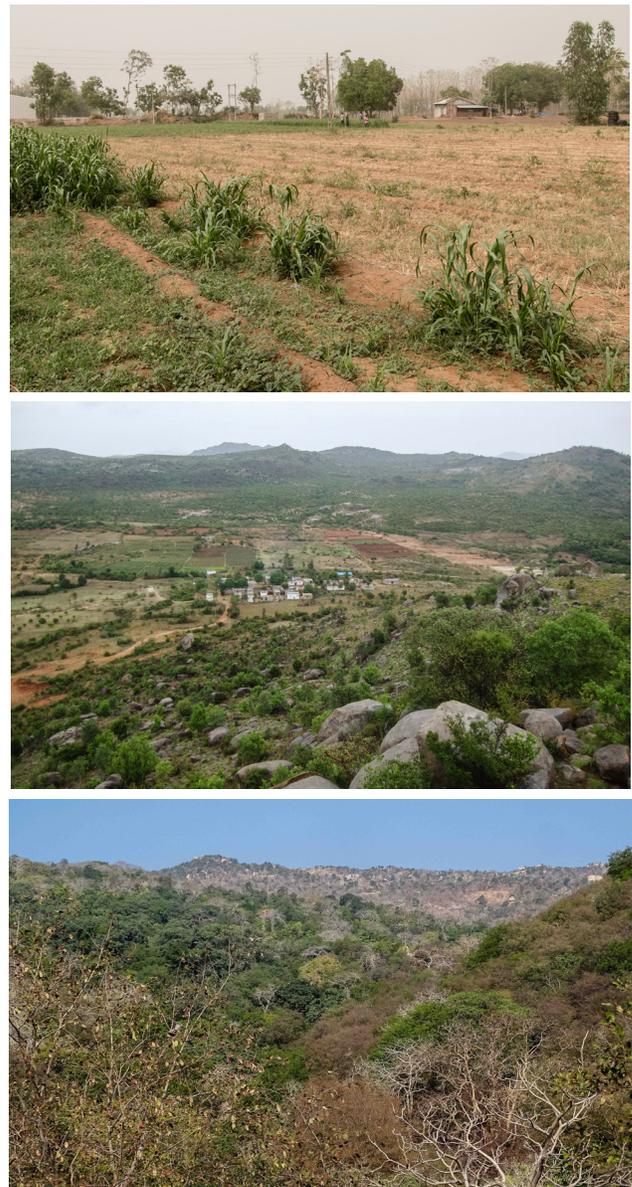


Figure 8. Typical habitats of *Geochelone elegans* in India. *Top:* An agricultural area, Gujarat. Photo by N. D’Cruze. *Middle:* An unprotected rural area, Andhra Pradesh. Photo by N. D’Cruze, World Animal Protection. *Bottom:* A protected area, Jassore Wildlife Sanctuary, Gujarat. Photo by R. Vyas.

scrub forests, grasslands, and some coastal scrublands of arid and semi-arid regions, but also commonly inhabits human-dominated landscapes including fields, hedgerows, and plantations (Deraniyagala 1939; Das 2002; Choudhury et al. 2000; de Silva 2003). The most distinguishing feature of *G. elegans* habitat is its aridity (Anand et al. 2005). Most occurrences are under 200 m altitude, but records from 450 m and even as high as 900 m have been reported (D’Cruze et al. 2016). In Sri Lanka, this species occurs throughout the dry habitats up to 270 m altitude (de Silva 2003).

Hutton (1837) provided one of the most complete accounts of *G. elegans* habits, which was partially reprinted by Smith (1931) and commented upon further by Moll (1989). *Geochelone elegans* is most active during the monsoon rains when it is known to forage and copulate throughout the day (Moll 1989). Outside of the monsoon season the species is predominantly crepuscular, typically venturing out in early morning and late afternoon, hiding under bushes or tufts of grass throughout the rest of the day and night (Daniel 1983; Moll 1989). Individuals were observed foraging between 0630–1030 hrs and between 1630–1830 hrs by de Silva (2003). During long periods of drought *G. elegans* can be rather inactive and individuals have been reported to go without food for long periods of time (Daniel 2002).

Diet. — With regards to feeding ecology, the species is largely herbivorous, feeding on various grasses, herbaceous succulent vegetation, fruits, and fallen flowers (Das 1991; de Silva et al. 2017). Alagar Rajan and Balasubramanian (1991) observed *G. elegans* in the wild feeding on plant leaves belonging to the families Asclepiadoideae, Convolvulaceae, Cyperaceae, Euphorbiaceae, Papilionaceae, and Poaceae (formerly Gramineae). However, *G. elegans* is also known to scavenge on animal matter, including centipedes, insects, slugs, snails, excreta of dogs and birds, and carrion (Jayakar and Spurway 1966; Das 1991; Alagar Rajan and Balasubramanian 1991; Kataria 1995; Gadhvi 2001; Jayawickrama et al. 2010; de Silva et al. 2017). Cannibalism in captivity has also been documented by Soman (1990) who observed an old male *G. elegans* that attacked and ate the heads of three smaller tortoises. The phenomenon of eating animals perhaps applies only to captive specimens deprived of a complete natural diet (Whitaker 1974) and in the wild when food availability during dry periods is extremely low (Anand et al. 2005).

Reproduction. — Frazier (1987) studied growth and maturity of *G. elegans* in captivity and reported female sexual maturity at the age of 10 years. However, Das (1991) and Vyas (1996) reported sexual maturity at the age of 6–7 years. Nesting seasons coincide with the monsoons that vary depending on the geographic location (e.g., May to June in western India, March to June and October to January in southern and eastern India and northeastern coastal Sri Lanka) (Das 2002; de Silva et al. 2017). Females typically

produce two clutches annually (exceptionally up to four clutches) comprising 2–10 eggs (Deraniyagala 1939; Whelan and Coakley 1982; Vyas 2005; Bidmon 2006). However, exceptionally up to 24 eggs have been recorded (B.C. Choudhury, pers. comm.). Nesting females dig a chamber approximately 10–15 cm deep with a pot-shaped bottom which they cover and urinate on. Generation time has been estimated to be around 10 years (B.C. Choudhury, pers. comm.). Eggs vary from 36–52 x 27–39 mm in length and width and have a mass of 18–42 g (Smith 1931; Deraniyagala 1939; Jayakar and Spurway 1966; Whelan and Coakley 1982; Vyas 2005; Bidmon 2006). The egg shells are significantly thinner and much more brittle than those of other tortoises, and are hard-shelled to resist the dry and hot atmosphere (Anand et al. 2005). Hatchlings are approximately 38.4 mm in CL, with a mass of about 18.5 g. When studying *G. elegans* in captivity, Vyas (2005) found a positive correlation between egg size and hatchling size, between female size and clutch size, and also between female size and egg size.

Courting males pursue and ram and push females with their thickened gular scutes. When the female comes to a stop, the male mounts from the rear and places his forefeet on her third pleural scutes. Males may then raise their hind feet free of the ground and smash their anal scutes against the lower, rear portion of the female’s carapace. During this phase and after intromission the male may utter short grunts. Aggressive males also ram and push rival males during mating season to drive them away from potential mates.

The species is selective about its nesting sites (Anand et al. 2005). The soil must be neither too damp nor too dry, but soft enough to be able to excavate. It must also show characteristics that indicate that it will not become waterlogged, too hot or too dry in summer. Incubation of the eggs usually takes as few as 47 days, but up to 257 days has been recorded (Jayakar and Spurway 1966; Whelan and Coakley 1982; Daniel 2002; Vyas 2005). Hatchlings may remain in the nest until rains soften the soil, allowing them to emerge (Ernst and Barbour 1989; Vyas 2005).

Parasites. — *Amblyomma clypeolatum* is a specific ectoparasite of *G. elegans* in India and Sri Lanka, and has been reported from Rajasthan and Gujarat in western India and Andhra Pradesh in southern India (Warburton 1925; Robinson 1926; Sharif 1928; Seneviratna 1965; Frazier and Keirans 1990; Sharma 2001). Frazier and Keirans (1990) reported heavy parasitization of hosts by ticks from Andhra Pradesh (56%, 5 of 9 individuals) over those recorded from Rajasthan and Gujarat (2%, 2 of 90 individuals). Srinivasulu and Srinivasulu (2002) also recorded low levels of host parasitization (11%, 2 of 19 individuals) that suggests trends may vary locally. During a recent study by Liyanaarachch et al. (2015), the following ticks were observed on *G. elegans*: *Amblyomma clypeolatum*, *A. testudinarium*, and *Haemaphysalis turturis*. Nathanael et al. (2004) reviewed the



Figure 9. Illegally sourced *Geochelone elegans* collected in Gujarat, India. Photo by N. D’Cruze.

parasites of captive *G. elegans* in Sri Lanka. Pharyngodonid nematodes and the spirurid round worm *Camallanus trispinosus* are specific endoparasites reported in captive *G. elegans* (Matsuo et al. 1999; Jeyathilakan et al. 2015).

Population Status. — Wild populations of this species are present in both protected areas and in agricultural landscapes in range states (D’Cruze et al. 2016). Substantial wild populations appear to still exist in India and Sri Lanka, but recent detailed field surveys regarding their exact status are currently lacking (D’Cruze et al. 2016). Any populations in Pakistan appear to be extremely localized and small, with recent detailed field surveys also lacking (D’Cruze et al. 2016).

Historically, the largest wild *G. elegans* populations in India were reported to have been found in the Aravali Hills of Rajasthan, the Chitoor District of Andhra Pradesh, fringes of the Little Rann of Kutch, Gir Wildlife Sanctuary, and Gir Forest National Park in Gujarat (Moll 1989). Frazier (in Das 1991) recorded estimated densities of 4–12.5 animals per ha in Gujarat. In Sri Lanka, Tennent (1861) and Ferguson (1877) reported *G. elegans* as being particularly abundant in Puttalam and Chilaw, as did Deraniyagala (1939) in Udappuwa and on the island of Karaduva. Dattatri and Vijaya (1983) and Dattatri (1984) found that the tortoise was common in Yala and Wilpattu National Parks (Moll 1989).

Threats to Survival. — The main current threats to the survival of *G. elegans* include illegal collection and habitat loss (WWF 1994; Sekhar et al. 2004; Anand et al. 2005; Vyas 2010; de Silva 2017; D’Cruze et al. 2015, 2016). Illegal collection can be subdivided into two further categories: collection for utilization by local communities and collection for the international wildlife trade (D’Cruze et al. 2015).

In some rural areas in India *G. elegans* is sometimes consumed for subsistence (Anand et al. 2005; D’Cruze et al. 2015). However, individuals are also kept as pets in many homes, their owners believing that they bring good luck and fortune (Anand et al. 2005; D’Cruze et al. 2015). Over 100 hatchlings were observed in one urban household alone (D’Cruze et al. 2015). In addition, for many people



Figure 10. Part of a confiscation in 2017 of nearly 2100 smuggled *Geochelone elegans* in Sri Lanka. Photo by A. de Silva.

in some societies, *G. elegans* plays a more spiritual role as it is thought to represent a reincarnation of the Hindu God Vishnu (D’Cruze et al. 2015). A total of 22 animals were observed at three different Shiva temples in the state of Gujarat, India (D’Cruze et al. 2015). However, in Sri Lanka some societies consider *G. elegans* to be a bad omen and unlucky (and called a *hooniyam ibba* = “witchcraft tortoise”) if one should enter into a garden (de Silva, pers. obs.).

However, it is illegal collection for the international wildlife trade that is of most serious concern. Numerically, *G. elegans* is the single most confiscated species of tortoise or freshwater turtle worldwide and is thought to represent around 11% of global seizures involving chelonians (P.P. van Dijk, pers. comm.). Between 2000 and 2015, at least 34,080 live individual *G. elegans* were recorded as seized by wildlife and customs authorities during 118 different enforcement actions internationally (CITES 2017). Noteworthy is that during this time nearly two-thirds of all seized live *G. elegans* (21,316 animals) were detected and seized within India (CITES 2017).

A separate analysis of seizure events in India reported by the media between 2011 and 2015 revealed that at least 8,533 individual *G. elegans* were seized and that this species occurred in at least 23% of all such seizure events (223) reported during this time period (Mendiratta et al. 2017). In Sri Lanka, unpublished data provided by the Customs Department and other enforcement officials (including the Navy, Police and Flying Squad) noted that at least 3,130 individual *G. elegans* were seized between 2015 and 2017 alone (Malsinghe et al. 2017; de Silva, pers. comm.).

In Thailand, *G. elegans* was also the most frequent illegally traded tortoise seized by enforcement authorities between 2008 and 2013 (5,966 individuals during 15 cases) and is the most commonly observed tortoise at the infamous Chatuchak Market in Bangkok (Chng 2014). Additional seizures of *G. elegans* occurred in Germany, Indonesia, the Netherlands, the Philippines, Slovakia, Spain, the United Kingdom, and the United States, in most cases from air travelers arriving from Asia, as well as some from express mail parcels sent from Asia (CITES 2017).

However, studies have shown that these seizures represent only a small portion of a far larger off-take (D’Cruze et al. 2015; CITES 2017). D’Cruze et al. (2015) reported the illegal collection of at least 55,000 (mostly juvenile) *G. elegans* from just one location (comprising 16 villages) from the state of Andhra Pradesh in India over a period of one year. This figure is three to six times larger than the 10,000–20,000 individuals previously estimated to be poached throughout the entire range of the species annually (Sekhar et al. 2004).

Although ownership of *G. elegans* is likely to have been a long-held cultural practice in some range states (WWF 1994), such as the northwestern Indian states of Gujarat, Maharashtra, and Rajasthan (D’Cruze et al. 2015), the international commercial trade in this species appears to be a relatively new and rapidly increasing phenomenon (D’Cruze et al. 2015; CITES 2017). Moll (1983) found no evidence of trade in *G. elegans* at any of the wildlife markets visited throughout India during the late 1970s and early 1980s, and it was not until the mid-1990s (WWF 1994) that initial conservation concerns regarding this illegal activity were first raised. Das (1989) estimated an annual turnover of 10,000 animals in Calcutta’s New Market alone in the late 1970s, before enforcement of domestic legislation helped curtail this domestic trade (Choudhury and Bhupathy 1993).

With regards to trade routes, this species is being illegally smuggled from India and Sri Lanka into pet markets in Asia, Europe, and the United States (de Silva 2003; Horne et al. 2012; Vyas 2015; CITES 2017), but the majority of animals appear to be destined for use as exotic pets in Asian countries, such as Thailand, China, and Malaysia (Shepherd et al. 2004; D’Cruze et al. 2015; Chng and Bouhuys 2015).

In India, wild-caught *G. elegans* are transported by road or rail to export locations and domestic retail trade hubs (CITES 2017). Illegal exports have been documented from Kolkata (Calcutta) by sea cargo to Malaysia, Singapore, and Thailand, and by air from Bengaluru (Bangalore), Chennai (Madras), Vishakhapatnam (Vizag), Kolkata, and Mumbai (Bombay) to Bangkok, Thailand, or Kuala Lumpur, Malaysia, as well as by land into Bangladesh followed by air transport from Dhaka to Bangkok (CITES 2017). From Bangkok, onward transports were documented to Hong Kong, Japan, Taiwan, and other destinations (CITES 2017). In Sri Lanka, although trade route data are currently lacking, sea cargo along the northeast coast has been recorded (de Silva 2017).

In addition to conservation concerns, the illegal trade in *G. elegans* also represents an on-going animal welfare threat (Sekhar et al. 2004; Anand et al. 2005). Physical injury and stress associated with illegal capture, handling, and overcrowding usually leads to disease and death of many traded animals (Warwick 1990; Baker et al. 2013).

Habitat loss is also occurring throughout the range of *G. elegans*; in particular, scrub forest habitat is being converted to orchards and cash crop agriculture, leading to reduction

of available area of the preferred habitat type (Vyas 2006, 2010; de Silva 2015; D’Cruze et al. 2016). Although *G. elegans* is a relatively adaptable species, able to tolerate anthropogenically altered habitat, continued habitat loss is likely to further impact wild numbers (Vyas 2006; de Silva 2015; D’Cruze et al. 2016).

Additional documented threats faced by *G. elegans* include accidental mortalities via road kills and agricultural equipment such as brushmowers, and discarded fishing nets (de Silva 1996, 2003, 2015; Ekanayake et al. 2004; Jayawickrama et al. 2010), as well as deliberate killings to protect crops (de Silva 2003, 2015).

Conservation Measures Taken. — Wild populations of *G. elegans* are present in both protected areas and in agricultural landscapes in range states (D’Cruze et al. 2016). Available information indicates that this species maintains relatively large populations with an extent of occurrence (EOO) of >20,000 km² and an area of occupancy (AOO) of more than 2,000 km² (D’Cruze et al. 2016). However, based on recent documented levels of seizures, illegal trade, and the suspected future reduction in population size that could occur because of this activity, an IUCN listing of Vulnerable A4cd has been assessed based on concerns that population reductions of >30% are likely to occur if this exploitation continues or expands (D’Cruze et al. 2016). This echoes earlier national CAMP workshop assessments of populations of *G. elegans* in India (Molur and Walker 1998) and Sri Lanka (de Silva et al. 2000).

Surveys by Vyas and Parasharya (2000) and Vyas (2006) in Gujarat have confirmed the presence of *G. elegans* from either within or less than 30 km from the boundaries of several protected areas, including Gujarat: Balaram Ambaji Wildlife Sanctuary (W.S.) and Jessore Sloth Bear Sanctuary, Jambughoda W.S.; Saurashtra: Barada W.S., Gir National Park (N.P.) and Sanctuary, Girnar W.S., Hingolghadh Nature Education Sanctuary (mostly released confiscated specimens), Mitiyala W.S., Pania W.S., Rampara W.S., Velavadar N.P., and Gaga Bustard Sanctuary (now part of Kutch); and Kutch: Narayan Sarovar Chinkara Sanctuary and Wild Ass Sanctuary.

In India, *G. elegans* is still thought to be present in the following additional protected areas: Andhra Pradesh: Gundla Brahmeswaran W.S., Nagarjunasagar Srisailem W.S.; Gujarat: Lalaji Bustard W.S., Narayan Sarovar W.S., Pania W.S.; Kerala: Chinnar W.S.; Madhya Pradesh: Sailana W.S.; Rajasthan: Jamwa Ramgarh W.S., Kumbhalgarh W.S., Mount Abu W.S., Nahargarh W.S., Phulwari ki Nal W.S., Ranthambore N.P., Sajjangarh W.S., Sariska N.P. and W.S.; and Tamil Nadu: Kalakad-Mundanthurai Tiger Reserve, Point Calimere W.S., Mudumalai W.S., and Sathyamangalam W.S.

In Sri Lanka, *G. elegans* is still thought to be present in the following Wildlife National Parks: Adam’s Bridge, Angammedilla, Bundala, Chundikkulam, Delft, Flood Plains,

Gal Oya, Horrowpatana, Kaudulla, Kumana (Yala East), Lahugala Kitulana, Lunugamvehera, Madhu Road, Maduru Oya, Minneriya, Somawathiya, Udawalawe, Ussangoda, Wasgamuwa, Wilpattu, and Yala (Ruhuna).

Geochelone elegans has been included on CITES Appendix II since 1975, allowing international trade only if export permits are issued by the country of origin (CITES 2017). However, to safeguard its wild populations, India, Sri Lanka, and Pakistan have chosen to adopt stricter domestic measures than CITES (WWF 1994). In India the species was placed under Schedule IV of the Wildlife (Protection) Act 1972 and for over 40 years it has been illegal to possess and commercially trade this species either within or from India (Sekhar et al. 2004). Similarly, in Sri Lanka *G. elegans* is protected under the Sri Lanka Fauna and Flora Ordinance (1993), and in Pakistan the Forest, Environment and Wildlife Department of the Government of Sindh, through a notification issued in 2014, included *G. elegans* along with other chelonian species of Pakistan in Schedule II (Protected Animals) of the Sindh Wildlife Protection Ordinance 1972. Furthermore, none of the three range countries have permitted or recorded legal exports of commercial quantities of live, wild-collected specimens since 1999 (CITES 2017).

Advocacy, targeted lobbying, and public awareness campaigns using evidence-based research are thought to have contributed to an observed significant reduction in the scale of *G. elegans* openly traded in pets shops in Malaysia since 2003 (Chng and Bouhuys 2015). These initiatives, which raised the profile of *G. elegans* and the issue of illegal trade, also resulted in two new wildlife laws being passed in Malaysia that now afford legal protection for this species (Chng and Bouhuys 2015). Similarly, a number of enforcement drives in India have also helped to protect wild populations of *G. elegans*. Most recently, in 2017, the Wildlife Crime Control Bureau (WCCB) of India was awarded a certificate of commendation by the CITES Secretariat for its effort to combat the proliferating illegal trade in freshwater turtles and tortoises following “Operation Save Kurma” which resulted in the seizure of approximately 16,000 animals between December 2016 and January 2017 (The Hindu, 2017).

Conservation Measures Proposed. — Given the scale of the illegal trade in *G. elegans*, it is recommended that more detailed research, surveys, and monitoring should be carried out in order to establish the full impact that this unregulated activity has on wild populations (D’Cruze et al. 2015). In addition, increased information about levels of trade in *G. elegans* (for both online and physical markets) and enforcement actions taken (including seizures, forensic analysis of seized specimens, arrests, prosecutions and judgments, and the disposal of seized specimens) are also recommended. Inventories of current captive *G. elegans* populations, including breeding data and mortality rates,

rehabilitation centers and other captive facilities and new developments on captive breeding activities and wild release programs would also prove useful in this regard.

From a policy perspective, transferring *G. elegans* from CITES Appendix II to Appendix I is recommended, as this would help to safeguard remaining wild populations, aid national enforcement efforts, and better reflect current legislation in range states. There are some early indications that India and Sri Lanka will act in unison to co-propose this legislative change at the 18th CITES Conference of the Parties (CoP 18) in Sri Lanka in 2019. Similarly, given that legal trade in other Asian countries appears to be undermining range state efforts to safeguard wild populations of *G. elegans*, it is recommended that these ‘sink’ countries should implement corresponding national bans regarding commercial trade in this species (Nijman and Shepherd 2015; D’Cruze et al. 2015). In particular, given Thailand’s concerning current role as a country of transit, extending its Wild Animal Reservation and Protection Act (WARPA) to protect non-indigenous species could help aid existing enforcement efforts to address this illegal trade activity (Nijman and Shepherd 2015; D’Cruze et al. 2015).

Given the apparent relatively recent development of a highly organized international criminal trade network (involving range states, Thailand, and other Asian countries, such as China), ongoing and increased cooperation between relevant national enforcement bodies in collaboration with the Association of Southeast Asian Nations’ Wildlife Enforcement Network (ASEAN-WEN) is also recommended (D’Cruze et al. 2015), including efforts to address online trade via social media. To help reduce consumer demand for *G. elegans*, further studies should be carried out to acquire a more detailed understanding of the attitudes and behaviors of consumers in states identified as trade hubs and or sinks (e.g., Thailand and China). This information will help to inform existing and any future human behavioral change initiatives focused on reducing consumer demand for this protected species.

In range states, the development of national conservation strategies to guide Government agencies and other conservation stakeholders on actions to conserve *G. elegans* would prove useful. Similarly, the development of *G. elegans* trade monitoring kits would help frontline enforcement staff identify *G. elegans*, sample large volumes of seizures, and provide guidance on their disposal. Producing a database of suitable housing facilities for long-term placement of live *G. elegans* would also help maximize the conservation outcomes and welfare needs of confiscated specimens. With specific regard to India, transferring *G. elegans* from Schedule IV to Schedule I or part 2 of Schedule II of the Wildlife (Protection) Act 1972 would provide teeth and strengthen existing enforcement efforts (Vyas 2006, 2015).

In addition to developing effective anti-poaching measures, these national conservation strategies should also incorporate measures to address habitat loss. Management plans should also incorporate site-specific measures to address other anthropogenic pressures on wild *G. elegans*, such as accidental mortalities (e.g., as a result of agricultural equipment and vehicular traffic) and deliberate killings (e.g., as a result of efforts to protect cash crops).

Captive Husbandry. — The captive husbandry of *G. elegans* has been extensively described by Deraniyagala (1939), Jayakar and Spurway (1964, 1966), Tardent (1972), Whitaker (1974), Kirsche (1976), Whelan and Coakley (1982, 1985), Biswas and Acharjyo (1984), Frazier (1989), Rao and Subba Rao (1990), Das (1991), Jagannadha Rao (1995), Grigus (1998), de Silva (2003), Vyas (2005), Rao (2005), Bidmon (2006), and Fife (2007).

With regards to commonly encountered problems related to health, captive *G. elegans* are reportedly prone to bladder stones when not kept well hydrated, and respiratory problems when kept in suboptimal conditions that are not warm or dry enough for this species (Fife 2007). Symptoms of the latter include labored breathing, nasal discharge, a gaping mouth, puffy eyes, lethargy, and loss of appetite. Beak abnormalities in captive individuals may occur as a result of poor nutrition and in severe cases may lead to mortalities as a result of starvation (Fife 2007). *Geochelone elegans* is not an overly aggressive breeder in captivity and so associated injuries are not reported to be of major concern (Fife 2007), although cannibalism among captive males has been documented (Soman 1990).

Soft shell is another severe problem that can occur in captive *G. elegans*, resulting from a lack of direct sunlight and calcium (Fife 2007). The condition can also be attributed to *Hexamita parva*, a flagellate protozoan of the urinary tract that disrupts absorption of nutrients, robbing the shell of collagen (Fife 2007) or to a new picornavirus recently documented by Heuser et al. (2014). Pyramiding is a condition of abnormal growth that results in a bumpy carapace or the appearance of “pyramids” on the top of the shell. This condition is reportedly most often seen in captive *G. elegans*, although it does not pose a major health issue unless dietary deficiencies are a contributing factor; it can hinder the ability of a male tortoise to mount the female, thus preventing mating.

While some small-scale captive breeding may be occurring at some zoos and with some private keepers, few of the offspring are traded internationally, and no large-scale commercial captive production facilities are known to exist (CITES 2017). Vyas (2006) reported that captive specimens of *G. elegans* were being kept in 16% ($n = 26$) of the 164 captive wild animal facilities in India. He also reported that none of the captive production facilities in India were known to have successfully bred any *G. elegans* in captivity within

the previous 12 months and that data regarding sex ratios were not available from 10 of the institutions.

More recently, information on numbers of *G. elegans* held in captivity provided by the global online database Species 360 (2018) indicated that a total of 1,374 (267 males, 257 females, 850 of unknown sex) were being held at 96 different zoos and aquaria in four different geographical regions. In Asia, a total of 1,138 (181 males, 197 females, 760 of unknown sex) were reported from 33 different institutions. In Europe, a total of 116 (29 males, 32 females, 55 of unknown sex) were reported from 26 different institutions. In Oceania, a total of 20 (6 males, 4 females, 10 of unknown sex) were reported from 5 different institutions, and in North America, a total of 100 *G. elegans* (51 males, 24 females, 25 of unknown sex) were reported from 22 different institutions. These data are not comprehensive as they refer only to Species 360 member institutions.

Current Research. — To our knowledge, there is no research involving wild populations of *G. elegans* underway at this time. A number of captive breeding projects in India and Sri Lanka are being conducted and monitoring of released animals will be a component of any future reintroduction plans. A range-wide phylogeographic study to further delineate the degree of distinctiveness among the three disjunct populations of *G. elegans* is sorely needed.

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