ARTICLES

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Assessment of the Threatened Status of *Testudo kleinmanni* Lortet, 1883 (Testudines: Testudinidae) for the IUCN Red List

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ABSTRACT. – *Testudo kleinmanni* Lortet, 1883, is one of the smallest tortoises to occur in the Mediterranean region. Its northeastern populations in the Egyptian Sinai and Israel were recently described as a separate species, *Testudo werneri* Perälä, 2001. *Testudo kleinmanni* as currently defined had a historical distribution in northern coastal Egypt with two disjunct populations in Libya. Very little is known about the biology of this species, and no field-based analyses exist on population sizes or densities. The whole Egyptian subpopulation has been extirpated in the last few decades primarily due to agricultural practices, industrial activities, expansion of human settlements, and primarily collection for the illegal pet trade, all of which factors also affect the remaining world population in Libya. Until 2002, *T. kleinmanni* had a global IUCN Red List status of Endangered (A1abcd). The species is also listed on CITES Appendix I. Population density data from Israel for closely related *T. werneri* as well as recent field and locality data from Libya were applied to estimate the present population and threatened status of *T. kleinmanni*. The species' global extent of occurrence covered an estimated area of 123,610 km^2 less than three generations ago, today it is estimated at around 16,600 km^2. Within the same period population sizes are estimated to have decreased by over 85% from around 55,600 to 7500 individuals, of which ca. 5000 are adults. This figure is less than the number of animals recorded from the illegal pet trade in the 1990s alone. Fairly good habitat patches still exist in Libya but the global population of *T. kleinmanni* could realistically face extinction in less than 20 years (or in ca. one generation) if habitat degradation and trade cannot be stopped. Concerted conservation measures at national and international levels, and development and implementation of national legislation in Libya and Egypt are needed to save *T. kleinmanni* from extinction. *Testudo kleinmanni* qualifies for listing as Critically Endangered (A2abcd + A3d) under current IUCN Red List Criteria; an up-list in status was recommended and accepted by IUCN in 2003.

KEY WORDS. – Reptilia; Testudines; Testudinidae; *Testudo kleinmanni*; *Testudo werneri*; tortoise; threatened species; conservation; status; IUCN Red List; Libya; Egypt

The Egyptian tortoise, *Testudo kleinmanni*, Lortet, 1883, previously listed as Endangered by the IUCN Red List (IUCN, 2002; assessed in 1994), was re-assessed for its threatened status in 2002 and subsequently up-listed by IUCN as Critically Endangered (IUCN, 2003). This report formed the basis for that listing change.

Taxonomy. — Order: Testudines. Family: Testudinidae. Scientific name: *Testudo kleinmanni*. Species authority: Lortet, 1883.

Synonyms. — *Testudo leithii* Günther, 1869 (not *Testudo leithii* Carter, 1852). The species was classified into the subgenus *Pseudotestudo* by Loveridge and Williams (1957). This subgeneric name is nonapplicable for *T. kleinmanni* because the taxon was based on juvenile characters not retained into adulthood (Bour, 1989).

Taxonomic Comments. — Populations east of the Nile delta in Egypt (Sinai) and in Israel formerly assigned to *T. kleinmanni* have been shown to encompass a separate species, *Testudo werneri* Perälä, 2001 (Perälä, 2001). Consequently, this report does not take into account information based on the above geographical region traditionally incorporated into papers on *T. kleinmanni*. The threatened status of *T. werneri* is being assessed separately.

Common Names. — Egyptian tortoise (E); Leith's tortoise (E); Tortue d'Egypte (F); Tortue de Kleinmann (F); Ägyptische Landschildkröte (G); Tortuga de Plastrón Articulado (S).

Countries of Occurrence. — Egypt (north coast and Western Desert); Libya (Tripolitania, Cyrenaica).

Current Population Trends. — Decreasing.

Major Threats. — Illegal trade, agricultural and industrial expansion and settlements, habitat degradation.

Previous (2002) Red List Status. — EN A1abcd – Endangered (IUCN, 2002). The previous global threat classification (assessed in 1994, prior to the split of *T. werneri* from *T. kleinmanni*) treated both species together.

Proposed (2003) Red List Status. — CR A2abcd + A3d - Critically Endangered. Proposed change accepted by IUCN Red List Authority in 2002 and subsequently by IUCN (2003).

Historic Distribution

Historically, the range of *T. kleinmanni* (as presently defined) ran along the Mediterranean coastal strip up to about 90–120 km, exceptionally further, towards the inland in Libya—where disjunct populations exist in Tripolitania and in the Cyrenaican Peninsula—and more or less continuously from northeastern Libya to the Western Desert and the north coast of mainland Egypt (Lortet, 1883, 1887; Loveridge and Williams, 1957; Buskirk, 1985; Iverson, 1986, 1992; Baha El Din, 1994; Fritz and Buskirk, 1997; Perälä, 2001). The range has possibly been much greater in the past, and localities further inland or in the west, such as Siwa Oasis and the Tripolitanian range, respectively, may represent the last remnants of a more extensive distribution in historical times; the range may have decreased with natural aridification and expansion of the Saharan desert. Thus, *a priori* treatments of isolated occurrences of *T. kleinmanni* as human introductions, or as extralimital, should be viewed with caution.

All historical and recent localities known or inferred to have supported *T. kleinmanni* populations are presented below, based on the sources quoted above. Additional information is based on Baha El Din (2002b) and A. Pieh (*pers. comm.*). Geographical coordinates are given for separate localities in Egypt with identical headings, based on information provided by Baha El Din (1994). Coordinates for a few Libyan localities are taken from Baha El Din (2002). Museum acronyms below follow Leviton et al. (1985).

Egypt. — El Hammam; SE El Hammam; S El Hammam; El Omayed; Maryut; Alexandria; vic. of Alexandria; 77 km W Alexandria; Wadi El Natrun; Giza; E Sidi Abd El Rahman; El Daba; S El Daba (31°00'15"N, 28°26'29"E); S El Daba (30°58'27"N, 28°26'56"E); E Matruh (31°01'04"N, 28°26'56"E); Ras El Hekma; E Matruh (31°09'23"N, 27°34'34"E); 43 km SE Matruh; 26 km E Matruh; Mersa Matruh; Agniba nr. Mersa Matruh; 20 km W Matruh; SW Matruh (31°12'54"N, 27°05'21"E); SW Matruh (31°08'32"N, 27°00'19"E); SW Matruh (30°41'07"N, 26°34'23"E); Siwa Oasis; SE Abu Laho; Abu Laho; N Qattarani (31°28'47"N, 26°11'20"E); N Qattarani (31°31'10"N, 26°13'14"E); 5 km S Buqbuq; 32 km E Salum; 1.6 km S Sidi Barrani; 10 km E Salum; Salum.

Libya (Cyrenaica). — Wadi Giarabub 75 km S Tubruq; btw. Giarabub and Tubruq [this reference from Buskirk (1985) might be based on the preceding one]; btw. Bir Sceferzen and Esc-Scegga (Qasr ash Shaqqah) on the Giarabub to Tobruk (Tubruq) road; W Tubruq (32°07'11"N 23°35'58"E); Darnah (Derna); 35 km S Darnah; 20 km SE Darnah; Suluntah S Al Bayda; ca. 30 km S Mekhili; S Gebel Akhdar (32°11'49"N 22°18'46"E); Barca (Al Marj); Qaminis (Gheminez); Kouf National Park (specimen in FMNH collection; Schleich, 1987); Ras Bayad (32°02'24"N 24°01'39"E).

Libya (Tripolitania). — Ca. 30–50 km W Tripoli, close to coast; Gharyan; btw. Tarhuna and Bin Ghashir; Al Khums; Leptis Magna; hills nr. Gharyan. Additionally, Loveridge and Williams (1957) mentioned *T. kleinmanni* without further details from Sirtica (Sirt, Surt), a locality isolated halfway between Tripolitania and Cyrenaica at the Mediterranean, in the Surt province in northern central Libya.

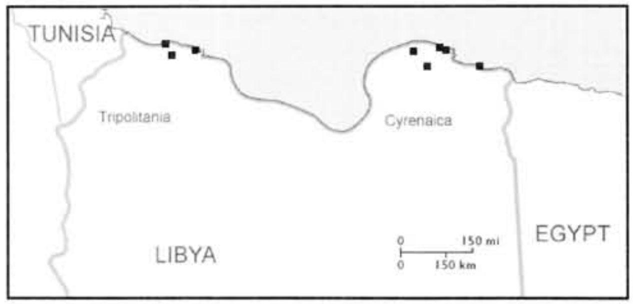

Figure 1. Present world distribution of *Testudo kleinmanni* as inferred from locality data presented by Fritz and Buskirk (1997), Perälä (2001), Baha El Din (2002b), and Pieh (*pers. comm.*). The species has recently been extirpated from its former distribution in northern and western coastal Egypt.

Present Range

The present remaining range of *T. kleinmanni* as currently understood is presented in Fig. 1.

Egypt. — In practice, *T. kleinmanni* has been extirpated from its former main distribution area in Egypt. Baha El Din (1994), who surveyed in essence the whole former range of *T. kleinmanni* in Egypt, concluded that populations disappeared completely within a recent period of approximately 10 to 20 years, that is, between the early 1970s and the early 1990s. This time frame is estimated to represent around, or slightly more than, one generation length for *T. kleinmanni*—where "generation" is defined as in IUCN (2001)—taking into consideration that maturity as such is probably reached at about 10–20 years in the wild as is the case in several other species of testudinids living in semiarid or arid conditions (Woodbury and Hardy, 1948; Brushko, 1977; Kuzmin, 2002).

Recently, in 2001, two wild tortoises were found in a protected coastal area in the Western Desert (exact locality undisclosed), the first record for *T. kleinmanni* in Egypt in over 20 years (Baha El Din, 2002a). This finding, although significant per se, does not change the fact that *T. kleinmanni* is effectively extinct in Egypt.

Libya. — Recently verified, detailed locality data for the present occurrence or range of *T. kleinmanni* in Libya are largely lacking. The last published account dates back nearly 15 years (Schleich, 1989), and his article is apparently based on fieldwork conducted in 1983 (Schleich, 1987). Because the bulk trade that affected thousands of Libyan *T. kleinmanni* since the late 1980s (Baha El Din, 1994) is likely to have had a great negative impact on the population, only very recent locality data (all from this millennium except Gharyan from 1997) are used in the following assessment of the species' present range in Libya; older data are additionally discussed).

Alexander Pieh (*pers. comm.*) found five individuals of *T. kleinmani* after rain 20 km southeast of Darnah towards Tubruq during fieldwork in May 2000. He also encountered one dead animal in a wadi near Darnah, as well as tracks of two *T. kleinmanni* near Suluntah. He found no evidence of tortoises on the coast around Surt (Sirt, Sirtica). Baha El Din (2002b) found four *T. kleinmanni* in April 2002, as follows: an adult female crossing the highway west of Tubruq; a fresh roadkill adult female in semidesert south of Gebel Akhdar; an adult male wandering on a stony hillside at Ras Bayad; a dried carapace of an adult female among flotsam on the beach (same locality).

The occurrence of the species in Tripolitania has been much debated (Fritz and Buskirk, 1997). The existence of wild tortoises in this region in northwestern Libya was finally verified by A. Pieh (Perälä, 2001). Pieh (*pers. comm.*) encountered four individuals of *T. kleinmanni* at one locality in Tripolitania, around the ruins of ancient Leptis Magna east of Al Khums in May 2000. Fritz and Buskirk (1997) and Pieh (*pers. comm.*), also quote an amateur herpetologist as having witnessed large numbers of *T. kleinmanni* being offered for sale in 1997 in Tripoli ("some hundred", according to Pieh who has seen photographic evidence). These tortoises were said to have been collected in a hilly area near Gharyan. *Testudo kleinmanni* are often seen in a local market in Tripoli (Baha El Din, 2002b).

According to Baha El Din (2002a), Libyan researchers have recently started fieldwork on local populations with the effect that "new populations have been found". She further stated that the Libyans also found "some animals in western Libya where the species was not previously known, possibly introduced". It is not clear whether the reference to new populations includes the Tripolitanian range. According to Baha El Din (2002b), "the natural occurrence of *T. kleinmanni* in Tripolitania is not convincingly proven". He continued that "despite several recent reports of *T. kleinmanni* specimens found in the region, these animals could have easily been introduced artificially by man in recent years". Baha El Din (2002a) added that "some internal trade and transport of these animals occurs", and that "these animals could be easily established in the seemingly suitable habitats of Tripolitania". The above statements (Baha El Din, 2002a,b) that *T. kleinmanni* was not known from Tripolitania until recently, including the assumption about recent introductions by man, must however be considered erroneous according to previously published evidence (Fritz and Buskirk, 1997; Perälä, 2001), and additional data as described above. Such speculative statements are also counterproductive from a conservation point of view because they can be used to legitimize the mixing of geographically restricted populations. Further, success rates or establishment of faunal introductions or invasions into previously uninhabited areas are generally very low, and wild stock usually perish (reviewed in Hunter, 1996; among others). The oldest known museum specimen from Tripolitania, ZMH-R 00616 (from Al Khums), was recorded already in 1899, and several more were collected over 40 years ago (Fritz and Buskirk, 1997). Additionally, one *T. kleinmanni* specimen from the early 1990s was collected at "ca. 30–50 km W Tripoli, close to coast", i.e., northwest of Al Khums, and two more from "West Libya" around the same time (MTKD collection data; Perälä, 2001). These data strongly support the natural occurrence of *T. kleinmanni* in northwestern Libya.

In conclusion, whereas *T. kleinmanni* is already essentially extinct in Egypt, it can still be found in two distinct, and geographically disjunct regions in Libya (Tripolitania and Cyrenaica).

Habitat Preferences and Current Habitat Status

Egypt. — *Testudo kleinmanni* populations in northern Egypt are historically associated with desert and semi-desert habitats characterized or dominated by compact sand and gravel plains with scattered rocks and shallow sandy wadis, although populations were also known to occur in or adjacent to coastal salt marsh habitats (Lortet, 1887; Baha El Din, 1994). The primary habitat preferences for *T. kleinmanni* in Egypt using the modified version of the Global Land Cover Characterization (GLCC) classification, as indicated in Annex C (IUCN, 2001), is hot desert (GLCC category 8.1). The majority of the species' primary habitats in Egypt are currently severely degraded, or already completely destroyed (Baha El Din, 1994).

Libya. — In Cyrenaica, northeastern Libya, the species occurs in shrubby sand and stone desert habitats (coast) and semidesert habitats with *Artemisia* association (further inland), according to Schleich (1987, 1989). Schleich et al. (1996) considered the species to generally occupy the margins of sandy, or dry stony, habitats. The species can apparently also be found (together with *T. graeca* species complex tortoises) in more vegetated Mediterranean subtropical shrub evergreen forests, as can be inferred from Schleich (1989) who cites Suluntah as a locality. It is however not clear how typical this habitat association is for *T. kleinmanni* in northeast Libya, thus it is probably most appropriate to describe the species' primary habitat preference in Cyrenaica as Mediterranean scrub (GLCC category 3.5.4). The same GLCC category is applicable to historical *T. kleinmanni* habitat in northwestern Libya (Tripolitania).

Habitats are still in fairly good condition in Libya, but there are signs of extensive overgrazing in many parts, particularly in Cyrenaica, and ploughing for growing cereals is a common practice, and trends and plans for habitat utilization are unclear (Baha El Din, 2002a). According to fieldwork by Pieh (*pers. comm.*) in Cyrenaica habitat is locally still very good near Suluntah, and reasonably well preserved in the wadi system near Darnah. However, habitat on the whole coastal stretch between Darnah and Tubruq is severely degraded, possibly due to extensive, and continuing, nomadic activity in that area. In Tripolitania habitat degradation due to human expansion is very evident on the coast east of Al Khums around Leptis Magna, whereas habitat in more southerly areas towards the inland near Gharyan is apparently less degraded (A. Pieh, *pers. comm.*). Further, according to Pieh, the coastline between Al Khums and the Tunisian border features occasional spots of undisturbed habitat. Although there are no records from near the Tunisian border, Pieh speculates that *T. kleinmanni* could occur there based on habitat factors alone. Pieh concludes that the coast around Surt between Tripolitania and Cyrenaica, scattered with salt plains, is too arid and degraded to support tortoises at present.

Extent of Occurrence

As discussed above, *T. kleinmanni* has become effectively extinct in its former range in Egypt. Judging by data produced in Iverson (1992), Buskirk (1985), and Baha El Din (1994), the species' extent of occurrence in Egypt, possibly up to the early 1970s, is estimated as having been around 67,860 km^2. According to available data (Buskirk, 1985; Iverson, 1986, 1992; Fritz and Buskirk, 1997; Perälä, 2001; Pieh, *pers. comm.*), the small northwestern (Tripolitanian) range—delimited possibly by the northern neighborhood of Gharyan in the inland, Leptis Magna and regions slightly west of Tripoli on the coast—encompasses an estimated area (extent of occurrence) of around 5500 km^2. Nothing is known about local population densities, but A. Pieh (*pers. comm.*) concluded that the coastal subpopulation had to be severely fragmented because of a mosaic of badly degraded habitat. The estimated extent of occurrence for the present Cyrenaican population of *T. kleinmanni* is around 11,100 km^2, as measured using a minimum convex polygon and locality data provided by Baha El Din (2002b) and Pieh (*pers. comm.*). Some 40 years ago the Cyrenaican *T. kleinmanni* population had possibly an estimated extent of occurrence of 50,250 km^2 as calculated using data from Buskirk (1985), Iverson (1992), and Perälä (2001), as well as assuming that the distribution was continuous from Cyrenaica to western Egypt. The isolated locality of "Sirtica" (Loveridge and Williams, 1957) some 300 km west of Qaminis (Gheminez) in western Cyrenaica was not taken into account.

Area of Occupancy

Because no fieldwork-based data on the area of occupancy exist for *T. kleinmanni*, the area of occupancy is simply defined as 10% of the area of extent of occurrence, as applied in the Red List Criteria (IUCN, 2001), yielding the estimates presented in Table 1. These data are used in subsequent estimates below.

Population Size and Density

Mendelssohn (1982) estimated 20 years ago the global population size of *T. kleinmanni* (including *T. werneri* from Sinai and Israel) at less than 10,000 individuals, including immatures. This figure seems to have been an underestimation as regards current estimates and statistics on trade as presented below. Additionally, one factor skewing his estimate is that Mendelssohn (1982) was not aware of the existence of *T. kleinmanni* in northwestern Libya, a region not taken into account in his assessment.

Although no population density assessments based on local field data have been published for *T. kleinmanni* in mainland Egypt and Libya, densities are thought to be very low (Buskirk, 1985; Schleich, 1989; Baha El Din, 1994, 2002a,b; A. Pieh, *pers. comm.*). Locals in Libya stated in April 2002 that populations of the species still exist in many parts of Cyrenaica, but that they have declined notably in recent years due to collection (Baha El Din, 2002b).

Let us assume that Mendelssohn's (1982) figure on average population densities of 4.5 individuals per km^2 for his *T. kleinmanni* (= *T. werneri*) in Israel is applicable for *T. kleinmanni*. This could be justified because *T. werneri* is a close relative, and no other relevant data exist. When population sizes are subsequently calculated using Mendelssohn's (1982) population density relative to an estimated area of occupancy defined as 10% of the area of extent, then population sizes for *T. kleinmanni* would have been the following approximately 2–3 generations (ca. 30-50 yrs) ago: Egypt, 30,500; Cyrenaica, 22,600; Tripolitania, 2500 individuals, respectively. This method estimates the past total world population at 55,600 individuals, substantially more than the estimate by Mendelssohn (1982), which, however, reflected the situation later in the early 1980s (for which period no area of extent data exist).

Using the same formula based on estimates about present areas of occupancy, current population sizes would be as follows: Egypt, 0 (the two existing individuals omitted); Cyrenaica, 5000; Tripolitania, 2500 individuals, respectively. The total present world (= Libyan) population of *T. kleinmanni* would thus be estimated at 7500 individuals, which is considerably less than the number of recorded animals collected in Libya for the pet trade in the 1990s (data presented below). Out of the existing global population around 75% (5000 individuals) would be mature adults if Mendelssohn's (1982) data on population structure for *T. werneri* is applicable for *T. kleinmanni*. According to the above estimate, the global population of *T. kleinmanni*

Table 1. Estimated areas of occupancy (km^2) of *Testudo kleinmanni*, based on 10% of areas of extent of occurrence.

	Past	Present
Egypt	6786	0
Libya (Cyrenaica)	5025	1110
Libya (Tripolitania)	550	550
Global	12,361	1660

would have declined by 86.5% or 48,100 individuals in less than three generations. Out of these, at least about 10,700 individuals have been recorded from the illegal pet trade in the 1990s alone (Baha El Din, 1994; Ventura, 1995; Pieh, *pers. comm.*), and a considerable proportion has undoubtedly gone unrecorded. Because relatively good habitat still exists in Libya it is possible that the earlier inferred reduction in the extent of occurrence primarily reflects pressure from collection and illegal trade, rather than habitat degradation.

Because no accurate, fieldwork-based data on population sizes or densities exist, the estimates presented here could deviate considerably from reality. Taking trade factors into account, the present population of *T. kleinmanni* might be even less than a few thousand individuals, perhaps only hundreds, but hard evidence is lacking. It is clear, however, that there is a high potential risk of the global population of *T. kleinmanni* facing extinction in the near future, even within 20 years or less, or in more or less one generation, if the remaining population in Libya continues to be affected by similar factors, notably trade, which essentially extirpated the species from Egypt in a few decades.

Based on the above assumption about actual or potential levels of exploitation alone, *T. kleinmanni* meets the IUCN (2001) Red List Critically Endangered criteria (Version 3.1) of CR A3d due to a population size reduction of ≥ 80% suspected to be met within the next 10 years or three generations, whichever is the longer.

Reduction in Population Size

Since the late 1950s, as judged by counts of all known *T. kleinmanni* localities, past and present (56, including Sirtica), as listed above, relative to localities from the 21st century alone (8 localities), based on Baha El Din (2002b) and Pieh (*pers. comm.*), the reduction in population size of *T. kleinmanni* has been around 85.7% assuming that average population densities are equal.

It can also be deduced from earlier calculations that the global extent of occurrence of *T. kleinmanni*, estimated at 123,610 km^2 in the late 1950s, has decreased by around 86.6% to 16,600 km^2 in less than 50 years, or in less than three *T. kleinmanni* generations. Assuming equal population densities, the reduction in population size would mirror the aforementioned value of 86.5% (and that based on the estimated area of occupancy noted above). This figure is very close to the one calculated from locality counts above (85.7% population reduction). These data meet with Red List criteria CR A2.

Major Threats

Major threats and disturbance factors are listed in Table 2. Explanations for the threats and disturbance factors are presented in Baha El Din (1994, 2002b) and Buskirk (1985), thus they appear here without excessive commentary, although past, present, and future trends are given in parentheses after each specific threat category. Each of these time frames represents three *T. kleinmanni* generations (> 30 to 60 years). Information on Libya is based on Baha El Din (2002b), A. Pieh (*pers. comm.*), as well as Schleich (1987, 1989). There is reason to believe that most threats listed by Baha El Din (1994) for Egypt are largely applicable for the situation in Libya; Baha El Din (2002b) concluded recently that, as is the case in Egypt, tortoises in Libya are threatened by both collection for the pet trade and by habitat destruction, but that collection seems to be a more serious and immediate threat in the short run.

In addition to especially agricultural (including overgrazing), development, and industrial pressure, *T. kleinmanni* was very heavily affected by (eventually illegal) national and international pet trade that started using Libyan stock after Egyptian subpopulations were harvested to extinction (Baha El Din, 1994). In addition to figures published in Baha El Din (1994) and Ventura (1995), I witnessed around 600 (out of originally over 1000) *T. kleinmanni*, destined for the illegal market, which were held at a reptile wholesaler's warehouse in the Czech Republic in 1997. All animals were of Libyan origin as judged by their appearance. The dealer noted openly that, when rumors about up-listing of *T. kleinmanni* from CITES Appendix II to Appendix I began circulating in the mid-1990s, he traveled to Egypt to buy the stock of over 1000 tortoises.

Table 2. The following threats to *Testudo kleinmanni* can be identified in accordance with IUCN (2001) standard classification categories (Major Threats Authority File, Annex 3, IUCN Red List Criteria). Past, present, and future trends are given in parentheses. Only those categories which are met are listed.

Category 1. *Habitat Loss/Degradation* (human induced):
- Agriculture. -
  - 1.1.1.2. Small-holder farming (present, future);
  - 1.1.1.3. Agro-industry farming (present, future);
  - 1.1.4.1. Nomadic livestock (past, present, future);
  - 1.1.4.2. Small-holder livestock (present, future).
- Extraction. -
  - 1.3.6. Groundwater extraction (present, future).
- Infrastructure Development. -
  - 1.4.1. Industry (present, future);
  - 1.4.2. Human settlement (present, future);
  - 1.4.3. Tourism/recreation (present, future);
  - 1.4.5. Transport – water (present, future).

Category 2. *Invasive Alien Species* (directly affecting the species):
- 2.2. Predators (present, future).

Category 3. *Harvesting* [hunting/gathering]:
- 3.5. Cultural/scientific/leisure activities. -
  - 3.5.2. Sub-national/national trade (present, future);
  - 3.5.3. Regional/international trade (present, future).

Category 4. *Accidental Mortality*:
- Collision. -
  - 4.2.2. Vehicle collision (present, future).

Category 8. *Changes in Native Species Dynamics*:
- 8.2. Predators (present, future).

Category 9. *Intrinsic Factors*:
- 9.1. Limited dispersal (past, present, future);
- 9.2. Poor recruitment / reproduction / regeneration (present, future);
- 9.5. Low densities (present, future);
- 9.7. Slow growth rates (past, present, future);
- 9.9. Restricted range (present, future).

Category 10. *Human Disturbance*:
- 10.1. Recreation/tourism (present, future);
- 10.2. Research (effectively in the past); see account on hematological studies in Buskirk (1985).

Further, this dealer noted that he was successfully smuggling his stock out from the Czech Republic, specifically into the European Union and Japan.

The brochure of TortoiseCare (The Egyptian Tortoise Conservation Program) (Anonymous, 2000) as well as Baha El Din (2002b) listed the illegal trade in *T. kleinmanni* of Libyan origin within Egypt as continuing. Baha El Din (2002b) reported that the Libyan customs had been consulted by the Libyan Environment General Authority to prevent the export of tortoises from Libya, but Libyan *T. kleinmanni* were still entering the Egyptian market. There were nevertheless reports of several shipments said to have been stopped recently before crossing the border into Egypt (Baha El Din, 2002b). Trade in *T. kleinmanni* exists within Libya itself, too (Fritz and Buskirk, 1997; Pieh., *pers. comm.*; Baha El Din, 2002b), with potentially devastating consequenes for the remaining world population. According to locals, collection pressure is higher in the east than in the west. In Cyrenaica, animals are collected by locals and sold for 1 Libyan lira each to Egyptian traders who take the animals across the border to Egypt. In Tripolitania there is no similar demand for tortoises and animals are not collected as much (Baha El Din, 2002b). Tortoises have a low annual biomass production resulting in a high degree of sensitivity to population disturbance and consequent poor recovery abilities from such activities as trade collection (Iverson, 1982).

Conservation Measures

Conservation measures, both present and those needed, and that are realistically achievable within the next few years, are listed in Table 3. Comments on numbered notes from Table 3 are discussed in the text below.

Note (1). — Whereas *T. kleinmanni* is covered by international conservation policies (IUCN Red List; CITES Appendix I), and although it is protected by Egyptian law (Baha El Din, 1994; Anonymous, 2000), the species is unprotected in Libya (Anonymous, 2000; Baha El Din, 2002b). However, recent information (Baha El Din, 2002a,b) suggests that the Libyan Environment General Authority and local academics show interest for tortoise conservation in Libya, and that they are looking forward to cooperating with the Egyptian based TortoiseCare program. There exists a lobby to include both *T. kleinmanni* and *T. graeca* (= *T. cyrenaica* Pieh and Perälä, 2002) on the Libyan list of protected animals in an explicit manner (Baha El Din, 2002b). Despite protection of *T. kleinmanni* by law in Egypt, the law is not implemented at all times (Baha El Din, 1994; Anonymous, 2000), as noted by anecdotal evidence (I. Siirilä, *pers. comm.*).

Baha El Din (2002b) indicated that TortoiseCare would continue to seek funding for future activities for the conservation of *T. kleinmanni*, and particularly for the development of a species action plan that would take into consideration the conservation needs of the species on a global level, including both Egypt and Libya.

Table 3. Conservation measures in place and needed for *Testudo kleinmanni* as noted on a standard Conservation Measures Authority File as required by IUCN Red List Criteria, Annex 3 (IUCN, 2001). Selection of a higher level action (e.g., 1.2. Legislation), does not mean that all the actions below this (e.g., 1.2.1 Development and 1.2.2. Implementation), are indicated. It simply indicates that legislation is either in place or is needed as part of a policy-based action for the taxon concerned. Selection of any action lower down the hierarchy automatically implies that the higher levels are indicated (IUCN, 2001). As some of the points do not apply to conservation measures in both Egypt and Libya, brief commentaries, as indicated by numbers, are presented in the text.

	In Place	Needed
1. Policy-based actions		
1.1. Management plans		
1.1.1. Development		yes (1)
1.1.2. Implementation		
1.2. Legislation		
1.2.1. Development		
1.2.1.1. International level		
1.2.1.2. National level		yes (1)
1.2.1.3. Sub-national level		
1.2.2. Implementation		
1.2.2.1. International level		
1.2.2.2. National level		yes (1)
1.2.2.3. Sub-national level		
1.3. Community management		
1.3.1. Governance		
1.3.2. Resource stewardship		
1.3.3. Livelihood alternatives		
2. Communication and Education		
2.1. Formal education		
2.2. Awareness		
2.3. Capacity-building/Training		yes
3. Research actions		
3.1. Taxonomy		yes (2)
3.2. Population numbers and range		yes
3.3. Biology and ecology		yes
3.4. Habitat status		yes
3.5. Threats	yes	
3.6. Uses and harvest levels		yes (3)
3.7. Cultural relevance		
3.8. Conservation measures		yes (4)
3.9. Trends/Monitoring		yes (5)
4. Habitat and site-based actions		
4.1. Maintenance/Conservation		yes
4.2. Restoration		
4.3. Corridors		
4.4. Protected areas		
4.4.1. Identification of new protected areas		
4.4.2. Establishment		yes (6)
4.4.3. Management		
4.4.4. Expansion		
4.5. Community-based initiatives		yes
5. Species-based actions		
5.1. Re-introductions		
5.2. Benign introductions		
5.3. Sustainable use		
5.3.1. Harvest management		
5.3.2. Trade management		
5.4. Recovery management		
5.5. Disease, pathogen, parasite management		yes (7)
5.6. Limiting population growth		
5.7. *Ex-situ* conservation actions		
5.7.1. Captive breeding/ Artificial propagation	yes (7)	
5.7.2. Genome resource bank		

Note (2). — Populations from Sinai and Israel, attributed traditionally to *T. kleinmanni*, were shown to comprise a separate species, *T. werneri* (Perälä, 2001). The limited data available also suggest that the geographically isolated subpopulation of *T. kleinmanni* from Tripolitania might additionally be taxonomically distinct. Therefore, and according to basic principles in conservation biology, including pathological and ecological aspects, it is essential that local subpopulations are not mixed in any circumstances, including possible breeding projects, whether *in-* or *ex-situ*. The use of captive or confiscated stock of unknown origins or parentage in conservation programs should be discouraged at all times for the same reasons.

Note (3). — Largely known for Egypt only (Baha El Din, 1994) where monitoring is continuing (Anonymous, 2000). No available data for Libya.

Note (4). — Conservation measures are on-going in Egypt (Baha El Din, 2002a) but not yet in Libya. More research is needed also in Egypt, such as a systematic search and identification of habitat pockets where tortoises might still exist.

Note (5). — In existence in Egypt, starting in Libya.

Note (6). — Protected areas exist in Egypt, including the one in which two individuals were recently found, and more are needed according to Baha El Din (1994, 2002a) and Anonymous (2000). Reintroduction projects have been stalled in Egypt (Baha El Din, 2002a). The species may occur in Kouf National Park in northeast Libya (Schleich, 1987) where one specimen was found 20 years ago. Other Libyan reserves in areas of tortoise activity are non-existent (Baha El Din, 2002b). Protected areas would greatly enhance the survival prospects of the entire species if trade can be stopped.

Note (7). — Before the recent description of *T. werneri* from Sinai and Israel, TortoiseCare ran a reintroduction and breeding program at Lake Bardawil in Sinai (Zaranik Protected Area) using confiscated *T. kleinmanni* of Libyan origin as founder stock (Perälä, 2001). Recently 10 individuals of wild native *T. werneri* were identified within this area (S. Baha El Din, in litt., 2001; Baha El Din, 2002a), raising concerns from a conservation point of view of potential genetic contamination, pathogens, and other ecological risks (Perälä, 2001). As a result of this discovery of wild *T. werneri*, TortoiseCare shifted its focus to conservation of the wild population, and the previously released *T. kleinmanni* in the same area were collected and returned to enclosures in Cairo (Baha El Din, 2002a). This was appropriate action; nevertheless, there is a chance that genetic mixing between the two species, or exchange of potential pathogens, may already have taken place. Thus both stocks, the wild *T. werneri* living *in-situ* at Zaranik as well as the originally released *T. kleinmanni* from this area, ought to be considered potential carriers of introduced disease and/or hybrid offspring, and both groups should be kept isolated from any other tortoises or subpopulations. Sperm storage is a well known phenomenon in chelonians, and delayed fertilization can occur years after copulation (reviewed in Zug et al., 2001).

Captive breeding of confiscated *T. kleinmanni* is continuing in enclosures in Cairo (Baha El Din, 2002a). TortoiseCare is not currently pursuing reintroduction of *T. kleinmanni* in Egypt, but this remains a future option, according to Baha El Din (2002a). Any captive breeding or reintroduction programs in the future ought to take comments under point (2) into account. In addition, any such activities—if found to be legitimate after analysis under IUCN guidelines as well as basic priciples in conservation biology—should be based on wild stock of exactly known geographical affinities to avoid genetic mixing plus incalculable ecological and pathological risks. On the other hand, *in-situ* head-start programs could be effective in some regions, and are comparatively safe.

Conclusions

Today, *T. kleinmanni* persists naturally in Libya only, and Egyptian populations are essentially extinct. The extirpation of subpopulations from vast areas has occurred within the last few decades. Just a handful of tortoises have been encountered by biologists in a few localities in the wild within the last 20 years, although it is clear that relatively large numbers of *T. kleinmanni* have at least existed in Libya during the last decades, as can be inferred from information regarding the illegal trade. This trade in tortoises may currently be the main threat to survival of the species. Habitat is disappearing fast due to human induced factors, though relatively undisturbed patches exist in Libya. Decrease in *T. kleinmanni* population sizes has been estimated at over 85% within less than three generations. Focus must be given to basic research including population and habitat based studies throughout the distribution, as well as conservation and management of the species and its habitat. Education of the general public to increase awareness to the plight of *T. kleinmanni* is not to be underestimated, and legislation must be up-dated and implemented.

If threats are not addressed, it is possible that the global population of *T. kleinmanni* faces extinction in 20 years. This is a real possibility considering what has happened locally in Egypt, where the species has already been extirpated. Concerted national and international conservation efforts are needed to save the species from extinction. These efforts must be based strictly on scientific criteria and openness as opposed to animal welfare philosophy; this latter trend is apparent in many recent programs regarding chelonians with potentially catastrophic effects on wild populations (Pieh, 2001; Perälä, 2002). Consultation with individual specialists and other relevant parties such as the IUCN/SSC Tortoise and Freshwater Turtle Specialist Group are encouraged at all times regarding planning and implementation of conservation efforts.

In conclusion, based on the data presented above, and the IUCN Red List Categories and Criteria Version 3.1 (2001), the IUCN Red List Category (threatened status) of *T. kleinmanni* should be up-listed to CR A2abcd + A3d - Critically Endangered. This was reviewed and accepted by the Red List Authority and subsequently by the IUCN (2003).

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