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A New Species of *Testudo* (Testudines: Testudinidae) from the Middle East, with Implications for Conservation

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ABSTRACT.—**Examination and analysis of over 140 specimens of the endangered tortoise *Testudo kleinmanni* from all areas within its historical distribution on mainland Africa and the Levant confirmed the existence of two allopatric species in this region. A new tortoise species, occurring east of the Nile delta, and restricted today to the Negev desert (Israel) and to northern Sinai (Egypt), is described. The new species has typically a rounded, considerably wide midbody and a very wide posterior carapace combined with very narrow vertebrals, a relatively modest elevation of the anterior plastron lobe, a gently sloping upper carapacial arch, which is posteriorly depressed, relatively flared, serrated edges of free marginals, a flared supracaudal in both sexes, usually not running in parallel with the posterior carapacial arch, and a short supracaudal in females, among other readily verifiable characteristics. Reflecting these relatively great differences in shell morphology, the new species differs from *T. kleinmanni* by 17 (male) and 18 (female) morphometric character ratios. The new species is additionally fully diagnosable by using Principal Component Analysis and Linear Discriminant Function Analysis with cross-validation. The previous lectotype designation for *T. kleinmanni* was not based on a syntype and is, therefore, invalid. A new lectotype is designated. Both species are endangered because of loss of habitat and other anthropogenic factors. The new species is additionally threatened by an introduction programme involving the release of confiscated *T. kleinmanni* into northern Sinai.**

The Egyptian tortoise *Testudo kleinmanni* Lortet, 1883—the smallest representative of circum-mediterranean *Testudo*—was described from material collected by E. Kleinmann in 1875 near Alexandria in Egypt (Lortet, 1883, 1887). However, the name was considered a junior synonym of *Testudo leithii* Günther, 1869 until the publications by Mertens and Wermuth (1955) and Loveridge and Williams (1957). These authors concluded independently that the name *leithii* was already preoccupied by a fossil pelomedusid turtle described from India in 1852. Additionally, the type of *Testudo leithii* was claimed to originate from "Sindh, Baluchistan" (Günther, 1869), modern northwestern Pakistan, where the species has never been found again. Loveridge and Williams (1957) considered this type locality an error, but this geographic aspect already led Lortet (1887), who knew the description but had not seen the type, to doubt the type locality of *leithii* and to speculate that *kleinmanni* and *leithii* might represent the same species. Lortet (1883) described *T. kleinmanni* without designating a holotype, but some of the syntypes still survive in a few collections, notably in the Lyon museum where he worked. Mertens (1967) listed, or designated (Iverson, 1992), a lectotype (SMF 7810; semiadult male; Alexandria; leg. and don. Lortet 1881) citing Boettger (1893), who already refered to the same specimen as "Typus von *T. kleinmanni*," which could either be taken as an earlier lectotype designation according to Article 74 of the old ICZN Code (Anonymous, 1964) or as listing of a presumed syntype. In any case, the only real (physical and traceable) voucher specimens on which Lortet's (1883) description is based, that is, syntypes according to the Articles 72 and 73 of the old Code (Anonymous, 1964)—as indicated by two accounts (Lortet, 1883, 1887)—are those collected by Kleinmann in the vicinity of Alexandria and donated to the author in 1875 (Lortet, 1887). Hence, SMF 7810 [specimen "3175 a" of Boettger (1893)] cannot represent a syntype as it was collected only in 1881 by Lortet himself, making any lectotype designation based on this specimen—whether by Boettger or Mertens—invalid, according to the old Code, Article 74(a)(i) (Anonymous, 1964). The type locality of *T. kleinmanni* is "dans les sables de la basse Égypte, surtout dans les environs d'Alexandrie" (Egypt), according to Iverson (1992), and is based on a direct quote from Lortet (1883).

Until recently, the range of *T. kleinmanni* was believed to extend along coastal regions from Tripolitania in western Libya (Iverson, 1992; Fritz and Buskirk, 1997; and confirmed by fieldwork by A. Pieh, pers. comm., June 2000), and Cyrenaica in eastern Libya in the west through mainland Egypt to north of El Arish on the Sinai Peninsula, Egypt, and northern Negev desert in Israel in the east (Lortet, 1883; Tristram, 1884; Calabresi, 1924; Flower, 1933; Loveridge and Williams, 1957; Werner, 1982, 1987, 1988; Buskirk, 1985; Geffen, 1990; Iverson, 1992; Baha El Din, 1994; Bringsøe and Buskirk, 1998; among others). Interestingly, the Nile delta seems to form a major distributional gap cutting the historical range of *T. kleinmanni* in half. There are no records from the delta between Alexandria and Damietta.

During fieldwork in the Negev desert and visits to collections in Jerusalem and Tel-Aviv, the suspicion arose that *T. kleinmanni* from east of the Nile delta might be specifically distinct from populations occurring in the west [in practice Libya, as populations on mainland Egypt are already extinct (Baha El Din, 1994)]. This study was initiated to test this hypothesis.

Materials and Methods

Summary of Material.—Over 140 specimens of *T. kleinmanni* throughout the known range of the species were investigated. This sample is believed to contain almost all available material from Israel and the Sinai Peninsula. Museum specimens were examined in 10 scientific collections as listed in Appendix 1. Museum abbreviations are based on standards suggested by Leviton et al. (1985), with the exception of PCHP (Chelonian Research Institute, Oviedo; formerly: Peter C. H. Pritchard collection). Additionally, data were recorded from two living adults from the Negev desert, examined and released in the field by I. Siirilä, T. Koivu, and J. Perälä in 1997. The animals (field reference numbers JP 97.3.36-7) are two of three (2 adults, 1 juvenile) mentioned and depicted in Perälä (2000). Data from these individuals are deposited in BMNH.

Grouping.—The material was allocated into two geographical groups: (1) western, comprising animals from west of the Nile delta and (2) eastern, for specimens from east of the Nile delta. Specimens labeled "Egypt" without further detail of locality, were classified as western by morphological criteria after preliminary comparative examination of the material, except BMNH 1933.9.3.5-6, which were grouped into eastern category. Errors in allocation of specimens would subsequently show in multivariate analyses, and typically museum records discriminate between mainland Egypt (Egypt) and the Sinai Peninsula (Sinai).

The true origin of the type of *T. leithii* (BMNH 1947.3.4.35) was also of interest, and it was put initially into the western group on morphological grounds.

Measurements.—Quantitative data were recorded from 45 shell characters using calipers straight-line to the nearest 0.1mm. Additionally, with reference to one character (CU), a tape ruler was used to the nearest millimeter. Most parameters, as indicated with symbols, follow those published among others in Ernst and Lovich (1986‡), Iverson and McCord (1989+, 1997*) and Ernst et al. (1998†). All other measurements are defined below. Recorded characters included maximum (not midline) carapace length (CL; ‡, +, *), maximum plastron length (PL; ‡, +, *, †), midline (minimum) plastron length (PL-m), curved carapace length over the dome, from the anterior tip of nuchal scute to the posterior tip of supracaudal (CU), maximum midbody width within central bridge area not affected by a potential flaring of anterior or posterior marginals, that is, at marginals 5–6 (MI), maximum width of shell at posterior marginals 7–9 (MA), maximum (not midline) gular scute length (GU-l; +), maximum (combined, i.e., left plus right) gular scute width (GU-w; *), gular scute height in a 90° angle to horizontal plastron level as the minimum distance between gular scute/humeral midline crossing and dorso-median gular lip surface (GU-h), maximum shell height (HE; +, *), maximum inner width of anterior shell opening parallel to horizontal level (ASO-w), maximum inner height of anterior shell opening parallel to median axis (ASO-h), left minimum bridge length (BR; *), maximum (combined) humeral scute width (and subsequent plastron scute widths) in a 90° angle to median axis (HUM-w), maximum (combined) pectoral scute width (PEC-w), maximum (combined) abdominal scute width (ABD-w), maximum (combined) femoral scute width (FEM-w), maximum (combined) anal scute width (AN-w), maximum nuchal scute length (NU-l; †), maximum nuchal scute width (NU-w; †), maximum gular midline (intergular) length (GU-m), left humeral midline (interhumeral) seam length (HUM-m; +, *), left pectoral midline (interpectoral) seam length (PEC-m; +, *), left abdominal midline (interabdominal) seam length (ABD-m; +, *), left femoral midline (interfemoral) seam length (FEM-m; +, *), maximum anal midline (interanal) seam length (AN-m), maximum width of first vertebral scute (V1-w; †), maximum width of second vertebral scute (V2-w; †), maximum width of third vertebral scute (V3-w; †), maximum width of fourth vertebral scute (V4-w; †), maximum width of fifth vertebral scute (V5-w; †), maximum median length of first vertebral scute (V1-l; †), maximum median length of second vertebral scute (V2-l; †), maximum median length of third vertebral scute (V3-l; †), maximum median length of fourth vertebral scute (V4-l; †), maximum median length of fifth vertebral scute (V5-l; †), first costal length as the minimum straight-line distance between the anteriormost and posteriormost contact points with adjacent (normally first and fifth) marginal scutes (C1), costal two ventral length along marginals (C2), costal three ventral length along marginals (C3), costal four ventral length along marginals (C4), maximum dorsal width of supracaudal scute (SUP-d), maximum ventral (= max. total) width of supracaudal scute (SUP-v), maximum median length of supracaudal scute (SUP-l), maximum head width (HEAD), minimum distance between right eye and tympanum (EYE-TY), and, minimum distance between right eye and nostril (EYE-NO). Additionally, notes were made of body and individual scute forms, coloration, markings and potential abnormalities. All listed parameters could not always be recorded from every specimen examined due to shell injuries, abnormal growth/missing features, and human error (for further details, see below under "Data Analysis/Principal Components"). Some long-term wild-caught captives were used in the assessment of categorical character data (plastron markings) but excluded from morphometric analyses resulting from potential husbandry-related malformations, notably individuals from the Tel-Aviv University Expo Zoo—all from Israel according to Ora Kerman of TAU.

Data Analysis.—All statistical analyses were performed using MINITAB, Release 12.1 (Minitab, Inc.). Data, for every mensural character and for both populations separately, were preliminarily checked for normality (Anderson-Darling test) and for linearity by regression against maximum carapace length. Growth was allometric only in relatively small/young individuals [up to about 65 mm CL (males) and 75 mm CL (females), respectively], as expected and consistently isometric in subadult and adult specimens within both groups. Accordingly, specimens with a maximum carapace length of less than those indicated above were excluded from further morphometric analyses (but were used in the assessment of categorical variation). Eventually, 99 specimens (36 ♂ + 40 ♀ western and 15 ♂ + 8 ♀ eastern) were compared for mensural character variation. The above material and additionally juveniles and originally (upon collection) crushed/damaged specimens (as listed in Appendix 1) were used in analyses of categorical data. According to inference from preliminary investigations, four individuals, MTKD D 34854 (western Libya), USNM 139093 [Gheminez, Cyrenaica (Libya)], TAU 12026 (Gevulot, Israel) and TAU 5635 (south of Gevulot, Israel) were omitted from further analyses because of their presumed hybrid status (intermediates between *T. kleinmanni* and tortoises currently classified into the *T. graeca* species complex). These putative hybrids differed from all other specimens by an atypical morphology or color pattern or both. Multivariate clustering of specimens from both populations was investigated using Principal Component Analysis (PCA). PCA components were calculated from the covariance matrix using data from 41 (males) and 40 (females) mensural characters. The remaining parameters—CU, PL-m, ASO-h (for females only), HEAD, EYE-TY, and EYE-NO—and four specimens (BMNH 1933.9.3.16; JP 97.3.37; MCZ 54045; PCHP 4447) were not taken into account owing to missing data. Sexes were analyzed separately. Discriminant Function Analysis (DFA), using linear discriminant function (Mahalanobis distance), and additionally cross-validation to compensate for an optimistic apparent error rate, was used to test how reliably specimens were classified into known groups using PCA scores from the first three principal components. Morphological character variation in 46 shell parameters among both groups was investigated using univariate analysis of variance (one-way ANOVA) with the significance level set at $\alpha = 0.05$ and sexes treated separately. With respect to this character analysis, data were standardized for body size by division by maximum carapace length; thus the ratios eliminating the effect of size-related variation, and allowing for direct comparisons between individuals and populations. Despite some theoretical concerns associated with the use of ratios, this method of standardization has clearly been shown to produce unbiased and effective results in practice (Iverson and Graham, 1990) and is widely used in modern chelonian taxonomy (e.g., Cann and Legler, 1994; Iverson and McCord, 1994, 1997; Seidel et al., 1999). The normality of the residuals and equal variances were routinely checked relative to every character to be certain of the statistical validity of the ANOVA results. The effect of geographical localities relative to the occurrence of distinct plastron markings or their combinations was checked using chi-square tests and the above significance level.

Systematics.—On theoretical grounds reviewed recently by Grismer (1999), in this study taxonomic inferences are made in accordance with the lineage-based evolutionary species concept (Simpson, 1961; Wiley, 1978; Frost and Hillis, 1990).

Results and Discussion

In Principal Component Analysis, the first three components together account for 87.2% of the total variance (males) and 82.0% (females), with PC1 (interpreted as size) capturing by far the most information from the underlying data structure (males: eigenvalue 444.72, 81.7% of total variability; females: 420.0, 73.9%). Summary statistics and component loadings for PC1-3 are found in Table 1. PC scores for each population and gender are presented in Table 2. With respect to males, PC score plots (PC1+PC2 and PC2+PC3) show a clear separation of two completely nonoverlapping clusters corresponding to the geographical populations of *T. kleinmanni* from each side of the Nile delta (scores for PC1+PC2 are presented in Fig. 1). Variation on axis PC2 (interpreted to represent body form) is highly significant (ANOVA $F_{1,49} = 129.39$, $P < 0.0001$). As for females, plots of PC scores from PC1+PC2 (Fig. 2) also discriminate well between the two populations, and variation is again greatest on axis PC2 (ANOVA $F_{1,44} = 69.59$, $P < 0.0001$) although there is also statistically significant variation with respect to size (PC1; ANOVA $F_{1,44} = 5.33$, $P < 0.026$). Discriminant Function Analysis on scores from PC1-3 without or with cross-validation classified 100% of all individuals correctly into known groups irrespective of gender (Table 3) (the same result is achieved using raw character data). Additionally, as indicated by clustering of PC scores and DFA, there is strong evidence that the true geographic origin of the type of *Testudo leithii* Günther, 1869 lies within mainland Egypt (Fig. 2)—*T. kleinmanni* was not known from Libya until the early 20th century (Calabresi, 1924)—and that the type specimen was subsequently exported to Baluchistan or mixed up with material coming from there, as suggested by Lortet (1887).

Among males 17 and among females 18 significant to highly significant differences were found between the eastern and western population with respect to basic morphometric characters standardized for body length (Tables 4–6).

Pectoral blotches were present significantly more often (80.9% of individuals) in animals from the eastern population than in specimens from the west (21.3%; $\chi^2 = 37.759$, df = 1, $P < 0.0001$). A combination of abdominal and pectoral markings were present in 78.7% of animals from the east but only in 11.5% of individuals of western origin ($\chi^2 = 49.725$, df = 1, $P < 0.0001$). Over one third (23 of 61, or 37.7%) of animals from the west showed no plastral markings whatsoever, as opposed to eastern tortoises in which some form of plastral pattern was present in every examined specimen ($\chi^2 = 22.516$, df = 1, $P < 0.0001$).

The strong morphological heterogeneity of the two allopatric populations is interpreted as clear evidence for a divergent evolutionary history and the formation of two genealogical lineages within current *T kleinmanni*. Though the ecology of *T. kleinmanni* has been researched in detail in Israel only, examination of relevant literature suggests the existence of discrepancies in ecological adaptations between the Israeli and mainland African populations (Baha El Din, 1994; Flower, 1933; Geffen and Mendelssohn, 1988, 1989, 1991; Schleich, 1989; Schleich et al., 1996). Because the eastern population is morphometrically distinct and geographically isolated from *T. kleinmanni* from mainland Egypt west of the Nile delta and Libya, it is here described as follows.

Testudo werneri sp. nov.
Negev Tortoise
Figure 3

Holotype.—HUJ 949, adult female, in alcohol. Collected by Haas, Werner et al., 12 March 1963, from sand dunes 14 km south of Be'er Sheva (northern Negev desert, Israel). This specimen was the first record of *T. kleinmanni* in Israel. [The species' occurence as "*T. kleinmanni*" in the vicinity of Hebron and in Be'er Sheva in "Syria," or between Hebron and Be'er Sheva and in the Arabah south of the Dead Sea in "Palestine"—in a region that is nowadays Israel—was already known to both Lortet (1883) and Tristram (1884), respectively, but these observations were rebutted by Flower (1933) whose misinformed opinion was echoed by most subsequent authors (but see Bringsøe and Buskirk, 1998)].

Paratypes.—Seventeen specimens (locality data listed in Appendix 1): Males: BMNH 1900.2.8.11; BMNH 1933.9.3.12; HUJ 16047; HUJ 16048; TAU 5636; TAU 7468; TAU 8363; TAU 12022; TAU 12712; TAU 12769; TAU 14120; TAU 14126. Females: BMNH 1933.9.3; HUJ 989; TAU 6295; TAU 11898; TAU 13397.

Type Locality.—Northern Negev desert, Israel.

Distribution.—*Testudo werneri* spreads, historically, roughly from northern Negev near Be'er Sheva, and vicinities of Be'er Mash'abim, Holot

TABLE 1. Component loadings (eigenvectors) and summary statistics (eigenvalue, proportional and cumulative percentage of information captured) from eigenanalysis of the covariance matrix for first three Principal Components (PC1–3) from separate analyses of males and females of *Testudo kleinmanni* and *Testudo werneri* sp. nov.

	Males			Females				Males			Females		
Variable	PC1	PC2	PC3	PC1	PC2	PC3	Variable	PC1	PC2	PC3	PC1	PC2	PC3
CL	−0.448	−0.063	−0.301	−0.420	−0.184	−0.111	AN-m	−0.068	−0.130	0.126	−0.036	−0.006	0.057
PL	−0.360	−0.158	−0.509	−0.358	−0.106	0.004	PEC-w	−0.256	0.264	0.123	−0.285	0.339	−0.114
MI	−0.273	0.260	0.108	−0.299	0.205	−0.066	ABD-w	−0.258	0.221	0.111	−0.283	0.177	0.044
MA	−0.261	0.379	0.106	−0.292	0.352	0.057	V1-w	−0.063	−0.182	−0.018	−0.058	−0.086	−0.008
GUL-1	−0.017	−0.009	−0.110	−0.041	0.004	−0.068	V2-w	−0.084	−0.196	0.111	−0.088	−0.071	−0.017
GU-w	−0.046	−0.001	−0.114	−0.056	0.068	−0.071	V3-w	−0.114	−0.224	0.131	−0.109	−0.145	−0.014
GU-h	−0.030	−0.105	0.060	−0.029	−0.042	0.030	V4-w	−0.129	−0.205	0.119	−0.103	−0.265	0.003
HE	−0.192	−0.325	0.285	−0.184	−0.346	0.220	V5-w	−0.166	0.027	0.009	−0.116	−0.221	0.098
ASO-w	−0.162	0.171	0.038	−0.176	0.258	−0.117	V1-1	−0.073	−0.130	−0.083	−0.077	−0.068	−0.080
ASO-h	−0.057	0.075	0.051	*	*	*	V2-1	−0.082	−0.154	0.161	−0.082	−0.059	0.006
BR	−0.167	−0.141	−0.185	−0.185	−0.134	−0.054	V3-1	−0.100	−0.299	0.225	−0.088	−0.169	0.076
HUM-m	−0.140	0.108	0.045	−0.171	0.123	−0.029	V4-1	−0.089	−0.024	0.172	−0.093	−0.121	0.004
FEM-w	−0.174	−0.148	0.147	−0.186	0.071	0.188	V5-1	−0.113	0.084	0.064	−0.106	−0.124	−0.007
AN-w	−0.170	0.172	0.094	−0.144	0.038	0.133	C1	−0.141	−0.154	0.052	−0.136	−0.059	−0.029
NU-1	−0.021	−0.034	−0.080	−0.033	0.010	−0.036	C2	−0.082	0.008	−0.054	−0.999	0.037	−0.142
NU-w	−0.002	0.013	0.005	−0.007	0.022	−0.111	C3	−0.085	−0.054	0.077	−0.083	−0.063	−0.090
GU-m	−0.016	0.048	−0.075	−0.037	0.014	−0.082	C4	−0.103	−0.003	0.037	−0.081	−0.105	0.084
HUM-m	−0.055	−0.036	−0.015	−0.039	0.064	−0.035	SUP-d	−0.088	−0.093	0.181	−0.046	−0.090	0.048
PEC-m	−0.014	0.052	−0.253	−0.069	−0.146	−0.508	SUP-v	−0.142	−0.071	0.136	−0.120	−0.276	−0.123
ABD-m	−0.146	0.109	0.044	−0.108	0.071	0.684	SUP-1	−0.070	−0.125	−0.221	−0.040	−0.231	0.090
FEM-m	−0.032	−0.116	−0.225	−0.029	−0.057	−0.037							
							Eigenvalue	444.72	17.82	11.86	420.00	27.36	18.78
							Proportion	0.817	0.033	0.022	0.739	0.048	0.033
							Cumulative	0.817	0.850	0.872	0.739	0.787	0.820

TABLE 2. Principal component scores from eigenanalysis of the covariance matrix. Males and females of *Testudo kleinmanni* (K) and *Testudo werneri* sp. nov. (W) were treated separately. PC1–3 = Pricipal Components 1–3. Key to symbols: * type of *T. leithii*; ** lectotype of *T. kleinmanni*; *** type of *T. werneri*.

K♂♂			K♂♂			K♀♀			W♂♂		
PC1	PC2	PC3	PC1	PC2	PC3	PC1	PC2	PC3	PC1	PC2	PC3
−175.295	3.732	−0.117	−252.786	2.376	−7.911	−286.070	−8.591	7.646	−221.585	11.940	6.183
−187.527	5.139	−5.478	−242.196	−0.289	−7.920	−278.819	−5.438	7.605	−239.172	16.536	−3.089
−211.596	4.199	−3.596	−261.783	4.067	−7.573	−290.284	−7.978	16.502	−237.697	14.315	−3.377
−193.964	3.365	−5.370	−254.958	7.118	−4.294	−279.125	−5.689	10.634	−252.656	9.780	−2.227
−223.613	5.092	−1.639	−283.857	−1.297	0.834	−289.934	−14.671	14.881	−207.625	10.428	−0.695
−233.755	6.122	−4.739	−235.132	4.708	−1.314	−289.563	−10.080	3.292	−214.872	12.410	−0.432
−218.905	4.693	−0.973	−243.626	6.491	4.561	−253.063	−7.972	4.679	−228.300	13.134	−0.887
−239.634	3.776	−2.030	−225.135	7.125	−2.098	−297.187	−4.321	14.956	−243.157	14.331	−5.479
−240.989	7.052	−8.756	−204.431	3.531	−1.564	−268.322	−7.571	10.568	−240.170	10.092	−5.091
−213.053	5.117	−5.988	−216.821	5.874	0.548	−262.419	−7.490	4.489	−220.460	13.793	−3.843
−219.735	2.258	−4.834		K♀♀		−253.341	0.301	11.044	−241.077	10.645	−5.004
−214.402	−0.867	−2.095	PC1	PC2	PC3	−284.033	−3.353	4.847	−247.587	11.360	−4.723
−254.165	3.802	−5.388	−255.568	−0.388	8.743	−285.805	−5.275	4.581	−200.328	9.689	−1.402
−231.249	1.752	2.651	−250.427	−4.313	12.104	−281.127	−8.553	−1.705	−223.351	12.073	−8.478
−259.244	7.163	0.520	−224.383	−6.609	7.236	−280.890	−9.267	−0.187	−242.249	10.012	−2.229
−278.383	3.690	4.687	−277.670	−8.089	6.307*	−269.960	−4.977	10.326			
−238.817	4.914	−1.776	−252.112	−0.470	0.718	−269.621	−3.374	11.531		W♀♀	
−228.962	6.098	1.614	−246.061	−5.071	8.154	−264.652	−8.532	9.650	PC1	PC2	PC3
−229.247	3.628	0.966	−278.043	−10.396	10.323	−250.415	−6.457	6.484	−276.513	12.047	11.324
−224.314	5.891	−6.146	−275.582	−4.516	0.012**	−284.802	−5.500	5.939	−269.194	8.838	8.205
−210.152	0.660	−4.988	−267.892	−5.576	1.643	−290.981	−2.810	13.235	−322.837	0.833	5.019***
−231.077	7.644	−0.836	−238.052	−4.038	5.967	−289.769	−7.410	10.543	−308.071	1.208	3,014
−242.682	6.340	−7.436	−265.944	−9.653	2.933	−282.896	−9.107	5.923	−309.141	4.733	6.309
−213.537	4.672	−0.412	−291.210	−9.039	5.991	−275.679	−5.286	1.805	−285.031	4.471	4.659
−235.471	3.024	−4.720	−223.942	−0.951	10.789	−277.196	−4.716	12.674	−253.380	3.444	2.951

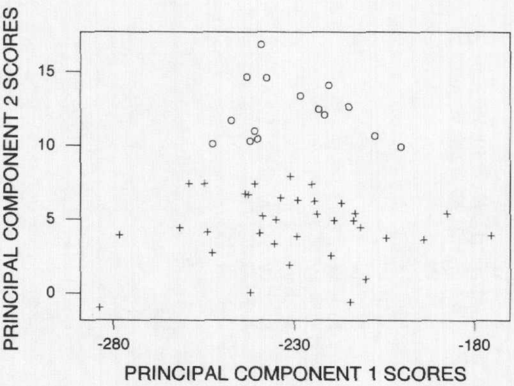

FIG. 1. Principal Component scores from PC1 and PC2 for males of *Testudo kleinmanni* (plusses) and *Testudo werneri* sp. nov. (open circles).

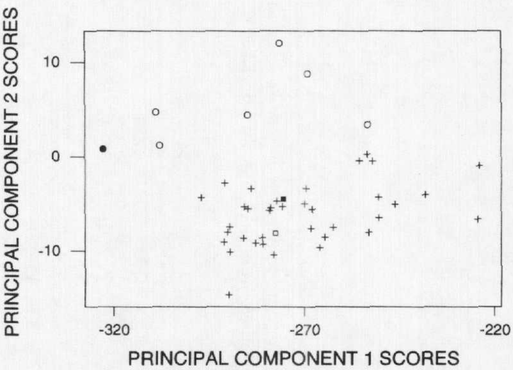

FIG. 2. Principal Component scores from PC1 and PC2 for females of *Testudo kleinmanni* (plusses) and *Testudo werneri* sp. nov. (open circles). Type specimens are indicated as follows: HUJ 949 (14 km south of Be'er Sheva, Israel), type of *T. werneri* sp. nov. (solid circle); MG 42000414 (Alexandria, Egypt), designated lectotype of *T. kleinmanni* (solid square); BMNH 1947.3.4.35 ("Sindh, Baluchistan"), type of *Testudo leithii* (open square).

Haluza, Holot Agur, and areas SE of Dimona, further southwest along Mediterranean coastal regions on the Sinai Peninsula to the Nile delta in mainland Egypt. Today, it is almost entirely restricted to Israel. Lortet's (1887) reference to Damietta (modern Dumyãt), where he saw live animals (refered to as *T. kleinmanni*), cannot be substantiated by existing museum material, but is credible. A specimen (BMNH 1900.2.8.11) collected· 1900 by Stanley Flower in Kantarah-il-Khastreh (possibly modern Al Qantarah) at the Suez Canal represents the westernmost verifiable record for *T. werneri*. Baha El Din (1992) reported a single individual from the southern shore of Lake Bardawil, and unconfirmed sightings of single animals from near El Gorah and 20 km southwest of El Arish, on northern Sinai. A single population was recently found on northern Sinai near the Israeli border (S. M. Baha El Din, pers. comm., 2000; J. R. Buskirk, pers. comm., 2000). The distributions of *T. kleinmanni* and *T. werneri* correspond to great extent with those of the lacertid lizards *Acanthodactylus pardalis* (Lichtenstein, 1823) (coastal areas west of the Nile in Egypt to Cyrenaica, Libya) and the recently described *A. beershebensis* Moravec et al., 1999, a Negev endemic (Moravec et al., 1999). Previously, *A. pardalis* was considered to occupy the pooled distribution of both species.

Etymology.—The new species is named in honor of Y. L. Werner of the Hebrew University of Jerusalem, one of the most active pioneers and true greats of Israeli and Middle Eastern herpetology, who has been over the years largely responsible for assembling the finest collection of herpetological specimens in the Middle East (HUJ: Zoological Museum, Herpetology).

Diagnosis.—Although *T. werneri* is superficially similar to *T. kleinmanni*, in practice it is readily distinguished from the latter especially (in dorsal and ventral view) by the rounded, considerably wide midbody combined curiously with narrow vertebrals and a wide posterior carapace, a relatively modest elevation of the anterior plastron lobe, a gently sloping upper carapacial arch which is relatively depressed posteriorly (in lateral view), the flared, dentate (serrated) free marginals, a flared supracaudal in both sexes not running in parallel with the pos-

TABLE 3. Summary of classification from Discriminant Function Analysis with cross-validation. Linear method for response: Species (sexes treated separately). Predictors: Principal Components 1–3 (PC1–3).

Males			Females		
Classification group	"True" group: *kleinmanni*	"True" group: *werneri*	Classification group	"True" group: *kleinmanni*	"True" group: *werneri*
kleinmanni	35	0	*kleinmanni*	38	0
werneri	1	15	*werneri*	0	7
Total N	35	15	Total N	38	7
N correct	35	15	N correct	38	7
Proportion	1.000	1.000	Proportion	1.000	1.000

TABLE 4. Results of univariate analysis of variance of ratios of 17 (♂♂) and 18 (♀♀) characters to carapace length between males and females of *Testudo kleinmanni* (K) and *Testudo werneri* sp. nov. (W). Sample sizes: Males: $N = 36$ (K) and $N = 15$ (W); Females: $N = 40$ (K) and $N = 8$ (W), except where indicated with an asterisk (*).

Males				Females			
Character	*F*	*P*	*kleinmanni* v *werneri*	Character	*F*	*P*	*kleinmanni* v *werneri*
				CL	4.88	0.032	K < W
CU	21.72	<0.0001	K > W *(K, *N* = 24; W, *N* = 4)	CU	22.03	<0.0001	K > W *(K, *N* = 28; W, *N* = 3)
MI	4.69	0.035	K < W	MI	11.39	0.002	K < W
MA	15.25	<0.0001	K < W	MA	18.71	<0.0001	K < W
GU-h	11.4	0.001	K > W	Gu-h	4.95	0.031	K > W
HE	13.84	0.001	K > W	HE	12.61	0.001	K > W
PEC-w	5.78	0.020	K < W	ASO-w	7.85	0.007	K < W *(K, *N* = 40; W, *N* = 7)
ABD-w	5.36	0.025	K < W	HUM-w	5.49	0.024	K < W
FEM-w	7.31	0.009	K > W	PEC-w	14.58	<0.0001	K < W *(K, *N* = 40; W, *N* = 7)
AN-1	7.71	0.008	K > W	ABD-w	10.8	0.002	K < W *(K, *N* = 40; W, *N* = 7)
V1-w	19.96	<0.0001	K > W	AN-w	4.07	0.049	K < W
V2-w	10.3	0.002	K > W	V3-w	4.83	0.033	K > W
V3-w	14.25	<0.0001	K > W	V4-w	13.49	0.001	K > W
V4-w	10.35	0.002	K > W	V5-w	9.06	0.004	K > W
V1-1	22.41	<0.0001	K > W	V3-1	9.51	0.003	K > W
V2-1	11.74	0.001	K > W	SUP-d	4.08	0.049	K > W
V3-1	16.73	<0.0001	K > W	SUP-1	19.69	<0.0001	K > W
C1-1	6.04	0.018	K > W	EYE-TYMP	9.32	0.005	K < W *(K, *N* = 24; W, *N* = 3)

TABLE 5. Descriptive statistics for 45 basic character ratios (and body length = CL in mm) for males of *Testudo kleinmanni* and *Testudo werneri* sp. nov. Characters were standardized for CL. Abbreviations: Char = character; Mean = mean ratio; SE = standard error; SD = standard deviation; *N* = sample size.

Taxon	Char	Mean	SE	SD	*N*	Char	Mean	SE	SD	*N*	Char	Mean	SE	SD	*N*
kleinmanni	CL	97.456	1.957	11.744	36	NU-1	0.079	0.002	0.010	36	V2-1	0.210	0.002	0.015	36
werneri		98.213	1.781	6.900	15		0.074	0.002	0.008	15		0.195	0.003	0.011	15
kleinmanni	PL	0.834	0.004	0.023	36	NU-w	0.054	0.002	0.015	36	V3-1	0.203	0.003	0.019	36
werneri		0.819	0.011	0.041	15		0.056	0.003	0.013	15		0.182	0.002	0.009	15
kleinmanni	PL-m	0.768	0.004	0.025	36	GU-m	0.095	0.002	0.013	36	V4-1	0.187	0.003	0.019	36
werneri		0.768	0.008	0.029	15		0.100	0.003	0.011	15		0.186	0.003	0.010	15
kleinmanni	CU	1.273	0.007	0.034	24	HUM-m	0.104	0.002	0.012	36	V5-1	0.213	0.002	0.015	36
werneri		1.189	0.011	0.023	4		0.102	0.003	0.011	15		0.220	0.004	0.016	15
kleinmanni	MI	0.694	0.005	0.029	36	PEC-m	0.117	0.004	0.024	36	C1	0.311	0.002	0.014	36
werneri		0.711	0.005	0.021	15		0.121	0.004	0.017	15		0.301	0.003	0.012	15
kleinmanni	MA	0.707	0.005	0.030	36	ABD-m	0.265	0.004	0.023	36	C2	0.200	0.001	0.009	36
werneri		0.739	0.005	0.019	15		0.278	0.006	0.022	15		0.203	0.002	0.008	15
kleinmanni	GU-1	0.111	0.002	0.014	36	FEM-m	0.070	0.002	0.014	36	C3	0.191	0.002	0.011	36
werneri		0.111	0.003	0.012	15		0.063	0.004	0.014	15		0.188	0.002	0.008	15
kleinmanni	GU-w	0.153	0.002	0.013	36	AN-m	0.134	0.002	0.013	36	C4	0.181	0.002	0.014	36
werneri		0.149	0.007	0.026	15		0.122	0.004	0.016	15		0.181	0.003	0.013	15
kleinmanni	GU-h	0.098	0.002	0.010	36	PEC-w	0.604	0.005	0.027	36	SUP-d	0.143	0.003	0.019	36
werneri		0.088	0.002	0.009	15		0.622	0.004	0.015	15		0.138	0.004	0.014	15
kleinmanni	HE	0.510	0.004	0.025	36	ABD-w	0.628	0.004	0.023	36	SUP-v	0.270	0.003	0.020	36
werneri		0.482	0.007	0.025	15		0.643	0.004	0.016	15		0.270	0.006	0.024	15
kleinmanni	ASO-w	0.442	0.004	0.022	36	V1-w	0.217	0.002	0.013	36	SUP-1	0.158	0.004	0.023	36
werneri		0.453	0.003	0.011	15		0.198	0.004	0.016	15		0.147	0.004	0.014	15
kleinmanni	ASO-h	0.155	0.002	0.011	35	V2-w	0.240	0.002	0.015	36	HEAD	0.155	0.002	0.009	28
werneri		0.161	0.003	0.011	15		0.226	0.004	0.014	15		0.152	0.003	0.008	7
kleinmanni	BR	0.442	0.004	0.022	36	V3-w	0.271	0.002	0.014	36	EYE-TY	0.057	0.001	0.005	23
werneri		0.429	0.006	0.022	15		0.255	0.003	0.012	15		0.057	0.003	0.006	3
kleinmanni	HUM-w	0.425	0.004	0.024	36	V4-w	0.246	0.003	0.015	36	EYE-NO	0.047	0.001	0.006	26
werneri		0.430	0.005	0.020	15		0.232	0.003	0.012	15		0.051	0.002	0.004	5
kleinmanni	FEM-w	0.446	0.004	0.022	36	V5-w	0.268	0.003	0.018	36					
werneri		0.429	0.003	0.011	15		0.277	0.005	0.020	15					
kleinmanni	AN-w	0.348	0.004	0.027	36	V1-1	0.185	0.002	0.010	36					
werneri		0.361	0.003	0.013	15		0.171	0.002	0.006	15					

TABLE 6. Descriptive statistics for 45 basic character ratios (and body length = CL in mm) for females of *Testudo kleinmanni* and *Testudo werneri* sp. nov. Characters were standardized for CL. Abbreviations: Char = character; Mean = mean ratio; SE = standard error; SD = standard deviation; *N* = sample size.

Taxon	Char	Mean	SE	SD	*N*	Char	Mean	SE	SD	*N*	Char	Mean	SE	SD	*N*
kleinmanni	CL	111.495	1.363	8.620	40	NU-1	0.072	0.001	0.009	39	V2-1	0.221	0.002	0.015	40
werneri		119.250	3.968	11.223	8		0.075	0.003	0.007	8		0.212	0.004	0.012	8
kleinmanni	PL	0.875	0.003	0.022	40	NU-w	0.048	0.002	0.013	40	V3-1	0.214	0.002	0.014	40
werneri		0.874	0.010	0.029	8		0.055	0.003	0.008	8		0.196	0.007	0.020	8
kleinmanni	PL-m	0.813	0.004	0.023	40	GU-m	0.099	0.002	0.010	40	V4-1	0.205	0.002	0.013	40
werneri		0.825	0.012	0.032	7		0.103	0.003	0.009	8		0.200	0.005	0.014	8
kleinmanni	CU	1.284	0.005	0.026	28	HUM-m	0.109	0.002	0.012	40	V5-1	0.198	0.003	0.019	4
werneri		1.212	0.008	0.015	3		0.116	0.010	0.028	8		0.194	0.003	0.009	8
kleinmanni	MI	0.718	0.003	0.020	40	PEC-m	0.120	0.004	0.023	40	C1	0.319	0.003	0.016	40
werneri		0.747	0.011	0.031	8		0.119	0.008	0.023	8		0.315	0.007	0.019	8
kleinmanni	MA	0.714	0.004	0.025	40	ABD-m	0.277	0.005	0.032	40	C2	0.225	0.004	0.025	40
werneri		0.755	0.009	0.024	8		0.277	0.006	0.018	8		0.230	0.003	0.010	8
kleinmanni	GU-1	0.110	0.001	0.009	40	FEM-m	0.074	0.003	0.017	40	C3	0.199	0.003	0.017	40
werneri		0.113	0.003	0.008	8		0.066	0.005	0.015	8		0.192	0.003	0.009	8
kleinmanni	GU-w	0.145	0.002	0.011	40	AN-m	0.155	0.003	0.017	40	C4	0.183	0.002	0.014	40
werneri		0.153	0.002	0.007	8		0.143	0.013	0.038	8		0.176	0.005	0.013	8
kleinmanni	GU-h	0.105	0.001	0.008	39	PEC-w	0.628	0.004	0.026	40	SUP-d	0.149	0.003	0.018	40
werneri		0.09	0.003	0.009	8		0.670	0.012	0.033	7		0.135	0.006	0.016	8
kleinmanni	HE	0.536	0.004	0.026	40	ABD-w	0.654	0.003	0.020	40	SUP-v	0.255	0.004	0.027	40
werneri		0.498	0.012	0.034	8		0.683	0.012	0.030	7		0.236	0.013	0.035	8
kleinmanni	ASO-w	0.441	0.003	0.022	40	V1-w	0.209	0.002	0.014	40	SUP-1	0.160	0.003	0.016	40
werneri		0.465	0.007	0.017	7		0.199	0.006	0.017	8		0.133	0.003	0.010	8
kleinmanni	ASO-h	0.148	0.002	0.010	39	V2-w	0.250	0.002	0.013	40	HEAD	0.143	0.001	0.008	31
werneri		0.150	0.004	0.013	8		0.245	0.005	0.015	8		0.142	0.002	0.005	5
kleinmanni	BR	0.476	0.002	0.013	40	V3-w	0.290	0.002	0.016	40	EYE-TY	0.052	0.001	0.006	24
werneri		0.471	0.008	0.022	8		0.277	0.005	0.013	8		0.063	0.005	0.009	3
kleinmanni	HUM-w	0.427	0.002	0.013	39	V4-w	0.257	0.003	0.017	40	EYE-NO	0.044	0.001	0.005	26
werneri		0.440	0.007	0.019	8		0.234	0.005	0.013	8		0.041	0.002	0.003	4
kleinmanni	FEM-w	0.456	0.003	0.018	40	V5-w	0.267	0.003	0.017	40					
werneri		0.467	0.006	0.018	8		0.248	0.003	0.007	8					
kleinmanni	AN-w	0.332	0.002	0.015	40	V1-1	0.185	0.002	0.013	40					
werneri		0.345	0.008	0.023	8		0.181	0.004	0.012	8					

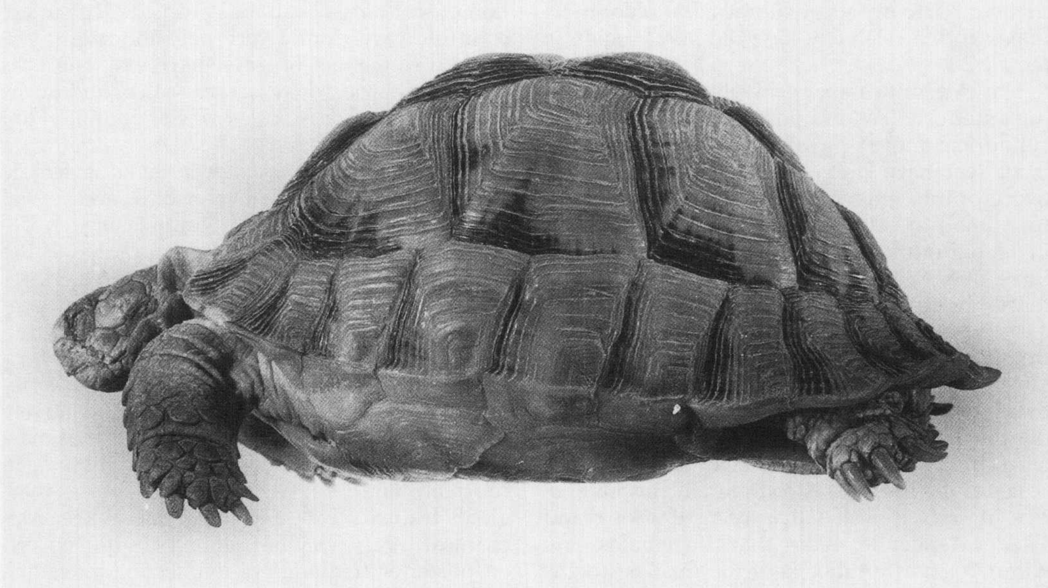

FIG. 3. Holotype of *Testudo werneri*, HUJ 949, adult female, 131.0 mm CL. Photograph by Aibi Niv (HUJ).

terior carapacial arch, and the short supracaudal of females.

Description.—A small-sized species of *Testudo*, carapace length up to 131.0 mm in females (mean 119.25 mm) and 106.4 mm in males (mean = 97.53 mm). Xiphiplastral kinesis is well developed in both sexes, although this feature is evidently not as pronounced as in *T. kleinmanni* in which latter species the posterior plastron lobe is exceptionally well hinged allowing for maximal flexibility. The interpectoral seam is longer than the interfemoral, as is also typical of *T. kleinmanni*. The anterior carapace rim between the first marginals is only modestly indented towards the nuchal scute, the carapace is usually relatively low domed (usually less than 50% of length in males) and it is highest at more or less between the anterior edge and the midpoint of the third vertebral scute. *T. kleinmanni* is typically highest at the posterior—or middle and posterior—portion of vertebral three. The upper part of the carapacial arch of *T. werneri* is modestly developed, gently sloping and angulate or edged rather than rounded in anterior, posterior and lateral view, and the posterior part of the carapace is relatively depressed as opposed to a more rounded posterior part in *T. kleinmanni*. *Testudo werneri* differs further from all other *Testudo* species by the following combination of characters (subject to individual variation): a pronounced flaring, reversion, dentation, and rounding of the free edges of all but the bridge marginals (features present in a minor portion of Egyptian and Libyan animals only); a relatively great flaring to the rear of the supracaudal, which scute forms usually an angle with the fifth vertebral (in *T. kleinmanni* the supracaudal runs usually continuously parallel with V5); a marked reversion of the posterior edge of the supracaudal; a relatively narrow contact between fourth and fifth vertebrals; a relatively wide midbody; a relatively large maximum carapace width (at posterior marginals); a relatively low gular/epiplastral region combined with a well (but moderately in comparison with *T. kleinmanni*) elevated anterior plastron lobe in both sexes; a relatively wide anterior shell opening in females; a relatively wide plastron across humeral scutes in females; a relatively wide plastron across pectoral and abdominal scutes in both sexes; a relatively narrow plastron at femorals in males leaving the hind feet a comparably large space between the posterior plastron lobe and the adjacent marginals; a relatively broad combined anal scute width in females; a relatively short interanal seam in males; very narrow first through fourth vertebrals in males and relatively narrow third, fourth and fifth vertebrals in females [vertebral 1 has typically slightly rounded lateral sides only but not a "lyre shape" (Gmira, 1995) as common in *T. kleinmanni*]; relatively short first and second vertebrals in males; relatively short third vertebrals in both sexes; the tendency for rounding of the dorsal surface of the fifth vertebral scute; a relatively short first costal scute in males; dorsally a relatively narrow, and medially a relatively short supracaudal scute in females and, a relatively long temporal region in females.

The extremities are relatively slender, featuring anteriorly five and posteriorly four thin and cylindrical, more or less transparent, claws. The front feet have bulky and subconical, mostly overlapping enlarged scales totalling three (proximal) to between four and six (outermost) in a longitudinal row (from elbow to claws) and three in a transverse row. These scales, of uniformly bright yellow to beige color, are strongly elevated anteriorly from the surface of the extremities (possibly as an adaptation to enable effective movement in loose sand). The apex of these scales tends to be generally more pointed than in *T. kleinmanni*. The throughout yellow to beige hind feet feature 2–3 swordlike enlarged scales at the heels, as is common in various species of *Testudo*. The tail is relatively long and slender, longer in males than in females, and without a horny tubercle at the tip. The thighs lack enlarged conical tubercles (spurs). The skin of soft parts is very thin and flexible, almost parchment-like and transparent.

Coloration of carapace in life is bright or dull yellow, typically with well-defined markings of dark brown to dark brownish-violet, very thin to medium broad bands (covering up to half of a given scute) running along the anterior and lateral margins of the vertebral scutes, and the anterior and lateral margins of the costals, much as in some but not most *T. kleinmanni*. Anterior edges of the marginal scutes feature often, but not necessarily, a dark and horizontally broad triangular pattern with the vertical apex located dorsally and the horizontal apex oriented posteriorly (the bridge marginals may be without any pattern). Such broad triangular markings on the marginals are rarely present in *T. kleinmanni*, in which species they are usually replaced by thin vertical bands or no bands at all. The basic coloration of the plastron is mostly bright or dull yellow. Dark brown, in most cases very well-defined triangular markings are typically present (97.8% of examined specimens) on the abdominal scutes, with the base at the anterior border and the apex oriented posteriorly. The anterior borders of the pectoral scutes feature usually (80.9% of examined specimens) a broader than long, dark brown fleck or semitriangular or rounded marking with the apex situated posteriorly. These markings are rarely present in one of the paired pectorals only. Additionally, according to the material examined, *T. werneri* seems to typically feature some kind of plastral pattern (100% of individuals examined); therefore, animals showing no plastral markings can be classified as *T. kleinmanni* with reasonable confidence by coloration only. The basic coloration of soft parts, head and posterior leg surfaces in life vary from a very pale and bright yellow to a greenish or grayish yellow. The eyes are often bordered by darker scales, and an irregular spot of dark scales may be found on top of the head.

Description of Holotype.—A large adult female with relatively elevated vertebral and costal shields, with the posterior carapacial arch declining modestly toward the supracaudal, the scute of which is ventally broad, strongly reverted, and flared to the rear. Highest at one-third the length of vertebral three. Midbody relatively wide, widest at sixth marginals. Maximum body width at eighth marginals. Vertebrals and supracaudal/V5 contact relatively narrow. Lower posterior edges of all free marginals well serrated, reverted, and showing a relatively large degree of flaring. Bridge marginals feature a well-developed lateral keel. Mechanical injury visible (minor part broken off) on posterior free edge of left second marginal. Anterior plastron lobe greatly elevated (but very modestly in comparison with *T. kleinmanni*). Lateral sides of femoral scutes relatively straight from base to around three-fourths the length. Gular region well exposed from anterior plastron surface in ventral view. Anterior extremities with three longitudinal rows of very large, subconical and partially overlapping scales, totalling six on the outer surface, and 3–4 closer to the body. Basic coloration of shell in alcohol is greyish yellow, with dark brown markings. The vertebrals feature relatively broad dark bands covering the anterior and lateral borders of each scute, with dark pigment filling up to 50% of the scute surface (notably V1-3). Anterior and lower lateral edges of costals feature thin to medium broad markings, which in places become striated toward the center of each scute. The anterior borders of anterior and posterior marginals are pigmented with more or less well-defined triangular or semitriangular markings. The bridge marginals feature only shades of such markings. The lateral borders and anterior (except for immediate central) surface of the supracaudal also feature a broad dark band. The nuchal is unmarked. Well-defined dark brown and triangular markings are present on both pectoral and abdominal scutes, with the bases located at the extreme anterior borders of the respective scute. Soft parts and head are basically greyish to bright yellow. Aggregates of brownish scales are present around the eyes, and on top of the head.

Dimensions of Holotype.—Maximum carapace length 131.0 (all measurements in millimeters), maximum plastron length 119.5 (91.2% of CL), median (midline) plastron length 111.0 (84.7%

of CL), midline width within bridge area 96.5 (73.7% of CL), maximum width at posterior marginals, i.e. maximum total width 97.4 (74.4% of CL), maximum gular scute length 15.9 (12.1% of CL), combined gular scute width 20.1 (15.3% of CL), gular height 13.1 (10.0% of CL), maximum height 70.5 (53.8% of CL), inner width of anterior shell opening 63.3 (48.3% of CL), inner height of anterior shell opening 23.3 (15.5% of CL), length of bridge 61.1 (46.6% of CL), combined humeral scute width 60.7 (46.3% of CL), combined femoral scute width 60.7 (46.3% of CL), combined anal scute width 46.5 (35.5% of CL), nuchal scute length 11.1 (8.5% of CL), maximum (posterior) nuchal scute width 7.0 (5.3% of CL), gular midline length 14.7 (11.2% of CL), humeral midline length 14.9 (11.4% of CL), pectoral midline length 18.2 (13.9% of CL), abdominal midline length 35.6 (27.2% of CL), femoral midline length 10.1 (7.7% of CL), anal midline width 21.4 (16.3% of CL), combined pectoral scute width 85.4 (65.2% of CL), combined abdominal scute width 87.1 (66.5% of CL), first vertebral width 25.2 (19.2% of CL), second vertebral width 33.3 (25.4% of CL), third vertebral width 37.2 (28.4% of CL), fourth vertebral width 29.9 (22.8% of CL), fifth vertebral width 31.3 (23.9% of CL), first vertebral length 26.0 (19.8% of CL), second vertebral length 28.5 (21.8% of CL), third vertebral length 27.7 (21.1% of CL), fourth vertebral length 24.6 (18.8% of CL), fifth vertebral length 25.1 (19.2% of CL), first costal length 40.2 (30.7% of CL), second costal length 30.1 (23.0% of CL), third costal length 24.8 (18.9% of CL), fourth costal length 22.3 (17% of CL), dorsal supracaudal width 18.2 (13.9% of CL), ventral supracaudal width 36.1 (27.6% of CL), median supracaudal length 16.7 (12.7% of CL), maximum head width 18.6 (14.2% of CL), minimum distance between eye and tympanum 7.6 (5.8% of CL), and minimum distance between eye and nostril 5.9 (4.5% of CL).

Mertens'/Boettger's Lectotype.—The lectotype designations by Mertens (1967), or, depending on interpretation, Boettger (1893), are not valid, as discussed previously in this article; thus *T. kleinmanni* lacks a type specimen. Therefore, MG 42000414, an alcohol-preserved adult female and syntype from Alexandria (Egypt) in the original Lortet collection in Lyon, is hereby designated lectotype of *T. kleinmanni*. This specimen is presumably one of the individuals collected by Kleinmann in 1875, because it died a year later at the Lyon museum. Hence, all former syntypes of *T. kleinmanni* are considered paralectotypes of the same taxon.

Description of Lectotype.—A large adult female with a very slender (narrow) body and well-domed (rounded) upper carapacial arch and abruptly descending sides. Carapace is highest at posterior region of third vertebral. Supracaudal is ventrally narrow, showing no great flaring to the rear, and runs almost parallel to fifth vertebral in lateral view. Supracaudal/V5 contact is relatively wide. Vertebrals are relatively broad, but V1 is very narrow anteriorly. Free marginals are only slightly flared and very modestly reverted, if at all, and not serrated except for M1,2 and 3. Anterior plastron lobe is well elevated from horizontal level. Basic shell color (in alcohol) is wooden yellow. Anterior and lateral borders of supracaudal, nuchal, all vertebrals and marginals, and anterior and lower lateral edges of the costals feature a relatively thin to medium broad band of brown pigmentation, which becomes striated toward the areolae. Only the third marginals show a hue of triangular pattern. The abdominals feature relatively poorly defined (delimited) triangular markings. The remaining plastral scutes are without any distinct pattern. Anterior extremities feature three longitudinal rows of very large, subconical and partially overlapping scales, totalling five on the outer surface and four closer to the body. Soft parts and head are grayish yellow, the head also with light brown, poorly delimited scutes on the top and snout, and dorsal, dark brown flecks in front of and behind the eyes, and in the posteriormost portion of the temple.

Dimensions of Lectotype.—CL: 114.8 (all measurements in millimeters), PL: 100.7 (87.7% of CL), PL-m: 93.7 (81.6%), MI: 79.5 (69.3%), MA: 80.5 (70.1%), GU-l: 13.1 (11.4%), GU-w: 18.1 (15.8%), GU-h: 11.5 (10.0%), HE: 59.0 (51.4%), ASO-w: 51.6 (44.9%), ASO-h: 15.7 (13.7%), BR: 53.4 (46.5%), HUM-w: 49.3 (42.9), FEM-w: 49.7 (43.3%), AN-w: 36.7 (32.0%), NU-l: 8.8 (7.7%), NU-w: 6.4 (5.6%), GU-m: 12.7 (11.1%), HUM-m: 13.4 (11.7%), PEC-m: 17.9 (5.6%), ABD-m: 29.7 (25.9%), FEM-m: 5.6 (4.9%), AN-m: 17.3 (15.1%), PEC-w: 72.6 (63.2%), ABD-w: 72.2 (62.9%), V1-w: 24.4 (21.3), V2-w: 28.6 (24.9%), V3-w: 32.6 (28.4%), V4-w: 27.0 (23.5%), V5-w: 28.4 (24.7%), V1-l: 20.5 (17.9%), V2-l: 25.8 (22.5%), V3-l: 23.9 (20.8%), V4-l: 22.2 (19.3%), V5-l: 23.2 (20.2%), C1: 38.8 (33.8%), C2: 28.8 (25.1%), C3: 24.6 (21.4%), C4: 19.6 (17.1%), SUP-d: 19.8 (17.2%), SUP-v: 29.1 (25.3%), SUP-l: 15.3 (13.3%), HEAD: 17.5 (15.2%), EYE-TY: 7.4 (6.4%), EYE-NO: 5.8 (5.1%).

Conservation.—The elevation of *T. kleinmanni* onto CITES I Appendix in 1995 essentially banned all legal trade in this species. However, this did not stop the illegal trade in animals within Egypt, despite a confiscation of more than 200 traded animals in the Cairo bazaars in 1997 (Highfield, 1997, and pers. comm.; Perälä, 2000). Some of these originally Libyan animals, that is, *T. kleinmanni*, have been released into an open-air enclosure and others introduced on an island, at Lake Bardawil on northern Sinai as part of a conservation program run in cooperation by Egyptian wildlife authorities and various international nongovernmental organisations, and the Royal Netherlands Embassy in Cairo (Baha El Din, 1999; E. Wenman, pers. comm., July 2000). This ongoing reintroduction program—which was established despite the fact that *T. kleinmanni* from Libya and northwestern Egypt, as opposed to those from northern Sinai and Israel, were known to have different ecological adaptations as cited above and discussed in Perälä (2000)—poses a major and immediate threat to the survival of *T. werneri*. Even if individuals were to be released in fenced areas or on an island, this would not be a secure solution. Introduced animals held in "closed" environments or farms have the tendency to escape into the wild. The introduction of *T. kleinmanni* within the range of *T. werneri* could contribute to the mixing (hybridization) of the two populations with devastating consequences and loss of biodiversity. However, hybridization is not the only serious threat posed by the introductions. Alien micro-organisms could also establish in new habitats. In similar circumstances, pathogens from released animals are suggested to have caused a large scale epidemic among wild *Gopherus agassizii* in Nevada and California (Jacobson et al., 1995).

In less than a hundred years, as predicted by Flower (1933), *T. kleinmanni* has become so rare that it is on the verge of extinction in the wild. The species is currently "technically" extinct in its former main distribution range in Egypt (Baha El Din, 1994) because of habitat destruction and fragmentation and other mainly anthropogenic factors discussed extensively in the same paper. *Testudo kleinmanni* is currently considered one of the most endangered chelonian species in the world as indicated by its CITES listing and IUCN Red List status (endangered). The discovery that *T. kleinmanni* is actually not a single taxon with a highly fragmented population structure but two separate species facing extinction should be taken into consideration in legislation and conservation efforts at national and international level. The protection of habitats occupied by *T. werneri* on Sinai and in Israel is essential for its survival.

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APPENDIX 1

SPECIMENS EXAMINED

Testudo kleinmanni. Adult males used in morphometric analyses.—LIBYA: Gheminez, Cyrenaica, USNM 139094; Cyrenaica, Derna, MTKD D 31598; NE Libya (Cyrenaica), PCHP 4319, 4321, 4323, 4340-1, 4438, 4441-3, 4445-6, 4484; Libya, MTKD D 26016, 28287, 29119. EGYPT: Alexandria, BMNH 1920.1.20.774, MG 42006132 (paralectotype), MG 42006138 (paralectotype); vicinity of Alexandria, MTKD D 32798; Mediterranean coast, MTKD D 31803, 32831; Salum, Western Desert Governate, MCZ 54045; Egypt, BMNH 1933.9.3.9-10, MNHN 7838 (ex 1879-774), MTKD D 32742, PCHP 3844, 3991, 4017, TAU 14198.

Adult females used in morphometric analyses.—LIBYA: NE Libya (Cyrenaica), MTKD D 28286, PCHP 4316-7, 4322, 4333, 4335-6, 4337-8, 4435-7, 4439, 4440, 4447-54; Gheminez, Cyrenaica, USNM 139092; ca 30-50km W Tripoli, close to coast, MTKD D 30855; W Libya (Tripolitania), MTKD D 32434-5, 34854; Libya, MTKD D 26017, 32832, PCHP 4686. EGYPT: Alexandria, BMNH 88.4.24.2, 1920.1.20.773, MG 42000413 (paralectotype), MG 42000414, designated lectotype of *Testudo kleinmanni* (this article), MG 42006125 (ex MG 110) (paralectotype); neighborhood of Alexandria, BMNH 1897.11.13.2-3 (only 1 specimen: male apparently lost); Mersa Matruh, NW Egypt, BMNH 1933.9.3.16; Agniba near Mersa Matruh, BMNH 1977.1218; Egypt, BMNH 1933.9.3.7, MNHN 1878-602 (DA 51 A) (paralectotype), 1987-971 (DA 51 B) (paralectotype), PCHP 3843, 3954-6; "Sindh" (extralimital), BMNH 1947.3.4.35 (ex BMNH 69.8.28.5), presented by Dr. Leith 1869 (type of *Testudo leithii* Günther, 1869).

Additional specimens examined.—EGYPT: Alexandria, MCZ 5081 (paralectotype), juv., MG 42006110 (paralectotype), deformed male; Giza, USNM 55758, adult male, no gular; Egypt, MNHN 1876-416 (paralectotype), skull, MNHN 1992.197 (DD 62) (paralectotype), skull and misc. bones; MNHN 9462 (paralectotype) (juv. female).

Testudo werneri. Adult males used in morphometric analyses.—EGYPT: Suez Canal, Kantarah-il-Khastreh, BMNH 1900.2.8.11 (paratype); N Sinai, BMNH 1933.9.3.12 (paratype); Egypt, BMNH 1933.9.3.6. ISRAEL: Negev: ca. 14 km S Be'er Sheva, HUJ 16047 (paratype), HUJ 16048 (paratype); Be'er Sheva, TAU 14120 (paratype); near Ashalim, Negev desert, JP 97.3.36 (examined in the field, data deposited in BMNH); 3 km N of Revivim, TAU 5636 (paratype); Gevulot, TAU 7468 (paratype), TAU 11941 (paratype); 1 km E of Rehovot, TAU 8363 (paratype); Agur Sands, TAU 12022 (paratype); Holot Agur, TAU 12769 (paratype); Holot Nahagur, TAU 12712 (paratype); Nahal Secher, TAU 14126 (paratype).

Adult females used in morphometric analyses.—EGYPT: N Sinai, BMNH 1933.9.3.14 (paratype); Egypt, BMNH 1933.9.3.5. ISRAEL: sand dunes 14 km S of Be'er Sheva, HUJ 949, coll. Haas, Werner et al. 12.3.1963 (first record of *T. kleinmanni* in Israel; holotype of *T. werneri* sp. nov.); 14 km S Be'er Sheva, HUJ 989 (paratype); 16 km S of Be'er Sheva, TAU 11898 (paratype); near Ashalim, Negev desert, JP 97.3.37 (examined in the field, data deposited in BMNH); Tel-Yerucham, TAU 6295 (paratype); Agur, TAU 13397 (paratype).

Additional specimens examined.—EGYPT: Sinai: El Bardawil, west to Nahal Yam settlement, HUJ 971 (crushed ad. male); North Sinai, HUJ 16142 (crushed ad.). ISRAEL: Bir Asluj sands, Boaz Shacham, 4 July 1999, HUJ (uncatalogued hatchling); Be'er Chagil, TAU 12017(ad. female, plastron deformed); Kibutz Gevulot, TAU 13150 (juv. male); Agur Sands, HUJ 22820, (juv. female), TAU 13889 (juv. male); Tel-Aviv, MNHN 1984-500 (deformed juv.), extralimital: probably from TAU's Expo Zoo, don. Mendelssohn; Israel (originally wild caught captives from TAU's Expo Zoo), TAU 11103 (juv. male), 11129 (juv.), 12141 (adult male), 12216 (adult male), 13139 (adult male), 13952-3 (juv. males), 14121 (ad. female), 14122-3 (ad. males), 9359 (ad. male), 9360-1 (ad. females).

Putative Hybrids.—West Libya, MTKD D 34854; Libya: Gheminez, Cyrenaica USNM 139093; Gevulot, Israel, TAU 12026; S of Gevulot, Israel, TAU 5635.