DISTRIBUTION AND STATUS OF CREASER'S MUD TURTLE, *KINOSTERNON CREASERI*

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ABSTRACT

Field studies on the Yucatan peninsula in 1985 and 1987 revealed 38 new localities for Creaser's mud turtle. This turtle typically inhabits shallow, temporary pools in undisturbed forest. It apparently estivates belowground during most of the dry season, and is active primarily during the wet season when forest pools are present. It is not a usual inhabitant of permanent water microhabitats (e.g. cenotes). Populations appear to be most dense in Quintana Roo, where deforestation has not been as intense as in northern Campeche and Yucatan. These turtles eat mainly animal matter. Females exhibit a 'tropical' reproductive pattern, producing few, large eggs during the middle of the wet season (August-October). Juvenile growth rates are rapid, but adults grow slowly and are not large in comparison to related congeners. Males are aggressive toward other males and only one was found in any single pool or pond.

INTRODUCTION

Kinosternon creaseri (Creaser's mud turtle; Fig. 1), described 51 years ago (Hartweg, 1934), is restricted to the Yucatan Peninsula of Mexico, and is one of the most poorly known Mexican turtles. Previously only 70 specimens were known from 18 localities (Iverson, 1983; APPENDIX A), and the species was listed as RARE in the IUCN Amphibia-Reptilia Red Data Book (Groombridge, 1982). In evidence of its rarity (or secretiveness), only two specimens were collected by Dr. Julian Lee of the University of Miami during nine months of herpetological field work on the Peninsula (Lee, 1980). Similarly, Himmelstein (1980) found only a single specimen during six trips totalling more than 53 field days over five different months. Despite intensive trapping I captured no specimens during my own Yucatan field work in April 1981.

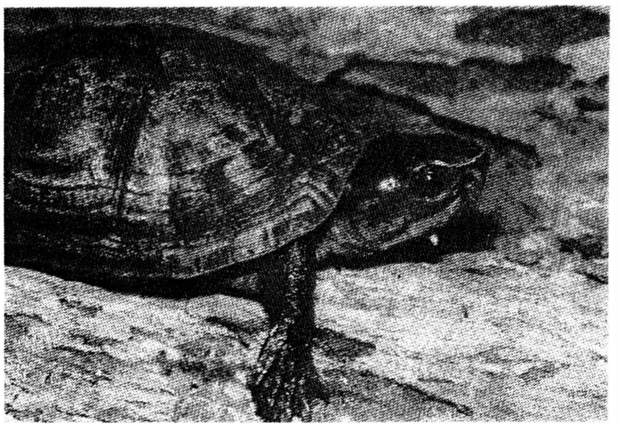

Fig. 1 Adult male *K. creaseri* (CL 124mm) from Quintana Roo, 21.9km N Playa de Carmen turnoff on coastal Hwy 307. Note the strongly hooked beak characteristic of this species.

METHODS

Because so little is known about the distribution, natural history, and status of this species, I surveyed the Yucatan peninsula in 1985 and 1987. All types of aquatic habitats (e.g. cenotes, lakes, temporary and permanent ponds) were trapped, seined, or, if shallow and relatively clear, searched visually. Although *K. scorpioides* and *K. leucostomum* were often captured in traps, only a single *K. creaseri* was ever trapped. Seining was also relatively unproductive; only two *K. creaseri* were seined. The most effective field capture technique involved thorough visual searches of shallow forest pools and roadside ponds with collection by hand. Driving roads during heavy rainstorms produced the most turtles, although little could be determined about natural microhabitats. Every one of the previously known localities (APPENDIX A) was visited except one that could not be located (Vivienda de Platanal). Because of the potentially threatened status of the species, most specimens observed in the field were released.

RESULTS AND DISCUSSION

Despite the documentation of 38 new localities, I was unable to extend the range of *K. creaseri* beyond that previously known (Fig. 2; APPENDIX A). The species range is (or was) probably continuous over much of the Yucatan peninsula, except in the northwestern quadrant, where it may be too dry for it to exist. Deforestation and the use of low areas for agriculture have apparently reduced populations in some areas, especially in the northern and western portions of the peninsula.

Future field work should be concentrated in southern Campeche and southern Quintana Roo, in particular the rectangular area between Dzibalchen, Escarcega, Felipe Carillo Puerto, and Chetumal.

Kinosternon creaseri is an average sized mud turtle, and males grow slightly larger than females (Table 1). Carapace length (CL in mm) is related to wet body mass (BM in g) by the equation $BM = 0.0006608\ CL^{2.649}$ (N = 20; CL range = 25.9 to 124.0; r = 0.998; p<0.0001). Plastron length averages 94.7% of CL in males, 97.1%

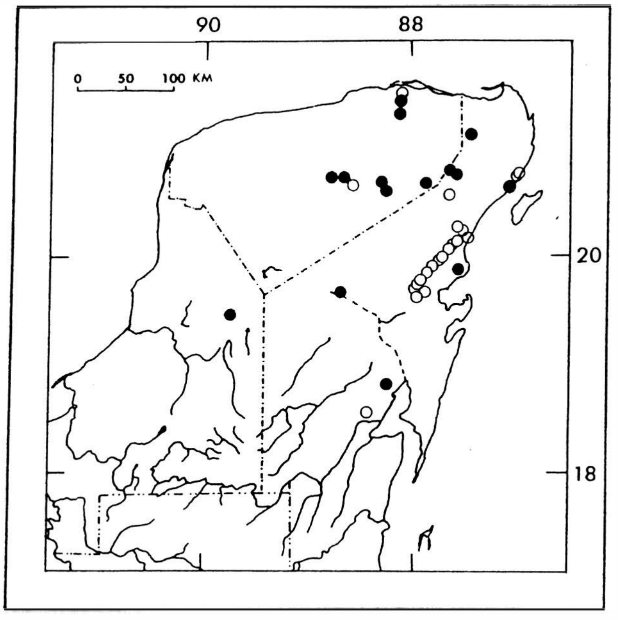

Fig. 2 Distribution of Creaser's mud turtle, *Kinosternon creaseri*, on the Yucatan Peninsula of Mexico. Solid circles represent previously known localities; open circles are new localities or previous ones confirmed during this study. Each symbol represents at least one locality.

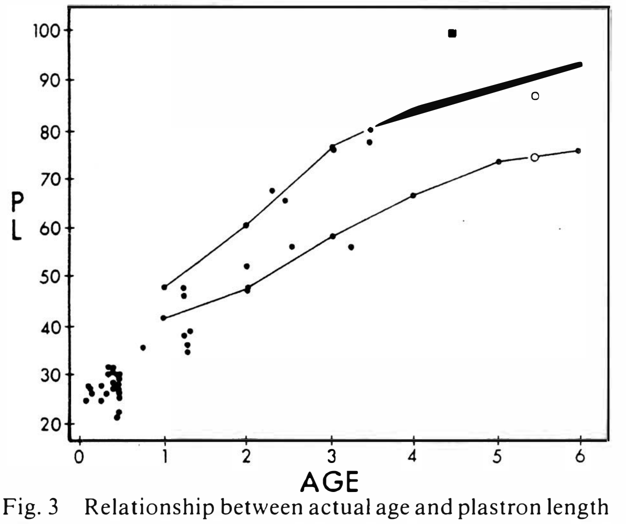

Fig. 3 Relationship between actual age and plastron length (PL in mm) for male (N = 1; solid square), female (N = 2; open circles), and juvenile (N = 56; solid circles) Creaser's mud turtles with obvious plastral annuli. Actual age was calculated by adding the proportion of the year that had passed (assuming growth from 1 June to 1 December) to the number of plastral annuli (excluding the one from the turtle's first winter). Solid lines connect mean estimated winter plastral lengths of turtles from Table 2. Each symbol represents at least one turtle.

		Male			Female		
Species	MFR	N	Mean CL	Range	N	Mean CL	Range
Kinosternon acutum	0.953	20	91.8	78.4-100.5	20	96.3	77.3-115.6
K. alamosae	1.083	36	113.2	83.5-127.2	19	104.5	89.2-120.3
K. augustipons	0.904	11	94.0	81.2-109.0	3	103.9	87.0-116.8
K. baurii	0.914	101	83.7	72.0-103.8	52	91.6	69.0-115.3
K. carinatum	1.069	17	119.4	86.5-161.7	16	111.6	81.3-138.0
K. creaseri	1.077	22	115.2	96.0-124.9	17	107.0	89.1-121.5
K. dunni	1.368	1	169.0	—	4	123.5	91.8-148.2
K. flavescens flavescens	1.103	158	115.5	78.0-141.9	137	104.7	76.6-135.1
K. flavescens arizonense	1.085	52	145.9	103.0-181.3	97	134.5	95.5-167.3
K. flavescens durangoense	1.167	5	153.0	134.0-182.9	4	131.1	117.9-144.6
K. herrerai	1.123	46	135.6	92.5-166.4	60	120.8	90.9-146.0
K. hirtipes	1.088	312	130.5	80.0-181.8	244	120.5	73.5-152.0
K. integrum	1.137	171	146.5	82.1-197.0	220	128.9	77.6-168.4
K. leucostomum	1.095	139	124.6	96.3-170.8	138	113.8	84.5-166.4
K. minor	0.954	310	82.3	46.9-124.3	341	86.3	47.1-132.9
K. oaxacae	1.138	15	138.9	93.0-175.1	15	122.1	94.9-140.5
K. odoratum (Indiana)	0.972	44	85.8	63.9- 95.5	26	88.3	65.0- 99.4
K. scorpioides cruentatum	0.993	69	114.4	86.8-138.8	82	115.2	84.2-147.5
K. scorpioides abaxillare	1.041	16	123.0	88.1-149.0	35	118.2	88.4-153.3
K. sonoriense	0.971	78	114.6	80.8-154.0	71	118.0	79.9-160.4
K. subrubrum hippocrepis	0.931	26	86.2	76.6- 95.4	31	92.5	80.0-111.3
K. subrubrum steindachneri	0.993	45	91.0	75.0-114.3	51	91.6	77.0-107.0
K. new species (Jalisco and Colima)	1.077	20	111.5	82.1-153.7	31	103.5	86.5-128.8

TABLE 1: Sexual dimorphism in kinosternine turtles. Ratio of mean male to mean female carapace length (CL) is included (MFR). Only externally sexable (not necessarily mature) turtles included.

in females, and 85.8% in small juveniles. Sexing of subadults >90mm CL is possible, based on tail length (long in males).

Based on counts of plastral annuli and the assumption that a single annulus is produced each year (see Ernst *et al.*, 1973), juvenile growth is very rapid (Fig. 3), and males appear to grow faster than females by their second year (Table 2). However, because turtles from different localities and years were included in this analysis, the potential for error exists. Six turtles captured early during their first year grew to an average of 88.3mm CL (range 84-93) and 80.9mm PL (range 78-86) during two years in captivity. This rate is significantly faster than estimates for natural growth, but the captives had water and food available year-round.

Kinosternon creaseri is easily confused with some peninsular specimens of *K. scorpioides*. However, the former can be reliably identified in the field by its aggressive behaviour, more pungent musk, and curved seam between the scutes of the plastral hindlobe and those of the fixed mid-portion of the plastron. *K. scorpioides* on the peninsula nearly always withdraws and closes its shell on capture, has a much less pungent odour, and has a straight seam across the anterior margin of the femoral scutes.

Kinosternon creaseri might also be confused with its probable sister taxon, a nearly parapatric species with similar body size and habits, *Kinosternon acutum* (Iverson, 1980). The latter species is known (in Belize, Corozal District, 2mi. N Orange Walk; UU 9449) from within 45km of the nearest record for *K. creaseri* (Quintana Roo, 13mi N Chetumal; SM 11448), and their ranges may overlap in southern Campeche and Quintana Roo. The difficulty in distinguishing them is evidenced by Duellman's (1965) misidentification of KU 70928 from 11km S Champoton, Campeche as *creaseri* rather than *acutum*, and my own misidentification (Fig. 2 in Iverson, 1980) of SM 11448 as *acutum* rather than *creaseri*. However, based on the results of a discriminant analysis of morphometric character ratios (Fig. 4; method after Iverson, 1981), they can be distinguished based on the usually straight anterior margin of the plastral hindlobe (usually curved in *creaseri*), the longer interabdominal seam (AB) and bridge length (BL), and the wider anterior plastral lobe (measured across plastron at level of junction of plastral margin and humeral-pectoral seams; PWA) found in *K. acutum*. BL/PWA averages 0.87 in female (range 0.75-0.97; N = 27) and 0.83 in male (0.77-0.93; N = 25) *acutum*, and 0.71 in female (0.64-0.79; N = 11) and 0.70 in male (0.60-0.77; N = 15) *creaseri*. AB/PWA averages 0.81 in female (0.70-0.94) and 0.79 in male (0.73-0.89) *acutum*, and 0.71 in female (0.64-0.78) and 0.70 in male (0.62-0.77) *creaseri*.

Like the results presented in Fig. 4, discriminant analysis of the same morphometric character ratios for *K. creaseri* alone suggests that specimens from the state of Yucatan differ significantly from those from Quintana Roo and Campeche. In the female analysis only the ratio of the width of the plastral hindlobe at the level of the junction of the plastral margin and the femoral-anal seams (PWD) to carapace length varied significantly among states. Females from Yucatan state had wider plastral hindlobes (mean PWD/CL = 0.36 in eight turtles from Yucatan, 0.33 in three from Quintana Roo). In the male analysis, the ratios PL/CL, AB/CL, and PWC/CL varied significantly among states. Males from Yucatan state had longer plastrons (mean PL/CL = 0.96 in nine turtles from Yucatan, 0.93 in six from Quintana Roo, and 0.94 in one from Campeche) and longer interabdominal seams (mean AB/CL = 0.29 in Yucatan, 0.27 in Quintana Roo, and 0.28 in Campeche). The Campeche male also had a wider

	MALES				FEMALES			
Age	N	Mean PL	Range	% increase from previous year	N	Mean PL	Range	% increase from previous year
0?	14	24.8	22.1- 27.8					
1?	6	45.5	37.5- 53.6					
1	4	47.1	41.2- 51.4	89.9	5	40.5	37.1-44.0	66.5
2?	5	55.2	50.1- 59.0					
2	4	60.1	52.0- 63.5	27.6	5	47.2	44.8-51.0	16.5
3?	2	76.3	74.6- 77.9					
3	3	75.8	68.1- 83.8	26.1	5	57.5	52.3-69.5	21.8
4	4	84.1	72.7- 96.7	10.9	5	65.8	60.5-77.6	14.4
5	3	86.8	74.8-100.6	3.2	5	72.6	65.1-84.0	10.3
6	3	93.5	83.0-107.0	7.7	3	75.9	69.1-81.9	4.5
7	2	89.9	86.6- 93.2	—	3	82.6	73.7-90.3	8.8
8	2	94.0	91.5 -96.5	4.6	2	86.3	83.7-88.9	4.5
9	2	97.7	96.7- 98.7	3.9	2	90.4	84.4-96.3	4.8

TABLE 2: Growth (plastron length in mm) of *Kinosternon creaseri* calculated from four males, five females, and 14 juveniles with obvious abdominal scute annuli. Ages 0?, 1?, 2?, and 3? indicate unsexable turtles of 0, 1, 2, and 3 growing seasons of age, respectively.

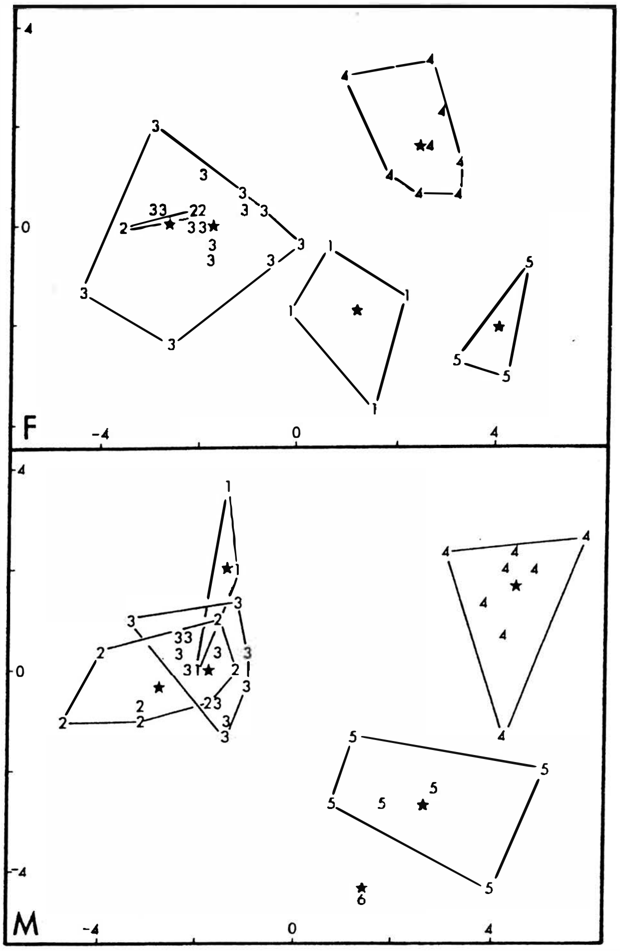

Fig. 4 Plots on the first two canonical axes of population means (stars) of female (above) and male *Kinosternon acutum* (populations 1-3) and *K. creaseri* (4-6) produced by discriminant analysis (SPSS-X program) based on 23 character ratios. Population codes are I, Veracruz and Oaxaca; 2, Tabasco; 3, Guatemala and Belize; 4, Yucatan; 5, Quintana Roo; and 6, Campeche. First two axes account for 69.4 and 19.5% of the variation, respectively, for females; and 66.1 and 19.5% for males.

plastral hindlobe measured across its anterior margin (mean PWC/CL = 0.35 in Yucatan, 0.35 in Quintana Roo, and 0.36 in Campeche).

Colouration also varies geographically. Live specimens from Quintana Roo are generally darker (blacks to dark browns versus medium browns), with lighter pigmented areas on the head and neck coloured pale yellow. However, specimens from near Piste in central Yucatan are much lighter with bright yellow markings on not only the neck and sides of the head, but also on the anterior surfaces of the forelegs. In spite of this apparently significant geographic variation, I do not advocate describing subspecies until more material is available and patterns of variation better understood.

Creaser's mud turtles were found in shallow (<0.5m), temporary forest pools (13), temporarily filled (<0.6m deep) borrow pits or roadside ponds (25), or on roads during rainstorms (26, including 23 first year turtles). They were not found in cenotes or other permanent water habitats, although these habitats were trapped and/or searched intensively. However, they must occasionally visit these habitats, because specimens have apparently been taken in them (e.g. UMMZ 73083 and 73086; APPENDIX A). With three exceptions only one *K. creaseri* was found in any single pool or pond. In two cases, each in a shallow forest pool, a male and female were found together in the same pool (one pair in copula on 17 August). Two first year turtles were also found together in the same pool. Microhabitat densities are thus probably not ever very great (see below).

Based on field observations, the species seems to be most common in the northern two-thirds of Quintana Roo. Broad sympatry between *K. creaseri* and *K. scorpioides, K. leucostomum, Rhinoclemmys areolata, Terrapene carolina yucatana*, and *Trachemys scripta* is known (Smith and Smith, 1980); however microsympatry between any of the latter five and *K. creaseri* has not previously been documented. We did observe *K. scorpioides* and *R. areolata* in similar pools as close as 25m to those wherein *K. creaseri* was found, but actually found *K. creaseri* in the same pond with another species of turtle only twice.

The first was a 20 by 15m roadside pond (max. depth 0.75m) in a cattle pasture adjacent to a sinkhole, and contained at least one *K. scorpioides*, one *K. creaseri*, 53 *T. scripta* (estimated biomass at least 135kg/ha !), and obviously introduced cichlid fish. This was also the only site where *K. creaseri* was found in water supporting a fish population, even though it was unnatural. The second site was also a roadside pond (25m x 15m x 1m maximum depth) in a natural depression in a second growth forest. A single trap baited with sardines and set for four hours produced one *K. scorpioides*, one *K. creaseri*, and one *K. leucostomum*.

Within the range of *K. creaseri* we observed *Trachemys* at nine new localities, *Rhinoclemmys* at 13, *K. leucostomum* at two, and *K. scorpioides* at 21. Like the latter two species, *Rhinoclemmys* probably also occurs microsympatrically with *K. creaseri* on occasion. In Quintana Roo we found hatchlings of *Rhinoclemmys* and *K. creaseri* on the road within 200 and 600 metres of each other at four localities, and a subadult *Rhinoclemmys* on the road within 50m of the nearest pond, which contained *K. creaseri*.

Creaser's mud turtles are apparently primarily carnivorous, since they defecated mainly insect parts and snail shells. However, occasional individuals defecated palm seeds. Captives ate only animal matter.

Creaser's mud turtle apparently spends most of the year buried underground. All but four collection records (Himmelstein, 1980, UMMZ 81539-40 and USNM 46271; collected in February or March) fall between June and December (the rainy season on the Yucatan peninsula), and I was unable to collect the species during intensive field work in April 1981 at the height of the dry season. Although estivation sites are unknown, turtles probably bury below leaves into the moist humus layer of the forest floor as pools dry up during the fall and winter. However, the February/March records suggest that turtles may reemerge whenever temporary pools are filled by rains.

The activity season apparently may be severely reduced during dry years. Although we found turtles fairly abundant in central and northern Quintana Roo in August 1985 and in central Quintana Roo in August 1987, the southern part of the state was very dry. Most roadside pools that obviously would normally hold water during the wet season were dry, and *Kinosternon*-sized turtle tracks suggested that turtles had moved into the nearby forest. Whether or not it is ever dry enough that turtles are forced to estivate through a wet season (i.e. be inactive for 18 months or longer) is not known. Other Mexican *Kinosternon* (at least *flavescens* and probably *alamosae*), in drier habitats, are capable of remaining inactive during such drought years (Iverson, 1988 and 1989).

Based on plastral annuli, female Creaser's mud turtles reach maturity at body sizes between 110 and 115mm CL and apparent ages between 10 and 15 years. Two dissected females of 106 and 108mm CL (with between 16 and 18 and ca. 10 plastral annuli, respectively) were immature, with no follicles over 2mm diameter. However, plastral annuli may not be perfectly correlated with age. The only adult female dissected (116mm CL, 207gm BM, and at least 17 plastral annuli on 25 August) contained a single, relatively huge egg (38.2 x 19.1mm; 8.9gm), its corresponding corpus luteum, and enlarged follicles of 19 and 13mm diameter. The latter suggest that two or three clutches of a single egg each might be deposited annually. Nest sites or nesting behaviour have not been observed.

This species exhibits a typical 'tropical' pattern of reproduction (c.f. Moll and Legler, 1971), with multiple, small clutches of large eggs being produced. Reproductive effort, as measured by wet clutch versus wet body mass, is relatively low in the single dissected female *K. creaseri* (4.3%) compared to that of most other *Kinosternon* (average ca. 10%); however, the average expenditure per progeny (EPP; wet egg versus wet body mass) is among the highest of the subfamily (4.3%). Typical kinosternines average 2%, and in some species EPP is as low as 0.4%. Only *K. acutum*, *K. augustipons* and *K. leucostomum* produce such relatively large eggs among the kinosternines (Iverson, unpublished), with EPP also near 4%.

Densities are very difficult to calculate because turtles typically inhabitat complex mosaics of shallow forest pools. In addition during rainy weather they apparently migrate among pools. Ticks were found on the neck of the specimen from Dzibalchen, Campeche (KU 75644), suggesting that terrestrial movements are common. The most surprising demographic observation is the abundance of first year turtles among the specimens previously collected (at least 25 of 68), as well as observed during my field work (30 of 54). Hatchling kinosternids are typically not commonly encountered.

Except in permanent water habitats, *K. creaseri* would appear to be the most abundant turtle on the Yucatan. We captured 28 *K. scorpioides* (including five juveniles and two hatchlings), 12 *Rhinoclemmys* (seven juveniles and five hatchlings), and 54 *K. creaseri* (including 12 juveniles and 30 hatchlings) in other habitats.

Creaser's mud turtles are very aggressive in comparison to congeners. On capture these turtles (even hatchlings) did not withdraw their heads and close their shells, but rather attempted to bite their captor (often viciously). The strong, prominent beak diagnostic of the adult of this species is probably an adaptation for aggressive encounters, rather than for feeding. At least six of the 15 subadult or adult turtles captured exhibited eroded carapace margins, probably due to aggressive encounters. When other adults were placed in the same container as an adult male they showed evidence within a day of biting along the anterior margins of their shells. Males also attacked *K. scorpioides* in a smaller manner. Even hatchlings exhibited intraspecific aggression. In captivity one would frequently mount another (in a typical kinosternid copulatory position) and attempt to bite the head and anterior margin of the other's shell. In the only case where two first year turtles were found in the same pool, the slightly larger individual was mounted on the shell of the smaller one, biting at it exactly as observed in captivity.

Because of the observations above, and the fact that only one male was ever found in any single pool in the field, it is believed that this species may be territorial. A male that is aggressive enough to drive other males from its forest pool would have unlimited access to food and females in that pool. Whether their aggression is directed interspecifically in the field is not known.

One additional behavioural difference between *K. creaseri* and *K. scorpioides* was observed. Hatchlings of the latter species frequently basked in captivity, but those of the former almost never did.

Although Creaser's mud turtle is much more common than previously thought, its preferred natural microhabitat (forest floor pools) is threatened due to intensive deforestation on the Yucatan peninsula. Removal of the forests increases evaporation, resulting in fewer pools of water. In addition, the basins that previously held water are usually the first to be exploited for cultivation because they are lower, wetter, and have richer soil. Therefore the status of this poorly known turtle should be monitored regularly.

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APPENDIX A

KNOWN LOCALITIES OF CREASER'S MUD TURTLE IN MEXICO

Specimen acronyms are BMNH, British Museum of Natural History; CM, Carnegie Museum of Natural History; CU, University of Colorado; FMNH, Field Museum of Natural History; JBI, John Iverson field observations; KU, Museum of Natural History, University of Kansas; MCZ, Museum of Comparative Zoology, Harvard University; SM, Strecker Museum, Baylor University; UAZ, University of Arizona; UMMZ, University of Michigan, Museum of Zoology; USNM, United States National Museum; and UU, University of Utah. Localities arranged generally north to south within state.

CAMPECHE

Dzibalchen: KU 75644.

QUINTANA ROO

Vivienda de Platanal: FMNH 29131 (locality not findable).

Pueblo Nuevo X-Can: UU 9450, CU 29178-93, KU 70918-20, 70930, CM 40118-20.

1.5km S, 7km E Pueblo Nuevo X-Can: KU 70921-22.

3.8km N Kantunil Kin: KU 171402.

21.9km N Playa del Carmen turnoff on coastal Hwy 307: JBI.

19.3km N Playa del Carmen turnoff on coastal Hwy 307: JBI.

Playa del Carmen: Himmelstein, 1980(81).

0.1km E Lago Coba: JBI (2 specimens).

0.3km S Lago Coba: JBI.

0.7km S Lago Coba: JBI (2 specimens).

1.9km S Lago Coba: JBI.

2.1km S Lago Coba: JBI.

7.7km N Hwy 307 on Coba Road: JBI (4 specimens).

2.9km N Coba Road on Hwy 307: JBI.

1.8km N Coba Road on Hwy 307: JBI.

1.1km N Coba Road on Hwy 307: JBI (2 specimens).

Coast road south of Tulum, 0.5km N of Tulum bypass turnoff to West: JBI.

8.9km SW Coba turnoff on Hwy 307 (= 87.3km NE of Felipe Carillo Puerto square): JBI.

18.0km SW Coba turnoff on Hwy 307: JBI.

22.3km SW Coba turnoff on Hwy 307: JBI (2 specimens).

22.4km SW Coba turnoff on Hwy 307: JBI.

24.6km SW Coba turnoff on Hwy 307: JBI.

24.8km SW Coba turnoff on Hwy 307: JBI.

24.9km SW Coba turnoff on Hwy 307: JBI (2 specimens).

27.0km SW Coba turnoff on Hwy 307: JBI.

27.5km SW Coba turnoff on Hwy 307: JBI.

36.6km SW Coba turnoff on Hwy 307: JBI.

37.1km SW Coba turnoff on Hwy 307: JBI.

37.9km SW Coba turnoff on Hwy 307: JBI.

41.0km SW Coba turnoff on Hwy 307: JBI.

41.8km SW Coba turnoff on Hwy 307: JBI.

42.7km SW Coba turnoff on Hwy 307: JBI.

49.1km SW Coba turnoff on Hwy 307: JBI.

50.0km SW Coba turnoff on Hwy 307: JBI.

50.9km SW Coba turnoff on Hwy 307: JBI.

52.7km SW Coba turnoff on Hwy 307: JBI

53.4km SW Coba turnoff on Hwy 307: JBI

61.1km SW Coba turnoff on Hwy 307: JBI

70.6km SW Coba turnoff on Hwy 307: JBI.

76.2km SW Coba turnoff on Hwy 307: JBI.

83.9km SW Coba turnoff on Hwy 307 (= 12.3km NE Felipe Carillo Puerto square): JBI.

7.8km ENE of Felipe Carillo Puerto square on Vigia Chica Road: JBI.

17.15km ENE of Felipe Carillo Puerto square on Vigia Chica Road: JBI.

29.1mi E Felipe Carillo Puerto: KU 157671.

0.5mi E Presumiada: CU 48020.

13.4mi SW Limones: KU 157670.

13mi N Chetumal: SM 11448.

YUCATAN

37.1km N Tizimin square: JBI.

13mi S Rio Lagartos: CU 45951.

12mi N Tizimin: CU 29996.

1.6km SW Catzin: KU 171403.

1.5mi S Libre Union: CU 29194.

Chicken Itza: USNM 46271, FMNH 27270, 36605, MCZ 46501 (formerly UMMZ 73088; paratype), UMMZ 73085 (paratype), 73089 (paratype), 73210 (paratype), 73087 (paratype), 81539-40.

Chicken Itza, Trail Thompson's Cenote: UMMZ 73083 (paratype).

Chicken Itza, 2mi S Hacienda: UMMZ 73084 (paratype).

Chicken Itza, XCan Cenote: UMMZ 73086 (paratype).

Chicken Itza, 1mi S Hacienda (type locality): UMMZ 73090 (holotype).

Piste: KU 70923-27, 70929, 70931, UAZ 28839, 28843, 28846-47, 28849-50, CU 18222-23, 16128, JBI (7 specimens).

8mi W Vallodolid: CU 45949.

Tekom: BMNH 1973.2505 (not examined).

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THE RELIABILITY OF THE TOE-CLIPPING METHOD WITH THE COMMON LIZARD (*LACERTA VIVIPARA*)

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ABSTRACT

Out of a group of 954 individuals of *Lacerta vivipara* 8% showed naturally caused toe losses during a four year field study. Another 2% was naturally marked by nail losses or seriously damaged toes. The adult females had the greatest chance of natural toe loss, about three times as much as the adult males. For full reliability the toe-clipping method needs some additional data of the animals marked.

INTRODUCTION

When studying lizards it is mostly necessary to be able to recognise the animals individually. During the last few decades a number of marking techniques have been developed which are used separately or in combination (e.g. Vogt, 1944; Carlström and Edelstam, 1946; Woodbury, 1956; Tinkle, 1967; Honegger, 1979). The most widespread marking method for lizards is toe clipping in certain combinations (Ferner, 1979).

The occurrence of natural toe loss, however, may cause confusion when identifying. Only a few field studies mention this problem (e.g. Tinkle, 1967; Schoener and Schoener, 1980). A population study on the common lizard (*Lacerta vivipara*) in the nature reserve 'Overasseltse en Hatertse Vennen' near Nijmegen, in which a total of 954 animals were marked, offered the opportunity to test the reliability of the toe-clipping method.

METHODS

The study area is formed by river dunes with some moorland pools. It is alternately covered by woods (coniferous as well as oak and birch coppice) and by heathland and cultivated areas (Strijbosch, 1988). Within this study area four test sites were selected lying close to each other. They were visited each day and the lizards found were captured by hand, marked — if captured for the first time — and measured.

A maximum of one toe per foot was clipped. When reading the toes of each foot were numbered 1-5 from left to right as seen from dorsal. The combination of the toes clipped at the four feet — in the order left front, right front, left hind and right hind — gave the individual marking number. An unmutilated foot had the figure 0. So an animal whose second toe of the left front foot was clipped as well as the third of its left hind foot and the fourth of its right hind foot bore the number 2034. This system offers the possibility to give 1,295 animals individual numbers (viz. $6^4 = 1296$ minus one for the combination 0000).

Whenever we found an animal that had lost one or more toes through natural causes, this resulted in a 'natural' marking number or in an alteration of the number already given. Also when a nail was lost or when a toe was seriously damaged we gave the animal a new number in order to avoid confusion when reading. If an animal lacked more than one toe per foot we gave it a fraction number (e.g. number $2^3/_4 14$ lacked an extra toe at the right front foot).