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Longevity in Some Ornate Box Turtles (*Terrapene ornata ornata*)

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Legler, in his estimable study of *Terrapene ornata ornata*, noted (1960:585) that "practically nothing" was known about longevity in the species. However, he suggested (p. 586) that a longevity of 50 years might be expected. Blair (1976) marked specimens of *T. o. ornata* on a plot of 0.93 ha near Austin, Texas, and made observations over 23 years. He was not able to find (p. 96) any evidence of longevity extending beyond the earlier part of the third decade in this population.

As discussed in Metcalf and Metcalf (1970), the present study was carried out in southeastern Cowley County, Kansas, in the prairie region of the southern Flint Hills. A study area of 1.5 ha was more intensively investigated but turtles were also sought in various places, as along roads, in mulberry groves, etc., within 1.15 km of the study area. Observations extended over 26 years, from 1957 to 1983 (and continue), with 1734 individuals numbered and marked to 15 August 1983. Only those individuals observed over a timespan of 10 or more years (but not necessarily each year) are considered. These include 115 specimens (56 males and 59 females) or 6.6% of the total number marked. For the 115 specimens noted, lengths of the plastron (in mm) when first and when latest observed are as follows (mean, range, SD):

Females (when first observed)	105.8	(59–129)	17.2
Males (when first observed)	104.6	(70–124)	10.0
Females (at latest observation)	119.0	(105–133)	5.5
Males (at latest observation)	112.9	(103–124)	4.6

The observations for the 115 turtles ranged from 10 to 18 years with a mean of 12.8. Twenty-eight individuals were observed for 15 or more years. Of the 115 turtles, 22, or 19.1%, were found dead. Of these deaths, 6 were attributable to human agencies (autos, mowers, etc.) and 16 seemingly to natural causes. Of the latter, 6 individuals were excavated by carnivores from hibernacula in the winters of 1974–1975 and 1981–1982, in the manner described by Metcalf and Metcalf (1979).

An estimate of age at the latest time observed for the 115 turtles was obtained by adding the span of years of observation to an estimate of age of an individual when first observed. This estimate was obtained by comparison of plastral length of individuals when first taken with lengths assigned to age groups by Legler (1960: figs. 9, 10). The nearest mean (by sex) was ascertained and assignment was made to the age group appropriate to that mean. Since there is considerable variation within each age class, the estimates are, of necessity, crude. Table 1 shows data for females in the 28 year class and males in the 26 and 27 year classes. These are the highest estimates obtained for the two sexes and suggest greater longevity among females.

Estimated ages at times of latest capture are presented in Table 2. Twelve females and 7 males (16.5% of the total number) were in the highest age categories graphed by Legler (13 years for females and 12 years for males). Maximum size is reached at about these ages, although turtles may live many years thereafter. For these individuals,

TABLE 1. Some data concerning 5 female and 4 male ornate box turtles estimated as being the oldest individuals for their respective sexes. Estimated age at latest observation was obtained by adding estimated age at first observation and number of years of observations (=obs.).

Identification number of turtle	3	47	77	292	485	359	144	191	417
Sex (F = female; M = male)	F	F	F	F	F	M	M	M	M
Year of first (above) and latest (below) obs.	1957 1973	1959 1975	1963 1979	1966 1982	1968 1983	1966 1982	1966 1980	1966 1983	1967 1981
Number of years of obs.	16	16	16	16	15	16	14	17	14
Plastron length (in mm) at first (above) and latest (below) obs.	117 120	117 123	117 117	116 116	119 119	111 112	119 119	104 110	124 124
Estimated age at first (above) and latest (below) obs.	12 28	12 28	12 28	12 28	13 28	11 27	12 26	9 26	12 26

TABLE 2. Numbers of ornate box turtles observed over ten or more years, categorized by estimated age when latest taken. For 59 females there was a mean of 22.49 years and SD of 3.75 and for 56 males a mean of 21.8 years and a SD of 2.53.

Estimated age	Numbers of turtles		Estimated age	Numbers of turtles	
	Females	Males		Females	Males
28	5	0	20	8	6
27	5	1	19	1	6
26	6	3	18	4	3
25	2	6	17	2	1
24	7	6	16	2	1
23	7	5	15	0	0
22	5	8	14	1	0
21	3	10	13	1	0

then, estimates of age are only minimal and actual ages may be several years in excess of those estimated. This being the case, it seems highly likely that some of these turtles have reached into their third decade. However, there is no compelling evidence for ages much in excess of the lower 30's. Thus, none of 50 turtles first observed in the late 1950's were observed later than 1975 and only 2 of the 86 individuals marked in the years 1960-1965 were observed into the 1980's. Of course, these are relatively small numbers of individuals; however, of 238 turtles marked in 1966, only 11 were retaken as late as 1982 or 1983. Further observation of the latter specimens should be of interest. The demography here may be similar to that observed by Blair (1976:96) in which he suggested a nearly complete turnover of the population studied in Texas within 32 years. The longevity estimates for our study population are also close to the findings of Blair—i.e., sometimes living into the third decade. They do not support the estimate of an age of 50 years by Legler, noted above.

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Male-biased Sex Ratio in a Cold Nest of a Hawksbill Sea Turtle (*Eretmochelys imbricata*)

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An increasingly convincing body of data indicates that incubation temperature affects the sexual differentiation of turtles (especially during a critical series of embryonic stages; Bull, 1980; Bull and Vogt, 1979, 1981; Morreale et al., 1982; Mrosovsky and Yntema, 1980; Pieau, 1975; Pieau and Dorrizzi, 1981; Spotila et al., 1983; Wood and Wood, 1982; Vogt et al., 1982; Wilhoft et al., 1983; Yntema, 1979; Yntema and Mrosovsky, 1980, 1982). Previous studies, especially with rare or endangered species of marine turtles, have suffered from limited sample sizes for experimentation and/or from the necessity for laboratory incubation out of the natural environment. A clutch of 141 *Eretmochelys imbricata* eggs was deposited on Soldier Key, Dade County, Florida on 25 October 1981 and began hatching on 21 January 1982 (91 days later!). Nesting by hawksbill turtles beyond the tropics is something of a rarity and in this case was very late in the season. The nest temperature was recorded four times during development, on 25 November 1981 as 23°C, 12 December as 22°C, 2 January 1982 as 25.2°C and at hatching on 21 January 1982 as 18.1°C. All hatchlings died within four days, most while still in their eggs (ms. in prep.). Upon their death, a random sample of 70 turtles was selected for histological examination of the gonads.

The left gonad was removed from each specimen and prepared for the light microscope (7-10 micra sections) using three staining procedures: hemotoxylin and eosin (Spotila et al., 1983), PAS with hemotoxylin (after Mrosovsky and Yntema, 1980) and Mallory's Trichrome (Sanders, 1972). Five of the gonads were not distinguishable, the remaining 65 were all male. The testes had characteristically well-developed seminiferous tubules in the medulla and a single layer of squamous epithelium as the outer cortical layer (Yntema and Mrosovsky, 1980; Spotila et al., 1983).

The November 25th nest temperature of 23°C is important because on this visit to the nest an egg was accidentally broken and the exposed embryo was at stage 18 or 19 (Yntema, 1968). These stages fall within the critical period for the effect of temperature on sex differentiation discussed by Yntema and Mrosovsky (1982) and Bull and Vogt (1981). During the period between laying (22 October 1981) and this critical stage (25 November 1981) there were only four days when the maxi-