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Occurrence of Double Clutching in the Southwestern Pond Turtle, *Clemmys marmorata pallida*, in the Los Angeles Basin

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Little is known about the reproductive biology of the western pond turtle, *Clemmys marmorata* (Holland, 1991, 1994; Rathbun et al., 1992; Ernst et al., 1994), in particular the frequency of oviposition in females. Several species of emydid turtles are known to deposit more than one clutch per nesting season (Gibbons et al., 1982; Ernst et al., 1994). The frequency of reproduction both on an intra- and interannual basis is a critical life history trait (Gibbons and Greene, 1990). Here I report on instances and the specifics of double clutching in the southwestern pond turtle, *Clemmys marmorata pallida* (Fig. 1).

Methods. — Turtles were captured and marked from 1992-94 as part of a long-term study in Chino Hills State Park, San Bernardino County, California. Females were palpated by hand and reproductive status confirmed by X-ray (Gibbons and Greene, 1979). Measurement of clutch size and egg width (to 0.01 mm) was made directly from the X-ray. A reference marker (U.S. 25 cent coin) was placed in the viewing field to compensate for poten-

tial variation in image size among radiographic machines. Gravid females were instrumented with radio transmitters and tracked on a daily basis, from April to June, until oviposition occurred and nesting sites were located. All post-ovipositional turtles were recaptured on a regular basis to determine if multiple clutches occurred. A two-sample t-test was used to examine variation in clutch size. Two-way analysis of variance and Tukey's multiple comparison test were used to compare variation in egg width (Congdon and Gibbons, 1983) among and within females. Simple linear regression was used to examine the effect of female carapace length (CL) on X-ray egg width (EW).

Results. — Fifteen individual females of potential reproductive size (CL > 110 mm; Holland, 1991, 1994) were captured and recaptured from 1992 to 1994. Of these, 3 of 8 were gravid in 1992, 7 of 14 were gravid in 1993, and 3 of 9 were gravid in 1994. Most of the females captured clutched at least once, but 2 clutched in 2 consecutive years and 1 clutched in all 3 years.

Of the 7 gravid females captured in 1993, 3 were observed to double clutch (Table 1). Turtle #16 (CL = 137.0 mm, mass = 344 g) was first captured on 29 April carrying 7 eggs (EW mean = 19.81 mm, range = 18.58-20.62). This first clutch was deposited on 4 May. On 8 June this animal was recaptured carrying 5 eggs (EW mean = 20.42 mm, range = 19.85-21.15). This second clutch was deposited on 10 June for an interesting interval of 38 days. Turtle #8 (CL = 152.4 mm, mass = 644 g) was first captured on 5 May carrying 7 eggs (EW mean = 21.13 mm, range = 20.28-21.90). This first clutch was deposited on 14 May. On 11 June this animal was recaptured carrying 8 eggs (EW mean = 20.86 mm, range = 20.27-21.55). This second clutch was deposited on 20 June for an interesting interval of 38 days. Turtle #12 (CL = 141.5 mm, mass = 432 g) was first captured on 5 May carrying 8 eggs (EW mean = 19.68 mm, range = 17.98-20.50). This first clutch was deposited on 11 May.



Figure 1. Female southwestern pond turtle, *Clemmys marmorata pallida*, San Diego County, California (gravid with 7 eggs, carapace length 134.3 mm). Photo by R.H. Goodman, Jr.

Table 1. Comparison of clutch parameters for three double clutching *Clemmys marmorata pallida*. Tukey's multiple comparison test: ** = $p < 0.01$ between turtles # 8 and 12, ++ = $p < 0.01$ between turtles # 8 and 16, and + = $p < 0.05$ between turtles # 8 and 16. Egg widths in mm.

Turtle Number	Clutch Number	Number of Eggs	Mean X-ray Egg Width	Standard Deviation
8	1	7	21.13 **/++	0.58
	2	8	20.86 **/+	0.40
12	1	8	19.68 **	0.85
	2	4	20.49	0.35
16	1	7	19.81 ++/+	0.67
	2	5	20.42	0.49

This animal was recaptured on 8 June carrying 4 eggs (EW mean = 20.49 mm, range = 19.98–20.74). This second clutch was deposited on 20 June for an interesting interval of 41 days.

There was no significant difference (two-sample t-test, $p = 0.37$) between clutch sizes in individual turtles. Comparisons of X-ray egg widths (Table 1) indicated that there were no significant differences ($p > 0.10$) in mean egg width between first and second clutches in individual turtles. Significant differences in egg width (two-way ANOVA, $p = 0.0005$) did exist among turtles. The first and second clutches of turtle #8 were significantly larger than the first clutches of turtles #12 and 16 (Table 1). Mean egg width was positively correlated with carapace length ($r^2 = 0.33$, $p = 0.0001$), probably due to the large body size of turtle #8.

Discussion. — Of the three turtles that double clutched in 1993, clutch size did not vary significantly in individual turtles. Turtles #12 and 16 had second clutches with fewer eggs (8 to 4 and 7 to 5 eggs, respectively), while turtle #8 had a larger second clutch (7 to 8 eggs). While the mean egg width did not differ significantly in individual turtles, there was a slight tendency for eggs in the smaller clutches to be larger. The significantly larger eggs of turtle #8 were due to a significant positive correlation of egg diameter with carapace length, which corresponds with patterns observed in some other turtle species (Congdon and Gibbons, 1983, 1985).

The etiology of double clutching in western pond turtles is not well understood. Holland (1991, 1994) indicated that many females in this species throughout its range may oviposit only in alternate years. Only a single instance of double clutching has been observed in the northern subspecies, *Clemmys marmorata marmorata* (F. Slavens, pers. comm.). Gibbons et al. (1982) stated that environmental factors that might affect reproductive frequency in turtles would include rainfall, water level, water temperature, extent of the habitat, seasonal timing, and the interaction of these factors. One possible factor contributing to double clutches in this study population of pond turtles might have been the increase in available resources resulting

from the El Niño condition that gave drought-prone southern California above average rainfall in the 1991–92 and 1992–93 rainy seasons.

When evaluating the status of a population of pond turtles, population dynamics, movements, seasonal activity patterns, and reproductive ecology are all important factors that must be considered. Detailed long-term studies need to be conducted on populations at different localities, especially in southern California, to obtain a better understanding of the life history strategies of this species.

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