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# Annual Deposition of Scute Rings in the Western Pond Turtle, *Clemmys marmorata*

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The western pond turtle, *Clemmys marmorata*, is the only native aquatic turtle from northern Baja California to southern Oregon, and along with the painted turtle, *Chrysemys picta*, the only native turtles on the entire Pacific Coast (Storer, 1930; Stebbins, 1985; Jennings and Hayes, 1995). Storer (1930) detailed aspects of the species' ecology, including counts of scute rings for several turtles. Although he presented no data to indicate that these rings were annual, he indicated that age in years could be inferred not to be greater than the number of rings. He found a maximum of 12 rings on adult turtles but did not provide a sample size.

Scute annuli have been found to be useful to determine age of juveniles of numerous species of turtles (Germano and Bury, 1998). It is also important to document that rings are produced annually (Galbraith and Brooks, 1987; Brooks et al., 1997). Here, we report the first data to determine if scute rings are produced annually and if size correlates with age in *C. marmorata*.

*Methods.* — We collected data on scute layers in *C. marmorata* from a variety of sites in central and northern California and southern Oregon. Turtles inhabited both ponds and streams, and were captured in net traps, wire-mesh traps, and by hand. For turtles that had visible scute rings and appeared to be growing (Germano and Bury, 1998), we counted the number of scute rings on the carapace and plastron (Fig. 1). We also measured turtles, marked them by filing notches in the marginals, and released them at the point of capture. In recent years, casts were made of scutes as a permanent record of annuli counts. The number of scute rings on turtles caught in subsequent years were compared to the number of rings counted at the time of first capture. No turtles with countable rings have been recaptured more than once at any site.

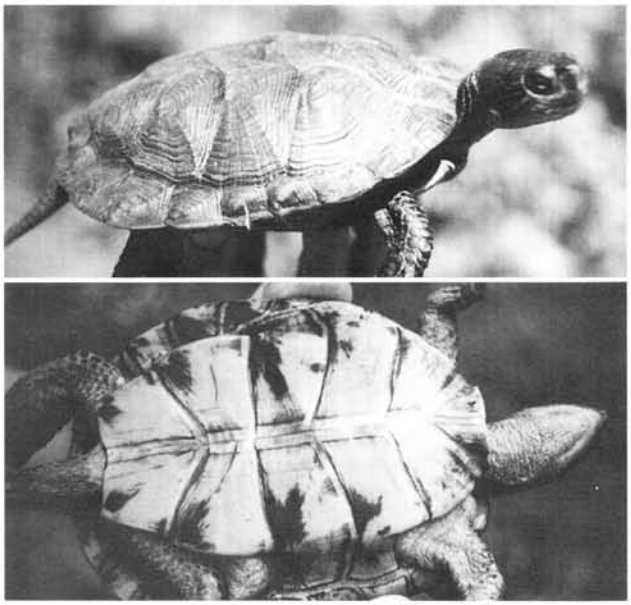

**Figure 1.** Scute annuli are easily discernible on the carapace (top) and plastron (bottom) of juvenile western pond turtles, *Clemmys marmorata*. Each photograph is of a different individual.

*Results and Discussion.* — Of 36 turtles that have been recaptured from 1993–98 and were young enough to still be depositing layers, 29 showed the addition of 1 annulus 1 year later, 6 had 2 annuli 2 years later, and 1 turtle added only 1 ring after 2 years (Table 1). The one turtle that added only 1 ring after 2 years had 10 layers initially, and this may be the age at which *C. marmorata* starts to slow overall growth, although the carapace length increased 9 mm in those 2 years. All 29 turtles with less than 10 annuli added annual rings, as did 6 of 7 turtles with 10 or more rings. Generally, carapace length increased 3–28 mm for these juvenile turtles,

**Table 1.** Numbers of growth rings (R) counted on scutes of western pond turtles (*Clemmys marmorata*) when first captured and at second capture in 1993–98. Straight-line carapace lengths (L) in mm. Only 1 of 36 animals (marked with *) did not deposit rings annually.

| | | Growth Rings (R) and Carapace Length (L) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1993 | | 1994 | | 1995 | | 1996 | | 1997 | | 1998 | |
| Location | ID No. | R | L | R | L | R | L | R | L | R | L | R | L |
| Oregon | | | | | | | | | | | | | |
| Yoncalla | 16 | 10 | 134 | 11 | 150 | | | | | | | | |
| Blue Butte Pond | 1691 | | | 14 | 157 | | | 16 | 161 | | | | |
| Jackson Creek | 2811 | | | 7 | 117 | | | 9 | 130 | | | | |
| Rawlins Pond | 3 | | | | | 3 | 74 | 4 | 87 | | | | |
| | 6 | | | | | 9 | 116 | 10 | 121 | | | | |
| | 251 | | | | | 7 | 105 | 8 | 108 | | | | |
| | 275 | | | | | 9 | 125 | 10 | 135 | | | | |
| | 5912 | | | | | 8 | 101 | 9 | 108 | | | | |
| Jenny Creek | 5752 | | | | | 4 | 80 | 5 | 92 | | | | |
| California | | | | | | | | | | | | | |
| Hayfork Creek | 359 | | | | | 12 | 132 | 13 | 137 | | | | |
| | 5798 | | | | | 7 | 112 | 8 | 118 | | | | |
| | 353 | | | | | 11 | 145 | | | 13 | 146 | | |
| | 5209* | | | | | 10 | 123 | | | 11 | 132 | | |
| | 373 | | | | | | | 4 | 77 | 5 | 85 | | |
| | 377 | | | | | | | 4 | 87 | 5 | 95 | | |
| Hell-To-Find Lake | 1 | | | | | | | 2 | 69 | 3 | 84 | | |
| | 22 | | | | | | | 7 | 126 | 8 | 131 | | |
| Goose Lake | 20 | | | | | | | 2 | 66 | 3 | 87 | | |
| | 25 | | | | | | | 6 | 129 | | | 8 | 143 |
| | 30 | | | | | | | 2 | 70 | 3 | 98 | | |
| | 37 | | | | | | | 6 | 143 | | | 8 | 151 |
| | 39 | | | | | | | 5 | 123 | 6 | 137 | | |
| | 50 | | | | | | | 2 | 77 | 3 | 94 | | |
| | 51 | | | | | | | 2 | 82 | 3 | 97 | | |
| | 52 | | | | | | | 3 | 90 | 4 | 99 | | |
| | 61 | | | | | | | 3 | 107 | 4 | 119 | | |
| | 80 | | | | | | | 2 | 71 | 3 | 105 | | |
| | 111 | | | | | | | | | 5 | 120 | 6 | 134 |
| | 112 | | | | | | | | | 5 | 144 | 6 | 147 |
| | 117 | | | | | | | | | 3 | 107 | 4 | 126 |
| | 146 | | | | | | | | | 4 | 113 | 5 | 124 |
| | 165 | | | | | | | 3 | 112 | 4 | 135 | | |
| | 172 | | | | | | | | | 4 | 132 | 5 | 150 |
| | 181 | | | | | | | | | 5 | 117 | 6 | 133 |
| | 187 | | | | | 4 | 99 | | | 6 | 123 | | |
| | 215 | | | | | | | | | 6 | 147 | 7 | 154 |

**Table 2.** Carapace length (mm) by scute annuli number of western pond turtles (*Clemmys marmorata*) at Hayfork Creek, California from 1968–73. Means given with standard deviation (SD).

| Annuli Number | *n* | Carapace Length (mm) Mean ± SD | Range |
|---|---|---|---|
| 0 | 4 | 32.73 ± 1.48 | 30.5 – 33.5 |
| 1 | 10 | 51.93 ± 4.86 | 42.5 – 60 |
| 2 | 30 | 66.55 ± 6.43 | 55 – 81 |
| 3 | 58 | 78.14 ± 6.00 | 66 – 92 |
| 4 | 58 | 87.51 ± 6.25 | 73 – 102 |
| 5 | 61 | 94.75 ± 5.20 | 83 – 103.5 |
| 6 | 58 | 102.47 ± 7.01 | 76 – 114 |
| 7 | 64 | 107.20 ± 15.82 | 93 – 126 |
| 8 | 60 | 116.73 ± 8.37 | 95 – 126 |
| Males | | | |
| 9 | 19 | 121.24 ± 6.08 | 111 – 131.5 |
| 10 | 12 | 129.04 ± 8.58 | 121 – 145 |
| Females | | | |
| 9 | 36 | 122.31 ± 7.88 | 110.5 – 139 |
| 10 | 20 | 129.15 ± 9.30 | 113.5 – 140.5 |

but turtle no. 353 from Hayfork Creek only increased carapace length 1 mm in 2 years while still adding 2 annuli (Table 1).

If annuli are deposited each year, body size should progressively and consistently increase with age (i.e., larger turtles have more annuli than smaller turtles). To test this relationship, we compared annuli and measured carapace length of 490 *C. marmorata* from Hayfork Creek, Trinity Co., California. The size of turtles increased steadily with age based on counting annuli (Table 2). This separate data set corroborates that size corresponds to age and annuli in *C. marmorata* up to at least 10 years of age.

Annual deposition of scute rings has been shown for the congeners *Clemmys guttata* (Ernst, 1975) and *C. insculpta* (Harding and Bloomer, 1979; Lovich et al., 1990, Ernst et al., 1994). The maximum number of annuli deposited by congeners is 14–18 for *C. guttata* (Ernst, 1975), 13 for *C. muhlenbergii* (Ernst, 1977), and 15–20 for *C. inscuplta* (Harding and Bloomer, 1979; Farrell and Graham, 1991; Ross et al., 1991). Most of the *C. marmorata* we examined seemed to stop depositing countable scute annuli after 12 to 14 years, but one turtle had 16 countable rings, the maximum number of scute annuli that we have seen for this species. These are the first data indicating that scute rings are deposited essentially annually and that size corresponds to age in juvenile *C. marmorata*.

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# Bait Preferences of Southeastern United States Coastal Plain Riverine Turtles: Fish or Fowl?

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Few studies have been conducted comparing the efficacy of different types of baits for trapping aquatic turtles. Lagler (1943) considered fresh fish and fowl entrails best, but provided no supportive data. Ernst (1965) compared the attractiveness of six different baits (including fresh fish and fowl entrails) to *Chrysemys picta*, *Chelydra serpentina*, and *Sternotherus odoratus*. He concluded that, although fish- and fowl-baited traps captured equal numbers of *C. serpentina* and *S. odoratus*, fowl was far superior to fish for attracting *C. picta*. However, since he ran each of the seven bait trials (including one unbaited control) consecutively, with a week of no trapping between each trial, biases related to seasonality, weather, trap habituation, and trap shyness may have influenced his results. Further, I am aware of