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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.

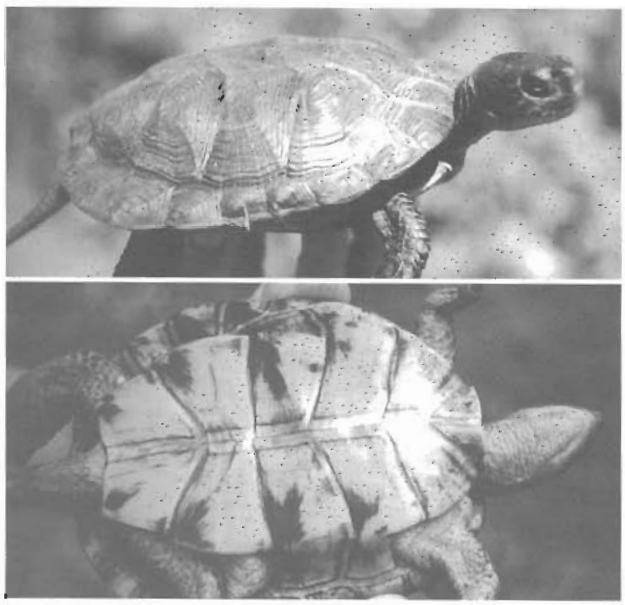

Figure 1. Scute annuli are easily discernible on the carapace (top) and plastron (bottom) of juvenile western pond turtles, *Clemmys marmorata*. Each photograph is of a different individual.

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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Literature Cited

BROOKS, R.J., KRAWCHUK, M.A., STEVENS, C., AND KOPER, N. 1997. Testing the precision and accuracy of age estimation using lines in scutes of *Chelydra serpentina* and *Chrysemys picta*. J. Herpetol. 31:521-529.

ERNST, C.H. 1975. Growth of the spotted turtle, *Clemmys guttata*. J. Herpetol. 9:313-318.

ERNST, C.H. 1977. Biological notes on the bog turtle, *Clemmys muhlenbergii*. Herpetologica 33:241-246.

ERNST, C.H., LOVICH, J.E., AND BARBOUR, R.W. 1994. Turtles of the United States and Canada. Smithsonian Institution Press, Washington, 578 pp.

FARRELL, R.F., AND GRAHAM, T.E. 1991. Ecological notes on the turtle *Clemmys insculpta* in northwestern New Jersey. J. Herpetol. 25:1-9.

GALBRAITH, D.A., AND BROOKS, R.J. 1987. Addition of annual growth lines in adult snapping turtles, *Chelydra serpentina*. J. Herpetol. 21:359-363.

GERMANO, D.J., AND BURY, R.B. 1998. Age determination in turtles: evidence of annual deposition of scute rings. Chelonian Conservation and Biology 3:123-132.

HARDING, J.H., AND BLOOMER, T.J. 1979. The wood turtle, *Clemmys insculpta* ... a natural history. HERP - Bull. New York Herpetol. Soc. 15:9-26.

JENNINGS, M.R., AND HAYES, M.P. 1994. Amphibian and Reptile Species of Special Concern in California. California Department of Fish and Game, Final Report, Contract No. 8023, Rancho Cordova, 255 pp.

LOVICH, J.E., ERNST, C.H., AND MCBREEN, J.F. 1990. Growth, maturity, and sexual dimorphism in the wood turtle, *Clemmys insculpta*. Can. J. Zool. 68:672-677.

ROSS, D.A., BREWSTER, K.N., ANDERSON, R.K., RATNER, N., and BREWSTER, C.M. 1991. Aspects of the ecology of wood turtles, *Clemmys insculpta*, in Wisconsin. Can. Field Naturalist 105:363-367.

STEBBINS, R.C. 1985. A Field Guide to Western Reptiles and Amphibians. Houghton Mifflin Company, Boston, 336 pp.

STORER, T.I. 1930. Notes on the range and life-history of the Pacific fresh-water turtle, *Clemmys marmorata*. Univ. Calif. Publ. Zool. 32:429-441.

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