Scutation and Scalation Patterns of Loggerhead Hatchlings in Greece

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Scutation (on the carapace) and scalation (on the head) patterns in turtles, including sea turtles, provide taxonomic information (Hughes 1974). Among the sea turtles, the most deviance from the scute pattern common to most individuals of a species as well as the greatest variability in pattern are found in the genus Lepidochelys (Mast & Carr 1989). Variation in these patterns is rather common in loggerhead turtles (Carr 1952 and references therein), with maximum variation appearing on marginal scutes (e.g., Brongersma 1961; Hughes & Mentis 1967). Further, large differences in scutation patterns were reported between adults and hatchlings in various parts of the world (Gadow 1899-cited in Türkozan et al. (2001); Hughes & Mentis 1967; Yntema & Mrosovsky 1980) including Mediterranean, and specifically in Turkey (e.g., Türkozan et al. 2001; Türkozan & Yilmaz 2007) and in Tunisia (Jribi et al. 2002). In Greece, scutation and scalation patterns were published only for adult loggerheads, nesting in Zakynthos (Margaritoulis & Chiras 2011). No such work for hatchlings is known for Greece.

To fill this gap, we present herein data on scutation and scalation patterns of loggerhead hatchlings collected, in varying intensity, over five nesting seasons within the period 1983-1990, at the nesting sites of Laganas Bay (Zakynthos Island) and of Kyparissia Bay (western Peloponnese), in the course of a long-term nest monitoring programme. We used alive or dead hatchlings, found either on the beach surface or inside nests during post-hatch excavations. The following carapacial scutes were counted: nuchal, vertebrals, costals, marginals, and supracaudals. We also counted the postocular scales on the head. Prefrontal scales and inframarginal scutes were excluded to avoid ambiguities because of their complexity. The work was carried out by trained volunteers and the data were recorded on site on specially designed datasheets. Due to various reasons, it was not always possible to count all above scutes and scales on the same hatchling.

We examined in total 440 hatchlings selected at random. The patterns of the observed scutes and scales appear on Table 1. The number of nuchal scutes was one or two, with the commonest pattern one nuchal, observed in 96.0% of all hatchlings. The number of vertebral scutes ranged from five to seven with highest frequency five scutes, observed in 91.5% of all hatchlings. All examined hatchlings had two supracaudals (n=438). Seven combinations of left and right costal scutes were observed with the combination 5-5 being the most frequent, i.e., 93.0% of the observed hatchlings. Eight combinations of left and right marginals were recorded, with highest frequencies observed in the combinations 12-12 and 11-11 representing 41.3% and 34.9%, respectively. Seven combinations of post-ocular scales were noted, with the typical combination 3-3 showing the highest frequency (95.7%).

In 423 hatchlings, 15 combinations of vertebrals and costals were recorded, with highest frequency the combination 5-5-5 (87.0%) followed by the combination 5-6-5 (5.0%) (Table 2). In 419 hatchlings, 36 different combinations of vertebral, costal and marginal scutes were found. The most frequent combinations were 12-5-5-5-12 (35.8%) and 11-5-5-5-11 (31.0%) (Table 3). Further, 43 combinations of nuchals, vertebrals, costals, marginal and supracaudals were found in 419 hatchlings. The most frequent combinations were 1-12-5-5-5-12-2 (35.1%) and 1-11-5-5-5-11-2 (30.1%) (Table 4).

Table 1. Number of scutes and scales, and their frequencies (%), encountered in loggerhead hatchlings in Greece (L: left; R: right; n: number of hatchlings).

Scute or scale	Number	n	Frequency (%)
Nuchal (n=423)	1	406	96.0
	2	17	4.0
Vertebral (n=423)	5	387	91.5
	6	29	6.9
	7	7	1.7
Supracaudal (n=438)	2	438	100.0
Costal (n=440)	**L - R**		
	4 - 4	5	1.1
	4 - 5	7	1.6
	5 - 4	2	0.5
	5 - 5	409	93.0
	5 - 6	8	1.8
	6 - 5	5	1.1
	6 - 6	4	0.9
Marginal (n=436)	11 - 11	152	34.9
	11 - 12	41	9.4
	12 - 10	1	0.2
	12 - 11	51	11.7
	12 - 12	180	41.3
	12 - 13	2	0.5
	13 - 12	2	0.5
	13 - 13	7	1.6
Postocular (n=421)	2 - 2	3	0.7
	3 - 2	3	0.7
	3 - 3	403	95.7
	3 - 4	3	0.7
	4 - 3	3	0.7
	4 - 4	5	1.2
	4 - 5	1	0.2

The present study shows that the most frequent pattern of carapacial scutes on loggerhead hatchlings in Greece is one nuchal, five vertebrals, five pairs of costals, and one pair of supracaudals. This pattern complies largely with the reported scutation pattern of hatchlings in other Mediterranean rookeries (e.g., Türkozan et al. 2001; Jribi et al 2002). The frequency of one nuchal (96.0%) is similar to the one reported for Turkey, specifically in Dalyan (97.7%) over 1967 hatchlings (Türkozan et al. 2001) and in Alata beach (95.5%) (Ergene et al. 2011). The most common pattern of five vertebral scutes (91.5%) is similar to the ones given for Tunisia (91.4%) (Jribi et al. 2002) and for Turkey, in Dalyan (89.9%) (Türkozan et al 2001) and in Alata (90.2%) (Ergene et al. 2011). For the most common combination 5-5 of costals, the same frequency of 93.0% was reported in Dalyan (Türkozan et al. 2001) and similar ones in Tunisia (95.2%) (Jribi et al. 2002) and in Alata (96.2%) (Ergene et al. 2011). However, there are remarkable differences in the variation of marginal scutes among Mediterranean rookeries. Türkozan et al. (2001) reported for the marginal variation 12-12 a frequency of 70.1% in Dalyan, Jribi et al. (2002) found 51.3% in Tunisia, and Ergene et al. (2011) 45.4% in Alata, all values higher than the 41.3% reported herein for Greece.

Table 2. Combinations of vertebral and costal scutes, and their frequencies (%), in 423 hatchlings (LC: left costal, V: vertebral, RC: right costal, n: number of hatchlings)

LC - V - RC	n	%
4 - 5 - 4	3	0.7
4 - 5 - 5	4	0.9
4 - 6 - 4	2	0.5
4 - 6 - 5	2	0.5
4 - 7 - 5	1	0.2
5 - 5 - 4	1	0.2
5 - 5 - 5	368	87.0
5 - 5 - 6	7	1.7
5 - 6 - 5	21	5.0
5 - 6 - 6	1	0.2
5 - 7 - 5	4	0.9
6 - 5 - 5	4	0.9
6 - 6 - 5	1	0.2
6 - 6 - 6	2	0.5
6 - 7 - 6	2	0.5

In adult and subadult loggerheads, the combination 12-12 of the marginal count has a frequency of 36.8% in Zakynthos (for nesting females) (Margaritoulis & Chiras 2011), 61.3% in Turkey (for nesting females) (Türkozan et al. 2001), 67.8% in Tunisia (for nesting females and subadults) (Jribi et al. 2002), and 53.9% (Casale et al. 2017) and 41.4% (Oliver 2014) for adults and subadults in central Mediterranean. These differences provide additional indication that the pattern of marginal scutes may vary per area (see also Casale et al. 2017) and confirm further the instability of the marginal count as a taxonomic character (see Hughes 1974; Kamezaki 2003).

The present study endorses previous findings in Mediterranean rookeries (Türkozan et al. 2001; Jribi et al. 2002; Ergene et al. 2011; and others) that scutation patterns in loggerhead hatchlings shows an increased variation in comparison to the scutation of adults, particularly in nesting females. Indeed, in the present study the encountered combinations of carapacial scute patterns in hatchlings were more numerous than the combinations reported for adult females (Table 5).

Table 3. Combinations of marginal, vertebral and costal scutes, and their frequencies (%), encountered in 419 hatchlings (LM: left marginal, LC: left costal, V: vertebral, RC: right costal, RM: right marginal, n: number of hatchlings)

LM-LC-V-RC-RM	n	%
11-4-5-4-11	2	0.5
11-4-5-4-12	1	0.2
11-4-5-5-11	2	0.5
11-4-6-4-11	1	0.2
11-4-6-5-11	2	0.5
11-4-7-5-11	1	0.2
11-5-5-5-11	130	31.0
11-5-5-5-12	33	7.9
11-5-5-6-11	3	0.7
11-5-5-6-12	2	0.5
11-5-6-5-11	5	1.2
11-5-6-5-12	3	0.7
11-6-5-5-11	1	0.2
11-6-6-6-11	1	0.2
11-6-6-6-12	1	0.2
11-6-7-6-11	1	0.2
12-4-5-5-11	1	0.2
12-4-5-5-12	1	0.2
12-4-6-4-11	1	0.2
12-5-5-4-11	1	0.2
12-5-5-5-10	1	0.2
12-5-5-5-11	40	9.5
12-5-5-5-12	150	35.8
12-5-5-5-13	2	0.5
12-5-5-6-12	2	0.5
12-5-6-5-11	5	1.2
12-5-6-5-12	8	1.9
12-5-6-6-12	1	0.2
12-5-7-5-12	4	1.0
12-6-5-5-11	1	0.2
12-6-5-5-12	1	0.2
12-6-6-5-12	1	0.2
12-6-7-6-12	1	0.2
13-5-5-5-12	2	0.5
13-5-5-5-13	6	1.4
13-6-5-5-13	1	0.2

A similarly large difference between hatchling and female adults appears in the variation of postocular scales. Margaritoulis & Chiras (2011) reported 100% stability of the postocular count of the females nesting on Zakynthos. However, in the present study hatchlings appear as having as much as seven variations of postocular scales, which

Table 4. Combinations of nuchal, marginal, vertebral, costal and supracaudal scutes, and their frequencies (%), encountered in 419 hatchlings (N: nuchal, LM: left marginal, LC: left costal, V: vertebral, RC: right costal, RM: right marginal, S: supracaudal, n: number of hatchlings)

N-LM-LC-V-RC-RM-S	n	%
1-11-4-5-4-11-2	2	0.5
1-11-4-5-4-12-2	1	0.2
1-11-4-5-5-11-2	2	0.5
1-11-4-6-4-11-2	1	0.2
1-11-4-6-5-11-2	2	0.5
1-11-4-7-5-11-2	1	0.2
1-11-5-5-5-11-2	126	30.1
1-11-5-5-5-12-2	32	7.6
1-11-5-5-6-11-2	3	0.7
1-11-5-5-6-12-2	2	0.5
1-11-5-6-5-11-2	5	1.2
1-11-5-6-5-12-2	3	0.7
1-11-6-5-5-11-2	1	0.2
1-11-6-6-6-11-2	1	0.2
1-12-4-5-5-12-2	1	0.2
1-12-4-6-4-11-2	1	0.2
1-12-5-5-4-11-2	1	0.2
1-12-5-5-5-10-2	1	0.2
1-12-5-5-5-11-2	37	8.8
1-12-5-5-5-12-2	147	35.1
1-12-5-5-5-13-2	2	0.5
1-12-5-5-6-12-2	2	0.5
1-12-5-6-5-11-2	5	1.2
1-12-5-6-5-12-2	7	1.7
1-12-5-6-6-12-2	1	0.2
1-12-5-7-5-12-2	3	0.7
1-12-6-5-5-11-2	1	0.2
1-12-6-5-5-12-2	1	0.2
1-12-6-6-5-12-2	1	0.2
1-12-6-7-6-12-2	1	0.2
1-13-5-5-5-12-2	2	0.5
1-13-5-5-5-13-2	5	1.2
1-13-6-5-5-13-2	1	0.2
2-11-5-5-5-11-2	4	1.0
2-11-5-5-5-12-2	1	0.2
2-11-6-6-6-12-2	1	0.2
2-11-6-7-6-11-2	1	0.2
2-12-4-5-5-11-2	1	0.2
2-12-5-5-5-11-2	3	0.7
2-12-5-5-5-12-2	3	0.7
2-12-5-6-5-12-2	1	0.2
2-12-5-7-5-12-2	1	0.2
2-13-5-5-5-13-2	1	0.2

Table 5. Comparison of scute combinations encountered in adult female and hatchling loggerheads in Greece (V: vertebral, C: costal, M: marginal, N: nuchal, S: supracaudal). Combinations of adult females were taken from Margaritoulis & Chiras (2011)

Scute combination	Number of combinations	
	Adults (females)	Hatchlings
V, C	9	15
V, C, M	12	36
N, V, C, M, S	13	43

indicates that hatchlings exhibit more variation than adults also in the number of postocular scales.

Various explanations are provided in the literature to elucidate scutation differences between adults and hatchlings, such as "orthogenetic variation" (Gadow 1899-cited in Türkozan et al. (2001)), atavistic reappearance of "previously lost" scutes (Newman 1906), and possibly reduced fitness of hatchlings with atypical scute variations resulting in fewer adults with such variations (Türkozan et al. 2001; Türkozan et al. 2007). Among these explanations we could also add the fusion of supernumerary plates (Gadow 1899-cited in Türkozan et al. (2001); Jribi et al. 2002) and the manipulation of eggs during incubation, since the differentiation of scutes and scales take place during incubation (Ewert 1979).

Nevertheless, in view of the scarcity of such data in the Mediterranean it is recommended that researchers continue scutation and scalation counts on both hatchlings and adults.

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