

is, the turtle emerges from the water, crawls up the beach, makes a body pit, excavates an egg-chamber, covers it up, camouflages it and goes back to sea, without laying any eggs. Pseudo-nesting is differentiated from non-nesting emergences, where the turtle returns to sea, without egg laying, interrupting the standard nesting procedure. To my knowledge, there is only one publication on this subject, and this concerns *Lepidochelys olivacea* in the Indian Ocean (Swaminathan and John 2011, *op. cit.*). Here, I present a first account of this phenomenon observed in the loggerhead sea turtle population nesting on Zakynthos Island, Greece.

ARCHELON conducts a long-term tagging program on Zakynthos nesting area (Margaritoulis et al. 2020. *Chelonian Conserv. Biol.* 19:133–136). Trained volunteers carry out tagging in varying intensity and time-periods, depending on resources. Volunteers follow a standard protocol to approach a nesting turtle in order to tag and measure it. The protocol includes approaching the turtle from behind to assess the stage of nesting procedure (e.g., excavating egg chamber, egg-laying, covering, camouflaging). During or just after the egg-laying process, volunteers examine the turtle's flippers for old tags or tagging scars and take carapace measurements. All tagged turtles are assigned a unique ID, usually the initial applied tag code, and all subsequently applied tags are related to this ID. In the course of these tasks, volunteers in Zakynthos observed that occasionally eggs were not actually laid although the turtle had opened the egg-chamber and accomplished the stereotype egg-laying movements (see Miller 1997. *In* Lutz and Musick [eds.], *The Biology of Sea Turtles*, pp. 51–82. CRC Press, Boca Raton, Florida). Regrettably, recording of this behavior was not required by the program protocol, and such incidents were noted at the discretion of the observer in the "Remarks" section of the standard data sheets.

I collected information on pseudo-nestings by examining the original data sheets for the 38-yr period from 1982–2019 to locate observers' remarks of such behavior. In case of a pseudo-nesting, I searched also the dates of the previous and subsequent appearances of the particular turtle in the same season, with the help of the electronic database in which the tagging data were stored. For the analysis, I used only the turtles' appearances within a window of 16 d before and after the pseudo-nest date. I chose 16 d because >90% of the inter-nesting intervals (i.e., the period between two successive nestings) range between 10 and

CARETTA CARETTA (Loggerhead Sea Turtle). PSEUDO-NESTING. Pseudo-nesting in sea turtles is defined as the otherwise complete nesting procedure, without the deposition of eggs (Swaminathan and John 2011. *Herpetol. Notes* 4:225–227). That

Turtle ID	Days before pseudo-nesting																Date of pseudo-nesting	Days after pseudo-nesting															
	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Z638																	23 June 1983																
Z338																	17 June 1986																
H3053																	26 June 1987																
T2676																	1 July 1987																
A006																	2 July 1989																
E4296																	16 July 1990																
H3053																	10 June 2002																
C6727																	25 June 2004																
H3053																	16 June 2005																
R9510																	9 July 2011																
ZA255																	17 June 2009																
M8060																	17 June 2019																

FIG. 1. Twelve cases of pseudo-nestings in *Caretta caretta* at Zakynthos Island, Greece, showing nesting appearances before and after the pseudo-nesting event. Black = egg-laying event; red = non-nesting emergence. One individual (H3053) made four pseudo-nests, two of them in the same season.

16 d for *C. caretta* in the Mediterranean (Broderick et al. 2002. *Oryx* 36:227–237).

I found 37 cases of pseudo-nesting behavior, accomplished by 32 different individual turtles; one turtle (ID: H3053) made four pseudo-nests (two of them in the same season) and two turtles (Z866, N5269) made two pseudo-nests each in different seasons. Of the 37 cases, 16 pseudo-nests were made by turtles that appeared once during the season and the remaining 21 pseudo-nests were made by 19 different turtles with multiple in-season appearances. Analyzing the latter group, and taking into account only the turtles that were observed within the 16-d window before and after the date of the pseudo-nest, I identified 12 cases that can possibly assist in elucidating the phenomenon of pseudo-nesting (Fig. 1). Examining the graph and having in mind the limitations of non-saturation tagging (which predisposes missed nestings), I concluded that most pseudo-nestings occurred within 1–3 d after a nesting (or non-nesting) emergence. In contrast, no nesting activity was observed, following a pseudo-nest, before the lower limit of the inter-nesting interval (10 d; Broderick et al. 2002, *op. cit.*). The four turtles without a nesting activity prior to their pseudo-nesting (A006, E4296, R9510, and M8060) may be an artifact as their prior nestings could have been missed by the observers. Indeed, assuming that these turtles had nested one to two days before their pseudo-nesting, their next nesting falls within the range of the inter-nesting interval (10–16 d; Broderick et al. 2000, *op. cit.*) (Fig. 1).

The reasons of pseudo-nesting are not known. Swaminathan and John (2011, *op. cit.*) provide as possible cause, in *Lepidochelys olivacea*, the satiation of predators during arribadas. However, this explanation cannot hold for Zakynthos where egg predation is negligible. Male adult sea turtles, distinguished by their long tails, were observed to emerge on nesting beaches and make the stereotyped movements of nesting procedure (Troëng 2000. *Chelonian Conserv. Biol.* 3:749–750; Zarate Bustamante 2006. *Herpetol. Rev.* 37:340–341; Limpus et al. 2009. *Chelonian Conserv. Biol.* 8:102–105). However, in Zakynthos none of the 32 pseudo-nested turtles had a long tail and all of the selected 12 cases were observed laying eggs in at least one of their appearances. Further, Swaminathan and John (2011, *op. cit.*) wonder whether pseudo-nesting turtles contained oviductal eggs. At Zakynthos the distribution of actual nests before and after a pseudo-nest (see Fig. 1) appears to coincide with the absence of oviductal eggs during pseudo-nesting.

It is known that several hormones trigger the reproduction stages of sea turtles, from ovulation to their return to sea (Guilette et al. 1991. *Gen. Comp. Endocrinol.* 82:121–130; Whittier et al. 1997. *Gen. Comp. Endocrinol.* 106:39–47). The fact that most pseudo-nests were made after an actual nesting provides evidence that pseudo-nesting may be caused by an inherent anomaly of reproductive hormones that continue to trigger a nesting behavior, although the oviducts have been emptied. The turtle H3053 that showed repeatedly pseudo-nesting behavior in the same and in different seasons (Fig. 1) probably had a major hormonal disruption. The presented results are only an attempt to contribute to the limited knowledge of pseudo-nesting behavior in sea turtles. Additional data using ultrasound scans and hormonal status through blood analyses could assist further in elucidating the phenomenon.

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