ARTICLES

Selecting the Wrong Beach to Start Monitoring on Crete: An Historic Failure

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Loggerhead turtle nesting in Greece was first discovered in Zakynthos (1977; Margaritoulis 1982) and later (1981) in the nearby Kyparissia Bay (Margaritoulis & Rees 2001), about 80 km from Zakynthos. Both areas showed remarkable nesting and later proved to be the largest nesting aggregations of *Caretta caretta* in the Mediterranean (Casale et al. 2018). In view of the protective measures that the Greek State had to take for these important rookeries, it was imperative to examine also other coastal areas whether they were supporting turtle nesting. One such area was thought to be the Island of Crete, as it is located in southern latitudes and features many and –at the time- mostly undeveloped beaches, especially along its southern shores. In late June 1982, while employed at the Ministry of the Environment, I undertook (with my wife Anna) a 10-day survey at the southern coast of Crete concentrating mostly at remote beaches. We arrived by ferry boat at the town of Iraklion and driving our Citroen 2CV to Agios Nikolaos, the easternmost large town of Crete, we reached the southern coast at Ierapetra (Fig. 1). Then following rough roads and trails to circumvent the many difficult (and dangerous) gorges we managed to reach several remote beaches where we recorded sparse turtle nesting on some of them (Fig. 2). Surprisingly, we found no tracks along the almost deserted beach of Kommos, at the southern part of Messaras Bay, which tempted us not to survey the remaining part of the bay. So, we continued checking remote beaches westwards until Plakias from where we drove to the town of Rethymno at the northern coast (Fig. 1). We did not have enough time to survey the Rethymno beach but a quick look from the town's eastern edge to the many hotels lined up along the beach prejudiced us that nesting there should be precluded. Next day we departed for the town of Chania where we had to take the evening ferry to Piraeus. On our way to Chania we noticed along the road an extensive beach, which seemed devoid of any remarkable development. We stopped at the small harbour of Georgioupolis village, at the western end of the beach (Fig. 1), and talked to fishermen. One of them, Giorgos Kordatzakis, told us that sea turtles do nest along Georgioupolis beach. We noted down his remark and not having time for anything else we departed for Chania.

The pressing needs of the Ministry to protect the nesting beaches of Zakynthos, prompted also from the intense international pressures, did not allow any further work on Crete. Nevertheless, the foundation of ARCHELON (then The Sea Turtle Protection Society of Greece) in 1983 and its blossoming in subsequent years (Rees 2005) tempted the undertaking of more systematic work on Crete. A promising site for this

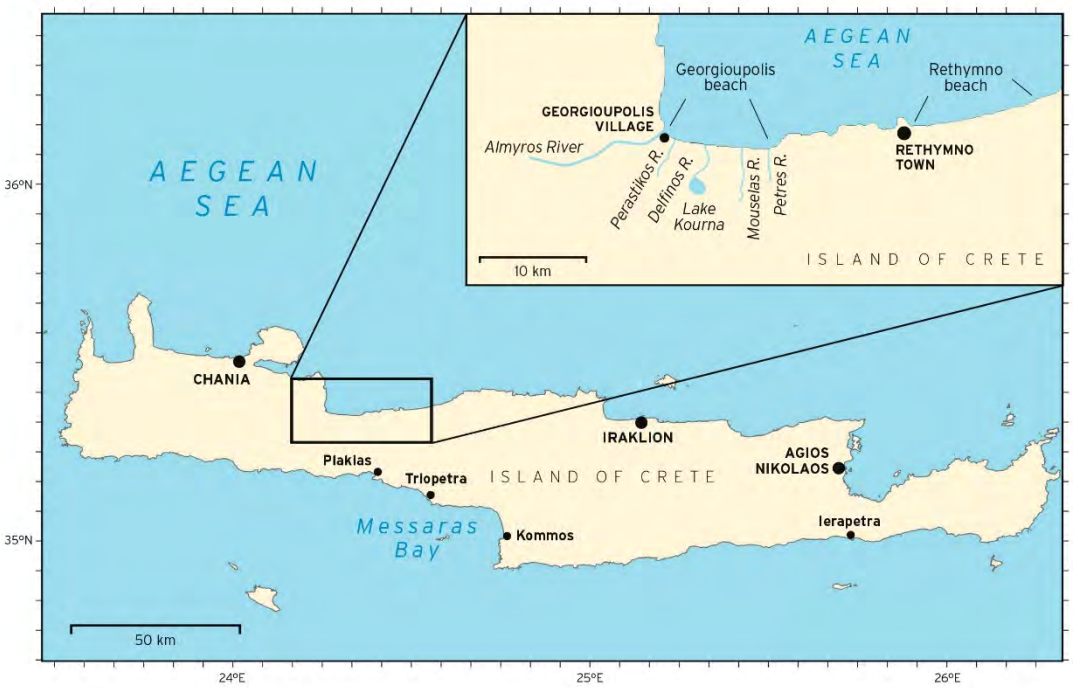

Figure 1. Sketch map of Crete showing localities mentioned in the text. The inset map shows the area around Georgioupolis and the nearby Rethymno beach.

would be Georgioupolis beach which had easy and safe access, with a village nearby, and work there would be within our small budget. Another reason for selecting Georgioupolis was the information that there were plans for the development of the area, which plans could be thwarted if the beach proved to host remarkable nesting.

The 9.5 km Georgioupolis beach, between the towns of Rethymno and Chania (approx. middle of beach: 35.353°N, 24.312° E) (Fig. 1), is backed in places by low sand dunes. Its width shows a great variation, from a few meters up to 100 m (Fig. 3). A river (Almyros River) flows at the beach's western end by the Georgioupolis village, with its estuary used for harbouring local boats (Fig. 4). Besides the river, four smaller streams flow into the sea cutting through the beach (Fig. 5) with one of them originating from a fresh-water lake (Lake Kourna) about 2.5 km behind the beach (Fig. 1). The lake at an altitude of about 22 m above sea level has a maximum depth of 25 m, hence the lake's bottom is below sea level (Tigilis 2007). Many species of aquatic fauna such as moorhens, ducks, herons, cormorants, eels, water snakes and terrapins are found in and around the lake (Kitching et al. 1976).

Georgioupolis beach faces to the north and receives heavy surf, especially in August when northern winds (meltemia) predominate in the Aegean Sea. The sea bottom, adjacent to the beach, has a mild inclination and is generally sandy with occasional reefs.

The national road passes behind the beach, at distances of 80-300 m from the water, providing easy access to the beach at various points. In the 1980's, there were only a few small hotels between the road and the beach, mostly located close to the village.

Following ARCHELON's field methodologies, tested in Zakynthos and Kyparissia Bay, we set up a small team of students that camped under the trees at the back of the beach and

Figure 2. A remote beach (Triopetra) on the southern coast of Crete exhibiting sparse nesting.

divided the beach in sectors to facilitate the monitoring work. Beach surveys, carried out on foot, started on 11 June and lasted until 4 August 1985. Nesting spoors were checked for eggs by hand excavation and in case of a nest this was marked with a bamboo stick and a hidden marked stone at a predetermined direction and distance from nest. No nest-protection measures were taken as no signs of egg predation or other apparent threats were noted. All nests were regularly monitored until the end of fieldwork (4 August), and the nests' markings (apparent and hidden) were checked and, if disturbed by weather or people, were restored.

At the first survey of 11 June no previous turtle tracks were found. First tracks were observed on 13 June, the first nest on 22 June and the last nest on 24 July. In total, 21 emergences were counted, of which 6 resulted in egg-laying (nesting success: 29%; nesting density: 0.7 nests/km). Most nests were concentrated at the eastern part of the beach, away from the village. Nest distances from the sea averaged 33.4 m (range: 14-50 m).

In a subsequent visit on 7 October 1985 only two nests were found, the other four being lost due apparently to the predominant strong winds in August. Excavation of these two nests, and counting of their contents, showed that one nest (laid on 6 July) had hatched successfully (clutch size: 133 eggs, hatching success: 82.7%, hatchling emergence success: 78.9%, in-nest hatchling mortality: 3.8%), while the other nest (laid on 23 July) contained 52 unhatched eggs.

The relatively low nesting level at Georgioupolis did not encourage continuation of the project in subsequent seasons. However, the beach was included in the rapid assessment study that covered almost the entire island of Crete in the period 1990-91 (Margaritoulis et al. 1995). In the course of this study, Georgioupolis beach was surveyed again in 1990 and 9 nests were recorded. This second survey decreased the probability of any erroneous conclusion caused from asynchronous

fluctuations of nest numbers resulting from different nesting cohorts (Limpus & Limpus 2003).

It is interesting to note that during scouting trips on Crete in 1989, to organize the rapid assessment study of 1990-91, a remarkable nesting activity was discovered at Rethymno, about 20 km east of Georgioupolis (Fig. 1). As a result, Rethymno beach (10.8 km beach length suitable for nesting) was included in the long-term monitoring program of ARCHELON and started to be systematically monitored in 1990. Monitoring results over the 15-year period (1990-2004) showed an average nesting level of 349.7 nests/year (range: 248-516) and an average nesting density of 32.4 nests/km (range: 23.0-47.8) (Margaritoulis et al. 2009), characterizing Rethymno as a "major" nesting area in Greece (*senso* Margaritoulis 2000) and as a beach of "very high" nesting activity in the Mediterranean (*senso* Casale et al. 2018).

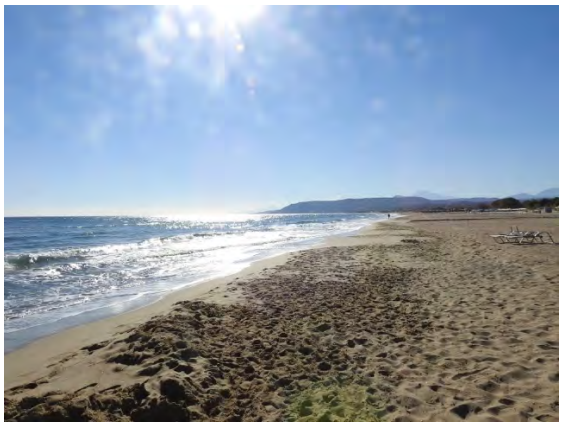

Figure 3. A general view of the 9.5 km Georgioupolis beach, from west towards the east.

Regrettably, Rethymno beach was not visited in the initial 10-day survey of June 1982, due to the mentioned above trivial circumstances. This unfortunate oversight apparently resulted that the much-needed conservation actions at Rethymno were delayed for several years, when coastal constructions and tourism activities had occupied a large part of Rethymno beach.

Today it is known that moderate or low nesting levels are not always easy to assess through snapshot surveys but need more systematic work to unveil their full potential. Examples are found in the Calabrian coast (Mingozzi et al. 2007) as well as in Sicily (Prato et al. 2022). This may explain the absence of nests, during the June 1982 survey, in Kommos beach of Messaras Bay, which today is a significant nesting area in southern Crete.

But why turtles did not nest in Georgioupolis in comparable numbers to the nearby Rethymno beach, particularly in view of the much lower disturbances in Georgioupolis? Discussions with locals gave the "explanation" that the sea water of Georgioupolis is "cooled" by the river and the streams, famed for their exceptionally cold water. Indeed, the 1985 field researchers had told me that it was very "unpleasant" to cross barefoot the streams due to their low temperature. Although I confirmed this myself, by crossing the streams, I could not find any objective temperature data in the literature or in the internet. It is known though that low water temperatures at the proximity of a sea turtle nesting area do not assist ripening of eggs and generally discourage nesting (Schofield et al. 2009; Panagopoulou et al. 2011).

Differentiations of nesting densities along the same or neighbouring beaches is a widespread phenomenon globally (e.g., Caldwell et al. 1959; Shoop et al. 1985; Türkozan 2000). Although it is not always clear why some beaches are used for nesting and others not (Miller et al. 2003) there is a

Figure 4. The estuary of Almyros River, by the village of Georgioupolis, used as a harbour for small local boats.

plethora of abiotic and biotic factors that play some role in nest site selection (Mortimer 1995; Mazaris et al. 2006). At population level other factors, away from nesting beach (e.g., surface currents), may favour or not specific nesting areas (Carr 1987; Bolten 2003). Besides the low sea water temperature at the proximity of the nesting area (Schofield et al. 2009), other reasons that may discourage nesting could be the harvest of nesting females (Munoz et al. 1989), the change of the offshore surface currents transporting hatchlings to nursery habitats (Musick & Limpus 1997), and the change of sand temperature regimes (Ackerman 1997).

Figure 5. One of the cold-water streams flowing into the sea at Georgioupolis beach.

Despite our failure to select for systematic monitoring a more appropriate beach on Crete, the work done in Georgioupolis was not in vain. Our meagre nesting data were taken into account, by the Ministry of the Environment, in the planning of a Housing Control Zone (issued in 1990) for the wider area that regulated building and tourism development, and later (1995) in the establishment of a NATURA 2000 site (GR4340010 - DRAPANO (VOREIOANATOLIKES AKTES) – PARALIA GEORGIOUPOLIS – LIMNI KOURNA – SPILAIO PSIMAKI) that contains Georgioupolis beach, Lake Kourna and a wide part of the surrounding area.

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