



Patterns and intensity of ghost crab predation on the nests of an important endangered loggerhead turtle population



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ABSTRACT

Predation is one of the most important threats to the early life stages of most endangered vertebrates. On small oceanic islands that host very important endangered sea turtle rookeries, ghost crabs are the main nest predators. Mortality in nests was evaluated on the island of Boa Vista which hosts around 75% of the nests in the Cape Verde archipelago, which is one of the world's largest loggerhead turtle (*Caretta caretta*) rookeries. In an extensive survey of the island, egg mortality significantly varied between beaches and averaged 70%. One of the main causes of egg mortality was predation by ghost crabs (*Ocypode cursor*) that stole an average of 33 eggs per nest. No other egg predator was observed during the study. In an intensive field experiment, the egg mortality for non-protected nests was 82% and ghost crabs predated an average of 50% of the total number of eggs. Even though female tracks on the beach are very conspicuous immediately after egg laying, very few nests were predated during this period. In contrast, most of the nests were predated at the end of the incubation period (after day 40 of incubation), when female tracks are not visible on the beach. Nests predated by larger crabs suffered a lower predation rate, suggesting that these larger dominant crabs defend the nest they prey upon. On-beach nest relocation had no significant influence on reducing egg predation. Females preferred nesting on beaches with higher hatching success although predation was not a risk that they seemed able to assess.

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1. Introduction

Many sea turtle populations are facing extinction and one of their main natural threats is nest predation. Opportunistic predators can easily consume the majority of sea turtle eggs every nesting season (Barton and Roth, 2008; Leighton et al., 2010). Sea turtles are known for coming to shore and laying their eggs on sandy beaches. Females dig nest chambers on the beach, and after oviposition they cover their eggs, camouflage the nest site and return to the ocean. During incubation, eggs are exposed to several threats that can cause a significant embryo mortality (Ditmer and Stapleton, 2012) such as beach flooding or erosion (Van Houtan and Bass, 2007; Wood et al., 2000), infections produced by microorganisms (Phillott and Parmenter, 2001; Sarmiento-Ramírez et al., 2010), poaching (Frazier, 1980; Hope, 2002), natural predation (Dodd, 1988; Donlan et al., 2004; Fowler, 1979) and even expected redundant impacts by off-road vehicles (ORVs) on sandy beaches (Schlacher et al., 2008). Carnivore mammals are considered the most important turtle nest predators (Ratnaswamy and Warren, 1998), and the regulation of

mammalian carnivores (e.g. raccoon *Procyon lotor* in Florida, USA) to reduce nest predation is a common practice (Barton and Roth, 2007; Pennisi, 2006). However, these mammalian carnivores also predate on ghost crabs (Mendonça et al., 2010) which are considered the second most important nest predator on many nesting beaches (Le Buff, 1990; Thompson, 1995; Trocini et al., 2009; Witherington, 1999). The reduction or absence of carnivore mammals seems to cause a significant increase in ghost crab abundance which leads to an overall increase on turtle nest predation (Barton and Roth, 2008; Brown, 2009; Pennisi, 2006).

Ghost crabs (*Ocypode* spp.) are the largest and most conspicuous invertebrates found in all tropical and semitropical 'ocean-exposed' sandy beaches around the world. Functionally they are the main bioturbators of beaches and form a key ecological link in the food webs of these ecosystems (Lucrezi and Schlacher, 2014). They have a planktonic larval stage that at a very small size transforms into a terrestrial animal that will live the rest of its life on the beach (Diaz and Costlow, 1972). *Ocypode* crabs are the fastest crustaceans on land and have acute senses of sight, smell, and hearing (Lucrezi and Schlacher, 2014). They dig deep, complex and sometimes voluminous sand burrows in the intertidal zone of closed beach areas where they remain during the warmer hours of the day, and show a crepuscular and nocturnal activity (Schuchman and Warburg, 1978). The main reason for this terrestrial

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behavior is their need to maintaining a high level of humidity on their gills so that they can breathe (Warburg and Shuchman, 1979; Weinstein et al., 1994). At night larger crabs can explore drier beach areas but smaller individuals are obliged to remain closer to the water. They are very sensitive to the trampling and compaction of the sand by humans and are considered a good bio-indicator of beach quality use (Lucrezi and Schlacher, 2010; Schlacher et al., 2011).

Several ghost crab species with a very wide geographical distribution, and with similar morphology and ecology, have been identified. They display extraordinary trophic plasticity, occupying several trophic role levels (e.g. scavengers), obtaining food through a variety of strategies, and consuming a wide diversity of prey (Lucrezi and Schlacher, 2014). Even though several studies are based on the predation of ghost crabs on turtle nests, overall there is little information about the pattern and behavior of these decapods when predated the nests. Lucrezi and Schlacher (2014) summarized ghost crab predation rates on sea turtle nests, eggs, and hatchlings (*Ocypode* spp.), although the compiled data is mostly focused on *Ocypode quadrata*, a species from the USA and French Guiana.

Ocypode cursor Linnaeus, 1758 has been found predated turtle nests on the western African coast and the Eastern Mediterranean (Aheto et al., 2011; Smith et al., 1996; Strachan et al., 1999). Former studies on the dispersal, population structure and burrow shape of *O. cursor* in northern Israel were conducted by Schuchman and Warburg (1978). Recently, a preliminar investigation was conducted on the species on the volcanic islands of Cape Verde (tropical Eastern Atlantic, Fig. 1) focused on population density and the spatial distribution of burrows (Rodrigues, 2012), and/or essays on the turtle nest detection behavior that those crabs presented (Frederico, 2013). This species is very abundant and predated loggerhead turtle (*Caretta caretta*) nests in Cape Verde, where no native or introduced carnivore mammal species is present. The island of Boa Vista (archipelago of Cape Verde) hosts the

biggest loggerhead rookery in the Eastern Atlantic (Marco et al., 2012), and ghost crabs are the only relevant predators of turtle nests there (Marco et al., 2011; Varo-Cruz et al., 2005). This rookery is reproductively isolated from the other Atlantic populations (Monzón-Argüello et al., 2010), having exclusive mitochondrial DNA haplotypes, which suggests that this isolation occurred a long time ago. The population has recently been considered the most endangered loggerhead population in the Atlantic and one of the most endangered sea turtle populations in the world (Wallace et al., 2011). Boa Vista, the easternmost and third largest island (620 km²) in the archipelago of Cape Verde, has volcanic products, minor intrusions and a thin partial sedimentary cover (Dyhr and Holm, 2010) where white sandy beaches are common and calculated to comprise around 46% of the total island coastline, estimated on 160 km (Almeida et al., 2012). The scarce human presence on many isolated beaches seems to be a prolific factor and has favored the existence of a high density of ghost crab populations (Barros, 2001).

The impact of ghost crab predation on nest survival has been assessed. To have knowledge on which areas, when, how and with what frequency ghost crabs attack nests and consume the eggs can provide an interesting insight into this singular predator–prey interaction, as well as provide relevant information to compile a risk assessment of this natural threat on endangered turtle populations. Additionally, the evaluation of management techniques to reduce this natural threat can help to improve the productivity of this population and reduce the risk of these sea turtles, catalogued as endangered, becoming extinct.

2. Materials and methods

Loggerhead turtle nest survival and ghost crab predation were studied during the 2005 season in the Reserva Natural da Tartaruga, the main nesting area on Boa Vista that hosts around 75% of the nests

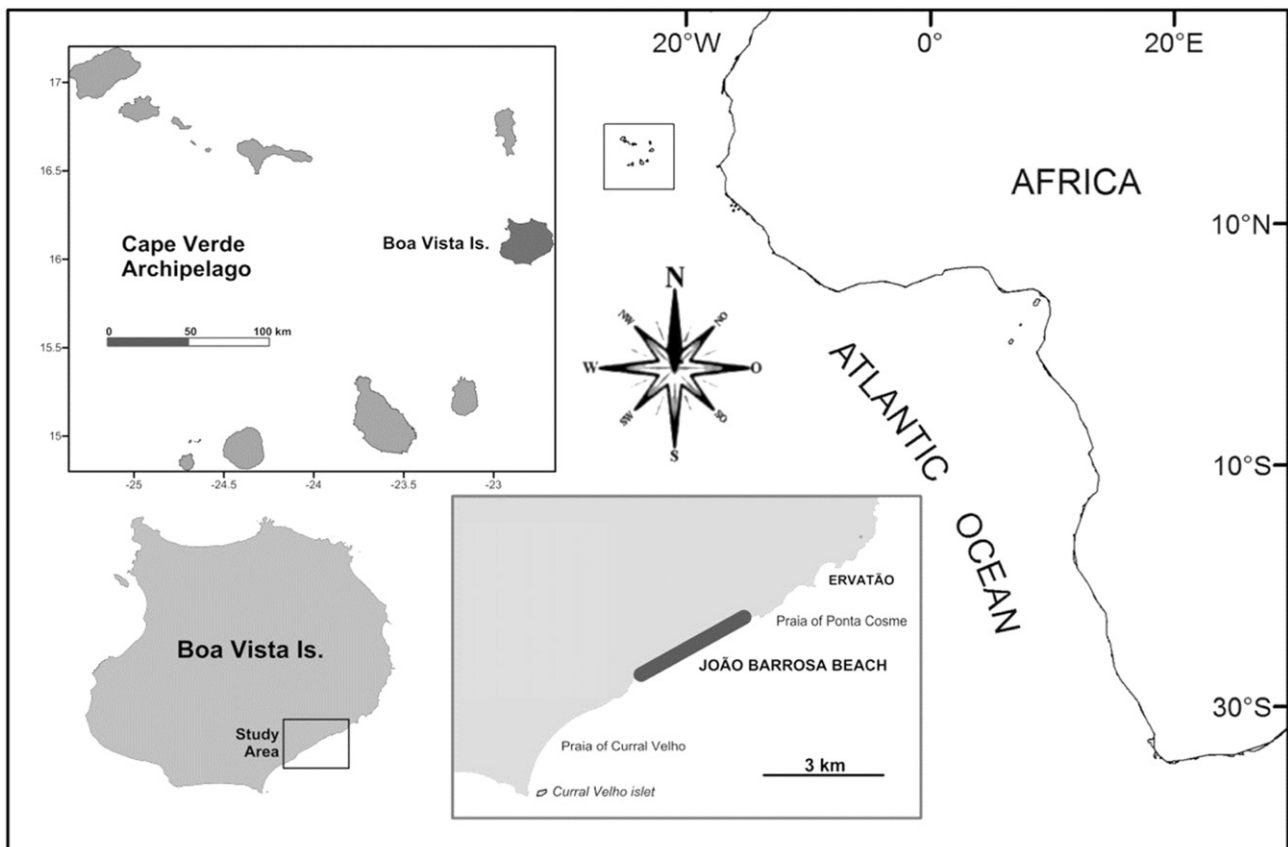


Fig. 1. Maps of Cape Verde, the island of Boa Vista and the study beach of João Barrosa in the southeast of the island.

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