



First video record of mating behavior of the ghost crab *Ocypode quadrata* (Fabricius, 1787) (Crustacea, Decapoda, Ocypodidae)

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Abstract: Information about reproductive behavior is a key aspect of species conservation. Herein we present for the first time a video record of the ghost crab *Ocypode quadrata*'s mating behavior in natural habitat on two sand beaches with contrasting anthropogenic pressures.

Key words: reproductive behavior, copulation, invertebrates, sandy beach, Atlantic Ocean.

Primeiro registro do comportamento reprodutivo do caranguejo-fantasma *Ocypode quadrata* (Fabricius, 1787) (Crustacea, Decapoda, Ocypodidae). **Resumo:** Informações sobre o comportamento reprodutivo são fundamentais para a conservação das espécies. Apresentamos registros de comportamento de acasalamento do caranguejo fantasma *Ocypode quadrata* em duas praias com pressões antrópicas contrastantes.

Palavras-chave: comportamento reprodutivo, cópula, invertebrados, praia arenosa, Oceano Atlântico.

Sandy beaches are the most common coastal environment worldwide, and their role in providing social and economic benefits requires the maintenance of natural habitats and biodiversity conservation (Defeo et al. 2021). Ghost crabs are iconic invertebrates of sandy beaches and serve as a key link in energy transfer across adjacent ecosystems (Rae et al. 2019). Copulation of ghost crabs may occur in burrows, termed 'copulation burrows' (Hughes 1973), or on beach surfaces (Negreiros-Fransozo et al. 2002). Gravid females are recognized by the dark-colored or bright-orange mass of eggs attached to their swimmerets.

Ocypode quadrata (Fabricius, 1787) is the only species of ghost crab found on the east coast of the Americas (Lucrezi & Schlacher, 2014). It has a free-swimming larval phase lasting up to three months (Diaz & Costlow, 1972; Jackson et al., 1991). Although there is a continuous presence of juveniles, recruitment peaks differ between regions, occurring in spring-summer on subtropical beaches (Branco et al., 2010) and in winter-spring on tropical beaches (Oliveira et al., 2016). The species has an estimated lifespan of three to four years (Alberto & Fontoura, 1999; Oliveira et al., 2016). Gravid females are usually found in small numbers on the beach surface and likely remain inside their burrows

throughout most of the development phase, leaving only to release eggs (Negreiros-Fransozo et al., 2002).

The decline of *O. quadrata* populations related to habitat degradation has been widely documented from local to large spatial scales, mainly along the Brazilian coast (Barboza et al., 2021). Although the species is the most studied invertebrate on sandy beaches, basic information regarding reproductive biology, such as mating behavior in the natural environment, remains unknown. Hartnoll (1969) described mating behavior for Brachyura, including some Ocypodidae species; however, mating behavior of *O. quadrata* has only been recorded under laboratory conditions (Hughes, 1973). To the best of our knowledge, we present herein the first report of *O. quadrata*'s mating behavior in its natural environment.

The mating behaviors were observed on two sandy beaches in northern Rio de Janeiro, Brazil. The first record occurred at Cavaleiros Beach (22°24'24"S; 41°48'1"W) beginning at 9:55 PM on October 26th, 2022 (Fig. 1D, E; video available as electronic supplement <https://youtu.be/lT9lXXHilk>). This beach is intermediate-reflective with a moderate slope and serves as the primary tourist destination for beachgoers in Macaé City. The

natural vegetation has been suppressed by coastal armoring, and the beach is exposed to litter pollution, artificial lighting, and human trampling. The second mating behavior record was made at 9:03 PM on February 15th, 2023 (Figure 1C; video in Supplementary Material) at the Restinga de Jurubatiba National Park (RJNP, 22°17'56.01"S; 41°41'16.20"W, Figure 1B). This beach is reflective, with an accentuated slope, and is located within a marine protected area that encompasses about 44 km of preserved sandy beaches.

Mating records (Figure 1C, E) were obtained at the intertidal zone of sandy beaches at night. At first, we observed the couple of ghost crabs together and motionless. In both events, the male was on top, and the female was upside down, with their ventral regions touching each other and with their pleons unfolding. The males' claws and legs were grabbing the females'. The couples performed short synchronous movements. The females kept their eyes lowered into their sockets during the beginning of the sighting, while the males kept his eyes raised. Also, during observation, the couple performed short synchronous movements on the sand but grabbed each other. Based on the observation of both events, we were able to identify successive stages of the mating behavior described by Hughes (1973): the

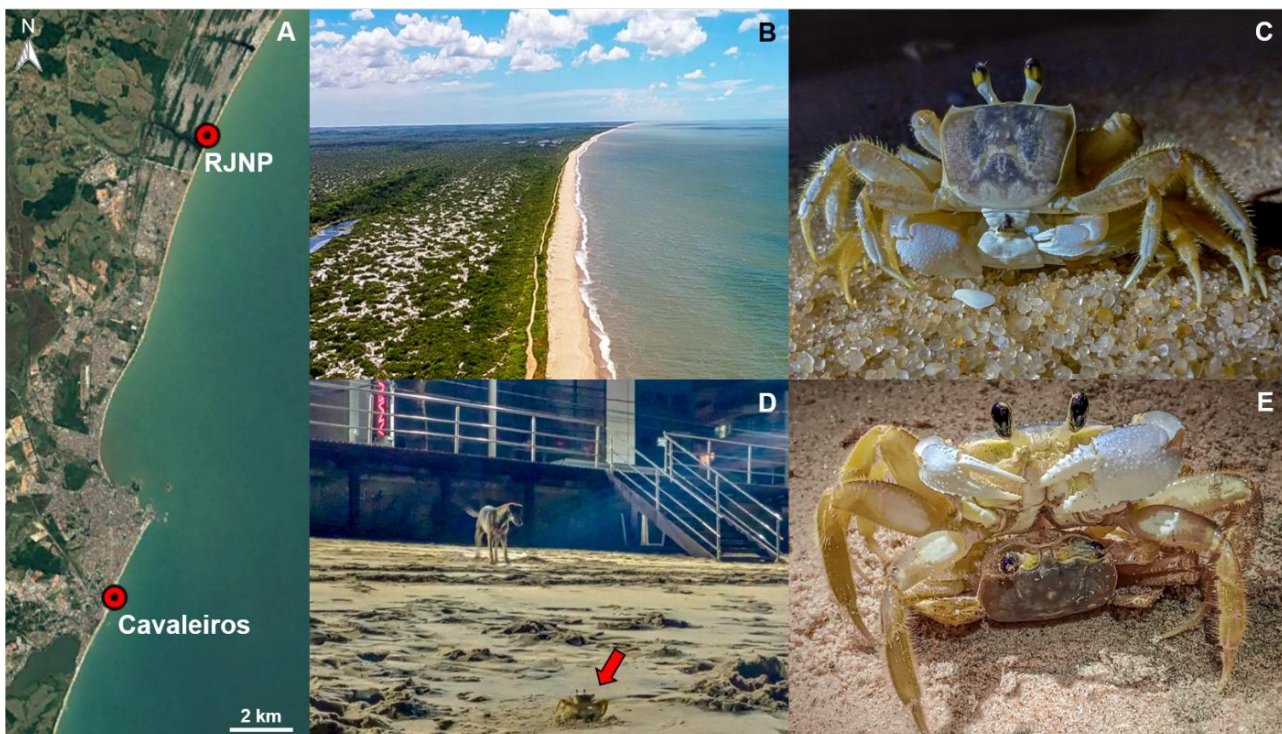


Figure 1. (A) Restinga de Jurubatiba National Park - RJNP and Cavaleiros Beach; (B) RJNP; (C) Back view of mating at RJNP; (D) Cavaleiros Beach, the red arrow indicates the crabs during mating. Detail of interaction between dog and ghost crabs (E) Frontal view of mating at Cavaleiros Beach.

male positions on top and the female positions upside down, with their ventral regions in contact and with their pleons unfolded; the male bends the body backward towards the female and, together, they perform short movements still grabbed to each other (video in Supplementary Material). This "mating entanglement" lasted about 15 minutes in both events, until the male left the position.

Our reports on natural habitats are similar to the behaviors described in detail by Hughes (1973), at the third and last stages of mating. This suggests that mating behavior can be successfully studied under laboratory conditions during manipulative experiments. Besides describing mating behavior in natural habitats for the first time, these records were registered on sandy beaches with contrasting anthropogenic pressures, showing that even at impacted beaches local population potentially contributes to larval exportation. Urbanized beaches are more exposed to anthropic disturbances such as the presence of domestic dogs that potentially disrupt natural processes (Maslo *et al.*, 2022). In our record, the dog depicted in Figure 1D attempted to interrupt the mating by approaching the individuals, but was promptly prevented from doing so. Therefore, identification of aspects of reproduction on beaches with different modifications of the natural habitat brings to light the need for studies about reproductive behavior, and the potential influence of anthropogenic pressure on urbanized beaches.

Ethical statement

Collection of crabs and biological samples were conducted following all applicable ethical regulations regarding collection of biological samples and experimentation with animals. Investigation was performed under permit 81381-1 issued by ICMBio/MMA – Brazilian Ministry of the Environment, through the SISBIO system.

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