

On a trip to the mainland: occasional records of the rocky crab *Grapsus grapsus* (Linnaeus, 1758) (Decapoda: Grapsidae) on the Brazilian coast

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ABSTRACT

The Sally lightfoot crab, *Grapsus grapsus* (Linnaeus, 1758), is distributed along the Eastern Pacific coast and along the Western Atlantic coast, from the Gulf of Mexico to the Southwestern Atlantic. In Brazil, the only established populations are found on the Brazilian oceanic islands, although two previous records (1901 and 1966) reported the presence of individuals on the continental coast. Here, we report new records of the Sally lightfoot crab on the coast of the states of Espírito Santo and Rio Grande do Norte, southeastern and northeastern Brazil, respectively. We also discuss three main hypotheses that could explain occasional records (1901, 1966, 2005, and 2020) of single individuals on the mainland: rafting events associated with flotsam and debris carried by oceanic currents; hitchhiking on vessels and fishing boats navigating routes from the Brazilian oceanic islands to the mainland; and stochastic settlement through larval dispersal.

KEYWORDS

Hitchhiking, larval dispersal, oceanic islands, rafting, Southwestern Atlantic

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The Sally lightfoot crab *Grapsus grapsus* (Linnaeus, 1758) is distributed along the Eastern Pacific, from Baja California to northern Chile, including the Galapagos Islands, and through the Western Atlantic, from the Gulf of Mexico to the Southwestern Atlantic (Teschima *et al.*, 2016) (Fig. 1A). In Brazil, established populations of the Sally lightfoot crab are found mainly in the intertidal rocky shores of the four oceanic islands: St Peter and St Paul Archipelago, Fernando de Noronha Archipelago, Rocas Atoll, and Trindade and Martim Vaz insular complex (Freire *et al.*, 2011; Teschima *et al.*, 2016). In addition to these insular populations, single individuals were previously reported on the Brazilian continental coast by Moreira (1901), who mentioned the presence of the Sally lightfoot crab in the state of Pernambuco, but without a specific location, and by Fausto Filho (1966) — one female collected at Mucuripe beach, state of Ceará, northeastern Brazil, in 1965 (Fig. 1B). Due to these records, Melo (1996) described its distribution throughout the Brazilian coast up to the

state of Espírito Santo ($\sim 20^\circ\text{S}$), which is the Trindade Island latitude. However, no established population of the Sally lightfoot crab was confirmed on the Brazilian coast to date, and records from the coast are restricted to single individuals observed at random sites. Here, we report two new records of individuals of the Sally lightfoot crab found in the northeastern and southeastern coasts of Brazil (Fig. 1B).

In 2005, an adult individual of the Sally lightfoot crab, about 7 cm carapace width, was seen at least on five occasions at Ilha dos Franceses ($20^\circ 55' 36''\text{S}$ $40^\circ 45' 15''\text{W}$) (Fig. 1C) — a small island located five kilometres off the coast of Espírito Santo (ES), southeastern Brazil — by a group of researchers from the Federal University of Espírito Santo during fieldwork. The specimen, which is here proposed to be the same individual due to its size and color pattern, was recorded between April and October in a small region of the exposed side of the rocky shore, near large crevices and mussel (*Perna perna* (Linnaeus, 1758)) patches.

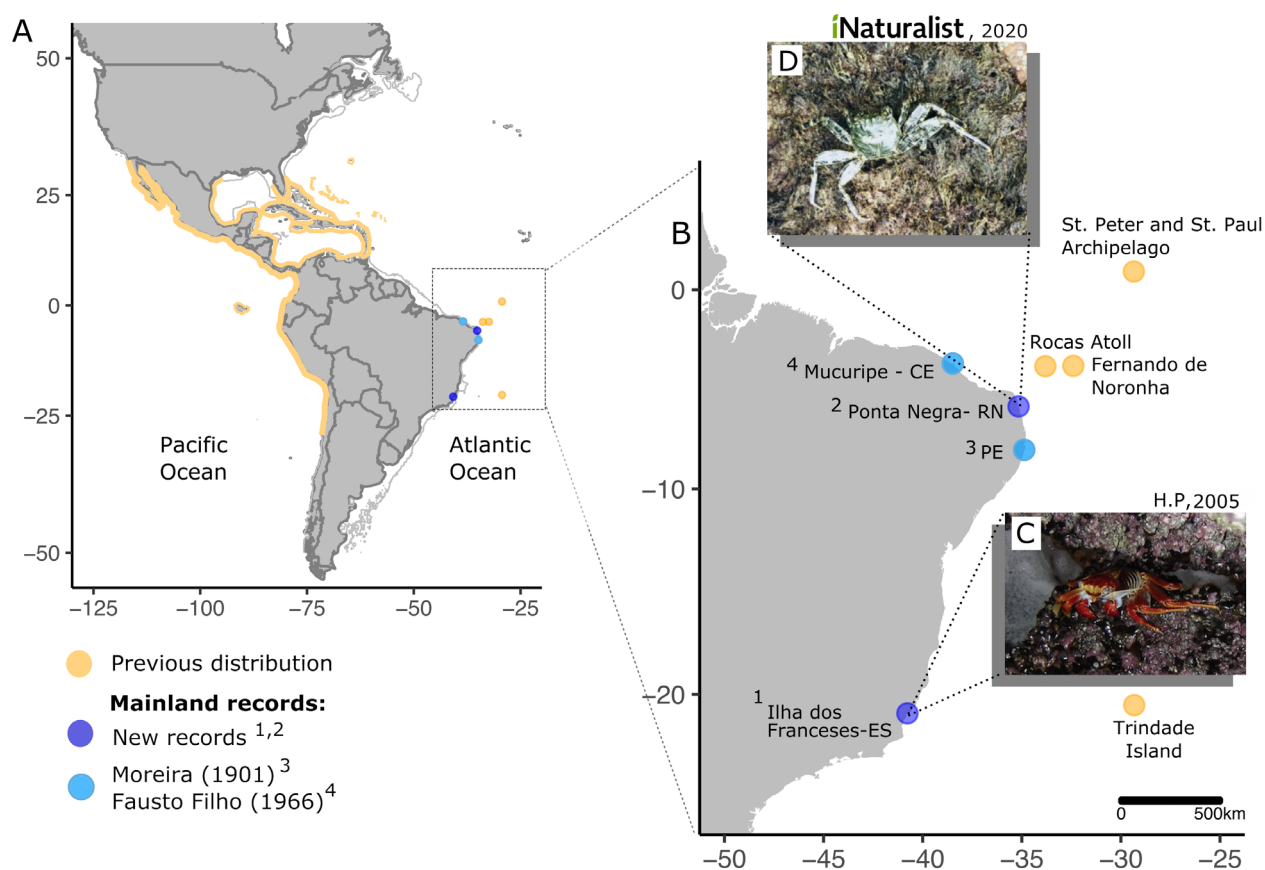


Figure 1. Geographic distribution of *Grapsus grapsus*. Locations of the mainland records: Fausto Filho (1966), Moreira (1901) (A) and new records (B). Photographs of the adult individual recorded at Ilha dos Franceses, state of Espírito Santo, Brazil (C) and the juvenile individual recorded at Natal, state of Rio Grande do Norte, Brazil (D). Images by: Hudson Pinheiro (C) and Juliana Lins (D).

The second record was based on a single individual on a rocky shore of Ponta Negra beach (5°52'59"S 35°09'50"W) (Fig. 1D), state of Rio Grande do Norte, northeastern Brazil. The morphological features and the obvious green color are typical of a juvenile crab (Freire *et al.*, 2011). This record was posted to the nature observation website iNaturalist on 14 February 2020 (<https://www.inaturalist.org/observations/38641375>). Citizen science pictures, when properly used, can improve our knowledge about species distributions, population dynamics (Hochachka *et al.*, 2012) and also trigger taxonomic studies (Perger, 2019). Science is getting more inclusive and needs society commitment, which means we must continue to encourage and validate the effort of citizen science naturalists.

Hypotheses associated with these records assume that these individuals found on the Brazilian mainland coast may be hitchhikers that probably came with oceanic flotsam, debris and vessels, or are the result of a stochastic settlement from the larval pool. Other Grapsidae species such as *Planes* spp. and *Pachygrapsus laevimanus* Stimpson, 1858 can disperse both as juveniles and adults while rafting on debris or flotsam carried by large ocean currents (Pfaller *et al.*, 2019). Rafting ability has been pointed out as an important characteristic for fishes to cross biogeographic barriers and to inhabit Brazilian oceanic islands (Luiz *et al.*, 2012; Pinheiro *et al.*, 2018), and it is also an important feature for transportation of peracarid crustaceans, especially on biotic substrates such as macroalgae, which provide food and shelter during their journey (Thiel, 2003). The ocean current system of the South Atlantic (Stramma and England, 1999) allows for the transport of material from the islands of St Peter and St Paul, Rocas Atoll, and Fernando de Noronha towards the Brazilian coast, both in the northwards direction, following the North Brazilian Current and in the southwards direction with the Brazilian Current. *Grapsus* spp. are active crabs, with strong prehensile legs, and are capable of immersion in sea water, enabling arrival at sites by rafting (Hartnoll, 2011). Successful rafting events are rare and are dependent on unpredictable conditions, but could explain the occasional arrival of single individuals of the Sally lightfoot crab to the Northeastern Brazilian coast.

Both previous and new records on the mainland are in the routes of fishing boats and vessels sailing to the Brazilian oceanic islands. On Trindade Island, 1,200 km off the coast of the state of Espírito Santo, there is a scientific station and a permanent Brazilian Navy detachment. Supply ships navigate to the island every two months, increasing the chance of transporting insular species to the mainland and vice versa. The city of Natal, where the second record was reported, is also the departure port of both scientific expeditions and fishing boats that work nearby Rocas Atoll and St Peter and St Paul Archipelago, increasing the chances of species transport. In addition to these routes, there is steady round-trip recreational sailing activity to Fernando de Noronha favored by the trade winds.

Stochastic colonization from the oceanic larval pool has been suggested to explain the record of rare marine organisms and established populations in geographically isolated reefs (Mazzei *et al.*, 2019). For many marine organisms, dispersal is not limited and ecological barriers better explain the current distributional patterns of species (Pinheiro *et al.*, 2017). The South Equatorial Current favors larval transportation from the northern Brazilian oceanic islands towards the mainland coast, and could also be an explanation for the occurrence of this occasional record on the northeastern Brazilian coast. Recent sightings of the Sally lightfoot crab show the importance of distinguishing occasional records from established populations when considering species ranges. The increase in sightings on the continental coast may assist in separating colonization events from human induced transport, as mechanisms. Long-term studies that allow monitoring the arrival of the Sally lightfoot crab at these sites are excellent opportunities to study establishment and extinction processes on ecological timescales.

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REFERENCES

- Fausto Filho, J. 1966. Primeira contribuição ao inventário dos crustáceos decápodos marinhos do Nordeste brasileiro. *Arquivos da Estação Biológica Marinha da Universidade Federal do Ceará*, 6: 31–37.
- Freire, A.S.; Pinheiro, M.A.A.; Karam-Silva, H. and Teschima, M.M. 2011. Biology of *Grapsus grapsus* (Linnaeus, 1758) (Brachyura, Grapsidae) in the Saint Peter and Saint Paul Archipelago, Equatorial Atlantic Ocean. *Helgoland Marine Research*, 65: 263–273.
- Hartnoll, R.G. 2011. Ascension Island: contrasting biogeography of land and rock crabs. IX Colloquium Crustacea Mediterranea, Torino, September 2–6, 2008. *Museo Regionale di Scienze Naturali di Torino*, 29: 375–385.
- Hochachka, W.M.; Fink, D.; Hutchinson, R.A.; Sheldon, D.; Wong, W.K. and Kelling, S. 2012. Data-intensive science applied to broad-scale citizen science. *Trends in Ecology & Evolution*, 27: 130–137.
- Linnaeus, C. 1758. *Systema naturae per regna tria naturae, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis*. 10th ed., v. 1. Holmiae, Laurentii Salvii, 824p.
- Luiz, O.J.; Madin, J.S.; Robertson, D.R.; Rocha, L.A.; Wirtz, P. and Floeter, S.R. 2012. Ecological traits influencing range expansion across large oceanic dispersal barriers: insights from tropical Atlantic reef fishes. *Proceedings of the Royal Society B*, 279: 1033–1040.
- Mazzei, E.F.; Pinheiro, H.T.; Morais, R.A.; Floeter, S.R.; Queiroz, L.V. and Ferreira C.E.L. 2019. Parrotfishes of the genus *Scarus* in southwestern Atlantic oceanic reef environments: occasional pulse or initial colonization? *Marine Biodiversity*, 49: 555–561.
- Melo, G.A.S. 1996. Manual de identificação dos Brachyura (caranguejos e siris) do litoral brasileiro. São Paulo, Editora Plêiade, 604p.
- Moreira, C. 1901. Contribuições para o conhecimento da fauna brasileira. Crustáceos do Brasil. *Arquivos do Museu Nacional do Rio de Janeiro*, 11: 1–151.
- Perger, R. 2019. A new species of *Johngarthia* from Clipperton and Socorro Islands in the Eastern Pacific Ocean (Crustacea: Decapoda: Gecarcinidae). *Pacific Science*, 73: 285–304.
- Pfaller, J.B.; Payton, A.C.; Bjorndal, K.A.; Bolten, A.B. and McDaniel, S.F. 2019. Hitchhiking the high seas: Global genomics of rafting crabs. *Ecology and Evolution*, 9: 957–974.
- Pinheiro, H.T.; Bernardi, G.; Simon, T.; Joyeux, J.-C.; Macieira, R.M.; Gasparini, J.L.; Rocha, C. and Rocha, L.A. 2017. Island biogeography of marine organisms. *Nature*, 549: 82–85.
- Pinheiro, H.T.; Rocha, L.A.; Macieira, R.M.; Carvalho-Filho, A.; Anderson, A.B.; Bender, M.G.; Di Dario, F.; Ferreira, C.E.L.; Figueiredo-Filho, J.; Francini-Filho, R.; Gasparini, J.L.; Joyeux, J.C.; Luiz, O.J.; Mincarone, M.M.; Moura, R.L.; Nunes, J.A.C.C.; Quimbayo, J.P.; Rosa, R.S.; Sampaio, C.L.S.; Sazima, I.; Simon, T.; Vila-Nova, D.A. and Floeter, S.R. 2018. South-western Atlantic reef fishes: zoogeographic patterns and ecological drivers reveal a secondary biodiversity center in the Atlantic Ocean. *Diversity and Distributions*, 24: 951–965.
- Stimpson, W. 1858. *Prodromus descriptionis animalium evertibratorum, quae in Expeditione ad Oceanum Pacificum Septentrionalem, a Republica Federata missa, Cadwaladaro Ringgold et Johanne Rodgers Ducibus, observavit et descripsit. Pars V. Crustacea Ocyropodoidea. Proceedings of the Academy of Natural Sciences of Philadelphia*, 10: 93–110.
- Stramma, L. and England, M. 1999. On the water masses and mean circulation of the South Atlantic Ocean. *Journal of Geophysical Research*, 104(C9): 20863–20883.
- Teschima, M.M.; Stroher, P.R.; Firkowski, C.R.; Pie, M.R. and Freire, A.S. 2016. Large-scale connectivity of *Grapsus grapsus* (Decapoda) in the Southwestern Atlantic oceanic islands: integrating genetic and morphometric data. *Marine Ecology*, 37: 1360–1372.
- Thiel, M. 2003. Rafting of benthic macrofauna: important factors determining the temporal succession of the assemblage on detached macroalgae. *Hydrobiologia*, 503: 49–57.