

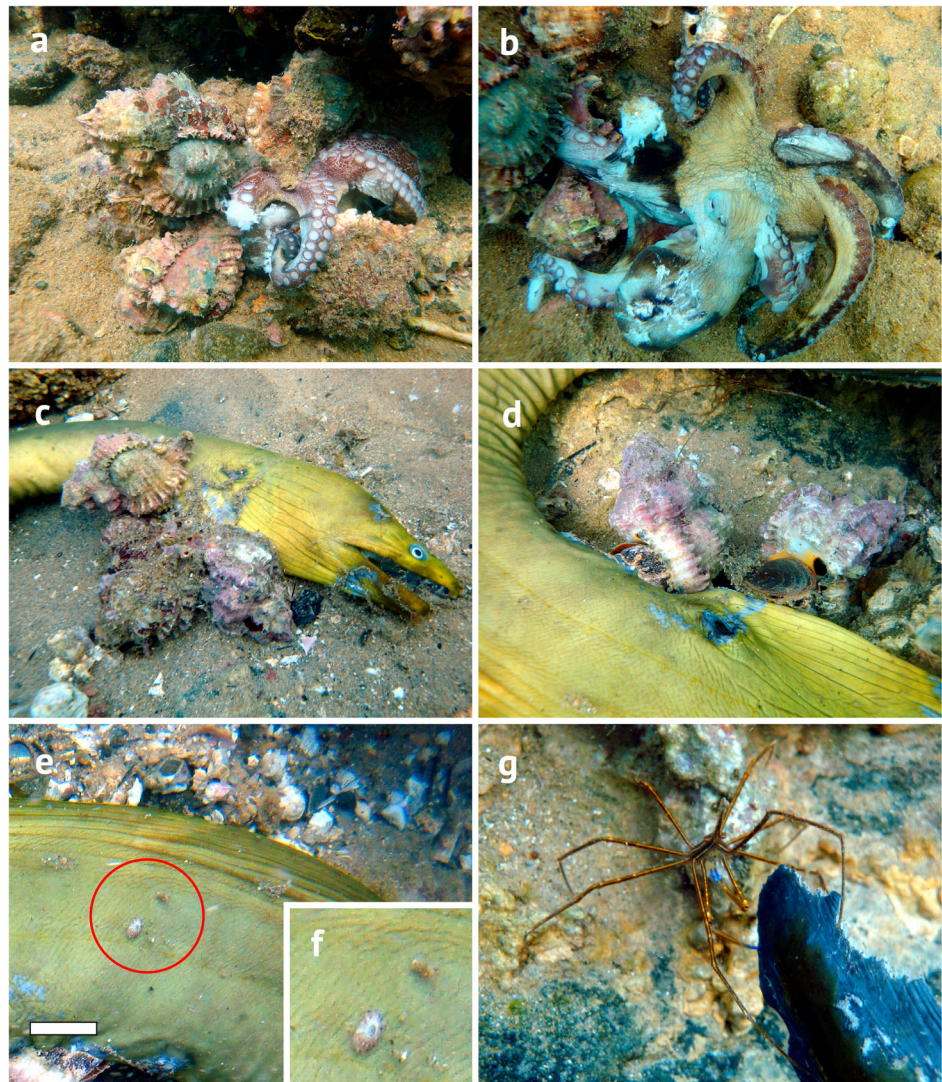


Scavenging behavior by *Phyllonotus oculatus* (Gastropoda: Muricidae) in a South Atlantic reef

G. F. de Carvalho-Souza^{1,2} · E. González-Ortegón¹

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Fig. 1 The oculate apple murex, *Phyllonotus oculatus*, feeding on the carcass of the reef octopus *Octopus insularis* (a, b) and the green moray *Gymnothorax funebris* (c, d). Other scavenger species observed: the gastropods *Fissurella* sp; (f below, left) and *Neritina virginea* (f above, right) (e, f), and the arrow crab *Stenorhynchus seticornis* (g). Scale bar = 5 cm



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✉ G. F. de Carvalho-Souza
gustavofcsouza@gmail.com

✉ E. González-Ortegón
e.gonzalez.ortegon@csic.es

¹ Instituto de Ciencias Marinas de Andalucía (ICMAN-CSIC), Campus Universitario Río San Pedro, 11519, Puerto Real, Cádiz, Spain

² Universidad de Cádiz, Campus de Excelencia Internacional del Mar (CEI-MAR), 11510, Puerto Real, Cádiz, Spain

Scavengers play a key role in nutrient cycling and in the energy transfer between the terrestrial-aquatic interface (Beasley et al. 2012). Obligatory scavengers feed exclusively on carrion, while some predator species act opportunistically as facultative scavengers when carrion is available (Morton 2006; Moleón and Sánchez-Zapata 2015). Species of the gastropod family Muricidae, such as *Ergalatax contracta* (Reeve, 1846), display the opportunistic habit of scavenging other predators' leftovers on subtidal sands (Morton 2006). Muricidae is one of the largest families of carnivorous snails, utilizing a specialized shell-drilling ability to assess their prey (Dietl and Herbert 2005).

The genus *Phyllonotus* Swainson, 1833 is a member of this family and its species are medium-large sized carnivorous snails, called 'murex' or rock snails, usually with a robust and globose-oval shell. Although four species of this genus are reported in the Caribbean and South America, *Phyllonotus globosus* Emmons, 1858, *P. margaritensis* (Abbott, 1958), *P. pomum* (Gmelin, 1791), and *P. oculatus* (Reeve, 1845) (Barroso et al. 2016), knowledge about the scavenging behavior present in tropical reef ecosystems remains limited compared to deep, intertidal habitats or temperate coastal regions. Furthermore, as carrion is not commonly observed in reef environments, few studies have examined the rate of scavenging on reefs and consequently, non-predatory mortality is likely to be underestimated, even though it is an important element in biomass models (Keable 1995; Rassweiler and Rassweiler 2011).

The present study is based on two observations of the muricid gastropod, *P. oculatus* acting as a scavenger on shallow rocky reefs and highlights the important role of scavengers in the reef food web. The observations were made during field surveys between 3 and 5-m depth at the Porto da Barra rocky reefs in Todos os Santos Bay (Bahia State, Brazil), 13°0' 13.86"S 38°32'1.35"W, which is a recently implemented marine protected area (April 2019). This shallow urban reef has a long history of anthropogenic impacts with a high concentration of artisanal and recreational fishing (de Carvalho-Souza and Tinôco 2011), which has consequently led to a reduction in large fish predators.

The first case concerns the consumption of the carcass of a reef octopus of the species *Octopus insularis* Leite & Haimovici, 2008 (Cephalopoda: Octopodidae) by eight individuals of *P. oculatus* on 25 May 2009 (Fig. 1a, b). Throughout the observation (~30 min), the individuals of *P. oculatus* were feeding on, or stayed near, the carrion. Several parts of the octopus carcass had already been consumed, such as the arms and ventral side, where the muricids were more concentrated (Fig. 1a), probably due to the access to the parts with a high nutrition content. Two other individuals were also observed approaching the carcass, probably due to the muricids' ability of long-distance chemodetection of carrion (Morton 2006).

The second case involved an individual of the green moray, *Gymnothorax funebris* Ranzani, 1839, partly consumed by four individuals of *P. oculatus*, on 01 October 2011 (Fig. 1c). In this record, it was possible to see how the attacks were carried out with the long proboscis extended into a drilled hole (Fig. 1d). On this occasion, other common scavenger species were also observed consuming the carcass such as *Fissurella* sp. (Gastropoda: Fissurellidae), *Neritina virginea* (Linnaeus, 1758) (Gastropoda: Neritidae) (Fig. 1e, f), and the arrow crab, *Stenorhynchus seticornis* (Herbst, 1788) (Brachyura: Majidae) (Fig. 1g). Both observations had conditions with good visibility and low wave action.

When the site was revisited the following day (22–24 h after), the carcasses were no longer found. It appears, as hypothesized by Rassweiler and Rassweiler (2011), that there may be a rapid consumption of carcasses in the reef environment. Also, Keable (1995) noted that invertebrates will consume carrion when larger scavengers are excluded from the ecosystem, as in this case. Interestingly, these observations are the first record of scavenging by *P. oculatus* on shallow rocky reefs of the South Atlantic, despite its wide geographic distribution on the Atlantic coast. Although our findings support the idea that scavenging by gastropods may be important for maintaining food webs of coral reefs, the full extent of how the scavenging rate contributes to cleaners, cycling and nutrition input in reef ecosystems needs further investigation.

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Declarations

Conflict of interest The authors declare no competing interests.

Ethical approval No animal testing was performed during this study.

Sampling and field studies No permits were needed for the present observational field study.

Data availability Data sharing not applicable to this article as no datasets were generated or analyzed during the current study.

Author contribution GF de C-S and EGO conceived and designed research. GF de C-S conducted field observations. GF de C-S and EGO wrote the manuscript. All authors read and approved the manuscript.

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