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The influence of allochthonous macroalgae on the fish communities of tropical sandy beaches

Ryan Andrades [a,*], Marcelo P. Gomes [a,b], Guilherme H. Pereira-Filho [c], Jesser F. Souza-Filho [d], Cristiano Q. Albuquerque [a], Agnaldo S. Martins [a]

[a] *Departamento de Oceanografia e Ecologia, Universidade Federal do Espírito Santo, Av. Fernando Ferrari, 514, Goiabeiras, 29075-910 Vitória, Espírito Santo, Brazil*

[b] *Instituto Federal de Educação, Ciência e Tecnologia do Espírito Santo - Campus Piúma - Rua Augusto Costa de Oliveira, 660 - Praia Doce - Piúma- ES - CEP: 29285-000, Brazil*

[c] *Instituto do Mar, Universidade Federal de São Paulo, Campus Baixada Santista, Av. Alm. Saldanha da Gama, 89, 11030-400 Santos, SP, Brazil*

[d] *Universidade Federal de Pernambuco, Museu de Oceanografia, Av. Arquitetura, s/n, Cidade Universitária, 50740–550 Recife, PE, Brazil*

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ABSTRACT

This study evaluates the hypothesis that detached macroalgae (drift algae) influence the structure of fish communities in the surf-zones of two tropical sandy beaches from the central coast of Brazil. Surf-zone seine hauls were conducted weekly during three consecutive 6-week periods according to the occurrence of drift algae – in pre-drift, drift and post-drift periods. Drift algae comprised 33 macroalgae species and likely came from offshore rhodolith beds. Fish biomass, density and species richness increased from pre-drift to drift periods, and species composition differed significantly between periods, particularly in the more sheltered of the sampled beaches. The density of young-of-the-year (YOY) fishes also increased significantly from the pre-drift to drift periods, suggesting the importance of drift algae to early fish stages. The gut contents of the two most abundant species during the drift algae period, *Trachinotus falcatus* and *Trachinotus goodei*, demonstrated the importance of macrophyte-associated amphipods in their diets, suggesting that the drift algae may be used as feeding habitats for these species. Our results showed that the influx of allochthonous drift algae may structure fish communities of tropical sandy beaches and that it may also represent an important alternative resource for YOY fish by providing shelter and food during autumn and winter.

1. Introduction

Surf zones of sandy beaches are important nursery grounds for many fish species worldwide, particularly during their early life (McLachlan and Brown, 2006). They are also used as transient habitats for fish migrating between inner shelf zones and coastal ecosystems such as estuaries and mangroves (Cowley et al., 2001; Able, 2005). The high wave-energy and shallow waters usually observed in sandy beaches provide shelter from predators and support elevated densities of the mobile invertebrates that provide food resources for juvenile fish (Baristic et al., 2005; Niang et al., 2010). Given their importance as nursery grounds, natural and anthropogenic disturbances in these habitats can profoundly affect fish communities, leading to ecological responses that may vary in time and space (Syms and Jones, 2000). For example, fish from sandy beaches may be subject to anthropogenic impacts such as fishing, beach nourishment and oil spills (Schlacher et al., 2007; Defeo et al., 2009). However, natural disturbances such as freshwater runoff, storms and seasonal winds may occasionally trigger the input of allochthonous organic and inorganic materials into sandy beaches (Colombini and Chelazzi, 2003; Gomes et al., 2003).

Coastal ecosystems worldwide usually receive large amounts of allochthonous macroalgae and seagrasses, also referred to as macrophytes, which may provide food and habitat for marine fauna in the surf zones or when it is stranded as beach-cast wrack (Rossi and Underwood, 2002; Crawley and Hyndes, 2007). Allochthonous macrophytes can be detached from their substrate by storms or strong currents (Colombini and Chelazzi, 2003). Upon detachment, algal tissues may be called drift algae or simply detached macrophytes. When algal drifts approach surf zones, they are mostly consumed by benthic crustaceans (Colombini and Chelazzi, 2003; Crawley et al., 2009) and may be finally deposited ashore. These benthic crustaceans in surf zones may in turn be fed on by juvenile fish (Helmer et al., 1995). Fish abundance and biomass have been

* Corresponding author.
E-mail address: ryanandrades@gmail.com (R. Andrades).

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positively correlated with the mass of detached macrophytes in temperate sandy beaches (Robertson and Lenanton, 1984; Crawley et al., 2006). Therefore, detached and non-detached macrophytes in coastal areas may provide better nursery grounds for juvenile fish before they recruit to adult habitats and may support higher fish diversity than bare sand habitats (Ornellas and Coutinho, 1998; Gullström et al., 2008). The number of studies focusing on the effects of detached macrophytes in coastal environments has recently increased (e.g., Duong and Fairweather, 2011; Gonçalves and Marques, 2011). However, only a few studies have attempted to investigate their influence on the fish communities in surf zones of sandy beaches, particularly in temperate regions (Robertson and Lenanton, 1984; Lenanton and Caputi, 1989; Crawley et al., 2006). While abiotic factors (e.g. climate variability) are preponderant in shaping fish assemblages in temperate regions, biotic factors as competition and predation play a major role in tropical regions (Schemske et al., 2009). Therefore, drift algae may be even more important in structuring fish assemblages in tropical regions than they are for temperate ones. To our knowledge, there is no available information on the effect of drift algae on fish communities from tropical beaches, nor on sandy beaches from the western Atlantic.

In sandy beaches from the central coast of Brazil, drift algae occur a couple of times a year, mostly during early autumn (April), as a result of strong south winds following the first seasonal cold fronts after summer. Once arriving in the surf zones, these dense accumulations are deposited on the beach face, where they are colonized by macrofaunal organisms. In tropical beaches, this whole cycle lasts for approximately 8–20 weeks depending on factors such as wind speed, tide strength and human removal (Colombini and Chelazzi, 2003). In the study region, local fishermen believe that drift algae in nearshore areas are nursery habitats for crustaceans and fish, which reinforces the idea that macroalgae potentially affects fish populations. However, neither the direct effect of algal drifts on local fish assemblages nor the processes underlying those effects are clearly understood in tropical sandy beaches.

This study aimed to examine the effects of drift algae on fish communities from two tropical sandy beaches in the central coast of Brazil. More specifically, we evaluate how the local fish assemblages respond to intrusions of drift algae in terms of species composition and the proportions of life stages. In addition, we analyzed the diet of two locally dominant fish species as indicators of the importance of drift algae-associated organisms to the fish diet.

2. Materials and methods

The study area involved two sandy beaches located in the Central coast of Brazil (Fig. 1), which were selected based on the seasonal occurrence of drift algae. In morphodynamic terms, both beaches may be considered intermediate to dissipative and are separated from each other by rocky jetties, which limit their extensions and prevent drift algae transport between them. They are also geologically similar (Albino et al., 2006) as they were a single beach before the construction of the jetties to provide a basin for local fishing boats. Because their morphodynamic features are common among Brazilian tropical sandy beaches (Hoefel, 1998), and wrack deposition events are also observed in many tropical and subtropical sandy beaches (Rosa et al., 2007; Ruiz-Delgado et al., 2014), we expect our results may be representative of most Brazilian sandy beaches. Itaipava Beach (IB) is the unsheltered portion of beach that extends approximately along 1.1 km south from the small jetty, where coastal rocks are usually observed. Itaipava Docks (ID) is the northern 800 m portion of beach and is limited by the two jetties. The dominant climate type in this region is Tropical Monsoon with seasonal changes of wind direction and intensity (Vera et al., 2002; Peel et al., 2007). Wave height usually ranges from 0.2 m under the prevalent N-NE winds to 4 m under south wind incursions, which occur predominantly from autumn to winter.

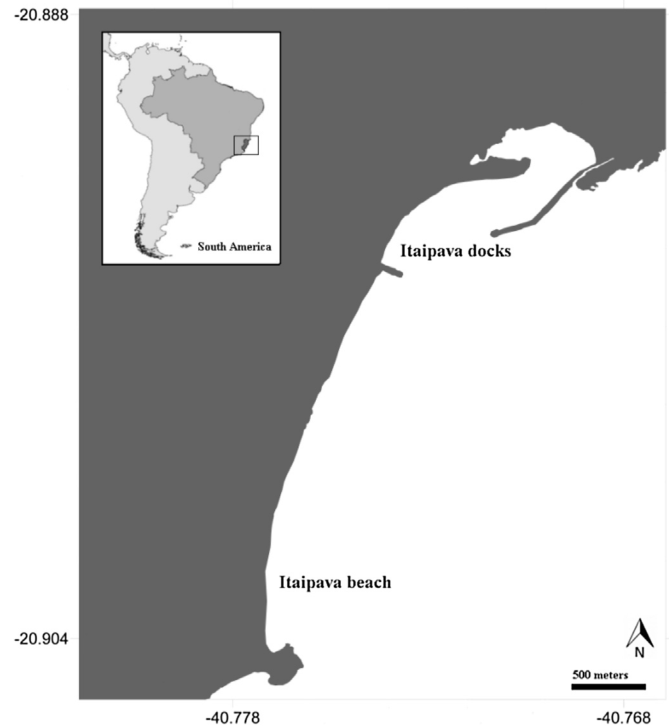

Fig. 1. Study area showing the location of the beaches: Itaipava Docks (ID) and Itaipava Beach (IB).

We previously observed that most drift algae accumulated for about six weeks during the early autumn (April–May). Therefore, sampling was carried out during three six-week periods to evaluate the characteristics of the fish community before, during and after the occurrence of drift algae. These three sampling periods are referred to as pre-drift, drift and post-drift and totaled 18 weeks of sampling from April to August of 2010.

Fish and drift algae were sampled in surf zones once a week at low tides using a seine net 8 m long and 1.7 m high, with a mesh size of 20 mm. Itaipava Docks and Itaipava Beach were sampled during the same day with two replicates at each site. The hauls were carried out parallel to the coast line. Due to the variability of the mass of drift algae in the surf zones, the haul lengths were not exactly the same and varied between weeks. All collected fish were preserved in 70% alcohol and stored in plastic bags. Macroalgae trapped in the net were collected and their volume in liters was measured following Crawley et al. (2006), although we used a 5-l plastic canister. For example, if 10 canisters were needed to fit the algal material collected from a given haul, the algal volume was measured as 50 l and was expressed as liters per 100 m^2.

Once in the laboratory, the macroalgae were identified to the highest possible taxonomic separation based on specific literature and checked according to Guiry and Guiry (2013). Sampled fish were identified to species and quantified per 100 m^2. All individuals were measured for total length, sexed and classified as adults or juveniles based on gonad examination, following Martins and Haimovici (2000). The juveniles were further separated into young of the year (YOY) and late juveniles (LJ) according to their total lengths, using their mean length-at-age-one from the