



Association between Juvenile Carangid Fish with the Jellyfish *Aurelia* Sp. and a Floating Plastic Bag

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Abstract

Understanding how juveniles of the commercially important carangid species are associated with floating substrata is important to surveys aimed at potential effects on fisheries, species-habitats relationships and human impacts. Herein, the first record of association between the juvenile carangid fishes *Caranx crysos*, the jellyfish, *Aurelia* sp. and a floating plastic bag is reported in tropical rocky shores, northeastern Brazil.

Keywords

Carangid fish; Interaction; Marine debris; South Atlantic Ocean

Introduction

The association behavior of fish and biotic-abiotic floating items has been widely recognized and many possible functions have been described for this such as protection, safeguard for early developmental stages and a meeting point [1]. The fish-jellyfish association is regarded as a temporary symbiosis for the schooling behavior, evasion from predators and prey collection [2,3]. Yet, it is likely that these interactions are flexible, due to the physiological and ecological relationships and ontogenetic changes between the host and commensal species [4,5]. Natural floating objects (e.g. tree trunks, kelp, pumice) have freely traveled for thousands of years, dispersing in the world's oceans [6]. In the last century, human activities have added floating marine debris (FMDs), providing a 'new habitat' for several species, so-called 'hangers-on', which are 'hitch-hiking' on these floating substrata [7]. Members of the Carangidae family are one of the most frequent fish groups associated with floating substrata, mainly jellyfishes [2]. The blue runner, *Caranx crysos* [8] (Carangidae) is an important commercial fish species in Brazilian waters, and is also reported in association with fish aggregation devices (FADs), dolphins, whale sharks, jellyfishes and algae throughout their range [1,9-11]. This is a schooling coastal-pelagic species with distribution in eastern Atlantic (Senegal to Angola) including the western Mediterranean, and in the western Atlantic, ranging from Brazil to Nova Scotia, Canada, including the Gulf of Mexico and the Caribbean [12]. Recently, new records increased their range, to the Bay of Biscay [13], British waters south of Dorset [14], Adriatic Sea [8,15], Newfoundland waters [16] and northwestern Mediterranean

[17]. The present study reports the first record of association between juvenile carangid fishes *Caranx crysos*, the jellyfish *Aurelia* sp. (Scyphozoa) and a floating plastic bag observed along rocky shores of the Todos os Santos Bay, Bahia State, northeastern Brazil.

Material and Methods

Observations were made during two free dives (~30 min. per session) on two rocky shores. The first record of interaction with jellyfish was observed on 3 October 2009 at rocky shore named Yacht Club (38°31'52.92" W 12°59'57.04" S). The second observation with a jellyfish and a plastic bag was recorded on 25 October 2009 at Porto da Barra beach, city of Salvador (38°32'01.19" W 13°00'13.85" S). On this occasion a great and unusual amount of jellyfishes and FMDs were photographed and video-recorded at this site, inlet of the Todos os Santos Bay (See Supplementary Material available online). The "focal animal method" was used throughout the visual census and all occurrences were recorded on plastic data sheets [18]. Individuals were photographed during daytime and the total length (TL) was visually estimated. The depth ranged 2-6 m and horizontal visibility was 10 m. Three specimens of juvenile fish (two associated with jellyfish, one with the plastic bag) were captured with a small hand net and were identified based on specialized literature [19,20]. Identification of jellyfish was based on Migotto et al. [21] and Morandini et al. [22]. The *Aurelia* genus is in taxonomic review so no firm identification of the species could be determined, being found in the Brazilian coast.

Results

About 15-35 juvenile individuals of carangid fish, *C. crysos* of variable sizes (10 mm to 20 mm TL) were observed with jellyfishes, *Aurelia* sp. (n=3, 100-130 mm TL) (Figure 1a,1b) and 21 individuals with plastic bag (n=1, 300 mm TL) (Figure 1c,1d) (both co-occurring). Carangid fishes were observed swimming around the floating substrata or sheltered among the jellyfish umbrella and likewise with the plastic bag. During all observations the schools showed similar behavior when disturbed by the approaching divers (n=1-2), concentrating in the jellyfish umbrella and also in the lower region of the plastic bag in an apparent attempt to hide (Figure 1c,1d). Moreover, despite the fact that large amount of floating substrata was observed, FMDs and jellyfishes were associated only with this fish species.

Discussion

The interaction between carangid fish and floating structures has been reviewed and updated previously by Mansueti [23], Purcell and Arai [2], Castro et al. [1], Thiel and Gutow [6] and Kondo et al. [3]. To our knowledge, this is the first report of association between juvenile carangid fish, *C. crysos*, the jellyfish, *Aurelia* sp. and a plastic bag co-occurring on tropical rocky shores. Juvenile stages of carangid fish have often been reported, in association with floating structures, such as jellyfishes [24], *Sargassum* mats [25] and anthropogenic debris (eg. abandoned fishing nets, buoys, pallets, industrial residues, etc.) [1]. Two hypotheses are widely suggested and observed here regarding association of fishes with floating substrata, especially jellyfishes: that is as a meeting point for school formation in the early life stages and to provide shelter and consequently, protection from predators.

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However, Bonaldo et al. [24] recorded an opportunistic predation by the grouper *Mycteroperca acutirostris* (Serranidae) on juvenile scads, *Trachurus lathami* (Carangidae) during an association with jellyfish, *Chrysaora lactea* (Pelagiidae), while the medusa was being damaged. Although the failure to prevent predation may occur in particular circumstances, these authors describe that before and after the disturbance, the protection given by the jellyfish to the juvenile fish was effective. Considering that the floating plastic (e.g. bags) may be mistakenly consumed by some generalist and opportunist predator (e.g. turtles) [26], further field surveys are needed to better understand if the effectiveness of protection with jellyfishes is also offered by floating abiotic objects to the young fish during attempts of predation by opportunistic hunters. Besides these functions, the floating substrata (anthropogenic or not) may also provides extra capacity of dispersion to new areas and opportunistic prey through associated-fauna [6]. In particular, special attention should be given to these plastic items, increasingly common in the oceans, due to their highly persistence and hydrophobic nature in the environment as a pathway of transportation of species. Plastic pollution may disrupt coastal and marine systems in many ways (accumulation, dispersion, pollutants) which can in turn cause far-reaching disruptions throughout the marine habitats, associations and food web [7,27]. As the marine debris grows and provides optimum substrates the larval and juvenile stages of diverse marine organisms such as *C. crysos*, new species FMDs-associated may shift their ranges, distributions, and abundances and, consequently, alter ecosystem and could endanger the endemic biota [7]. Goldstein et al. [27] recorded several

fish species plastic-associated exhibiting three behaviors: staying almost exclusively within the FMDs, and remaining underneath or swimming around the FMDs with or without close association, such, for macroalgae-associated fishes. The authors suggested that larger FMDs may be more likely to associations with fishes due to more stability and easy detection through visual and auditory cues. We also observed the carangid fish associated with plastic bag displayed similar behavior for jellyfish-associated fishes. The record observed herein can be a combined result of the high abundance of the jellyfishes and FMDs. Thus, the association behavior of juvenile *Caranx crysos* with floating substrata (jellyfish and plastic bag) may have been adopted here to facilitate a meeting point for conspecifics (schooling behavior), potential protection against predators and perhaps, facilitate the dispersion to new areas, and therefore could demonstrate a multifunctional behavioural response. Associations as the ones described here, clearly highlight the linkage and importance of these interactions and the degree of human interference in the habitats.

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