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# Ecological aspects and potential impacts of the non-native hydromedusa *Blackfordia virginica* in a temperate estuary

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ABSTRACT

The hydrozoan *Blackfordia virginica* has been reported over a wide geographical area, although it is mainly restricted to scattered records within estuarine areas of temperate and tropical regions. The aim of this study was to understand the spatial and temporal variability of an established population of this non-indigenous species on a temperate estuarine ecosystem, and its impacts over the plankton community. Sampling was conducted from 2011 to 2013 in the Mira estuary (Portugal) and higher densities were observed during the summer of 2013, with a maximum of 1689.3 medusae.m$^{-3}$. Spatially, higher abundances of medusae were associated with sites of higher abundance of oyster shells and higher percentage of hard substrate in the river bed. Smaller jellyfish were sampled in the vicinity of these hard substrate locations, suggesting these might be habitats for polyp fixation. A higher potential predation impact on the copepod population along the estuary was estimated for the summer of 2013, with a median half life of 6.1 days.



## 1. Introduction

The dispersal of aquatic species may be mediated by natural mechanisms. However human activities are thought to be the main vector for species transfer between territories nowadays (Ruiz et al., 1997; Occhipinti-Ambrogi and Savini, 2003). Shipping related vectors, such as hull fouling and ballast waters, as well as aquaculture and aquarium trade are considered the most important vectors for aquatic species transfer (Ruiz et al., 1997; Bax et al., 2003). Invasion by jellyfish species has been widely documented (Rees and Gershwin, 2000; Purcell et al., 2001; Wasson et al., 2001; Genzano et al., 2006; Graham and Bayha, 2007). Many species included in this group present a seasonal variation and may show extremely high abundances of the planktonic form during certain periods of the year (Pitt and Lucas, 2014). The seasonal occurrence depends on the species life cycle and life history characteristics, which enable a rapid population growth in response to favorable environmental conditions, such as temperature, salinity, food availability and lack or removal of top predators (Lucas, 2001; Boero et al., 2008). An opportunistic strategy may increase the potential as invasive species, as they may survive under extreme conditions during transportation and adapt well to the new conditions found in the invaded territory (Stachowicz and Byrnes, 2006; Lucas et al., 2012).

Jellyfish blooms can have considerable economic impacts, affecting fisheries and aquaculture by net clogging and fish injuring, disrupting tourism, due to allergic reactions to stings in swimmers, and stopping power plants, as a result of the blockage of cooling systems (Purcell et al., 2007; Richardson et al., 2009). Jellyfishes are zooplankton feeders and may affect the abundance of prey populations (including egg and fish larvae) by predation (Purcell, 1985; Shiganova and Bulgakova, 2000; Lynam et al., 2005) and dietary overlap with commercially important zooplanktivorous fishes (Purcell and Sturdevant, 2001).

The hydrozoan *Blackfordia virginica*, a non-indigenous species in

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many territories worldwide, is thought to be native to the Black sea (Mills and Sommer, 1995; Graham and Bayha, 2007) or to the Atlantic coast of North America (Zaitsev and Oztürk, 2001). Its life cycle includes two stages, a benthic polyp and a planktonic medusa (Mills and Sommer, 1995). The production of medusae by the hydroid is seasonal and it can reach high abundances (Wintzer et al., 2013; Marques et al., 2015). In Portugal, this species was first observed in the Mira estuary in May 1984 (Moore, 1987), and later in the Guadiana estuary (Chícharo et al., 2009). Although its presence in the Mira estuary has been noted for over 30 years, it is poorly documented and there is still a weak understanding of its distribution and the mechanisms promoting its successful colonization in this estuary. Hence, the goals of this study were to determine the medusa spatial distribution in the estuary in different periods of the year, to determine the environmental variables responsible for the temporal and spatial colonization, and to estimate its potential predation impact on the zooplankton community.

## 2. Materials and methods

### 2.1. Study area

The present study was conducted in the Mira estuary, which is located in the southwestern coast of Portugal. It is a relatively small tidal and channel-like estuary, approximately 40 km long with a maximum width of 400 m near the mouth (Blanton et al., 2000). Depth varies between 1.2 m upstream and 8 m close to the mouth. The Mira estuary region presents a sub-humid climate, characterized by a dry period from May until September and by a humid period between November and April (Loureiro et al., 1984). The average annual precipitation is 667 mm (Loureiro et al., 1984). The Santa Clara dam, located 50 km upstream, determines the freshwater input, and the estuary dynamics and salinity are mainly influenced by the tidal cycle (Andrade, 1986). The vertical gradients of salinity and temperature are generally weak for most of the river course due to shallow depths (usually less than 5 m) and low precipitation (Andrade, 1986), which results in a reduced freshwater flow. The estuary may be divided into three zones according to the physical and chemical characteristics of the water (Fig. 1): upper, middle and lower estuary. The upper estuary is highly influenced by freshwater inputs, with salinity ranging from 0 to 23 and temperature from 8 to 26.5 °C. In the middle estuary, salinity and temperature vary widely, 7–35 and 9–26 °C, respectively. The lower estuary is clearly influenced by the marine environment with temperature ranging from 12 to 22.5 °C and salinity from 27 to 35 (Costa et al., 1994).

In the Mira river basin there are no large urban areas and the main activities are small-scale agriculture, cattle breeding and aquaculture. The estuary is relatively unaffected by chemical and nutrient pollution (Castro and Freitas, 2006) being considered one of the least threatened by anthropogenic activities in the Portuguese coast (Bettencourt et al., 2003; Vasconcelos et al., 2007). In the past, the Mira estuary was important in exporting goods within the national territory. During the XIX and mid XX centuries, small cargo vessels arrived at the estuary from the United States and England (Andrade, 1986). In the late sixties, shipping activities ceased (Andrade, 1986) and since then only recreational boats enter the river.

### 2.2. Sampling and laboratory work

Sampling was conducted during July 2011 (summer), September (autumn) and December 2012 (winter), March (spring) and June

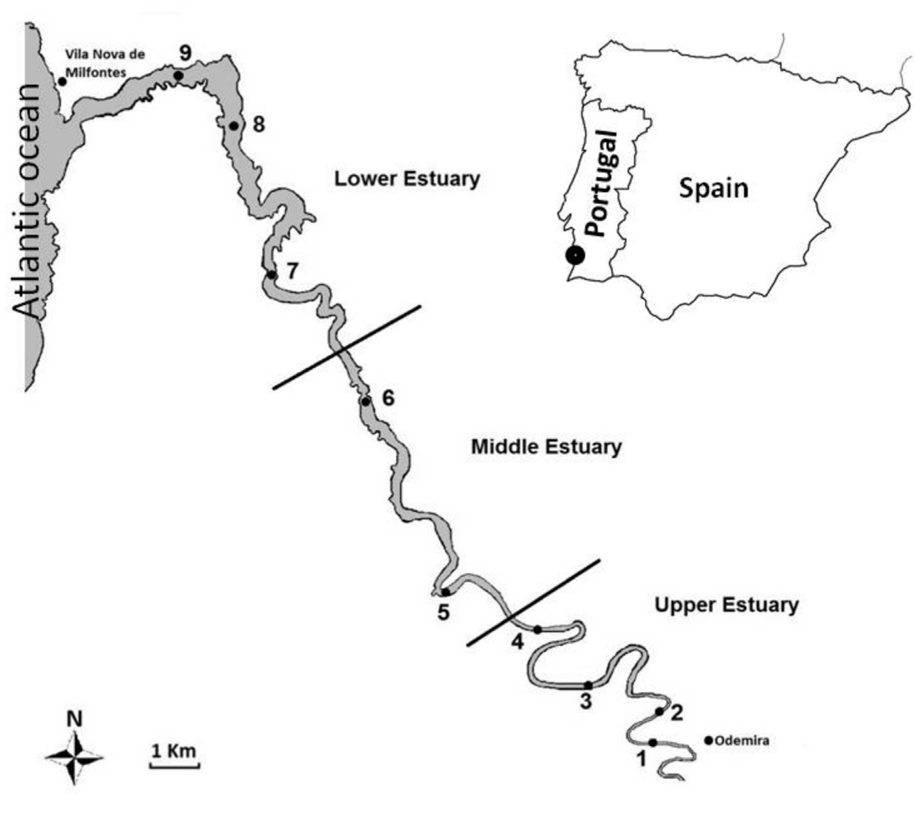


**Fig. 1.** Location of sampling stations in the Mira estuary (1–9). Upper estuary: **Site 1**–37° 35.932′N; 8° 39.506′W; **Site 2**–37° 36.327′N; 8° 39.018′W; **Site 3**–37° 36.615′N; 8° 40.787′W; **Site 4**–37° 37.193′N; 8° 40.208′W. Middle estuary: **Site 5**–37° 37.782′N; 8° 41.938′W; **Site 6**–37° 39.756′N; 8° 43.256′W. Lower estuary: **Site 7**–37° 41.688′N; 8° 44.616′W; **Site 8**–37° 43.186′N; 8° 45.041′W; **Site 9**–37° 43.661′N; 8° 45.904′W. Site 9 was not sampled during the 2011 survey. Source: Modified from Google Maps.