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Journal of Experimental Marine Biology and Ecology 342 (2007) 61–68

Journal of EXPERIMENTAL MARINE BIOLOGY AND ECOLOGY

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Distribution and long-term temporal patterns of four invasive colonial ascidians in the Gulf of Maine

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Received 1 September 2006; received in revised form 1 October 2006; accepted 9 October 2006

Abstract

Invasive ascidians are a growing concern for ecologists and natural resource managers, yet few studies have documented their short- and long-term temporal patterns of abundance. This study focuses on the invasion of the Gulf of Maine by the colonial ascidians *Botryllus schlosseri*, *Botrylloides violaceus*, *Diplosoma listerianum* and *Didemnum* sp. A. We examined the time of arrival and potential vectors for these four invasive ascidians using survey data (collected from 1969 onwards) and literature documentation. We also compared the dominance and seasonal patterns of abundance of these species using data from two identical panel studies; one conducted from 1979 to 1980, the other from 2003 to 2005. *Didemnum* and *Botrylloides* were most likely first introduced into the Damariscotta River, Maine in the early 1970's through oyster aquaculture while *Botryllus* and *Diplosoma* were probably transported by commercial and recreational vessels. The overall abundance of colonial ascidians has increased since 1979 and 1980. *Botryllus* was the only invasive colonial ascidian present during the 1979 to 1980 study and accounted for an average of 6.16% cover on panels. From 2003 to 2005, the more recently arrived colonial ascidians *Botrylloides* and *Didemnum* accounted for 7.38% and 2.08% cover respectively, while *Botryllus* covered only 1.16%. Our results reveal a shift in seasonal abundance between 1979 to 1980 and 2003 to 2004. In 1979 and 1980, colonial ascidians had the highest percent cover in fall and winter while in 2003 and 2005 they had highest percent cover in summer and fall. Seasonal patterns of space occupation by colonial ascidians were correlated with seasonal changes in seawater temperature.

Keywords: *Botrylloides*; *Botryllus*; *Didemnum*; Gulf of Maine; Invasive; Temporal distribution

1. Introduction

There is a growing awareness that invasive ascidians have caused changes in the structure and composition of benthic communities (Lambert, 2001; Whitlatch et al., 1995). Among the types of changes involved are alterations from native- to invasive-dominated communities and a reduction in the abundance of native species (Lambert and Lambert, 1998; Osman and Whitlatch, 1995a). Invasive ascidians can be transported to new areas by ship, either as larvae in ballast water (Svane and Young, 1989) or as juveniles and adults attached to boat hulls (Lambert, 2001; Godwin, 2003; Lambert and Lambert, 2003). Once they've become established in new locations, they can persist and become dominant members of the community (Lambert and Lambert, 2003).

Four species of invasive colonial ascidians are present in the Gulf of Maine, *Botryllus schlosseri*, *Botrylloides violaceus*, *Diplosoma listerianum* and *Didemnum* sp. A

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0022-0981/$ - see front matter © 2006 Elsevier B.V. All rights reserved.
doi:10.1016/j.jembe.2006.10.015

(Carlton 2003). *Botryllus* is the oldest invader and has been present since at least 1870 (Gould, 1870). *Botrylloides*, *Diplosoma* and *Didemnum* are more recent invaders and arrived within the last 25 yrs (Berman et al., 1992; Carlton, 1989; Harris et al., 1998; Bullard et al., 2007-this issue). Since their introduction, all of the species have become well established in New England fouling communities and two (*Botrylloides* and *Didemnum*) have become very abundant (e.g., Berman et al., 1992; Carman and Roscoe, 2003). Despite the fact that the three most recent invasions have been well documented, no work has assessed temporal changes within fouling communities that have resulted from these invasions. Additionally, little is known about the susceptibility of these invasive ascidians to native predators. Juvenile *Botrylloides*, *Diplosoma* and *Botryllus* are consumed by the snails *Mitrella lunata* and *Anachis lafresnayi* (Osman and Whitlatch, 1995b, 1998), but it is unclear which predators consume adults. The purpose of this study is to: 1) examine the probable vectors associated with the introduction of these four invasive ascidians. 2) compare long-term differences in dominance and seasonal abundance patterns of the ascidian species using data from two identical panel studies, one conducted from 1979 to 1980 the other from 2003 to 2005 and 3) identify predators of adult invasive ascidians.

2. Study species

Botryllus schlosseri is well established from Cape Cod, MA to Eastport, ME (Fig. 1). It has been present in the Gulf of Maine since at least 1870 (Gould, 1870). The remaining three species arrived much more recently. *B. violaceus* (originally misidentified as *Botrylloides diegensis*) was first observed in 1980 at Woods Hole, Massachusetts (Carlton, 1989) and in 1981 at Fox Point in the Great Bay Estuary, New Hampshire (Berman et al., 1992). It did not appear on panels at the Coast Guard Station, Newcastle, New Hampshire until 1982 (Berman et al., 1992). Photographic records indicate this species was also present in high abundances in 1982 on

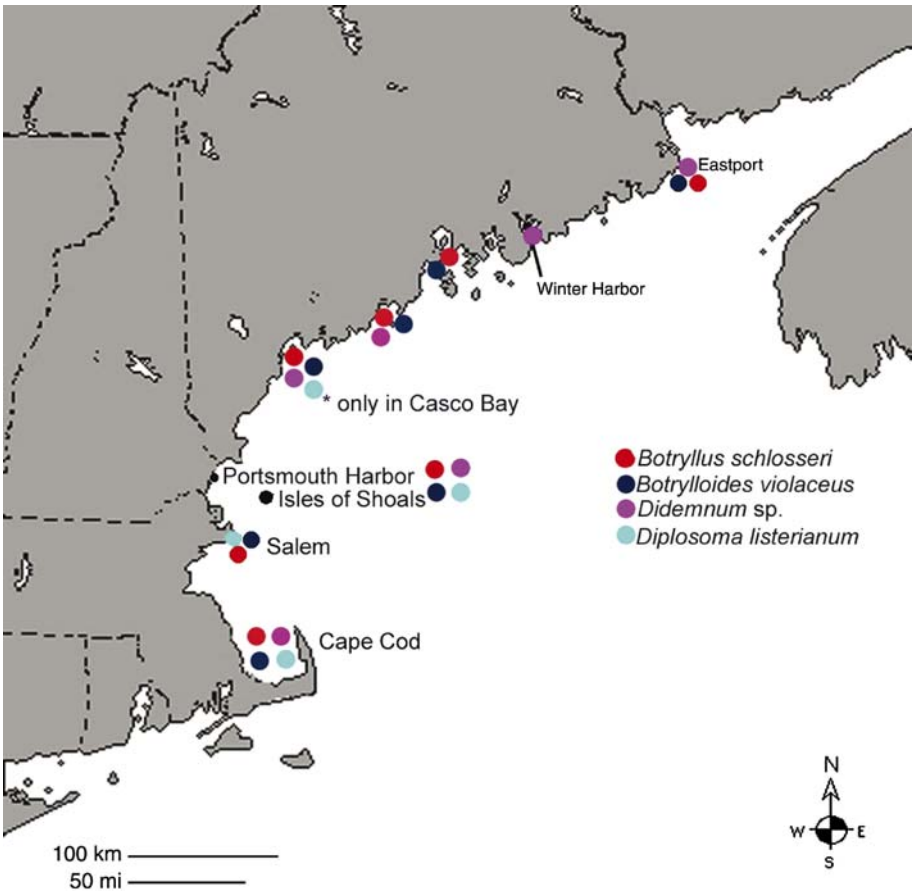

Fig. 1. Distribution of *Botryllus schlosseri*, *Botrylloides violaceus Didemnum* sp. A and *Diplosoma listerianum* in the Gulf of Maine.