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Invasion note

Seasonal abundance and occurrence of the Asian isopod *Synidotea laevidorsalis* in Delaware Bay, USA

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Abstract

In 1999 the marine isopod *Synidotea laevidorsalis* (Miers 1881), indigenous to the northwest Pacific, was first documented in Delaware Bay, USA. We monitored weekly recruitment of this isopod and several other motile species in the Maurice River, a tributary of Delaware Bay. A spatial survey was also conducted. Abundance of *S. laevidorsalis* varied seasonally but overwhelmingly dominated other co-occurring species by an order of magnitude or more throughout most of the year. Isopod abundance increased through the summer of 2004 and peaked in September, coincident with the passing of Hurricane Ivan. Field observations documented large populations, frequently associated with pilings and buoy lines, throughout Delaware Bay in salinities of 4 through 22 ppt. The dramatic abundance of this isopod indicates that there is considerable potential for altering community structure. This isopod has yet to be observed along the Atlantic Coast of New Jersey or in Chesapeake Bay, but it has been reported near Charleston, SC.

Abbreviations: cm – centimeter; ° – degrees; DRBC – Delaware River Basin Commission; HSRL – Haskin Shellfish Research Laboratory, Rutgers, The State University of New Jersey; mm – millimeter; N – north; NJ – New Jersey; NJDEP – New Jersey Department of Environmental Protection; ppt – salinity of water as measured in parts per thousand; SC – South Carolina; USGS – United States Geological Survey; W – west

Introduction

The marine isopod *Synidotea laevidorsalis* (Miers 1881) has appeared in the literature to illustrate the global spread of non-indigenous species (Chapman and Carlton 1991, 1994). A native to the boreal waters of the northwest Pacific, *S. laevidorsalis* has reached Europe, Australia and North America, presumably in ballast water (Chapman and Carlton 1994; Moore 2004). The Delaware Bay, located on the Atlantic coast of North America (Figure 1), contains some of the busiest ports in the United States with approximately 3000 cargo vessels arriving to the tri-state docking facilities in Delaware, New Jersey, and Pennsylvania each year (DRBC 2005a). In 1999 *S. laevidorsalis* was discovered at the Rutgers University, Haskin Shellfish Research Laboratory (HSRL), located at the mouth of the Maurice River on the Delaware Bay (R. Barber, personal communication). It is one of twenty-five non-indigenous aquatic species reported from

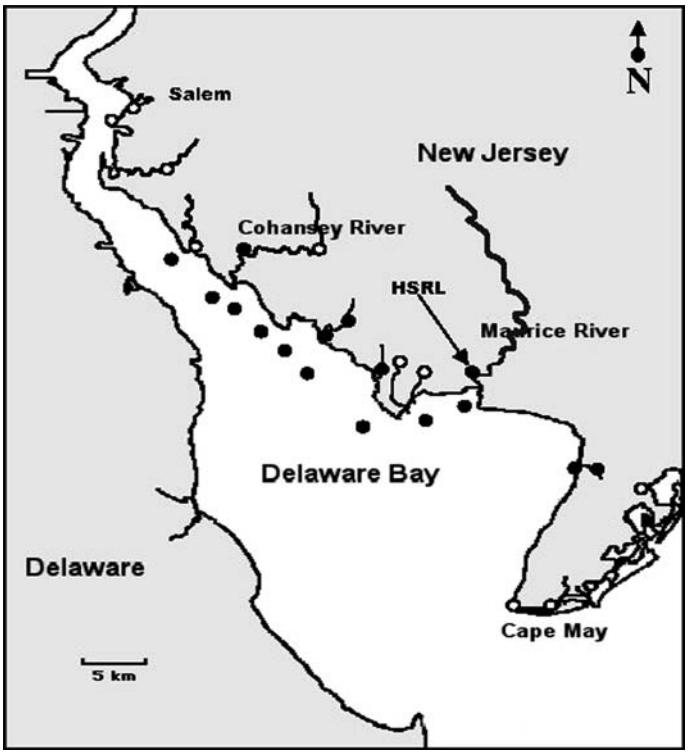

Figure 1. Occurrence of *S. laevidorsalis* along the New Jersey portion of Delaware Bay and its tributaries during summer 2004. Solid circles = present. Open circles = absent.

Delaware Bay (USGS 2005). The isopod is free-living and relatively conspicuous, often reaching 20–30 mm in length. Anecdotal reports by New Jersey Department of Environmental Protection (NJDEP) staff and local fisherman indicate that *S. laevidorsalis* is commonly found in large numbers during summer clinging to ropes and buoys throughout the bay. Here, we document the seasonal abundance of *S. laevidorsalis* from the site where it was first reported in Delaware Bay and provide an initial assessment of its distribution in Delaware Bay and elsewhere along the Atlantic Coast.

Materials and methods

A spatial survey was conducted to determine the general distribution of *Synidotea laevidorsalis* in the New Jersey waters of the Delaware Bay during the summer of 2004. Docks and piers in Delaware Bay tributaries between Cape May, NJ and Salem, NJ were inspected for *S. laevidorsalis*, and the presence of the isopod was noted in samples collected along a moderate to low salinity gradient during a routine oyster recruitment and mortality monitoring study. The presence of *S. laevidorsalis* was noted in oyster dredge samples collected monthly from seven sites between May and October 2004, or attached to oyster spat collectors, lines and buoys deployed from July through September. Latitude and longitude of each collection were recorded along with temperature and salinity. Several sites outside Delaware Bay between Charleston, South Carolina and Tuckerton, New Jersey were also inspected for the occurrence of *S. laevidorsalis*.

To document the temporal abundance of *S. laevidorsalis*, quantitative samples were collected weekly, from May 2004 for 1 year. A plastic mesh tray was deployed continuously from the HSRL dock in Bivalve, NJ. The tray measured 53×63×13 cm, was lined with 5 mm mesh, and contained several ribbed mussels (*Geukensia*

demissa) and oysters (*Crassostrea virginica*). It was suspended by rope approximately 30 cm above the bottom of the Maurice River. Each week, all motile fauna were removed, rinsed on a 1 mm sieve and enumerated by taxa. Seasonal abundance of *S. laevidorsalis* was compared to co-occurring native motile macrofauna, temperature, salinity, and river flow.

Results

Synidotea laevidorsalis was regularly observed in the New Jersey waters of Delaware Bay clinging to ropes or associated with other man-made material and natural substrate in the water column (Figure 1). Individuals ranged in size from a few millimeters to nearly 3 cm. The isopods were common and generally abundant (hundreds–thousands) on ropes and buoys used to deploy oyster spat collection bags from July to September 2004 between the Maurice River Cove (75°10.6′ N, 75°5.2′ W) and Arnolds Point (39°19.9′ N, 75°23.7′ W) in Delaware Bay. In contrast, they were only occasionally observed in benthic samples collected with an oyster dredge. The isopod was also observed in several tributaries draining into Delaware Bay from Cumberland and Cape May Counties in New Jersey, but was not observed in the Cape May Canal near the mouth of the Bay or in tributaries north of the Cohansey River (Figure 1). Salinities where the isopod was present ranged from 4 to 22 ppt. Outside of Delaware Bay, *S. laevidorsalis* was observed in the Stono River near Charleston, SC and in Charleston Harbor. Interestingly, it was not observed or reported from Chesapeake Bay, the Atlantic Coast of Virginia, or along the southern portion of the Atlantic Coast of New Jersey (Table 1).

The abundance of *S. laevidorsalis* in the Maurice River, NJ showed a distinctive seasonal pattern (Figure 2). Isopods were abundant from May through November 2005 with a dramatic

Table 1. Reported occurrence of *S. laevidorsalis* at sites outside Delaware Bay.

Site	Contact	Isopod present
Rutgers Marine Field Station, Tuckerton, NJ	Ken Able	No
The Wetlands Institute, Stone Harbor, NJ	David Bushek	No
MDDNR Cooperative Oxford Laboratory, Oxford, MD	Chris Dungan	No
Horn Point Environmental Laboratory, Horn Point, MD	David Bushek	No
Virginia Institute of Marine Science, Gloucester Pt, VA	AJ Erskine	No
Mult. sites, lower Chesapeake Bay and Seaside Virginia	AJ Erskine	No
Charleston Harbor, Charleston, SC	David Knott	Yes
Stono River, Charleston, SC	David Bushek	Yes

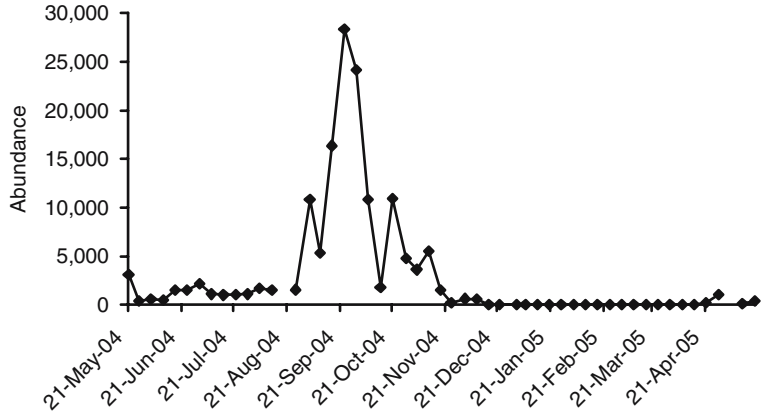

Figure 2. Synidotea laevidorsalis abundance sampled weekly from tray suspended at the HSRL dock.

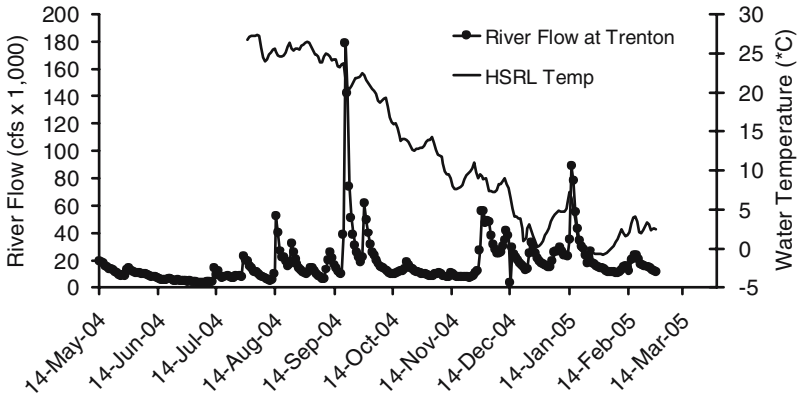

Figure 3. Average daily bottom water temperatures recorded from HSRL dock and daily mean water flow (cubic foot per second) of the Delaware River measured at Trenton, NJ (DRBC 2005b).

peak in September. The peak corresponded to the passing of Hurricane Ivan that caused major flooding in the Delaware watershed (Figure 3) and reduced salinities in the middle and upper regions of the Delaware Bay. Abundance declined more or less continuously after river flows returned to normal levels. By December 2004, the isopods were no longer detected and did not reappear until late March 2005. Mean size fluctuated between 10 and 12 mm with a range of 4–22 mm after September 2004. Size was not routinely measured prior to September 24, 2004.

Co-occurring motile macrofauna encountered in the Maurice River sampling tray represented four major taxonomic groups (Crustacea, Chordata, Platyhelminthes, and Annelida). Abundances varied among taxa and fluctuated seasonally, but while thousands of *S. laevidorsalis* were routinely collected, only three other taxa had abundances exceeding 100 individuals per sample (grass shrimp of the genus *Palaemonetes*, the mud crab *Rhithopanopeus harrisi* and amphipods, Figure 4). Of these taxa, only amphipods were present in numbers comparable to

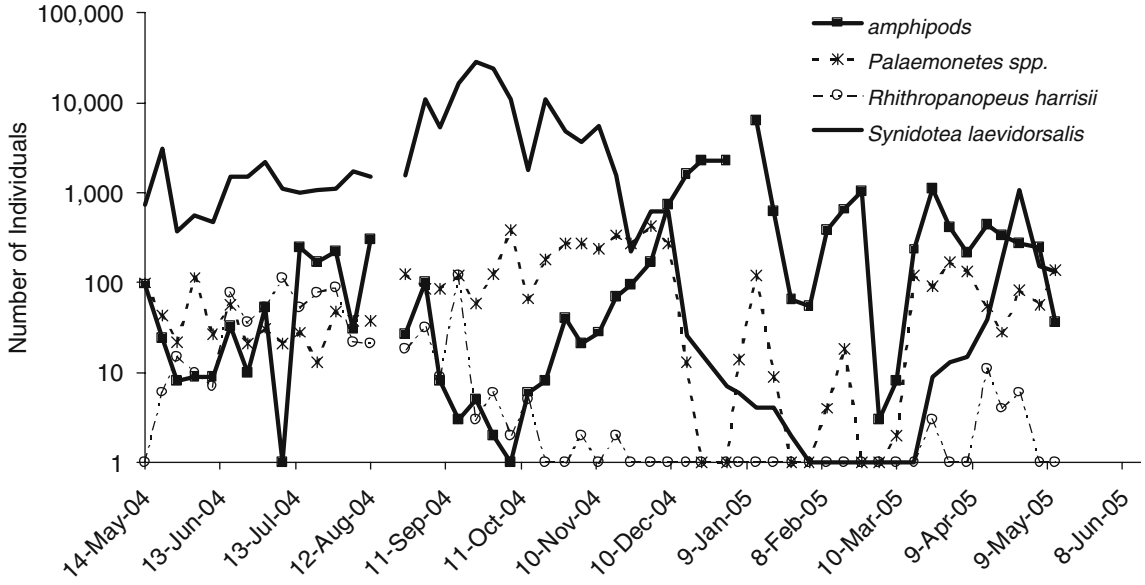

Figure 4. Weekly abundance of the four most abundant species from the tray maintained at the HSRL dock.

S. laevidorsalis (i.e., >1000 individuals in the sampling tray). Interestingly, amphipod and mud crab abundance dropped dramatically when isopod abundance peaked in September. Amphipod abundance recovered as isopod abundance declined, but crabs did not reappear in the trays until March 2005. Seven other taxa appeared intermittently throughout the year in relatively low numbers. These included *Nereis succine* ($n=89$), *Gobiosoma bosci* ($n=49$), *Callinectes sapidus* ($n=28$), *Macrobdella* spp. ($n=20$), *Stylochus ellipticus* ($n=10$), *Opsanus tau* ($n=7$), and *Anguilla rostrata* ($n=2$).

Discussion

Given its high abundance and distribution, it appears that *S. laevidorsalis* has successfully established a self-sustaining population within Delaware Bay, fulfilling the initial steps required of invading species (Kolar and Lodge 2001; Ray 2005). The affinity that *S. laevidorsalis* demonstrated for docks, buoys and floating lines in Delaware Bay is consistent with the findings of Chapman and Carlton (1994). Our preliminary distribution data suggest that *S. laevidorsalis* is confined to brackish salinities (4 through 22 ppt) within Delaware Bay. Notably, it was not observed at the Cape May Ferry landing or in the higher salinity waters of back bays along the Atlantic coast of New Jersey. Mees and Fockedey (1993) reported finding the isopod across a salinity range of 0.1–24 ppt in the Gironde estuary, France.

Invasive species are known stressors on preexisting community structures (Ruiz et al. 1999). The tremendous seasonal abundance of this isopod may significantly affect community structure within Delaware Bay and hence warrants further research. Floodwaters from hurricane Ivan may have temporarily increased local abundances of *S. laevidorsalis* by compressing the salinity gradient within the bay, but numbers had increased by an order of magnitude 2 weeks prior to the storm. This pre-storm increase suggests reproduction and recruitment and supports anecdotal reports of naturally high abundances during late summer in previous years.

The presence of a population near Charleston, SC, but none in Chesapeake Bay appears to indicate that these were human mediated introductions. The abundant marine traffic entering Delaware Bay provides an efficient conduit for such an introduction and was previously hypothesized as a conduit for the spread of this species (Chapman and Carlton 1991, 1994). Comparative studies on populations from Delaware Bay and the Stono River, Charleston provide an opportunity to address a variety of questions about this invasiveness of this species, its impacts and estuarine invasions in general. With locations dispersed along the Atlantic, Gulf and Pacific coasts of the United States, the National Estuarine Research Reserve System would provide an excellent platform for monitoring the establishment and spread of *S. laevidorsalis* (Wasson et al. 2002; Bushek 2004).

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