Further expansions of the Asian tunicate *Styela clava* Herdman 1882 in Ireland

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Abstract

The first records of *Styela clava* are reported from the northern coasts of Ireland from two sheltered inlets in 2008. On the south coast, high densities were found associated with mussel longlines in a shallow bay and remained abundant in 2009. There is a potential for expansion of the species that may impact upon aquaculture installations in Irish shallow waters. The distribution of the species in Ireland is reviewed.

**Key words:** *Styela clava*, fouling, marina, Ireland, tunicates, ascidians, alien species, aquaculture

Introduction

*Styela clava* Herdman, 1882 is a solitary oviparous hermaphrodite tunicate that can form dense aggregations. It is a native of the northwestern Pacific Ocean ranging from Japan to Siberia (Millar 1960) where it occurs as a fouling organism on immersed structures such as aquaculture equipment (Kang et al. 1980) as well as stones, rocks and other biota. It is unlikely to be mistaken for any other ascidian species in Ireland, as it is relatively large [it can attain a length of 22cm (Davis and Davis 2008)], with a club shaped body and a ‘leathery’ tunic. The first record of the species in Europe was in the Plymouth region, on the south coast of Britain, in the summer of 1953 (Carlisle 1954). It is thought that it was brought to Britain on returning warships at the time of the Korean War (Minchin and Duggan 1988). *S. clava* now occurs in many world regions, and is known from Port Phillip Bay, Australia (Hewitt et al. 1999), Wellington Harbour in New Zealand (Davis and Davis 2006), on the Pacific (Lambert and Lambert 1998, 2003) and Atlantic (Wonham and Carlton 2005; Pederson et al. 2005) coasts of North America. The species has been undergoing an expansion in Europe, and now ranges from Scotland (Davis and Davis 2004a) to the Mediterranean Sea (Davis and Davis 2008) and from Portugal (Davis and Davis 2005) eastwards to Denmark (Lützen 1999).

Its first appearance in Ireland was in Cork Harbour in 1971 (Guiry and Guiry 1973). In 1986, it was present throughout the innermost, often silted regions of the harbour attached to shells, stones and bottom laid oysters (Minchin and Duggan 1988). It was subsequently found in 2005 in sheltered intertidal areas and on oyster bags laid in trestles close to lowest tide. By 2005, it had extended its range to the marinas at Crosshaven in the Owenabwee Estuary (Minchin 2007). Spawning in Cork Harbour took place from September to November (Parker et al. 1999), thus providing a wide window for settlement. It also occurs outside of Cork Harbour, being found near the entrance of the 6.5 hectare Kilmore Lake, a marine lagoon on Whiddy Island in Bantry Bay, in 1998 (Healy 1998). It may have been brought there with half-grown oysters. This tunicate is now known from other locations that include the Fenit marina in Tralee Bay (Davis and Davis 2004a) and the marina in Dun Laoghaire Harbour, Dublin Bay, found there in 2004 (Minchin et al. 2006a). There was a single record from Dingle Harbour in 2004 (Minchin et al. 2006a); but specimens were not found here two years later (Minchin 2007). In
this account, we report the presence of *S. clava* from three previously unrecorded sites: two recent accounts from the northern coast of Ireland at Larne Harbour, Co. Antrim and Mulroy Bay, Co. Donegal, and from the shallow waters of Roaring Water Bay, Co. Cork on the south coast of Ireland.

**Material and Methods**

The two recent records of *Styela clava* from Irish northern localities were determined from collections made while SCUBA diving in May and June 2008. Specimens were collected for study at an ascidian workshop in August 2008 where its presence was confirmed on dissection. Shore sampling during July 2009 revealed further individuals in Larne Lough. In Roaring Water Bay, photographs were supplied by Vincent Roantree, and confirmation of the identity of *S. clava* was made from these.

**Results**

**Roaring Water Bay, Co. Cork**

*Styela clava* was found to the east of the entrance to Ballydehob, associated with mussel (*Mytilus edulis* L., 1758) longlines (Annex 1). Specimens were present in low numbers in 2006 (Vincent Roantree pers. comm.), and in 2007 they were more frequent. In 2008, the ascidian had become abundant on the undersurface of barrels, mooring lines and along the longline connecting the barrels (Figure 1) as well as the anchor lines for cultivating mussels *M. edulis*, but with only small numbers attached to the mussels held in cultivation (Jim O’Donnell, Colin Whooley pers. comm.). In 2009 they were present at a similar level of abundance.

**Mulroy Bay, Co. Donegal**

Agharooney Point, Lagmore Bay, North Water Six individuals were found at 11.5 to 12.5m depth attached to silty boulders on 25 May 2008 by JDN. Specimens were erect and had little associated fouling on their tests. On 3rd August 2008, close to the same position on a silty boulder slope, two individuals were collected from 13m depth and seven from 3-7m by divers attending an Ascidian Identification Workshop. These were attached to boulders, bedrock and to other sessile fauna. These ranged from 7-17cms total length.

![Figure 1. *Styela clava* attached to mooring lines in mussel culture in Roaring Water Bay (credit: Vincent Roantree)](image1)

![Figure 2. Low water occurrence of two *Styela clava* specimens from Larne Lough (credit: JDN)](image2)

**Massmount Bay, southern North Water** Ten individuals were found from 3-10m depth over a long slope over a gravel bottom on 26 June 2008 by B. Deegan and L. Scally. Specimens were not measured.

**Magheramourne Jetty, Larne Lough, Co. Antrim**

Single individuals were seen attached to the jetty pilings at a depth of 3-4m while diving on 18th June 2008 by J. Moore and C. Goodwin. A second dive on the same site on the same day resulted in a total of 8 specimens being removed. The identification was verified from photographs, but could be easily distinguished although the specimens were fouled. Further specimens were seen by divers on 12th August 2008. No specimens were seen by JDN during a subsequent visit to the intertidal area close to
and under the Jetty on 22nd August 2008. On 27th July 2009 a shore survey by JDN resulted in 3 specimens being seen - two attached to a tyre partly buried in mud ~200 m west of the Jetty (Figure 2) and one attached to Fucus serratus L., north of the Jetty.

*Styela clava* was observed on oyster trestles in Mill Bay, on the opposite eastern side of Larne Lough, in early 2009 (confirmation of identification was by staff at Northern Ireland Environment Agency from photographs). Three specimens were collected by JDN during a visit to Mill Bay on 28th July 2009 – two of these were attached to algae (one small), and one specimen floating free. A single specimen of *S. clava* was collected from a mooring rope in 1-2m at Ballydown (just north of Mill Bay) by A. and P. Ross on 25th July 2009.

**Discussion**

*Styela clava* was not found in Larne Lough in 2003 although its presence was expected (Minchin et al. 2006a). It may have been overlooked at this time. *S. clava* occurs at Ardrossan (Davis and Davis 2004b; Ashton et al. 2006) and Cairnryan in Lough Ryan, Scotland and there was the possibility of it being introduced with ferry traffic to Larne (Minchin et al. 2006a). This prediction was based on the likely past transmissions of *S. clava* by ferry to both Dun Laoghaire (Davis et al. 2007) and Cork Harbour (Guiry and Guiry 1973). It has been found on the hulls of decommissioned warships, barges and cranes. According to Davis et al. (2007), adults are unable to remain attached to a hull at speeds that exceed eight knots, although specimens may readily reside within sea-chests within the hull (Davis and Davis 2004b). While the short duration larval stage could be transmitted with ballast water over short journeys, this is thought to be unlikely, since ferries do not discharge significant amounts of ballast water. Leisure craft might also have transmitted the species attached to the hull (Minchin et al. 2006b).

The northern records of *S. clava* in Ireland are a recent and significant northward range extension. It remains unclear as to how the species could have arrived in Mulroy Bay or Larne Harbour. While it is possible that it spread from Scotland to Larne with ferry traffic, it is also possible that it was spread with leisure craft. There is a mooring area in Larne Lough associated with both the East Antrim Yacht Club and Larne Boat Club. In Asia, *S. clava* has been found on slow moving craft, on the hulls of barges and floating cranes (Xiuming 1979; Zhen 1988). The tunicates in Larne Harbour were also found close to an area where Pacific oysters *Crassostrea gigas* (Thunberg, 1793) are farmed on trestles on the shore, so it may have been introduced with transfers of oyster stock. The only other known areas with *S. clava* populations are where oysters are cultivated, Cork Harbour and on Whiddy Island in Bantry Bay, on the south coast of Ireland.

The appearance of *S. clava* in Mulroy Bay is more difficult to explain. This bay has strong tidal currents that pass through a series of narrow shallow channels; because of this, few craft make visits. Up until the mid-1980s, a small ship (coaster) used to enter the bay to berth at the Milford Quay, the most southern part of the Broadwater of this inlet, but there has been no known shipping traffic since then. From 1979 to 1994, there was a regular biological investigation in Mulroy Bay, and more than 200 dives were undertaken (by DM), but no *S. clava* were seen. The Agharooney Point site has been regularly dived by JDN (11 of the 18 years between 1990 and 2007 inclusive) without observing *S. clava*. This indicates a comparatively recent appearance. In 2005, pontoons at the northern end of the North Water were examined, and no *S. clava* were observed (Minchin 2007). In 2007, there was a development in the Bay involving the building of a bridge over one of the narrow Lough constrictions. A platform would have been used to survey this area, and might have been the source of an inoculation. However, the bridge site is situated some 9km away from the Mulroy Bay records, and no *S. clava* were found in the vicinity of the bridge area (B Deegan, L Scally, pers. comm.). There are no known imports of Pacific oysters that could explain an occurrence, and no oyster cultivation is known in the vicinity of the findings.

*S. clava* can attain high densities. It has caused serious impacts to the mussel *Mytilus edulis* culture industry in Prince Edward Island in the Gulf of St Lawrence in North America (Bourque et al. 2005) by overgrowing mussels to such an extent as to reduce their growth and commercial production. In the north-west Pacific it fouls aquaculture installations at varying levels of intensity, for example those used to culture the oyster *Crassostrea gigas* (Kang et al. 1980), scallop *Pinctopecten yessoensis* (Jay, 1857) (DM pers. obs. 1990), edible sea-squirt (*Rho et al.*
1993) and the netting of fish cages (Cao et al. 1998). In Ireland, it fouls bottom cultured oysters *Ostrea edulis* L., 1758 and *C. gigas* (Minchin and Duggan 1988); oyster bags on trestles (DM pers. obs.); marina pontoons (Minchin et al. 2006a) and hulls (Minchin and Duggan 1988); and idle recreational vessels (Minchin 2007), all at low levels of abundance. Elsewhere in Europe, it has been recorded at densities of up to ~1000 m\(^{-2}\) (Sandee et al. 1980).

However, the high density of *S. clava* in Roaring Water Bay is of some concern (Figure 1). Should its abundance increase further, it may compromise mussel cultivation in this region. On the south-west coast of Britain, increases of its abundance on mussel lines has also been noted (ICES 2008).

As Mulroy Bay is an area with a high dependency on aquaculture, there are concerns that the presence of this tunicate might also diminish molluscan production in this region, and add to the burden of fouling on fish cage netting. *S. clava* spawns as water temperatures rise above 15°C (Bourque et al. 2005) and larvae could be found as temperatures descended to as low as 11°C. Spawning is more profuse at water temperatures above 16°C; the longer this is sustained the greater the opportunity for settlements (Davis et al. 2007). These temperatures are regularly reached in July and August in each year. In 2007, water temperatures attained 16.5°C or more at a depth of 8m in Mulroy Bay for a short period. In the previous year, the water temperature was two degrees higher for about a month and attained 18°C for a short period (http://www.marine.ie). Should sea temperatures increase over the coming century, as a result of alterations to climate, more favourable annual recruitment may be expected (Boelens et al. 2005). Under such circumstances, fouling of aquaculture structures may attain levels likely to lead to the requirement for cleaning of stock and equipment, causing increased production costs.

Continued monitoring of this species, in conjunction with environmental conditions, is recommended where this species occurs in aquaculture areas. At some time it may become necessary to treat cultured molluscs to reduce the ascidian burden by using, for example, 5% acetic acid sprays (Carver et al. 2003) or brine dipping (Minchin and Duggan 1988). In New Zealand, treatment involving a 5% solution of a spray of sodium hypochlorite for *Didemnum vexillum*, which has a highly acid tunic, was found to be effective (Chris Denny pers. comm.).

*S. clava* is a robust species occurring in shaded intertidal areas, but is also capable of surviving aerial exposure under damp conditions for up to three days (Lützen and Sørensen 1993). It can endure temperatures ranging from -2 to 23°C (Buizer 1980; Lützen 1999), and has been found to depths of 40m offshore (Dauvin et al. 1991). However, it is more frequently encountered in the sheltered conditions found in some ports, bays and inlets. It tolerates salinities as low as 22 PSU over short periods of time (Davis et al. 2007) and so can occur in estuaries. It is well suited to maintain its Irish populations in the three new localities, as there is little freshwater inundation to these inlets and temperatures are well within its physiological range. While not all appearances of *S. clava* will lead to successful colonisation of the locality, it is likely that where they are presently established they will persist. It is from such populations that further Irish ports, harbours and estuaries will become colonised; this is particularly likely to occur in the highly indented south-west to north-west coastal areas. The recent findings suggest that since 2003 (Figure 3) there has been a considerable increase in the range of this species, and it has become abundant in one locality.
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References


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### Annex 1. Known occurrences of *Styela clava* in Ireland

<table>
<thead>
<tr>
<th>Survey site (Figure 3)</th>
<th>Location</th>
<th>Geographic coordinates</th>
<th>Year of first record</th>
<th>Status</th>
<th>Reference</th>
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<tbody>
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<td></td>
<td>Latitude (N)</td>
<td>Longitude (W)</td>
<td></td>
<td></td>
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<td>1</td>
<td>Dun Laoghaire Marina</td>
<td>53º17.82'</td>
<td>06º08.08'</td>
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<td>individuals</td>
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<td>2</td>
<td>North Channel, Cork Harbour</td>
<td>51º52.52'</td>
<td>08º12.46'</td>
<td>1971</td>
<td>clusters</td>
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<td>Marloge Marina</td>
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<td>2004</td>
<td>clusters</td>
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<td>4</td>
<td>Crosshaven Pier</td>
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<td>08º18.25'</td>
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<td>individuals</td>
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<td>51º32.50'</td>
<td>09º24.00'</td>
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<td>abundant</td>
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<tr>
<td>6</td>
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<td>51º41.18'</td>
<td>09º30.17'</td>
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<td>individuals</td>
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<td>10º16.67'</td>
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<td>09º51.75'</td>
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<td>05º46.09'</td>
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