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Research article

Spread of the Asian tunicate *Styela clava* Herdman, 1882 to the east and south-west coasts of Ireland

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Abstract

The Asian tunicate *Styela clava* Herdman, 1882 has been found at three new localities in Ireland during the period 2004 to 2005. The new localities are Dublin Bay on the east coast of Ireland and Tralee and Dingle bays on the south-west coast. They are present in low abundance. Before they have been known in Ireland since 1971 only from Cork Harbour on the south coast. All three sites where they were found are marinas for leisure craft.

Key words: *Styela clava*, invasive species, marina, leisure craft, Ireland, tunicate, ascidian

Introduction

Styela clava is a solitary, hermaphroditic, oviparous ascidian native to the north-western Pacific with a range from Japan to Siberia (Millar 1960). Its firm club-shaped body can attain a length of 200 mm, and attaches by an expanded membranous plate. It was first recorded in European waters, on the south coast of Britain, in 1953 as *Styela mammiculata* (Carlisle 1954). Since then it has expanded its range north to Denmark (Christiansen and Thomsen 1981) and south to Portugal (Davis and Davis 2005). It continues to spread worldwide. It is known from south Australia (Hewitt et al. 1999) and was found in 2005 in New Zealand (Davis and Davis 2006). It occurs on both coasts of North America (Wonham and Carlton 2005) and has recently been found on the west coast of Canada (Lambert 2003). In the St Lawrence Estuary, eastern Canada, it has caused declines in the production of the cultivated mussel *Mytilus edulis* (Bourque et al. 2005). Within its native range it is known to encumber the hanging culture of oysters (Kang et al. 1980) and edible sea-squirts (Rho et al. 1993), and foul fish cages (Cao et al. 1998). Densities of ~1000 m^{-2} are known in European waters (Sandee et al. 1980). The species is robust and can tolerate temperatures ranging from –2 to 23°C (Buizer 1980, Lützen 1999); it is capable of surviving for up to three days under cool damp conditions out of water (Lützen and Sørensen 1993). This account records its presence at three new sites in Ireland (Figure1).

It was first found in Ireland in Cork Harbour, on the south coast, in 1971 (Guiry and Guiry 1973). In 1986, it was present throughout the innermost region of this harbour and was found attached to oysters (Minchin and Duggan 1988). Specimens attained 14.5 cm in length and 50 g wet weight. In 1997 its reproduction was investigated and spawning was noted from September to November (Parker et al. 1999). Specimens were removed from floating pontoons at Marloge, East Ferry, in March 1999, and from the North Channel from a disused oyster farm during July 2002 (Figure 2). The Cork Harbour population would appear to be well established.

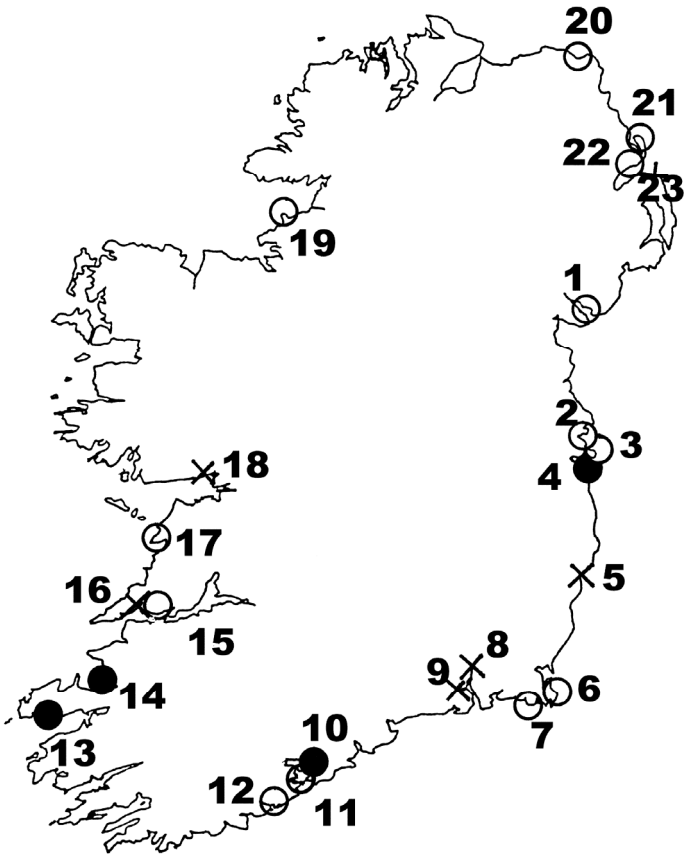

Figure 1. Areas sampled for *S. clava* in Ireland 2002-2006. Crosses indicate brackish water, open circles high salinity and dots where *S. clava* was found

Its occurrence and spread within Ireland is of concern because it fouls submerged structures and could impact on mollusc culture. We report on three new localities following a rapid survey of different regions in Ireland. We sampled floating pontoons, used for berthing small craft at marinas, and docks and quays. This is similar to the method undertaken to monitor the distribution of exotic species in North America (Pedersen et al. 2005). Pontoon surfaces, supporting piles and quay walls were examined either by feeling for the erect, firm specimens of *S. clava*, which protruded above the other ascidians present, or by scraping adhered biota from the surfaces.

Observations on the Irish coast

Twenty-three sites from all Irish coasts were examined from 2002 to 2005 (Figure 1, Annex). The following records extend its range in Ireland:

Locality 1: Fenit Harbour Marina, Co Kerry. Several were found in Fenit Harbour marina in September 2004 (Davis and Davis 2004a) and specimens were present in March 2005. Pontoons, pontoon 'fingers' and supporting piles had a dense fouling community of marine algae and the ascidians *Ascidiella aspersa, Ciona intestinalis, Molgula* sp, and *Botyllus schlosseri*; *S. clava* was sparsely distributed. The protruding *S. clava* tests were extensively fouled with smaller tunicates. Some *Styela* recruitment was noted; individuals from 2 to 3.5 cm in length were found, whereas the larger size class ranged from 12.5 to 16 cm in length. Specimens from Fenit Harbour have been deposited in the National Museum of Ireland.

Locality 2: Dingle Marina, Co Kerry. The pontoons supported a dense fouling community of *Laminaria*, *Fucus*, mussels, barnacles, anemones, fan worms, sponges and ascidians, principally

Ascidiella aspersa, Ciona intestinalis, Molgula sp, *Botyllus schlosseri* and occasional *Styela clava.* Ten *S. clava* of 60 to 115 mm, were found in September 2004.

Locality 3: Dun Laoghaire Marina, Co Dublin The principal fouling was from *Laminaria* sp, barnacles, mussels, anemones, sponges, *Ascidiella aspersa, Ciona intestinalis,* and *Molgula* sp. No *S. clava* were found in August 2003, despite extensive searching, however, three (60, 75 and 85 mm) were found in August 2004 and fifteen (75 to 180 mm) were found in November 2005; the size of these specimens suggests that they were between one and two years old. There was one small individual 15mm attached to the test of a specimen of 115mm. All were found within a small area of the pontoon array. In January 2006 several specimens were found at the northern side of the marina where they had not been seen in 2005.

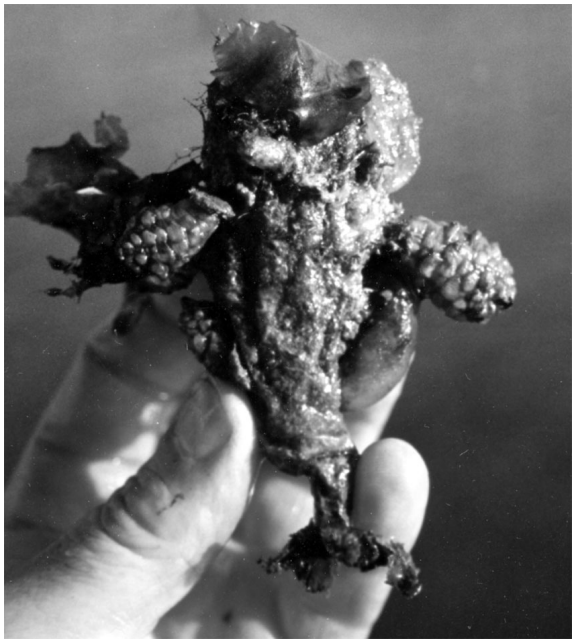

Figure 2. *S. clava* from Cork Harbour showing smaller attached individuals

Discussion

Styela clava larvae hatch from released eggs after ~12 hours and are active for a similar period before settlement. They rarely travel more than a few centimetres by sustained swimming activity and so normally congregate close to the parent population, but can be dispersed within an area covered by two tidal excursions. Populations tend to be continuous within suitable habitats at any locality, and adjacent bays and inlets may become populated as has happened in the Solent (Southern England) and the Limfjord (Denmark).

The larvae, although negatively buoyant, are negatively geotactic and positively phototactic, particularly when exposed to increased hydrostatic pressures and so they tend to settle near the water surface (Davis 1997). This makes pontoons, with their silt-free surfaces, suitable for settlement. Suitable conditions for establishment are found in sheltered localities with >22 psu and temperatures ≥16ºC for several weeks (Davis et al., in prep.).

Styela clava is thought to have first arrived in Europe in 1952 with naval vessels returning from the Korean War (Minchin and Duggan 1988). In eastern Asia it has since been found on the hulls of barges and floating cranes in Chinese ports (Xiuming et al. 1979, Zhen 1988). Consequently naval vessels could have acquired fouling, including *S. clava*, in the Yellow Sea before their departure from Korea. On return to Britain, naval craft are likely to have remained in port for some months, permitting a local population to evolve. *S. clava* has been found on a ship's hull in Cork Harbour (Minchin and Duggan 1988) and on towed vessels in Britain (Davis and Davis 2004b) including a decommissioned warship that had been towed between ports on the south coast of Britain. Towed and slow-moving vessels are a likely source for an introduction, as recent investigations by Davis and Davis (in prep.) indicate. At speeds of 5+ knots they can become stripped from the hull surface, unless they occur within protected hull spaces, such as sea-chests and thruster tubes (Davis and Davis 2004b). A wide range of taxa are known to occur on ships' hulls and some may evolve significant settlements arising from being anchored over a few days (Minchin and Gollasch 2003).

Leisure craft may remain idle for long periods, and so acquire high fouling burdens that include tunicates (Minchin et al. 2006). Although no *S. clava* have been found on such craft during visits to Cork Harbour, it is possible that boats known to have visited Fenit could have transmitted the species. As most small craft are serviced each year, and since *S. clava* reproduces in the year following settlement, it is those vessels not serviced over-winter that may transport them. The appearance of *S. clava* at marina sites could implicate small craft in transmissions; such

vessels do not normally attain the speed of a ship and individuals might remain attached to hull surfaces during voyages. Recent studies show that small craft can indeed transmit alien species (Minchin et al. 2006). The recent construction of marinas in Fenit (130 berths developed since 1996), Dingle (80 berths developed since 1992) and Dun Laoghaire (with 500 berths and opened in 2001) may have enabled this recent expansion. Recruitment appears to have taken place in Fenit and Dun Laoghaire but establishment at these three marina sites will need to be confirmed.

Commercial ships are likely to continue to carry *S. clava* as juveniles and adults attached to hulls. Sea-going barges that visit Fenit port may have populated this area from a port elsewhere in northern Europe. Such vessels enter dry-dock for servicing every three to five years; in the meantime this could provide sufficient time for dense fouling accumulations to form especially in protected hull spaces and areas where there are weathered antifouling treatments. It is possible commercial shipping could transport *S. clava* short distances as larvae in ballast in August and September. Transport in ballast water has been proposed as one of the main means for introducing species (see, for example, Carlton 1985). Any ship taking on ballast water in a port with a *S. clava* population will inevitably take-up larvae with the water. Should these be discharged in a viable state, less than 12 hours later, a new population could evolve. Colonisation will depend on conditions being suitable for growth and reproduction. In this way the Dun Laoghaire Harbour population might have been sourced from Holyhead by the regular ferry service; however, ferries do not normally carry large volumes of ballast water. Should ferry traffic be important in the spread of this species, then populations may be expected to appear in Larne Harbour, Belfast Lough and Rosslaire Port if conditions are suitable. These have shipping connections with ports containing *S. clava* populations (Cairnryan, Scotland with a service to Larne, Northern Ireland; Liverpool, England with a service to Belfast Northern Ireland; Cherbourg/Roscoff, northern France with a service to Rosslare, Ireland).

Dingle has little coastal ship traffic; the main arrivals are of leisure craft and fishing vessels from other Irish ports. Thus it seems likely that recreational boats may have introduced *S. clava*.

S. clava could also have been moved with oysters. Although there is a recommended means to control its spread by using brine dips (Minchin and Duggan 1988), this practice is not generally undertaken. Pacific oyster (*Crassostrea gigas*) movements from Cork Harbour to Tralee Bay, where there is a valuable native oyster (*Ostrea edulis*) fishery, are unlikely as this is not permitted. Oyster movements from Cork Harbour to Dingle and Dun Laoghaire Harbours are not known to have taken place.

It is expected that *S. clava* will expand its range in Ireland and elsewhere in Europe. Hull fouling is a likely mode of spread and small craft may also be capable of transmissions.

Samples of branchial basket tissue from each population have been submitted for DNA analysis and may enable the origin of each of the three populations to be identified to help elucidate transmission routes.

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Annex

Distribution of sampling sites in Ireland 2002-2006*. Observers DM – Dan Minchin, D – Martin and Mary Davis

Map Ref.	Location	Dates of surveys	Location coordinates		Salinity (psu)	Present	Observer
			Latitude, ºN	Longitude, ºW			
1	Carlingford marina	03.08.2005	54° 03.01’	06° 11.27’	N.A (marine)	No	DM
2	Malahide marina	06.08.2003 12.10.2005 18.01.2006	53º 27.26’	06º 09.21’	30.6, N.A, 33	No	D, DM
3	Howth marina	06.08.2003 17.04.2005 18.01.2006	53º 23.35’	06º 03.92’	25.9	No	D, DM
4	Dun Laoghaire marina	28.08.2004 15.04.2005 20.08.2005 18.01.2006	53º 17.82’	06º 08.08’	31.8, N.A, N.A, 34	Yes	D, DM
5	Arklow	02.08.2003	52º 47.72’	06º 08.66’	3.0	No	D
6	Rosslaire Quay	03.08.2003	52º 15.36’	06º 20.13’	32.2	No	D
7	Kilmore Quay marina	02.08.2003 03.04.2005	52º 10.35’	06º 35.20’	32.1, N.A	No	D, DM
8	New Ross Quay	03.08.2003	52º 23.44’	06º 57.00’	3.2	No	D
9	Waterford Quay	12.07.2002 02.08.2003	52º 15.64’	07º 06.28’	8.4, N.A	No	DM, D
10	Marloge marina	06.08.2004	51° 52.02’	08° 12.34’	31.4	Yes	DM
11	Crosshaven Pier	03.08.2003 14.08.2004	51º 48.28’	08º 18.25’	30.8, N.A	No	D, DM
12	Kinsale marina	14.06.2002 04.08.2003	51º 42.10’	08º 31.05’	N.A, 29.0	No	DM, D
13	Dingle marina	24.09.2004	52º 08.29’	10º 16.67’	29.8	Yes	D
14	Fenit marina	04.08.2003 24.09.2004 31.03.2005	52º 16.25’	09º 51.75’	30.2, N.A	Yes	D, DM
15	Foynes Port	24.09.2004	52º 36.93’	09º 06.07’	22.8	No	D
16	Kilrush marina	21.09.2004 02.06.2005	52º 38.10’	09º 29.67’	2.5, N.A	No	D, DM
17	Liscannor Pier	25.09.2004	52º 56.36’	09º 23.98’	31.7	No	D
18	Galway docks	22.04.2005	53° 16.19’	09° 03.00’	3	No	DM
19	Mullaghmore pontoon	08.08.2005	54° 27.78’	08° 26.23’	33.2	No	DM
20	Ballycastle Quay	05.08.2003	54º 12.40’	06º 16.38’	28.3	No	D
21	Larne Harbour	05.08.2003	54º 50.95’	05º 47.73’	31.5	No	D
22	Carrickfergus marina	05.08.2003	54º 42.65’	05º 48.80’	30.7	No	D
23	Bangor Harbour	12.11.2005	54º 39.86’	05º 40.19’	14.9	No	D

*Full reference to the data: Minchin D, Davis MH and Davis ME (2006) Spread of the Asian tunicate *Styela clava* Herdman, 1882 to the east and south-wests coasts of Ireland. Aquatic Invasions 1 (2): 91-96