

Aquatic Invasions Records

The slipper limpet *Crepidula fornicata* Linnaeus, 1758 becomes established in Ireland

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Abstract

Chains and solitary individuals of the slipper limpet *Crepidula fornicata* were found, some with egg capsules, at several localities within Belfast Lough on the north-east coast of Ireland during 2009. The species is widely dispersed, being found on the lower shore to depths of 7 m attached to scallops, mussels and stones and so is considered to be established. Shell winter growth checks indicated a possible arrival in or before 2004. While there have been previous records of this invasive species in Ireland, this is the only known established population.

Key words: slipper limpet, *Crepidula*, Belfast Lough, Ireland, alien, exotic

Introduction

The snail, the slipper limpet *Crepidula fornicata* Linnaeus, 1758, is native to the east coast of North America. It probably became established in Europe in the late 1870s following imports of American oysters *Crassostrea virginica* (Gmelin, 1791) to the south-east coast of Britain but was first recognised in 1893 (Crouch 1895). From there it has spread to most of the Atlantic coast of Europe ranging from Norway to Spain (Richard et al. 2006), with some small populations in the Mediterranean Sea (Parenzen 1939). It is well established in some inlets of the Bristol Channel (Seaward 1982). It has in recent decades spread northwards in Britain with related consignments of blue mussels *Mytilus edulis* Linnaeus, 1758 to the Menai Strait in the Irish Sea in 2006, where there was an attempt to remove it (Countryside Council for Wales 2009).

This species mainly occurs from low water to depths of ~20m (Blanchard 1997). Individuals start out as wandering males and subsequently settle and become females. Additional males cling to such females to form chains which may be composed of up to a dozen individuals (Fretter and Graham 1981). They can form vast

numbers sufficient to alter habitat, change communities, and in some localities form the predominant composition of biomass. Over a million tonnes of this species now exist in European waters (Quiniou and Blanchard 1987; Sauriau et al. 1989). Its appearance in Ireland was predicted with imports of half-grown oysters in the 1920s (Spicer 1923). While its occurrence from Belfast Lough is referred to by Fretter and Graham (1981) and subsequently by Hayward and Ryland (1995), the record was not recognised by Smith (1976). We know of no confirmed records of this species in this lough until those reported here. An erroneous record for Belfast Lough from the late 1990s was published on the NBN Gateway <http://data.nbn.org.uk> before being corrected. We describe the relative abundance and distribution of the species in Belfast Lough.

Material and methods

Collections were made by dredging (two foot scallop dredge) in March 2009 during an investigation by the Agri-Food and Biosciences Institute of all licensed aquaculture beds in

Belfast Lough. Two specimens of *Crepidula fornicata* were identified from this survey.

This find prompted a series of shore line surveys undertaken by walking stretches of the intertidal close to low water in Belfast Lough within one hour before and up to one hour after low water during March and May 2009, and April 2010. Intertidal visits were also made to a few sites in Carlingford Lough (May 2009) and Larne Lough (July 2009).

A further eighteen stations were dredged over mussel aquaculture beds in Belfast Lough in April 2009.

Specimens obtained were measured for longest straight (antero-posterior) length and distance between observed distinct winter growth check marks, using callipers to the nearest tenth of a millimetre. The first 1mm of each shell from the apex was not included (pre-settlement growth; Fretter and Graham 1981). Disturbance growth marks on the largest individuals were used to back-calculate an estimate of earlier years of its likely existence in Belfast Lough.

Results

Two live specimens of *Crepidula fornicata* were found attached to live scallops *Pecten maximus* (Linnaeus, 1758) collected from 4m on 4th March 2009 in Belfast Lough (Annex 1). A further 18 living and 3 fresh dead shells were collected from the shore at Jordanstown on the north side of Belfast Lough also in March 2009. These were attached to stones and shell (Figure 1). Two contained egg capsules (35+). A single specimen was collected at Fisherman's Quay shore, north of Jordanstown (March 2009), and a further 11 living attached to stones and shell and two recently vacated shells from the same area. Two specimens were found with egg capsules present under the shell (20+). A search at nearby Kilroot Power Station (north of this area) did not reveal any specimens. A further 15 specimens were observed during a revisit to Fisherman's Quay in April 2010.

Nine specimens of *C. fornicata* were collected from three stations during a dredge survey of the mussel beds in Belfast Lough in April 2009 at depths from 2-6m. Three of these were attached to living *Mytilus edulis*; the remainder were attached to vacant shells and stones. This is an area that is restocked with mussels from elsewhere.



Figure 1. Low water occurrence of three *Crepidula fornicata* specimens from Jordanstown, Belfast Lough (photo credit: JN).

One living specimen attached to a stone, and a recently vacated shell, were collected on the south shore of Belfast Lough at Craigavad and Seapark respectively in May 2009.

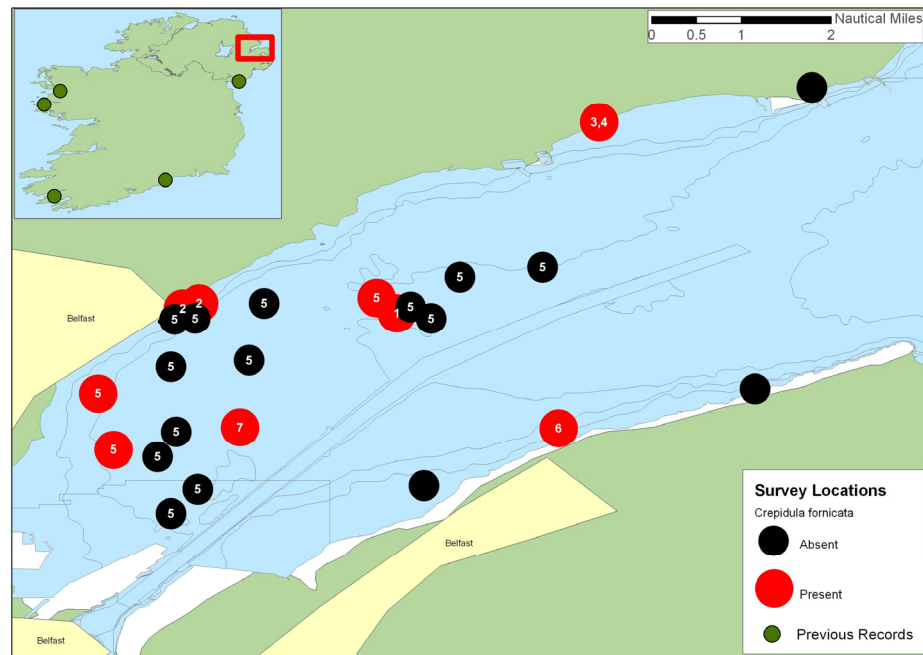
Two specimens in a chain attached to a large mature *Mytilus edulis* were found offshore in Belfast Lough in August 2009 (4m).

In February 2009, there was a report from The Netherlands of *C. fornicata* in mussels originating from Carlingford Lough. Yet despite two dredge surveys carried out in May 2009 by NIEA, in collaboration with the Marine Institute, Loughs Agency and the mussel aquaculture industry and a second undertaken by AFBI, there was no indication of its presence, suggesting a case of sample contamination. No specimens were found during searches on the north shore of Carlingford Lough (May 2009) or at selected shores in Larne Lough (July 2009).

In all sixty living *C. fornicata*, with chains of up to three individuals, as well as six recently vacated shells were collected from Belfast Lough in 2009 and early 2010 (Figure 2; Annex 1). Four females with broods were observed.

The live specimens ranged in shell length from 7.8 to 43.0 mm. Nineteen of these specimens (all collected in March 2009) were measured for winter (disturbance) growth checks. There appeared to be up to five year classes, with four distinct disturbance rings, indicating that the largest specimens measured (all from the intertidal) may have settled in early 2004 or late 2003. Growth for all classes averaged 9.7 and 8.6 mm for first and second years respectively since settlement, which is consistent with expected growth rates (Fretter and Graham 1981).

Figure 2. Sites visited in Belfast Lough during the present study, showing records of *Crepidula fornicata* (see Annex 1 for localities).



Discussion

We show the occurrence of *Crepidula fornicata* from Belfast Lough. No shell or specimens were recovered in surveys in the nearby Carlingford and Larne Loughs, where the Pacific oyster *Crassostrea gigas* is cultivated on trestles. Although only a small number of individuals were recovered in this study, their wide distribution from the lower shore to depths of 6m and the presence of a brood in four individuals indicate that the species is established.

Its first appearance in Ireland was with imports of half-grown American oysters (Sykes 1905) arriving in Ballinakill Bay on the west coast of Ireland in wooden oyster barrels originally imported from Long Island Sound to Britain. These were removed before the oysters were laid on the shore. It is possible that living specimens may, in the early 1920s, have been introduced by the same means to Carlingford Lough because six worn shells (of 18-38 mm shell length) appear in the collections of the National Museum of Ireland, Dublin labelled NMI 130.1925. However, no living specimens have since been recorded from this bay until the European open trade agreement, operating from January 1993, a time when imports of Pacific half-grown oysters, with low numbers of small

male specimens attached to oyster shells, were imported from France (Minchin et al. 1995). Males were also found on such imports to Dungarvan and Carlingford bays on the southern and eastern coasts of Ireland respectively. The oysters were held in meshed bags on trestles. Some months later the oysters were re-examined and no further specimens were found. It is likely these had become crushed by the turning of oysters within the bags.

Other records of *C. fornicata* exist but no living material is known to have survived following these records. Some of the records pre-date the cold winter of 1962-63 (Crisp 1964), during which two populations reported initially by Arnold (1960) from Kilmakilloge, Kenmare Bay on the south-west coast of Ireland and from Clew Bay on the west coast of Ireland (Minchin et al. 1995) may have died out. Both of these sites were carefully examined in the 1970s and the 1980s respectively and no shell material was found. There are other records of shells from the Irish coast. A single shell is known from Dublin Bay and some dozens of shells from Tralee Bay, following an import of autoclaved mussel shell from the Netherlands. The *C. fornicata* shells were laid together with the mussel shells on a native oyster *Ostrea edulis* fishery area with the intention of improving oyster settlements

(Minchin et al. 1995). However, subsequent examination of shores and sublittoral areas did not reveal any live *C. fornicata*.

In 2007, the forward part of the MV Napoli was held in Belfast Lough prior to dismantling. This vessel spent seven months beached in Lyme Bay, Dorset where *C. fornicata* is common. Samples taken from the vessel prior to transit to Belfast Lough (examined by CEFAS) revealed only a single small specimen of *C. fornicata*. The anchor and chain were cleaned prior to arrival in Belfast Lough, and no work was carried out on the vessel until it was in dry dock. *C. fornicata* develops as a male, but rapidly changes to female if it settles alone. Reproductive maturity for females is not reached for a minimum of 10 months, and normally not until the second or third year (Deslous-Paoli 1985). Once two years of age, they are normally not capable of movement (Fretter and Graham 1981) having attached to shell or stones. It is therefore extremely unlikely this vessel was the source of the *C. fornicata* population. The larger specimens collected were present before 2007, and there were very low numbers recovered from the hull, which we consider to be insufficient to generate a new population.

There are four possible ways that this snail may have become introduced. There is evidence that it can be transmitted on the hulls of vessels (Blanchard 1995), with consignments of oysters (Walne 1956) or mussels (Countryside Council for Wales 2009), with drifting materials (Korringa 1951) or possibly, but less likely, as a result of larvae dispersing from Britain.

The appearance of *C. fornicata* in Belfast Lough is probably associated with imports of mussels from Britain. Consignments of mussels from Wales for relaying in Belfast Lough are known to have been turned away during the early 2000s. It is possible that these may have been dumped in Belfast Lough, as their return would have been unsupervised. Such events could explain the current distribution. The presence of *C. fornicata* in Menai Strait was a result of a similar event (Sewell et al. 2008), but the relaying was confined to a comparatively small area. The control measures used to eliminate it at that locality may have been successful. However, the widely dispersed distribution of the species in Belfast Lough means it is unlikely to become controlled.

The current observations from Belfast Lough are the only records of an existing population in Ireland. Shell growth is known to cease between

January and March, resulting in an annual growth check (Fretter and Graham 1981). On this basis, the checks on the shell indicate that some *C. fornicata* were present in the Lough in or prior to 2004. This snail may extend its range further within Ireland. The significance of this introduction is likely to have serious economic impacts on resources, as it has on continental Europe (Richard et al. 2006). It may modify the trophic dynamics not only in Belfast Lough, but through its inevitable spread to other areas about the Irish coast.

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Annex 1. Known occurrences of living *Crepidula fornicata* in Ireland; new records in bold. Numbers refer to sites shown in Figure 2.

Figure Ref.	Location	Geographic co-ordinates		First record	Status	Reference
		Latitude, °N	Longitude, °W			
	Ballinakill Bay	53°33'	09°59'	1902	removed	Sykes 1905
	Killmakilloge	51°45'	09°47'	1960	extinct	Arnold 1960
	Clew Bay	53°49'	09° 40'	1960s	extinct	Minchin et al. 1995
	Dungarvan Bay	52°04'	07°35'	1993	individual males	Minchin pers. ob.
	Carlingford Lough	54°01'	06°08'	1993	individual males	Minchin pers. ob.
1	Belfast Lough: Folly Roads (4m)	54°40.97'	05°50.23'	04.03.2009	2 individuals	new record
2	Belfast Lough: Jordantown shore	54°40.98'	05°52.83'	09.03.2009 and 12.03.2009	18 individuals including 3 chains	new record
3	Belfast Lough: Fisherman's Quay shore	54°43.09'	05°47.83'	11.03.2009	1 individual	new record T. Cowan
4	Belfast Lough: Fisherman's Quay shore	54°43.09'	05°47.83'	25.03.2009 26.04.2010	11 + 15 individuals including 3+ 6 chains	new record
5	Belfast Lough: mussel beds (2-7m)	54°40.07' 54°39.44' 54°41.14'	05°53.41' 05°53.24' 05°50.31'	06.04.2009	9 individuals	new record
6	Belfast Lough: Craigavad shore	54°39.68'	05°48.28'	29.05.2009	1 individual	new record
7	Belfast Lough: Navital	54°39.69'	05°51.83'	02.08.2009	2 individuals in a chain	new record J. Erskine