

Rapid Communication

The most northern records of the exotic ascidian *Perophora japonica* Oka, 1927 (Ascidiacea: Perophoridae) in the north-east Atlantic

Dan Minchin^{1,2,*}, Julia Nunn^{3,4} and Bernard Picton⁵

¹Marine Organism Investigations, Marina Village, Ballina, Killaloe, Co Clare, Ireland

²Marine Science and Technology Centre, Klaipeda University, 84 Manto, Klaipeda, Lithuania

³Centre for Environmental Data and Recording, National Museums Northern Ireland, 153 Bangor Road, Cultra, Co. Down, BT18 0EU, Northern Ireland

⁴Cherry Cottage, 11 Ballyhaft Road, Newtownards, Co. Down, BT22 2AW, Northern Ireland

⁵Department of Natural Sciences, National Museums Northern Ireland, 153 Bangor Road, Cultra, Co. Down, BT18 0EU, Northern Ireland

*Corresponding author

E-mail: moitreland@yahoo.ie

Received: 14 May 2016 / Accepted: 20 July 2016 / Published online: 15 August 2016

Handling editor: April Blakeslee

Abstract

The northwest Pacific colonial ascidian *Perophora japonica* Oka, 1927 was first reported from Ireland in 2012 from Carlingford Marina and with increased frequency by 2014. Colonies were found in three additional marine inlets: Strangford Lough in 2012, Mulroy Bay in 2013, and Clew Bay in 2015. Colonies overgrew marine algae and sessile invertebrates attached to floating pontoon units supporting a marina boardwalk, and were also found on the low shore and at depths of 24 m. The species should now be considered established in Ireland. It is unknown how this ascidian arrived, but it is likely to be from elsewhere in Europe either on the hulls of vessels, with commercial oyster movements, or with drifting algae. These are currently the most northern records for the species in the north-east Atlantic, the nearest records to Ireland being from Anglesey on the north coast of Wales.

Key words: tunicate, Ireland, introduction, non-indigenous, range expansion, marine

Introduction

The colonial tunicate *Perophora japonica* Oka, 1927 is native to the northwest Pacific Ocean, and is commonly found along coasts in the Sea of Japan, and Pacific coasts of the islands of Hokkaido and Honshu, Japan, and from the Korean Strait (Nishikawa 1991). In Japan, it has been reported to foul Pacific oysters in cultivation (Akawara 1990). Within the Pacific, the species has been introduced to California on the west coast of North America, where it is known from a marina in Humboldt Bay in 2003 (Lambert 2005) and in 2011 from San Diego Bay and in 2012 from Bodega Harbor (California Department of Fish and Wildlife 2014).

On European Atlantic coasts, it was first recorded in 1982 from Normandy and northern Brittany (Monniot and Monniot 1985), and subsequently found

in the Gironde Estuary in the Bay of Biscay in 1992 (Pérez-Portela et al. 2012), in The Netherlands in 2004 (Faasse 2004; Gittenberger 2007), and north-western Spain in 2008 (El Nagar et al. 2010).

Perophora japonica appeared on the southwest coast of Britain at a marina in Plymouth Sound in August 1999 (Nishikawa et al. 2000). There was a brief presence a few years later in the Fleet Lagoon, on the south coast (Baldock and Bishop 2001). There are records from Guernsey in 2003, 2005 and 2007 (Bishop 2005; Pérez-Portela et al. 2012; Ryland et al. 2009). It appeared on the Norfolk coast south-east England in 2010 (Spray and Watson 2011) and in 2012 from the Helford River on the Cornish coast (Gall 2012) and Anglesey (Wales) (NBN Gateway 2016). To date, it has not been recorded in Scotland (Nall et al. 2015). Here we report the occurrence of *Perophora japonica* from three sea lochs on the

northern coasts, and Clew Bay on the western coast of the island of Ireland, representing the most northerly populations in the north-east Atlantic.

Methods and results

Marinas and shores were examined on the north-eastern Irish coast (Figure 1) during August and September 2012 from Carlingford Lough to Lough Foyle (Minchin and Nunn 2013). In Strangford Lough, colonies were encountered while examining the biota on the lower shore in August or September of 2012, 2013 and 2015. In Carlingford Lough, a marina berthing a hundred and fifty leisure craft, was examined during 2005, 2006, 2008, 2012 and 2014 (Minchin 2007; Ryland et al. 2009; Minchin and Nunn 2013). The exposed sides of the marina floating pontoons that support boardwalks were sampled using a scraper with pocket net that collected loosened fouling organisms. Floating pontoons are easily accessed at all tidal stages, whereas sampling on the lower shore restricted sampling time. Colonies were also collected at 24.2 m by using a 0.1m² Day grab in Carlingford Lough in July 2013 (R. Snijder pers. comm.) and from the shore in June 2013. In Mulroy Bay and Clew Bay, colonies were encountered while examining the biota on the lower shore in June 2013 (Mulroy) and August 2015 (Clew Bay).

Perophora japonica could be distinguished from the native *Perophora listeri* Forbes, 1848 by the green-yellow translucent zooids of ~4 mm and yellow, usually distal, stellate plaques (although these are seasonal). The native *P. listeri* has zooids which are generally transparent and somewhat laterally flattened (Millar 1970), and is the only native species of this genus known from British waters (Nishikawa et al. 2000).

Perophora japonica was found in four loughs and multiple sites within each lough (Table 1; Figure 1). A small number of colonies were first found attached to the holdfasts of *Saccharina latissima* (L.) Lamouroux at Carlingford Marina during late August of 2012. It was present at a low abundance on three of the thirty pontoons sampled (Minchin and Nunn 2013). By September 2014, colonies were more abundant on the laminae and holdfasts of this kelp (Figure 2). It had also increased its range, occurring at a low abundance on twenty pontoons and was common on seven of the thirty pontoons examined. Colonies also grew over mussels, serpulid polychaetes, ascidians, and the bryozoan *Bugula neritina* (Linnaeus, 1758). Colonies of *P. japonica* were observed on the shore under large boulders on the north side of Carlingford Lough. Also, specimens of *P. japonica* (with yellow

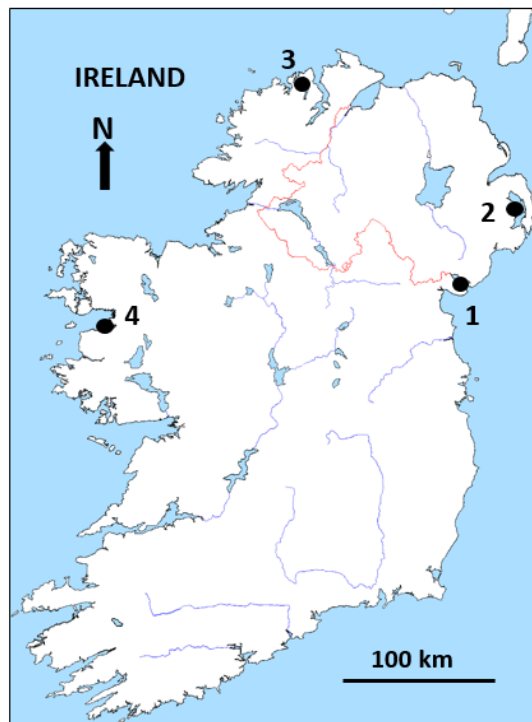


Figure 1. Distribution of *Perophora japonica* in Ireland. 1. Carlingford Lough, 2. Strangford Lough, 3. Mulroy Bay 4. Clew Bay.

plaques) were recovered at the entrance to this Lough at a depth of 24.2 m on a large stone from a gravel, shell, and coarse sand substrate—both the intertidal and the subtidal occurrences being in 2013.

Perophora japonica was first found in Northern Ireland from the lower shore of Sketrick Island Narrows in Strangford Lough on 17 September 2012 (Minchin and Nunn 2013). It has since been recorded from this site for five successive years (Table 1), and at two additional sites close to Sketrick Island.

Elsewhere, colonies of *P. japonica* were observed on the lower shore at two sites in Mulroy Bay in 2013, and from one site in Clew Bay in 2015 (Table 1). These colonies were either attached directly to the underside of boulders, or to fronds of *Fucus serratus* Linnaeus.

Discussion

Perophora japonica was first found in Ireland in 2012 in Carlingford Lough, and had increased its abundance there by September 2014. It was not noticed during previous surveys at this site in August 2005 and June 2006 (Minchin 2007), nor during September 2008 (Ryland et al. 2009). It is therefore likely to have arrived since 2008 although, when present in

Table 1. Records of *Perophora japonica* in Ireland.

Marine inlet	Position	Substrate	Dates	Collector
Carlingford Lough				
Greencastle Rocks	54°02.40'N, 06°06.61'W	rock	25.6.2013	JN
Killowen	54°04.37'N, 06°11.11'W	under boulders	25.6.2013	JN
Carlingford Marina	54°03.10'N, 06°11.47'W	pontoon fouling	28.8.2012	DM
East of Greenore	54°01.82'N, 06°07.31'W	Day grab, 24.2m	3.9.2014 12.7.2013	DM R. Snijder
Strangford Lough				
Sketrick Island Narrows	54°29.41'N, 05°38.57'W	large stones, <i>Fucus serratus</i>	17.09.2012 8.8.2013 11.8.2014 1.10.2015 22.7.2016	BP JN JN JN JN
Rainey Island Narrows	54°29.62'N, 05°38.93'W	<i>Fucus serratus</i>	21.9.2012 3.10.2012 21.8.2013	JN JN JN
Ballydorn Quay	54°29.40'N, 05°38.85'W	entwined in holdfasts of <i>Saccharina latissima</i>	2.9.2015	JN
Mulroy Bay				
Rawros Point	55°11.30'N, 07°05.90'W	under boulders	22.6.2013	JN
Crannoge Point	55°12.25'N, 07°08.40'W	under boulders	23.6.2013	JN
Drumnacraig Bay	55°12.30'N, 07°47.00'W	under boulders	21.6.2016	JN
Clew Bay				
Annagh Island	53°47.59'N, 09°35.75'W	under boulders & on <i>Fucus serratus</i>	1.8.2015	JN

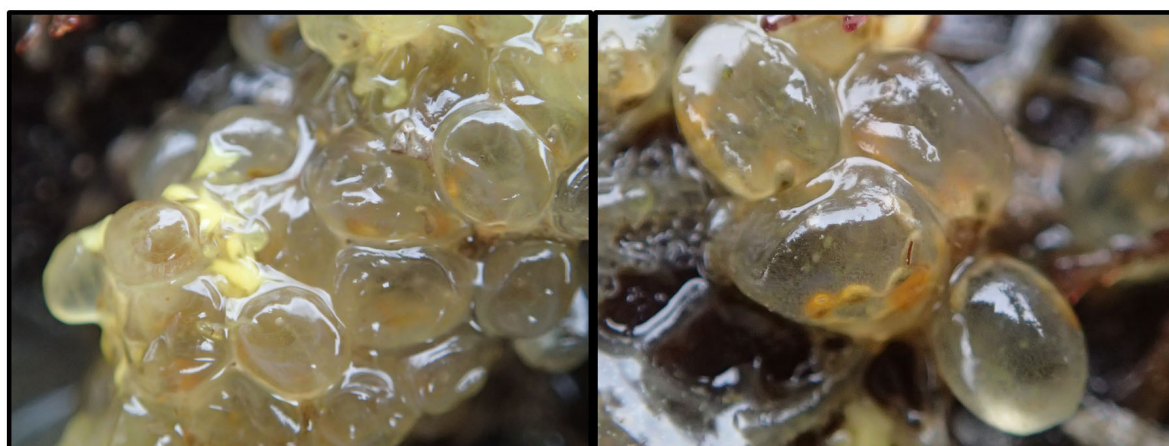


Figure 2. Examples of colonies of *Perophora japonica* found on fouling biota on marina pontoons in Carlingford Lough, August 2012.

low numbers, it might be overlooked due to its small size or be mistaken for the native *P. listeri* when the yellow stellate plaques were not present. At the Carlingford Marina, the colonies, of *P. japonica* were numerous, and present two years apart. It has also now appeared in three other separate marine inlets (and was present in Strangford Lough for five successive years); therefore, the species should be considered established in Ireland.

The occurrence of *P. japonica* close to Pacific oyster growing areas in all four inlets might suggest its

presence, and subsequent spread, is due to transmission along with oyster movements. This is possible because, since January 1993, Pacific oysters have been imported from France, and from Guernsey, near where *P. japonica* was first recorded in the English Channel (Monniot and Monniot 1985). In Japan, its occurrence as a fouling species on Pacific oysters indicates a potential mode of transport (Akawara 1990).

Small craft are also active in these same four inlets, although there is little such activity in Mulroy Bay, and there are no records known of this ascidian

occurring on the hulls of vessels. Nevertheless, *P. japonica* is known to occur on marinas in the north-east Pacific (Lambert 2005), Brittany (Pérez-Portela et al. 2012), the south coast of Britain (Baldock and Bishop 2001; Arenas et al. 2006; Bishop et al. 2015), and now in Carlingford Marina. Such a presence at marina sites implicates leisure craft in transmissions.

Natural dispersal can occur during the swimming larval stage, or by colonies attached to drifts of algae (rafting). It has been associated with *Sargassum muticum* in France (Monniot and Monniot 1985), which may also provide an opportunity for the species to spread. However, there is a third very effective means of dispersal. Colonies enlarge by budding asexually from the stolons, which produce terminal yellow plaques. These plaques are very sticky; they break off, float away, and stick to any substrate they come into contact with; subsequently developing stolons that bud to form new colonies (Mukai et al. 1983). The localised spread by stolons, the production of free-living larvae, and detachment of plaques make it likely that this small, inconspicuous, ascidian may already be spread over a greater area than at the sites where it has been found in this study. Apart from its common occurrence in Normandy, all other sites that have been invaded do not appear to be of management concern.

While the current records represent the most northerly records within Europe, it might soon be expected to appear on the western coast of Scotland. *P. japonica* is known to endure cold winters within its natural range since it occurs close to Vladivostok in the Russian Federation (Sanamyan 1998), and it has shown an ability to spread to quite separate marine inlets in Ireland.

Acknowledgements

We especially thank R. Snijder of the Department of the Environment of Northern Ireland for allowing us to include his record in this account and to three expert reviewers. We thank the managers and staff of the visited marinas for enabling us to sample. The work during 2012 was commissioned by the Northern Ireland Environment Agency.

References

Akawara KY (1990) Competitors and fouling organisms in the hanging culture of the Pacific oyster *Crassostrea gigas* (Thunberg). *Marine Behaviour and Physiology* 17: 67–94, <http://dx.doi.org/10.1080/10236249009378759>

Arenas F, Bishop JDD, Carlton JT, Dyrindya PJ, Farnham WF, Gonzales DJ, Jacobs MW, Lambert C, Lambert G, Nielsen SE, Pederson JA, Porter JS, Ward S, Wood CA (2006) Alien species and other notable records from a rapid assessment survey of marinas on the south coast of England. *Journal of the Marine Biological Association of the United Kingdom* 86: 1329–1337, <http://dx.doi.org/10.1017/S002531540614354>

Baldock B, Bishop JDD (2001) Occurrence of the non-native ascidian *Perophora japonica* in the Fleet, southern England. *Journal of the Marine Biological Association of the United Kingdom* 81: 1067

Bishop J (2005) *Perophora japonica*. A sea squirt. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 31/12/2014]. Available from: <http://www.marlin.ac.uk/speciesinformation.php?speciesID=4074>

Bishop JDD, Wood CA, Yunnice ALE, Griffiths CA (2015) Unheralded arrivals: non-native sessile invertebrates in marinas on the English coast. *Aquatic Invasions* 10: 249–264, <http://dx.doi.org/10.3391/ai.2015.10.3.01>

California Department of Fish and Wildlife (2014) Introduced aquatic species in California bays and harbors, 2011 survey. Sacramento California, 1–36 pp, <https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=80969>

El Nagar A, Huys R, Bishop JDD (2010) Widespread occurrence of the Southern Hemisphere ascidian *Corella eumyota* Traustedt, 1882 on the Atlantic coast of Iberia. *Aquatic Invasions* 5: 169–173, <http://dx.doi.org/10.3391/ai.2010.5.2.06>

Faasse MA (2004) De Aziatische zakpijp *Perophora japonica* Oka, 1927 in Nederland. *Het Zeepaard* 64: 179–181

Gall A (2012) Maerl in Cornwall: 2012 survey report, 13 pp. <http://www.seasearch.org.uk/downloads/Cornwallmaerl2012web.pdf>

Gittenberger A (2007) Recent population expansions of non-native ascidians in the Netherlands. *Journal of Experimental Marine Biology and Ecology* 342: 122–126, <http://dx.doi.org/10.1016/j.jembe.2006.10.022>

Lambert G (2005) First North American record of the ascidian *Perophora japonica*. *Journal of the Marine Biological Association of the United Kingdom* 85: 1011–1012, <http://dx.doi.org/10.1017/S002531540501204X>

Millar RH (1970) British ascidians. Synopses of the British fauna (New Series) No 1. The Linnean Society, London, 91 pp

Minchin D (2007) Rapid coastal survey for targeted alien species associated with floating pontoons in Ireland. *Aquatic Invasions* 2: 63–70, <http://dx.doi.org/10.3391/ai.2007.2.1.8>

Minchin DM, Nunn JD (2013) Rapid assessment of marinas for invasive alien species in Northern Ireland. Northern Ireland Environment Agency Research and Development Series No 13/06, 113 pp

Monniot C, Monniot F (1985) Apparition de l'ascidie *Perophora japonica* sur les côtes et dans les ports de la Manche. *Compte Rendu Sommaire des Séances Société de Biogéographie, Paris* 61: 111–116

Mukai H, Koyama H, Watanabe H (1983) Studies on the reproduction of three species of *Perophora* (Ascidacea). *Biological Bulletin (Woods Hole)* 164: 251–266, <http://dx.doi.org/10.2307/1541143>

Nall C, Guerin A, Cook E (2015) Rapid assessment of marine non-native species in northern Scotland and a synthesis of existing Scottish records. *Aquatic Invasions* 10: 107–121, <http://dx.doi.org/10.3391/ai.2015.10.1.11>

NBN Gateway (2016) <https://data.nbn.org.uk> (accessed 02 May 2016)

Nishikawa T (1991) The ascidians of the Japan Sea. II. *Publications of the Seto Marine Biological Laboratory* 35: 25–170

Nishikawa T, Bishop JDD, Sommerfeldt AD (2000) Occurrence of the alien ascidian *Perophora japonica* at Plymouth. *Journal of the Marine Biological Association of the United Kingdom* 80: 955–956, <http://dx.doi.org/10.1017/s0025315400003003>

Oka A (1927) Über eine *Perophora* aus Japan. *Proceedings of the Imperial Academy* 3: 558–560

Pérez-Portela R, Turon X, Bishop JDD (2012) Bottlenecks and loss of genetic diversity: spatio-temporal patterns of genetic structure in an ascidian recently introduced to Europe. *Marine Ecology Progress Series* 451: 93–105, <http://dx.doi.org/10.3354/meps09560>

Ryland JS, De Blauwe H, Lord R, Mackie JA (2009) Recent discoveries of alien *Watersipora* (Bryozoa) in Western Europe with redescrptions of species. *Zootaxa* 2093: 43–59, <http://dx.doi.org/10.1080/00785326.1998.10409376>

Sanamyan K (1998) Ascidians from the north-western Pacific region. 5. Phlebobranchia. *Ophelia* 49: 97–116, <http://dx.doi.org/10.1080/00785326.1998.10409376>

Spray R, Watson D (2011) North Norfolk's chalk reef. Report on surveys conducted by Seasearch East, 50 pp, <http://www.seasearch.org.uk/downloads/NorfolkChalkReefreport2010.pdf>