

Predicting invasion patterns in coastal ecosystems: relationship between vector strength and vector tempo

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Marine Ecology Progress Series 431:1–10 (2011)

Supplement

Table S1. Non-indigenous species in the Netherlands (NL) that are hypothesized or known to be associated with oyster imports. For each species, the year of first observation on European Atlantic or North Sea coasts, and in the Netherlands is given, as well as the vectors of introduction. Detailed distributional information was obtained from the literature; key references are indicated in the last column (references are listed in the 'Literature cited' section of the main paper)

Species	Distribution	Origin	1st record Europe	Vector to Europe	1st record NL	Vector to NL	Comments and source
Protista							
<i>Bonamia ostreae</i> Pichot, Comps, Tigé, Grizel & Rabouin, 1979	Netherlands, Spain, France? NE Pacific, California	NE Pacific	1977	oysters	1980	oysters	Wolff (2005b)
Coscinodiscophyceae							
<i>Coscinodiscus wailesii</i> Gran & Angst, 1931	North Sea, English Channel, Atlantic coast of France, Indo-Pacific	Indo-Pacific	1977	oysters, ballast water	1978	natural dispersal	Gollasch et al. (2008)
Bacillariophyceae							
<i>Thalassiosira punctigera</i> (Castracane) Hasle, 1983	North Sea, English Channel, S Atlantic, Indo-Pacific	Unknown	1978	oysters	1981	natural dispersal	Wolff (2005b)
Phaeophyceae							
<i>Undaria pinnatifida</i> (Harvey) Suringar, 1873	North Sea, Spain, Portugal, Mediterranean, California, Mexico, Argentina, NW Pacific, Australia, New Zealand	NW Pacific	1983	oysters, deliberate introduction	1999	oysters	Verlaque (2001)

Species	Distribution	Origin	1st record Europe	Vector to Europe	1st record NL	Vector to NL	Comments and source
<i>Colpomenia peregrina</i> Sauvageau, 1927	NE Atlantic S to Morocco, Mediterranean, N Pacific, New Zealand, Australia	NE Pacific	1906	shipping	1921	oysters, natural dispersal	J. T. Carlton pers. comm.
<i>Sargassum muticum</i> (Yendo) Fensholt, 1955	North Sea, Baltic Sea, S to Spain and Portugal, Mediterranean, N Pacific	NW Pacific	1966	oysters	1980	natural dispersal	Critchley & Dijkema (1984)
Rhodophyceae							
<i>Polysiphonia senticulosa</i> Harvey, 1862	Netherlands, Belgium, S England, Washington State, British Columbia, Japan, New Zealand, S Australia	NW Pacific	1993	oysters, hull fouling	1993	oysters, hull fouling	Maggs & Stegenga (1999) Guiry & Guiry (2009)
<i>Neosiphonia harveyi</i> J. Bailey 1848	North Sea, Atlantic Europe, Newfoundland to South Carolina, California, Japan, New Zealand	NW Pacific	1832	oysters	1960	oysters, natural dispersal	suggested introduction with <i>Crassostrea angulata</i> or with <i>Codium fragile</i> McIvor et al. (2001)
<i>Grateloupia turuturu</i> Yamada, 1941	NW Atlantic, NE Atlantic, Mediterranean, Japan	NW Pacific	1969	oysters	1993	oysters, hull fouling	initially described as <i>G. doryphora</i> Maggs & Stegenga (1999) Gavio & Fredericq (2002)
<i>Heterosiphonia japonica</i> Yendo, 1920	North Sea, Atlantic coast France, Spain, Mediterranean, Alaska, California, NW Pacific	NW Pacific	1990	oysters	1994	oysters	initially described as <i>Dasyisiphonia</i> sp. Maggs & Stegenga (1999) Verlaque (2001) Guiry & Guiry (2009)
<i>Dasya baillouviana</i> (S.G. Gmelin) Montagne, 1841	‘cosmopolitan’	NW Atlantic	1950	oysters, hull fouling	1950	oysters, hull fouling	Maggs & Stegenga (1999) Guiry & Guiry (2009)
<i>Colaonema daviesii</i> (Dillwyn) Stegenga, 1985	‘cosmopolitan’	NW Atlantic	1950	oysters, hull fouling	1950	oysters, hull fouling	introduced with <i>Dasya baillouviana</i> , epiphytic
<i>Bonnemaisonia hamifera</i> Hariot, 1891	NE Atlantic, Mediterranean, NW Atlantic, New Brunswick, California, Mexico, S Africa, Japan	NW Pacific	1890	oysters	1983	oysters, natural dispersal	Maggs & Stegenga (1999) Guiry & Guiry (2009)
<i>Lomentaria hakodatensis</i> Yendo, 1920	The Netherlands, Atlantic coast France, Mediterranean, Japan	NW Pacific	1984	oysters	2004	oysters	Stegenga (2004)
<i>Asparagopsis armata</i> Harvey, 1855	NE Atlantic S to Senegal, Mediterranean, Adriatic, California, S Africa, Australia, New Zealand	S Pacific	1925	oysters	1983	natural dispersal	Maggs & Stegenga (1999) Guiry & Guiry (2009)
<i>Antithamnionella spirographidis</i> (Schiffner) E.M. Wollaston, 1968	NE Atlantic, Mediterranean, Adriatic, S Africa, Australia, N Pacific	N Pacific	1906	hull fouling	1974	oysters	Maggs & Stegenga (1999) Wolff (2005b) Guiry & Guiry(2009)

Species	Distribution	Origin	1st record Europe	Vector to Europe	1st record NL	Vector to NL	Comments and source
<i>Antithamnionella ternifolia</i> (J.D. Hooker & Harvey) Lyle, 1922	NE Atlantic Scotland S to Portugal, Chile, China, S Africa, Australia, New Zealand	S Pacific	1906	hull fouling	1951	oysters	Eno et al. (1997) Maggs & Stegenga (1999) Wolff (2005b) Guiry & Guiry (2009)
<i>Anotrichium furcellatum</i> (J. Agardh) Baldock, 1976	The Netherlands, France, Spain, Portugal, Atlantic islands, Mediterranean, California, S Africa, Japan, Korea	Mediterranean?	1922	oysters?	1968	oysters?	unknown whether it is established in the North Sea Wolff (2005b) Guiry & Guiry (2009)
<i>Agardhiella subulata</i> (C. Agardh) Kraft & M.J. Wynne, 1979	N and S Atlantic, Mediterranean, Indian ocean, N Pacific	NW Pacific or NW Atlantic	1973	oysters, hull fouling	1998	oysters, hull fouling	cryptogenic; source of introduction to Europe is Japan Wolff (2005b) Guiry & Guiry (2009)
Polychaeta							
<i>Polydora hoplura</i> Claparède, 1869	‘cosmopolitan’	unknown	1869	oysters, hull fouling	1949	oysters	cryptogenic Korringa (1951)
<i>Proceraea cornuta</i> (Agassiz, 1884)	North Sea, British Isles, NW Atlantic, NE Pacific	NW Atlantic	1929	hull fouling	1941	oysters	Wolff (2005b)
Anthozoa							
<i>Diadumene cincta</i> Stephenson, 1925	The Netherlands, England, Germany, warm-temperate Atlantic?	unknown	1920	oysters, hull fouling	1925	oysters, hull fouling	cryptogenic Gollasch et al. (2008)
<i>Diadumene lineata</i> (Verrill, 1869)	N Atlantic, N Pacific, Indonesia, New Zealand, Hawaiian Islands	NW Pacific	1896	oysters, hull fouling	1912	oysters, hull fouling	Carlton (1979) Gollasch & Riemann-Zürneck (1996)
Hydrozoa							
<i>Gonionemus vertens</i> Agassiz, 1862	North Sea, British Isles, Brittany, Portugal, NW Atlantic, San Francisco Bay, NW Pacific	NW Pacific	1913	oysters, hull fouling	1960	oysters, hull fouling	Carlton (1979) Wolff (2005b)
Gymnolaemata							
<i>Smittoidea prolifica</i> Osburn, 1952	The Netherlands, NE Pacific	NE Pacific	1995	oysters	1995	oysters	probably more widespread, but misidentified as native species de Blauwe & Faasse (2004)

Species	Distribution	Origin	1st record Europe	Vector to Europe	1st record NL	Vector to NL	Comments and source
Maxillopoda							
<i>Myicola ostreae</i> Hoshina & Sugiura, 1953	The Netherlands, France, Japan, Korea	NW Pacific	1972	oysters	1992	oysters	Wolff (2005b)
<i>Mytilicola orientalis</i> Mori, 1935	The Netherlands, France, British Columbia to California, Japan	NW Pacific	1977	oysters	1992	oysters	Wolff (2005b)
Malacostraca							
<i>Hemigrapsus takanoi</i> Asakura & Watanabe, 2005	North Sea, France, Spain, Japan to China	NW Pacific	1994	oysters, hull fouling	2000	oysters, hull fouling	first identified as <i>Hemigrapsus penicillatus</i> Gollasch (1999)
Gastropoda							
<i>Urosalpinx cinerea</i> (Say, 1822)	The Netherlands, England, NW Atlantic, Washington to California	NW Atlantic	1927	oysters	2007	mussels	Faasse & Lighthart (2007)
<i>Rapana venosa</i> (Valenciennes, 1846)	The Netherlands, Belgium, Atlantic coast France, Adriatic Sea, Aegean Sea, Black Sea, Chesapeake Bay, Rio de la Plata, Japan, China	NW Pacific	1990s	oysters	2005	oysters, natural dispersal	Mann & Harding (2000) Kerckhof et al. (2006)
<i>Pteropurpura (Ocinebrellus) inornatus</i> (Récluz, 1851)	Japan, Korea, China, Washington to California, Brittany, The Netherlands	NW Pacific	1985	oysters	2007	oysters	Martel et al. (2004) Faasse & Lighthart (2009)
<i>Crepidula fornicata</i> (Linnaeus, 1758)	N Atlantic, Mediterranean, NE Pacific, Uruguay, South America, South Africa, Japan, Australia, Tasmania, New Zealand	NW Atlantic	1872	oysters	1926	oysters, natural dispersal	Gollasch et al. (2008)
Bivalvia							
<i>Petricolaria pholadiformis</i> (Lamarck, 1818)	N Atlantic, Mediterranean, Black Sea, Gulf of Mexico, NE Pacific	NW Atlantic	1890	oysters	1899	oysters, natural dispersal	Carlton (1999)
<i>Mercenaria mercenaria</i> (Linnaeus, 1758)	The Netherlands, Belgium, S British Isles, France, NW Atlantic, Gulf of Mexico, NE Pacific, China	NW Atlantic	1864	deliberate introduction	1934	oysters, deliberate introduction	Gouletquer et al. (2002) Wolff (2005b)
Ascidacea							
<i>Styela clava</i> Herdman, 1881	North Sea, Spain, Portugal, Gulf of St Lawrence to New England, Washington to California, Sea of Okhotsk, Siberia, Japan, Korea	NW Pacific	1952	oysters, hull fouling	1974	oysters	Lützen (1999)

Table S2. Macroalgal species recorded from Pacific oyster shells from the Oosterschelde estuary. The presence of each species on examined oysters is indicated as a percentage of the total number of oysters analyzed (n = 270). For species that occur on more than 15% of all examined oysters, the percentage of oysters that they occur on is printed in **bold**; these species are included in Fig. 6. na = not applicable

Species	% of oysters	Distribution	Status
Phaeophyceae			
<i>Dictyota dichotoma</i> (Hudson) J.V. Lamouroux, 1809	8	cosmopolitan	cryptogenic
<i>Laminaria saccharina</i> (Linnaeus) J.V. Lamouroux, 1813	2	N Atlantic, Baltic, Madeira, NE Pacific	cryptogenic
Chlorophyceae			
<i>Codium fragile</i> (Suringar) Hariot, 1889	4	cosmopolitan	introduced
<i>Ulva prolifera</i> O.F. Müller 1778	0.4	cosmopolitan	cryptogenic
<i>Ulva clathrata</i> (Roth) C. Agardh, 1811	1	cosmopolitan	cryptogenic
tubular <i>Ulva</i> sp.	10	na	na
foliose <i>Ulva</i> sp.	19	na	na
<i>Cladophora rupestris</i> (Linnaeus) Kützing, 1843	1	cosmopolitan	cryptogenic
<i>Cladophora</i> sp.	3	na	na
<i>Rhizoclonium implexum</i> (Dillwyn) Kützing, 1845	12	cosmopolitan	cryptogenic
<i>Monostroma oxyspermum</i> (Kützing) Doty, 1947	4	N Atlantic, Caribbean, NE Pacific, S Australia	cryptogenic
<i>Prasiola stipitata</i> Suhr ex Jessen, 1848	0.4	NE Atlantic, NW Atlantic, Chile, Australia, New Zealand	cryptogenic
Rhodophyceae			
<i>Agardhiella subulata</i> (C. Agardh) Kraft and M.J. Wynne, 1979	17	N and S Atlantic, Mediterranean, Indian Ocean, N Pacific	introduced
<i>Antithamnionella spirographidis</i> (Schiffner) E.M. Wollaston, 1968	22	NE Atlantic, Mediterranean, Adriatic, Morocco, N Pacific, S Africa, Australia	introduced
<i>Antithamnionella ternifolia</i> (J.D. Hooker and Harvey) Lyle, 1922	0.4	NE Atlantic, Scotland S to Portugal, Chile, China, S Africa, Australia, New Zealand	introduced
<i>Heterosiphonia japonica</i> Yendo, 1920	54	North Sea, Atlantic coast France, Spain, Mediterranean, Alaska, California, NW Pacific	introduced
<i>Neosiphonia harveyi</i> (J. Bailey) M.-S. Kim, H.-G. Choi, Guiry and G.W. Saunders 2001	1	North Sea, Atlantic Europe, Newfoundland to South Carolina, California, Japan, New Zealand	introduced
<i>Polysiphonia senticulosa</i> Harvey, 1862	21	Netherlands, Belgium, S England, Washington State, British Columbia, Japan, New Zealand, S Australia	introduced
<i>Polysiphonia nigra</i> (Hudson) Batters, 1902	31	NE Atlantic Spitsbergen S to Portugal, Atlantic Islands, Namibia, New Hampshire	cryptogenic
<i>Polysiphonia fucoides</i> Harvey, 1862	30	N and S Atlantic, Mediterranean	native
<i>Polysiphonia devoniensis</i> Maggs and Hommersand, 1993	0.4	N Atlantic	native

Species	% of oysters	Distribution	Status
<i>Polysiphonia stricta</i> (Dillwyn) Greville, 1824	13	N and S Atlantic, Baltic, Black Sea, Mediterranean, Adriatic, N Pacific, Antarctic	cryptogenic
<i>Polysiphonia denudata</i> (Dillwyn) Greville ex Harvey, 1833	4	N and S Atlantic, Mediterranean, Adriatic, Black Sea, Persian Gulf, W Indian Ocean, S Australia	cryptogenic
<i>Polysiphonia briodiae</i> (Dillwyn) Sprengel, 1827	1	N Atlantic, Baltic, Mediterranean, W Indian Ocean, NE Pacific, Australia, New Zealand	cryptogenic
<i>Polysiphonia</i> sp.	11	na	na
<i>Dasya baillouviana</i> (S.G. Gmelin) Montagne, 1841	20	cosmopolitan	introduced
<i>Erythrotrichia carnea</i> (Dillwyn) J. Agardh, 1883	26	cosmopolitan	cryptogenic
<i>Stylonema alsidii</i> (Zanardini) K.M. Drew, 1956	10	cosmopolitan	cryptogenic
<i>Colaconema daviesii</i> (Dillwyn) Stegenga, 1985	6	cosmopolitan	introduced
<i>Hypoglossum hypoglossoides</i> (Steckhouse) Collins and Hurvey, 1919	7	NE Atlantic, North Sea S to Senegal, Mediterranean, N Carolina to Florida, Caribbean, Australia, New Zealand	cryptogenic
<i>Antithamnion villosum</i> (Kützting) Athanasiadis, 1993	7	NE Atlantic, Baltic, N Carolina	cryptogenic
<i>Antithamnion cruciatum</i> (C. Agardh) Nägeli, 1847	1	NE Atlantic, Mediterranean, Baltic, Adriatic, Black Sea, NW Atlantic, Chile, China, S Australia	cryptogenic
<i>Pterothamnion plumula</i> (J. Ellis) Nägeli, 1855	16	NE Atlantic, Baltic, Atlantic Islands, Adriatic, Black Sea, Chile, W Indian Ocean, Fiji, NE Pacific, Macquarie Island,	cryptogenic
<i>Aglaothamnion feldmanniae</i> Halos, 1965	0.4	NE Atlantic, Mediterranean	native
<i>Callithamnion pseudobyssoides</i> P.L. Crouan and H.M. Crouan, 1867	1	NE Atlantic, Bermuda, N and S Carolina, Florida, S Australia	cryptogenic
<i>Callithamnion corymbosum</i> (Smith) Lyngbye, 1819	1	NE Atlantic, Baltic, Atlantic Islands, Mediterranean, Adriatic, Black Sea, Virginia, Jamaica, Brazil, China, Korea, Japan	cryptogenic
<i>Callithamnion tetricum</i> (Dillwyn) S. F. Gray, 1821	1	NE Atlantic, Morocco, Azores	native
<i>Ceramium nodulosum</i> (Lightfoot) Ducluzeau, 1806	2	NE Atlantic, Baltic, Italy, Madeira	native
<i>Ceramium cimbricum</i> H.E. Petersen, 1924	3	cosmopolitan	cryptogenic
<i>Chondrus crispus</i> Stackhouse, 1797	1	NE Atlantic, Baltic, Atlantic islands, Mediterranean, Angola, Ghana, NW Atlantic, Alaska, Oregon, Falkland Islands, Antarctic Peninsula	cryptogenic
<i>Lomentaria clavellosa</i> (Turner) Gaillon, 1828	1	NE Atlantic, Madeira, Mediterranean, New Hampshire, Brazil, Falkland Islands	cryptogenic