Aquatic Invasions (2011) Volume 6, Issue 3: 273–279
doi: 10.3391/ai.2011.6.3.04

Open Access

Research Article

Arrival of the alien fanworm *Sabella spallanzanii* (Gmelin, 1791) (Polychaeta: Sabellidae) in two New Zealand harbours

Geoffrey B. Read[1]*, Graeme Inglis[2], Peter Stratford[3] and Shane T. Ahyong[1,4]

[1]*National Institute of Water and Atmospheric Research (NIWA), Private Bag 14901, Wellington, New Zealand*
[2]*NIWA, PO Box 8602, Christchurch, New Zealand*
[3]*MAF Biosecurity New Zealand, PO Box 2526, Wellington, New Zealand*
[4]*Current address: Australian Museum, 6 College St., Sydney, NSW 2010, Australia*

E-mail: g.read@niwa.co.nz *(GBR),* g.inglis@niwa.co.nz *(GI),* Peter.Stratford@maf.govt.nz *(PS),* Shane.Ahyong@austmus.gov.au *(STA)*

**Corresponding author*

Received: 24 December 2010 / Accepted: 15 April 2011 / Published online: 11 May 2011

Abstract

The distinctive Mediterranean-Atlantic fanworm polychaete, *Sabella spallanzanii* (Gmelin, 1791), is recorded from New Zealand, in both North and South Island, consequent upon its discovery first in the port area of Lyttelton in Lyttelton Harbour and later 800 km further north in the port area of Auckland in Waitemata Harbour. Morphology distinguishing the species from other sabellids is highlighted. In the initial occurrence in March 2008 one large specimen was identified from samples taken by a surveillance team off subtidal wharf structures in Lyttelton port. In July and August 2008 further large specimens were found both nearby and dispersed across the inner port area, with reproductive maturity appearing imminent in some. The New Zealand Government funded repeated search and culling by divers, directed towards possible local elimination, with over 380 specimens removed from Lyttelton by December 2009. However, in August 2009 a single large specimen was found in an enclosed port area in Waitemata Harbour, then several more, and in October 2009 numerous specimens were found on a barge hull berthed there. Also it became apparent that a second generation of colonisers was present in both harbours. By early 2010 well-grown specimens had been found in disparate Waitemata Harbour locations over a large area. The decision to suspend culls was made in February 2010, and elimination efforts were abandoned in June 2010, two years after first detection. The arrival and apparent establishment of *S. spallanzanii* in New Zealand is ascribed to accidental international transfer probably in 2007, either via hull fouling or ballast water, but it is not known if the two ports were colonised via the same transiting vessel.

Key words: adventive, new record, Lyttelton Harbour, hull fouling, non-indigenous species, elimination, eradication

Introduction

Sabella spallanzanii (Gmelin, 1791) is a fanworm native to inshore waters of the Mediterranean Sea, and to the European Atlantic coast north to Normandy (Knight-Jones and Perkins 1998). An epifaunal polychaete present in Australia for more than twenty years but absent from New Zealand, it builds conspicuous leathery tubes projecting from subtidal hard structures, and has a crown of long spindly flexible radioles which are often distinctive in colour pattern (Figure 1A). The species is one of the largest extant sabellids, and builds tubes up to 0.5 m long. Since the year 2000 it has been registered as a notifiable organism under the New Zealand Biosecurity Act 1993 (New Zealand Government 2006), indicating its status as an unwanted alien. This report covers the timeline to date of the worm's presence in New Zealand after its initial detection. Analysis and review of detailed data on surveillance work, incursion response design and implementation, population dynamics and reproduction, and genetic origins are in preparation elsewhere or in as yet unpublished reports.

In New Zealand *Sabella spallanzanii* has been the subject of targeted surveillance against its arrival (Wotton and Hewitt 2004). The interest of government agencies in the invasive potential of this particular marine fanworm arose from the establishment of the species in southern and western Australian coastal waters, where initial discoveries (see Currie et al. 1998; Clarke et al. 2000) had been in or near ports and harbours, including locations through which shipping might frequently transit en route to New Zealand. The occurrences in Australia were the first documented for this species as an alien. High densities of *S. spallanzanii* were first found in the early 1990s in Port Phillip Bay, Victoria (Carey and Watson 1992), and soon after in Cockburn Sound, Western Australia (Clapin and Evans 1995), although the fanworm is suspected to have been present in both places since the early 1980s at least, and probably since the early 1970s in Western Australia (Clapin and Evans 1995). By 2000 it was assessed as having "invaded virtually all available subtidal habitats" in Port Phillip Bay (Cohen et al. 2000: 700). It had also fouled aquaculture structures, and was accidentally further spread via movement of shellfish stock (Gunthorpe et al. 2001). Genetic studies to date have not revealed from where the Australian populations originated (Patti and Gambi 2001).

Sabella spallanzanii incursions that are localised may be suppressed by physical removal of first colonisers, ideally before they have grown to maturity and reproduce (McEnnulty et al. 2001; Department of Fisheries, Western Australia 2005). Early detection of New Zealand settlements was needed if such countermeasures were to be feasible. Fouling biota have been surveyed at least twice in most New Zealand ports by the National Institute of Water and Atmospheric Research (NIWA) since 2001, as part of a national series of port biological baseline surveys funded by the New Zealand Government. In addition, a separate programme of targeted surveillance (Inglis et al. 2006d) has been in place since 2002 to watch for the first arrival of *S. spallanzanii* and six other potential marine pests.

Expert taxonomic determinations of the sabellids collected were essential. Whereas a false assertion of a *S. spallanzanii* occurrence would waste considerable resources, the consequences of an inability to recognise juvenile or damaged specimens of *S. spallanzanii* when collected include unchallenged incursions that could lead to establishment. While only two native sabellid species reach near comparable size to adult *S. spallanzanii*, the best scenario was that the first specimens collected of *S. spallanzanii* would be modest-sized but immature individuals, and thus it was not expected they would be easily distinguished from natives. In order to facilitate identification of *S. spallanzanii*, NIWA also obtained reference specimens from Museum Victoria, Australia, for direct comparisons and for field worker training.

Knight-Jones and Perkins (1998) emphasised a character set for *Sabella* that included the penicillate spiralled chaetal fascicle lobes of the abdomen and the lack of radiolar eyes and stylodes. Conversely identification guides to *S. spallanzanii* designed for lay persons (e.g., MAF Biosecurity New Zealand 2008) perhaps necessarily emphasise the asymmetric presence of a large spiral crown in one of the two groups of radioles with the other remaining non-spiralled and much less profuse, a feature which is usually more obvious in large individuals (Figure 1A). However, as Knight-Jones and Perkins (1998) point out, this is not a definitive feature, and not unique to genus *Sabella*, whereas the attribute of spiralled chaetal rows in abdominal neuropodia is a distinct apomorphy (Figure 1B) and can be readily seen under stereo microscopy.

Sabella spallanzanii is the earliest described member of *Sabella*, and there is no uncertainty as to its distinctness as a species. Worldwide *Sabella* Linnaeus, 1767 currently consists of only the three European species *S. spallanzanii* (type locality Malta), *S. pavonina* Savigny (English Channel), and *S. discifera* Grube (Adriatic Sea) (*Sabella* nomenclature as stabilised by Knight-Jones and Perkins 1998), whereas the rest of over 220 published binomina accumulated over time (see listing of Read and Bellan 2010) either belong elsewhere or are redundant synonyms. No *Sabella*-like sabellids were previously reported from the New Zealand coast. At least four original worm names in early literature for purported New Zealand *Sabella* exist, but these nominal taxa are all currently placed in genera dissimilar to *Sabella*. For example Knight-Jones and Perkins (1998) assigned into *Demonax* Kinberg (now *Parasabella* Bush) a sabellid from off Little Barrier Island first named as *Sabella aberrans* Augener, 1926.

Results and occurrences

A large worm tube was collected by NIWA divers in Lyttelton Harbour, New Zealand (Figure 2) during port surveillance sampling at the end of a wharf in the Lyttelton township inner port area near the dry dock, on 3 March 2008. Subsequently in the laboratory a sabellid worm was extracted from the tube and determined to be an adult *Sabella spallanzanii*, 115 mm long, excluding radiolar crown, but

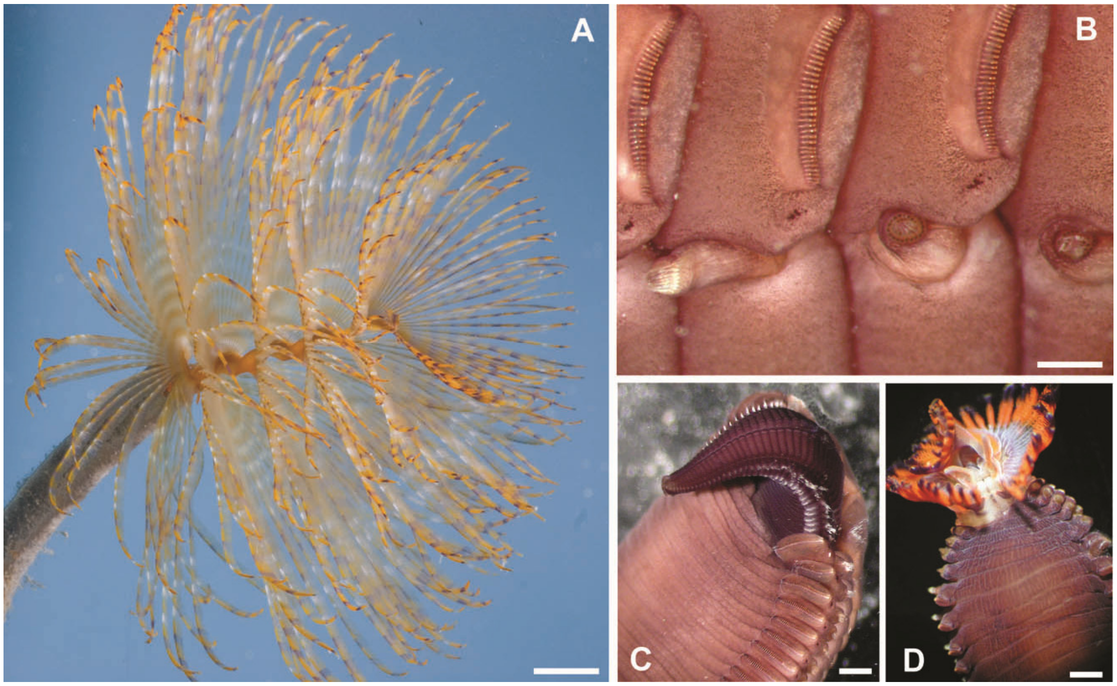

Figure 1. *Sabella spallanzanii*. A, culled worm from Lyttelton Harbour with spiral crown fully expanded; B, abdominal segments showing neurochaetal lobes penicillate in profile (left parapodium of the two fully visible), and the spiralled neurochaetal group visible end-on (right parapodium), with interramal eyespot groups ventral to the notochaetal uncinal row; C–D, worms with regenerating segments of posterior (C) and crown and thorax (D). Scale bars A 10 mm, B 0.5 mm, C-D 1 mm. Worms in A, C-D photographed alive. Photographs by N. Boustead (A), GBR (B–D).

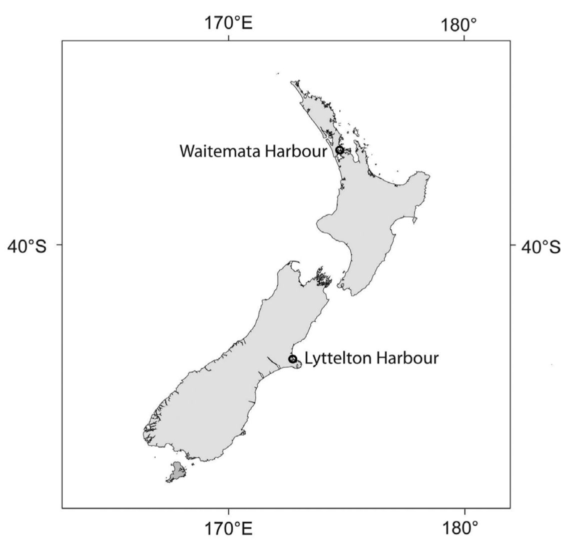

Figure 2. New Zealand harbours with *Sabella spallanzanii* first records.

lacking coelomic gametes. During the next surveillance survey on 10 June 2008 a further three *S. spallanzanii* specimens were collected from piles supporting the Oil Wharf, a quay just inside the port entrance used mainly by transiting fuel tankers. These were again large worms at 137, 150, and 168 mm body lengths, and tailed coelomic sperm were present in one specimen.

A targeted search for *S. spallanzanii* at the end of June 2008 found only four further specimens. None were found on structures just outside the semi-enclosed inner port area. However, 98 worms were subsequently collected in the inner port over several days during an intensive cull by commercial divers in August 2008. These worms were again mostly large (Table 1), and included some females assessed live as potentially reproductive, being gravid with dense coelomic oocytes at or above the size at maturity found in studies elsewhere (Currie et al. 2000; Giangrande et al. 2000). In December 2008 the New Zealand Biosecurity Minister announced the intention to continue local elimination culling in Lyttelton for several years as necessary (Carter 2008), a task considered feasible because the inner port is only about 1 km long, 0.5 km wide (~50 ha).

Periodic intensive searches and surveillance searches up to December 2009 detected a continual presence of *S. spallanzanii* large enough to be noticed by divers, but did not indicate a rapidly increasing population potentially beyond control as the numbers of worms recovered were relatively modest. Between April–July 2009 essentially the entire port infrastructure was inspected by the divers, with each search of different duration and area. Divers did not inspect the harbour seabed other than between piles. A second search of the port infrastructure occurred over August–December 2009. Overall more than 6,000 wharf piles in Lyttelton Port were searched at least twice each, recovering fewer than 350 worms in total. However, in May 2009 a specimen of *S. spallanzanii* was found for the first time on the quay immediately outside the inner port culled area (Stratford 2009).

The small size, down to less than 20 mm body length, of some worms recovered later in 2009 in Lyttelton strongly suggested reproduction had been successful and a second generation of settlement was now present. Such individuals were readily distinguished in appearance from short-bodied regenerating worms which were also found. Broken *S. spallanzanii* regenerate readily (e.g., Watson 1906), creating abnormally short survivor individuals (Figure 1C, D). Several times head and tail regenerating pairs from a former single adult were found still in the same tube, indicating natural or trauma-related reproduction by fission (noted also by Clapin and Evans (1995) in Australian worms).

Elsewhere on 19 August 2009 a NIWA port surveillance dive team found a probable *S. spallanzanii* tubeworm in Waitemata Harbour (Figure 2) in the city of Auckland port area at the entrance to Viaduct Basin Harbour, an enclosed area within the main shipping port allocated to yachts and small commercial vessels. Identity as *S. spallanzanii* was confirmed as a large immature female of 133 mm body length. A further search in the Viaduct Basin in early October 2009 found 7 similar adults and a worm of 35 mm length which appeared to be a 2nd generation individual. A cull in the same area in mid October by commercial divers recovered over 716 worms from the hull of a 97×24m barge, which had been in use along the local coast outside Waitemata Harbour, and was berthed near to the Viaduct Basin. Of those, 175 specimens were retained for analysis and the remainder taken away for burial on land. Then on 18 January 2010 a significant expansion of the known distribution was noted when the hull of a vessel removed from the water in Viaduct Basin was found to have 13 *S. spallanzanii* attached, three of which were near adult. This vessel had come from the upper reaches of Waitemata Harbour, and subsequently a further 13 *S. spallanzanii*, again a mixture of adults and a younger group, were found at or near locations where it had been moored in the Herald Island/Greenhithe area. A further 38 worms, likewise a mix of ages, were found in a search of vessel hulls and moorings over a large area of upper Waitemata Harbour a few days later, and further worms were found in February 2010.

In early February 2010 the Incursion Response Group of MAF Biosecurity New Zealand advised interested parties that culls by divers in Waitemata Harbour would cease, as the worm was too widespread for this technique to be effective. In June 2010 a public announcement was made that the local elimination programmes would cease at both Lyttelton and Auckland (MAF Biosecurity New Zealand 2010), although surveillance for the spread of *S. spallanzanii* elsewhere would continue. The time from detection to cessation of elimination attempts was just over two years (Table 1). Most of the removed first coloniser *S. spallanzanii*, some 584 individuals including a large number fixed in ethanol, are held for future study by NIWA on behalf of MAF Biosecurity New Zealand, in permanent storage in the NIWA Invertebrate Collection. No further locations were known by December 2010.

Discussion

The principal unnatural vectors by which polychaetes and other marine biota are translocated include live shellfish shipments, ship ballast water, and vessel hull fouling (Carlton 1987; Carlton and Geller 1993; Carlton 1996; Blake 1999; Minchin et al. 2005). An early report on alien marine biota in Lyttelton noted that the Antarctica-bound expedition ship "*Terra Nova*" had recently arrived from England via Australia, last port Melbourne, with its hull "covered with a plentiful growth of seaweed, barnacles, etc" (Chilton 1910). This biota was

Table 1. Summary timeline of *Sabella spallanzanii* incursion into New Zealand.

Date	Event
2000 – early 2008	*Sabella spallanzanii* as yet undetected in nationwide port surveys and in targeted port surveillance during the seven years after the New Zealand Government declares it to be an unwanted organism.
May 2008	Large tube-dwelling sabellid collected by surveillance divers from Lyttelton inner port wharf pile (Lyttelton Harbour, South Island, 5.3 m depth, 43°36′21.97″S, 172°42′45.68″E, 3/03/2008) identified as *S. spallanzanii* on 20/5/2008, and presence reported to MAF Biosecurity New Zealand.
August 2008	First intensive systematic culls by divers begin in Lyttelton Port, recovering 98 adult worms of up to 265 mm body length (mean length of intact females 133 mm (n = 42), males 116 mm (n = 48)).
May 2009	First detection of *S. spallanzanii* in Lyttelton Harbour beyond the enclosed inner port. Worms have not been eliminated from inner port structures, but numbers found remain low.
August 2009	First North Island *S. spallanzanii* detected (Viaduct Basin, Waitemata Harbour, Auckland, 36°50′26.92″S, 174°45′44.28″E, 19/08/2009).
October 2009	Colony of hundreds of *S. spallanzanii* removed from a Waitemata Harbour barge berthed near Viaduct Basin, 19/10/2009.
January 2010	First *S. spallanzanii* found on a vessel from a mooring site in upper Waitemata Harbour, 18/01/2010, with subsequently worms found to be widespread on structures and other vessels in the upper harbour.
June 2010	Announcement of cessation of *S. spallanzanii* elimination work at both Lyttelton and Waitemata harbours, 14/06/2010.

scraped off into the harbour. One hundred years later similar, if less conspicuous, trans-oceanic hull fouling transport is strongly suspected in the New Zealand arrival of *Sabella spallanzanii*. This species was found to colonise hulls of local small vessels, most notably in Waitemata Harbour, less so in inner Lyttelton Harbour where wharf pile surfaces were abundantly available.

No information is available on ocean-scale natural dispersal capabilities of *S. spallanzanii* over more than 2000 km of deep ocean eastwards from Australia, the nearest source of resident worms. However, as discussed by Read (2006), the great distance renders human-mediated transport on vessels from Australia to New Zealand much more likely for most arrivals of alien worms. This is particularly so in this case with first discoveries in Lyttelton and Auckland, two eastern coast ports that host frequent international shipping traffic, including trans-Tasman ships visiting on regular schedules from Australia. Transport of a cohort of this sabellid in ballast water as well as via hull fouling is possible as larvae reared in the laboratory can remain pelagic for 14 days (Giangrande et al. 2000, but cf. Department of Fisheries, Western Australia 2005).

Although short port layovers, good antifouling, and high hull speeds may mean large-tonnage ships today do not normally develop significant external fouling, *S. spallanzanii* might survive in ship sea chests, where substantial fouling can build up (Coutts and Dodgshun 2007; Lee and Chown 2007). Alternatively, it is also possible *S. spallanzanii* arrived in either port as fouling on a slow moving small recreational or work vessel. Finally, in addition to a higher probability arrival of fouled hulls originating in Australian ports, it should perhaps also be mentioned that for several years, including between 2005–2008, Italian Antarctic expedition vessels came direct from the Mediterranean Sea to berth in Lyttelton for a few days each austral summer, while in transit to the Ross Sea, Antarctica (pers. comm. S. Schiaparelli). For example R/V *Italica* was in Lyttelton 17–19 January 2007 (Cura and Ramorino 2007).

The sequence of events leading to the arrival of *S. spallanzanii* is relevant to management of New Zealand's marine biosecurity. Two prior surveys of Lyttelton Harbour in March 2002 and November 2004 did not detect *S. spallanzanii* (Inglis et al. 2006c; Inglis et al. 2008). Likewise the worm was not seen in Waitemata Harbour and nearby Auckland region marinas (Inglis et al. 2006a, b), and targeted surveillance at key ports around New Zealand (e.g., Morrisey et al. 2007) had not found it prior to the March 2008 Lyttelton discovery. If the worms detected in Lyttelton were the first generation of colonisers then a first settlement sometime in 2007 seems likely to account for the size of worms culled (only large worms were observed at first). We have no evidence of whether the occurrences in Lyttelton and Auckland are unrelated coincidences or due to the same vessel transiting between ports. Similarly we don't know if there was subsequent transport of local propagules from one port to the other. Equally large individuals were found in both ports, with a probable second generation of individuals in both locations at much the same time.

The continued culling of *S. spallanzanii* was the first attempted elimination project on a large scale in the marine environment in New Zealand. Initial occurrences appeared to be only in confined areas within both harbours, and thus it seemed feasible at least to considerably reduce the populations and limit spread. Unfortunately the sites could not be closed off from the sea, unlike the Darwin Harbour marina in Australia where a profuse settlement of *Mytilopsis* mussels was eliminated (Bax et al. 2002). The difficulty of ultimately achieving eradication of the fanworm greatly increased once new settlement had breached the initial confines. Also in the Waitemata Harbour event it is unknown if initial settlement was indeed as limited in extent as first appeared. It is a much larger harbour than Lyttelton, and unexpectedly there was settlement on hulls of small vessels which could visit the main port but had permanent moorings scattered around residential areas in the upper harbour. Consequently sizeable propagules grew undetected on those vessels while they were distant from the surveillance surveys in the main shipping and marina complexes.

Acknowledgements

Preparation of this report was supported by NIWA and MAF Biosecurity New Zealand. MAF Biosecurity New Zealand has funded all Mediterranean fanworm response work, including field and laboratory work of NIWA (contracts ZBS2000-04, ZBS2001-01, ZBS2009-24). A large number of staff from NIWA and other organisations have been involved since the worm was discovered. We thank them all and in particular the following for their work in the field, for sample and data processing, and for providing information: the NIWA surveillance dive and support teams, especially Don Morrisey and Matt Smith; the NIWA Christchurch Biosecurity team; Keren Spong and Holly Ferguson of NIWA Auckland; Serena Wilkens of the NIWA Marine Invasives Taxonomic Service (MITS); Cawthron Institute, Nelson, especially Rod Asher; and Diving Services NZ Ltd, especially Bruce Lines. We are grateful to Robin Wilson, Museum Victoria, for the donation of reference specimens, and to two anonymous reviewers for helpful suggestions. Stefano Schiaparelli assisted with the information on Italian Antarctic expedition voyages.

References

Bax NJ, Hayes K, Marshall A, Parry D, Thresher R (2002) Man-made marinas as sheltered islands for alien marine organisms: Establishment and eradiction of an alien invasive marine species. In: Veitch CR, Clout MN (eds), Turning the tide: the eradication of invasive species. Proceedings of the International Conference on Eradication of Island Invasives. IUCN SSC Invasive Species Specialist Group. IUCN, Gland, Switzerland, pp 26–39

Blake JA (1999) Shellfish culture as a vector for biological Invasions. In: Pederson J (ed), Marine Bioinvasions. Proceedings of the first National Conference. January 24–27, 1999. MIT Sea Grant College Program. Massachusetts Institute of Technology, Cambridge, Massachusetts, pp 403–404

Carey JM, Watson JE (1992) Benthos of the muddy bottom habitat of the Geelong arm of Port Phillip Bay, Victoria, Australia. *Victorian Naturalist* 109: 196–202

Carlton JT (1987) Patterns of transoceanic marine biological invasions in the Pacific Ocean. *Bulletin of Marine Science* 41: 452–465

Carlton JT (1996) Marine bioinvasions: the alteration of marine ecosystems by nonindigenous species. *Oceanography* 9: 36–43

Carlton JT, Geller JB (1993) Ecological roulette: the global transport of nonindigenous marine organisms. *Science* 261: 78–82, doi:10.1126/science.261.5117.78

Carter D (2008) Government takes action on biosecurity threat. NZ Government, http://www.beehive.govt.nz/release/government+takes+action+biosecurity+threat/ (Accessed 24 December 2010)

Chilton C (1910) Notes on the dispersal of marine Crustacea by means of ships. *Transactions of the New Zealand Institute* 43: 131–133

Clapin G, Evans DR (1995) The status of the introduced marine fanworm *Sabella spallanzanii* in Western Australia: A preliminary investigation. Centre for Research on Introduced Marine Pests Technical Report 2, pp 1–34

Clarke GM, Grosse S, Matthews M, Catling PC, Baker B, Hewitt CL, Crowther D, Saddlier SR (2000) State of the Environment Indicators for Exotic Environmental Pest Species. State of the Environment Reporting Unit, Environment Australia. Second Technical Paper Series (Biodiversity). Part 5, 32 pp

Cohen BF, Currie DR, McArthur MA (2000) Epibenthic community structure in Port Phillip Bay, Victoria, Australia. *Marine and Freshwater Research* 51: 689–702, doi:10.1071/MF00027

Coutts ADM, Dodgshun TJ (2007) The nature and extent of organisms in vessel sea-chests: A protected mechanism for marine bioinvasions. *Marine Pollution Bulletin* 54: 875–886, doi:10.1016/j.marpolbul.2007.03.011

Cura A, Ramorino MC (2007) Rapporto sulla Campagna Antarctica Estate Australe 2006-2007. Ventiduesima Spedizione. Programma Nazionale di Ricerche in Antartide (PNRA) Ant 07/01, pp 1–183

Currie DR, McArthur MA, Cohen BF (1998) Exotic marine pests in the Port of Geelong, Victoria. Marine and Freshwater Resources Institute Report 8, pp 1–57

Currie DR, McArthur MA, Cohen BF (2000) Reproduction and distribution of the invasive European fanworm *Sabella spallanzanii* (Polychaeta: Sabellidae) in Port Phillip Bay, Victoria, Australia. *Marine Biology* 136: 645–656, doi:10.1007/s002270050724

Department of Fisheries, Western Australia (2005) Introduced Marine Aquatic Invaders - a field guide. European Fan Worm, http://www.fish.wa.gov.au/docs/pub/IMPMarine/IMPMarinePage14a.php (Accessed 24 December 2010)

Giangrande A, Licciano M, Pagliara P, Gambi MC (2000) Gametogenesis and larval development in *Sabella spallanzanii* (Polychaeta: Sabellidae) from the Mediterranean Sea. *Marine Biology* 136: 847–861, doi:10.1007/s002279900251

Gunthorpe L, Mercer J, Rees C, Theodoropoulos T (2001) Best practices for the sterilisation of aquaculture farming equipment: a case study for mussel ropes. Marine and Freshwater Resources Institute Report 41, pp 1–48

Inglis G, Gust N, Fitridge I, Floerl O, Woods C, Hayden B, Fenwick G (2006a) Gulf Harbour Marina. Baseline survey for non-indigenous marine species (Research Project ZBS2000/04). Biosecurity New Zealand Technical Paper 2005/12, pp 1–56, unpaginated appendices

Inglis G, Gust N, Fitridge I, Floerl O, Woods C, Hayden B, Fenwick G (2006b) Port of Auckland. Baseline survey for non-indigenous marine species (Research Project ZBS2000/04). Biosecurity New Zealand Technical Paper 2005/08, pp 1–58, unpaginated appendices

Inglis G, Gust N, Fitridge I, Floerl O, Woods C, Hayden B, Fenwick G (2006c) Port of Lyttelton. Baseline survey for non-indigenous marine species (Research Project ZBS2000/04). Biosecurity New Zealand Technical Paper 2005/01, pp 1–64, unpaginated appendices

Inglis G, Gust N, Fitridge I, Floerl O, Woods C, Kospartov M, Hayden B, Fenwick G (2008) Port of Lyttelton Second baseline survey for non-indigenous marine species (Research Project ZBS2000-04). MAF Biosecurity New Zealand Technical Paper 2008/02, pp 1–139

Inglis G, Hurren H, Gust N, Oldman J, Fitridge I, Floerl O, Hayden B (2006d) Surveillance design for early detection of unwanted exotic marine organisms in New Zealand. Biosecurity New Zealand Technical Paper 2005/17, pp 1–228

Knight-Jones P, Perkins TH (1998) A revision of *Sabella*, *Bispira* and *Stylomma* (Polychaeta: Sabellidae). *Zoological Journal of the Linnean Society* 123: 385–467, doi:10.1111/j.1096-3642.1998.tb01370.x

Lee JE, Chown SL (2007) *Mytilus* on the move: transport of an invasive bivalve to the Antarctic. *Marine Ecology Progress Series* 339: 307–310, doi:10.3354/meps339307

MAF Biosecurity New Zealand (2008) Mediterranean fanworm *Sabella spallanzanii* [fact sheet]. MAF Biosecurity New Zealand, http://www.biosecurity.govt.nz/files/pests/mediterranean-fanworm/mediterranean-fanworm-factsheet.pdf (Accessed 24 December 2010)

MAF Biosecurity New Zealand (2010) Fanworm pest elimination programme to close [Press release and Questions and Answers document]. NZ Government, MAF Biosecurity New Zealand (14 June 2010), http://www.biosecurity.govt.nz/media/14-06-10/fanworm-response-close (Accessed 24 December 2010)

McEnnulty FR, Bax NJ, Schaffelke B, Campbell ML (2001) A review of rapid response options for the control of ABWMAC listed introduced Marine Pest species and related taxa in Australian waters. Centre for Research on Introduced Marine Pests Technical Report 23, pp 1–99

Minchin D, Gollasch S, Wallentinus I (2005) Vector pathways and the spread of exotic species in the sea. ICES Cooperative Research Report 271, pp 1–25

Morrisey D, Peacock L, Inglis G, Floerl O (2007) Surveillance for early detection of unwanted exotic marine organisms in New Zealand: Summer 2005-2006 MAF BNZ Research Project ZBS2001/01. MAF Biosecurity New Zealand Technical Paper 2007/02, pp 1–171

New Zealand Government (2006) Biosecurity (Notifiable Organisms) Order 2006 Regulations (SR 2006/320), pp 1–17

Patti FP, Gambi MC (2001) Phylogeography of the invasive polychaete *Sabella spallanzanii* (Sabellidae) based on the nucleotide sequence of internal transcribed spacer 2 (ITS2) of nuclear rDNA. *Marine Ecology Progress Series* 215: 169–177, doi:10.3354/meps215169

Read GB (2006) Adventive occurrence in New Zealand of the scale-worm *Paralepidonotus ampulliferus* (Annelida: Polychaeta: Polynoidae). *New Zealand Journal of Marine and Freshwater Research* 40: 643–654, doi:10.1080/00288330.2006.9517452

Read GB, Bellan G (2010) *Sabella* Linnaeus, 1767. In: Read GB, Fauchald K (eds) (2010) World Polychaeta database. World Register of Marine Species [WoRMS], http://www.marinespecies.org/aphia.php?p=taxdetails&id=129549 (Accessed 24 December 2010)

Stratford P (2009) Elimination of fanworm proceeds in Lyttelton Port. *Biosecurity New Zealand* 92: 14–15

Watson AT (1906) A case of regeneration in polychaete worms. *Proceedings of the Royal Society, London (B)* 77: 332–336, doi:10.1098/rspb.1906.0020

Wotton DM, Hewitt CL (2004) Marine biosecurity post-border management: developing incursion response systems for New Zealand. *New Zealand Journal of Marine and Freshwater Research* 38: 553–559, doi:10.1080/00288330.2004.9517260