

DISPERSAL OF THE INVASIVE TUBEWORMS *DESDEMONA ORNATA* AND
PSEUDOPOLYDORA PAUCIBRANCHIATA TO THE NETHERLANDS

(POLYCHAETA: SEDENTARIA)

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Recently two exotic tubeworms new to the fauna of the Netherlands have been recorded in inshore waters in the delta area: *Desdemona ornata* and *Pseudopolydora paucibranchiata*. Within the Polychaeta these worms belong to the group of the Sedentaria. These construct a tube, in which the body of the worm is hidden. The head and feeding appendages protrude from the opening. Most probably these tubes are a major factor in the transport of these animals around the world, as they provide excellent shelters when they are attached to the hull of a ship or commercially traded shellfish.

INTRODUCTION

On 5 September 2015 a citizen scientist of the 'Anemoon Foundation' found some intriguing sabellid polychaetes in the Goese Meer in the province of Zeeland. The worms differed from all other sabellids known from the Netherlands. They were tentatively identified as *Oriopsis* spec. and given to the author for examination. They proved to belong to *Desdemona ornata* Banse, 1957, a new species for the Netherlands. Additional samples were taken by the author from the same locality, the Goese Meer, and

similar habitats elsewhere in the southwest of the Netherlands. In these additional samples a second polychaete species unknown from the Netherlands was discovered: *Pseudopolydora paucibranchiata* Okuda, 1937. These species were described from South Africa and the Japan, respectively. Both are tubeworms, living in a self-constructed tube, with only the feeding appendages protruding. *Desdemona ornata* belongs to the family Sabellidae, characterised by a ring of feathered feeding appendages and therefore sometimes named fanworms.



Figure 1. *Desdemona ornata*, 18 september 2015, Goes, habitus of crawling specimen without tube, radiolar crown folded up. Figuur 1. *Desdemona ornata*, September 18, 2015, Goes, habitus van kruipend exemplaar, tentakelkranen samengevouwen.

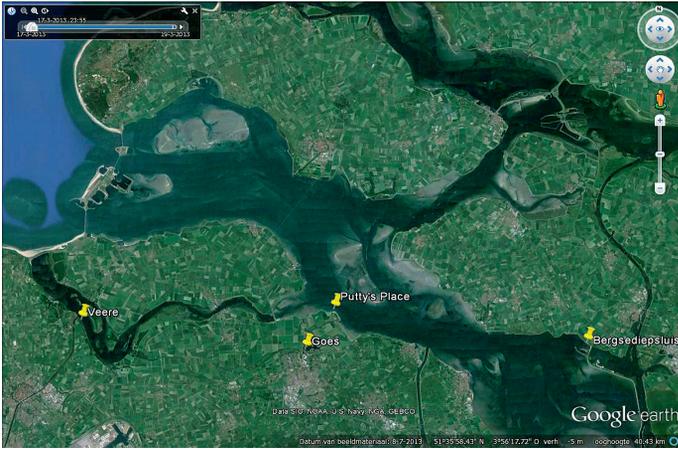


Figure 2. Sample locations.
 Figuur 2. Monsterlocaties.

Pseudopolydora paucibranchiata belongs to the family Spionidae, characterized by two long, flexible, strap-like feeding appendages (palps).

MATERIAL & METHODS

Sample localities

All sample localities (table 1, fig. 2) are in inshore waters in the delta area in the southwest of the Netherlands. The Goese Meer is a land-locked man-made water body, dug out to a depth of about 3 m and connected to the sea and to the harbour of the city of Goes by a canal. The Veerse Meer is a former estuary channel, now with very restricted tides. The Oosterschelde is a fully marine, tidal, former estuary channel.

The sample locations are shallow, from about 20 cm in the (almost) tideless Goese Meer and

Veerse Meer to 2 m deep at low water in the Oosterschelde, and have muddy sand bottoms. The bottoms are bare or have a very thin cover of diatoms or *Vaucheria*. In the Goese Meer and Veerse Meer the sediment may be temporarily covered by detached, sometimes decaying seaweeds.

Sampling, isolation and preservation

Samples were collected by scooping up the top layer (1 cm) of the bottom with a sample container. The sampled material was transferred to a picking tray and was studied under a dissecting microscope the next day. Polychaete worms with radiolar crowns or elongate palps protruding from tubes were transferred to a petri dish. Worms were not quantitatively removed from the tray. Only the largest specimens were taken. In the petri dish the polychaetes were removed from

Water body	Location	Date	Coordinates
Goese Meer	Goes	05,11,18.IX.2015,17.X.2015	N51°31'14.30" E3°53'39.89"
Veerse Meer	Veere	19.IX.2015	N51°32'41.71" E3°40'28.92"
Oosterschelde	Putty's Place	12.IX.2105	N51°32'43.34" E3°55'27.66"
Oosterschelde	Bergsediepsluis	31.X.2015	N51°31'0.57" E4°10'19.42"

Table 1. Sample locations and dates.

Tabel 1. Verzamellocaties and data.

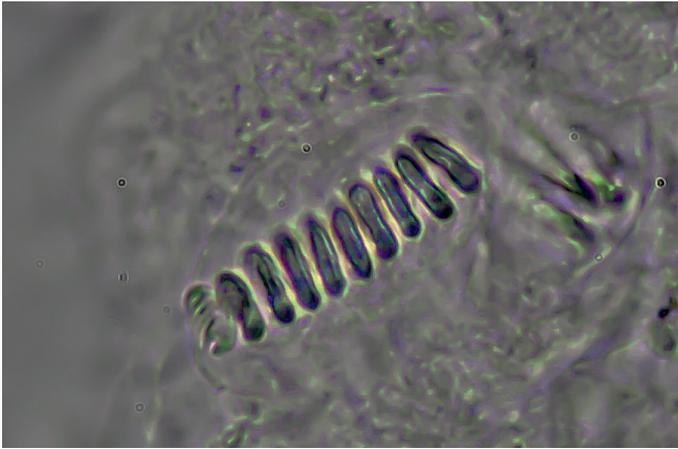


Figure 3. *Desdemonia ornata*, 11 september 2015, Goes, abdominal torus with one uncinus in lateral view.

Figuur 3. *Desdemonia ornata*, September 11, 2015, Goes, abdominale torus met een uncinus in zijaanzicht.

the tubes, observed alive, in some cases photographed, and fixed in a preservation solution (F-solv). After at least 24 h the polychaetes were transferred to ethanol 70 %. Bristles were removed with mounted insect pins (size 000) and transferred to a slide with lactic acid. Photos were taken with a Canon 500D camera through a Zeiss Standard microscope.

IDENTIFICATION

Desdemonia ornata (fig. 1)

Banse (1957) gives a key to *Desdemonia* and morphologically similar genera. Giangrande et al. (2015) provide a key to British and mediterranean sabellids and fabriciids which includes recently introduced species. The genus *Desdemonia* is very similar to the genus *Amphicorina* (syn. *Oriopsis*).

Authors	Origin	Length (mm)	# Chaetigers	Caruncle	Nuchal tentacle	Noto-setae	Branchiae to chaeta
Okuda (1937)	Japan	4-6	32-38	Post 3	+	+	15-17
Read (1975)*	Australia	-15	-60	Post 3	+	-	-25
Blake & Kudenov (1978)	Australia	?	?	Post 3	+	-	21-23 ¹
Myohara (1980)	Japan	5-10	45-60	?		+	19-23
Hutchings & Turvey (1984)	Australia	3-5	?	Post 3	+	-	20-22
Dagli & Çinar (2008)	Turkey	-10	-59	Post 3	+		14-18
Radashevsky (1993)	nw Pacific	18	65	4	+	-	26

Table 2. Reported main characters of *Pseudopolydora paucibranchiata* and *P. cf. paucibranchiata* (*) in the Pacific and Mediterranean. A question mark means that no information on the character is given, + and - mean presence and absence, respectively. Post 3 means to posterior of third chaetiger, 4 means to fourth chaetiger.

Tabel 2. Belangrijkste kenmerken van *Pseudopolydora paucibranchiata* en *P. cf. paucibranchiata* (*) in de Pacific en de Middellandse Zee uit de literatuur. Een vraagteken betekent dat de literatuur geen informatie geeft, + en - betekenen respectievelijk aan- en afwezigheid. Post 3 betekent tot achterzijde derde borstelsegment, 4 betekent tot vierde borstelsegment.

¹ According to Blake & Kudenov (1978) branchiae may be present backwards to chaetiger 35; however, Hutchings & Turvey (1984), studying the same material, counted branchiae only backwards to chaetiger 23 at most.



Figure 4. *Pseudopolydora paucibranchiata*, 17 oktober 2015, Goes, habitus.

Figuur 4. *Pseudopolydora paucibranchiata*, October 17, 2015, Goes, habitus.

It differs in the radioli, which in *Desdemonia* are not flanged as in *Amphicorina* (Banse 1957, Giangrande et al. 2015). According to Giangrande et al. (2015) a peristomial ring collar is present in *Amphicorina* and absent in *Desdemonia*. Illustrations of this species in literature are generally not very clear, but an excellent drawing may be found in Day (1967). *Desdemonia ornata* differs from other Dutch sabellids in the shape of the abdominal uncini (fig. 3). Although the colour pattern may not be diagnostic, it provides some additional confirmation. The radioli are whitish with transparent distal ends. At one third to halfway from the proximal end a conspicuous brown to black band is present in adults (fig. 1).

***Pseudopolydora paucibranchiata* (fig. 4)**

The genus *Pseudopolydora* is characterized by neuropodial hooks from chaetiger 8 backwards, as opposed to chaetiger 7 in other polydorin

genera, neuropodial hooks with secondary tooth closely applied to main tooth and chaetiger 5 not distinctly enlarged, with notochaetae not much reduced in size or number (Read 1975, Radashevsky 2012). Within the genus, *P. paucibranchiata* differs from other species by a combination of characters: frontal margin of prostomium rounded, caruncle extending to posterior margin of third chaetiger, small nuchal tentacle present, branchiae restricted to less than one third of the total number of chaetigers (table 2). Some key characters from literature are given in table 2. Most differences between data from publications are related to differences in length. Okuda (1937) and Myohara (1980) mention a dorsal lobe with a few very fine bristles immediately beside the palps on chaetiger 1. According to Imajima & Hartman (1964) these bristles are presumably neuropodial. The drawing of Okuda (1937) shows notopodial lobes on chaetiger 1 which are quite distinct from the neurochaetae, but the chaetae

Location	Depth (cm)	Salinity (psu)	<i>Desdemonia ornata</i>	<i>Pseudopolydora paucibranchiata</i>	<i>Polydora cornuta</i>
Goes	20	~20	++	++	+
Veere	20	~30	-	++	+
Putty's Place	200	~30	-	+	-
Bergsediepsluis	200	~30	-	+	-

Table 3. Sample locations with depth and salinity and presence of sedentary Polychaeta species. ++ means abundant.

Tabel 3. Vindplaatsen met diepte en saliniteit en aanwezigheid van kokerwormen. ++ betekent talrijk.

on these notopodial lobes are not visible. Unfortunately the type specimens of *P. paucibranchiata* were lost during World War II (Hutchings & Turvey 1984). Radashevsky (1993) mentions *P. paucibranchiata* from the NW Pacific without notochaetae. Specimens of *P. paucibranchiata* from the Netherlands have a small nuchal tentacle like the Japanese and part of the Australian specimens. It differs from the native *P. pulchra* (Carazzi, 1895) in the lower number of branchiae, the rounded prostomium and a constriction in the pennoned companion chaetae. Although the colour pattern is not diagnostic, it provides some additional confirmation. The body is faintly yellowish to brownish. The anal disc is white. The palps are transparent with a faint brown hue and regular yellowish white bands (fig. 4).

PRESENCE AT SAMPLE LOCATIONS

The presence or absence of the polychaetes *Desdemona ornata*, *Pseudopolydora paucibranchiata* and *Polydora cornuta* in the samples of different locations is given in table 3.

DISCUSSION

Dispersal history

Desdemona ornata was described from South Africa, where it was collected in 1949 from the mouth of the Klein River (Banse 1957). Hartmann-Schröder (1982) reports it from Australia. In the Mediterranean Sea it was recorded from Elba, Italy (Lardicci & Castelli 1986) and Saronikos, Greece (Panagopoulos & Nicolaidou 1989), both in 1986 and from Turkey (Sea of Marmara) in 2005 (Çinar et al. 2009). Smith et al. (1999) report records from 1997 onwards in Southampton Water and one record from the Kingsbridge estuary in south Devon in 1998 (both southern England). Cerberio et al. (1998) report it from the Ria de Pasaja (7 m) and the estuary of Bidasoa (3,5 m) on the coast of the Spanish Basque country in 1998. Its occurrence in 2010 in Portugal was mentioned by Correia et al. (2012).

The records from the Netherlands are the first from the coasts of the North Sea.

Pseudopolydora paucibranchiata was described from Japan (Okuda 1937) and is probably native to the NW Pacific (Radashevsky 1993, 2015). It has probably been introduced to the Pacific coast of North America, where it was found from 1951 onwards (Carlton 1979). Read (1975) reports *Pseudopolydora* cf. *paucibranchiata* from New Zealand, which exhibited small differences with *P. paucibranchiata*, mainly the absence of notopodial chaetae on the first chaetiger. However, Radashevsky (1993) mentions *P. paucibranchiata* from the NW Pacific without notopodial chaetae as well. Blake & Kudenov (1978) record *P. paucibranchiata* from Australia. Radashevsky (2015) found that in Australia one or more sibling species of *P. paucibranchiata* may occur. *Pseudopolydora paucibranchiata* was recorded for the first time from the Mediterranean Sea by Dagli & Çinar (2008). It was found in Izmir Bay from 1997 onwards and in Iskenderun Bay and Mersin Bay in 2005 (0.1–11 m). Simboura et al. (2010) mentioned it from Greece. Garmendia et al. (1998) and Cacabelos et al. (2008) reported it from the Ria de Ares y Betanzos and the Ria de Vigo in Galicia, respectively, in Spain and Rodrigues et al. (2011) from the Ria de Aveiro in Portugal. It has also probably been introduced to Brazil (Radashevsky 2015).

Records from the NE Atlantic coast north of Spain need caution because of slight morphological differences and a different depth range and habitat. *Pseudopolydora paucibranchiata* was recorded from 15–25 m depth in the Oslo Fjord in Norway in 1979 by Ramberg & Schram (1983). These authors note the absence of a nuchal tentacle. Kim et al. (2013) mention *P. paucibranchiata* from the northern North Sea between Norway and Scotland from depths down to 313 m. The doubts about the identity of presumed specimens of *P. paucibranchiata* in the NE Atlantic are expressed by different authors. Mackie & Erséus (1997) mention *Pseudopolydora*

cf. *paucibranchiata* in a list for the British Isles and Radashevsky (2012) included *Pseudopolydora* aff. *paucibranchiata* in a key for UK spionids. The introduction of *P. paucibranchiata* to the Netherlands probably happened recently as there are no previous records from the regularly monitored Oosterschelde and Veerse Meer (Leewis et al. 2014).

Ecological aspects

Desdemona ornata and *Pseudopolydora paucibranchiata* both have been mainly recorded from shallow and very shallow water. *Pseudopolydora paucibranchiata* has been recorded from depths of 0.1–11 m (Dagli & Çinar 2008). Records from deep water down to 313 m in the northern North Sea and adjacent areas (Mackie & Erséus 1997, Ramberg & Schram 1983, Kim et al. 2013) probably concern a different species (see 'Identification'). Both *D. ornata* (see Cerberio et al. 1998) and *P. paucibranchiata* (see Reish 1955, Dagli & Çinar 2008, Simboura et al. 2010) have been noted to occur particularly in organically enriched or polluted bottom sediments. As in coastal waters of the Netherlands organically enriched sediments are widespread, conditions for a firm establishment are met with, at least as far as sediment characteristics are concerned. Currently not much information on competition with other species is available. Dagli & Çinar (2008) state that *P. paucibranchiata* is a weak competitor that only thrives where conditions for most species are suboptimal. As the polychaetes are avid tube builders consolidation or alteration of the sediment is likely when densities are high.

In the Goese Meer *D. ornata* and *P. paucibranchiata* occur together with *Polydora cornuta* Bosc, 1802, another polydorin which often occurs in organically enriched habitats (Dagli & Çinar 2008, Pearson & Rosenberg 1978 as *P. ligni*). In the Veerse Meer *P. paucibranchiata* occurs together with *Polydora cornuta*. Both the location in the Goese Meer and the location in the Veerse Meer are characterized by accumulation and decay of seaweeds. The location Bergsedijsluis

is at the head of the Oosterschelde inlet, where tidal currents are absent, and close to a site for rope culture of mussels with heavy accumulation of organic matter.

Future prospects

Both *D. ornata* and *P. paucibranchiata* were found in high densities, the latter species in three different localities. As shallow organically enriched soft bottoms in sheltered locations are common in the Netherlands these species may be more widespread than currently known. If they arrived only recently, there is ample opportunity for further dispersal.

ACKNOWLEDGEMENTS

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SAMENVATTING

De exotische kokerwormen *Desdemona ornata* en *Pseudopolydora paucibranchiata* hebben Nederland bereikt (Polychaeta: Sedentaria)

De invasieve kokerwormen *Desdemona ornata* en *Pseudopolydora paucibranchiata* worden voor het eerst gemeld van het Noordzeegebied, respectievelijk Noordwest-Europa. Beide soorten werden aangetroffen in ondiep water in het zuidwestelijk deltagebied. Voor beide soorten is dit een noordoostwaartse uitbreiding langs de kust van Europa. Het zijn soorten die vooral voorkomen in habitats die aangerijkt zijn met organische stof. De introductievector is onbekend.

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