

## Research Article

## *Palaemon elegans* Rathke, 1837 (Caridea: Palaemonoidea: Palaemonidae) established in the Gulf of Finland

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### Abstract

New observations are presented on the distribution of *Palaemon elegans* Rathke, 1837 in the Gulf of Finland and in the Archipelago Sea. *P. elegans* has spread and become established in the north-eastern Baltic Sea. Ovigerous females and juveniles were found, indicating that *P. elegans* reproduces in this area. The species was recorded, sometimes in high densities, along the southern coast of Finland between Naantali and Loviisa. Information on the distribution of *P. elegans* along the Estonian coast is also included.

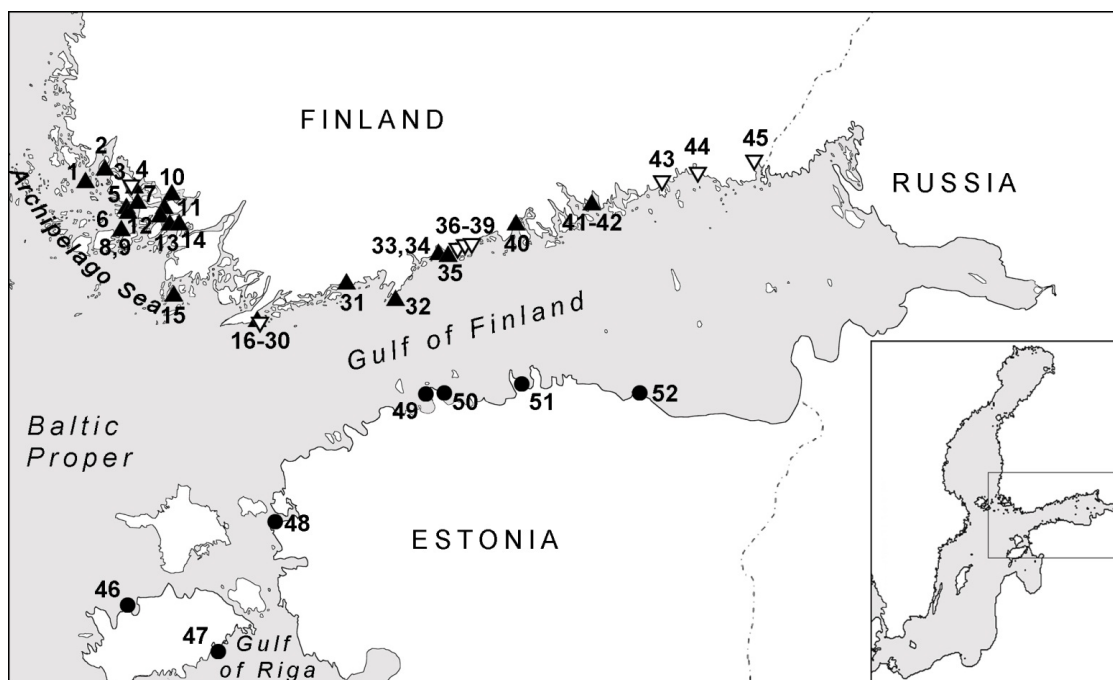
**Key words:** rock-pool prawn; alien species; north-eastern Baltic Sea; Archipelago Sea

### Introduction

The rock-pool prawn *Palaemon elegans* Rathke, 1837 is native to the Mediterranean Sea, the Black Sea and the Atlantic east coast from Scotland and Norway to Mauritania (d'Udekem d'Acoz 1999, cited in Reuschel et al. 2010). In the 1950s it was unintentionally introduced to Aral and Caspian Seas (Zenkevich 1963). It was first found in the Southern Baltic Sea in 2002 in Arkona Basin (Zettler 2003) and the Gulf of Gdansk (Janas et al. 2004) although it was earlier found sporadically in Wismar Bay (Köhn and Gosselck 1989, cited in Grabowski 2006). It rapidly colonized shores along the southern and south-western coasts of the Baltic Sea (Grabowski 2006; Janas and Mańcucka 2010 and references therein). There has been some confusion on whether *P. elegans* has already been a part of the coastal fauna in the southern Baltic Sea since 1920s, but such reports are most probably mistakes due to taxonomic

rearrangements and changes in nomenclature of palaemonid prawns (Grabowski 2006). An abrupt appearance and expansion in the Baltic Sea suggests introduction aided by humans and not natural range expansion from the North Sea. This view is supported by Reuschel et al. (2010), who showed that specimens in the southeastern Baltic Sea belong to the same haplotype group with the populations from the Black, Caspian and Mediterranean Seas, and not with those from the Atlantic Ocean. They even suggest that this haplotype group should be considered a cryptic species within the *P. elegans* species complex.

*Palaemon elegans* was first reported from Finland in 2003 (one specimen was observed in Vindskären, Tvärminne archipelago, in the northern Baltic Sea, Lavikainen and Laine 2004). In 2009 one specimen was found in Tvärminne Långskär (Hildén et al. 2010) but there have been no other published observations. Divers, however, reported and photographed the species in autumn 2009 in the Porkkala area in the Gulf



**Figure 1.** Sites of *Palaemon elegans* observations in the Gulf of Finland and adjacent water bodies. Observations from the Finnish coast are shown by filled triangles, sampling sites with no *P. elegans* are shown by empty down-pointing triangles and observations from the Estonian coast (Kotta and Kuprijanov 2012) are shown by filled circles. The insert shows the position of the sampling area in the Baltic Sea. See Appendix 1 for site details.

of Finland. It has recently been observed on the southern coast of the Gulf of Finland in Estonia in quantities suggesting establishment has occurred (Kotta and Kuprijanov 2012).

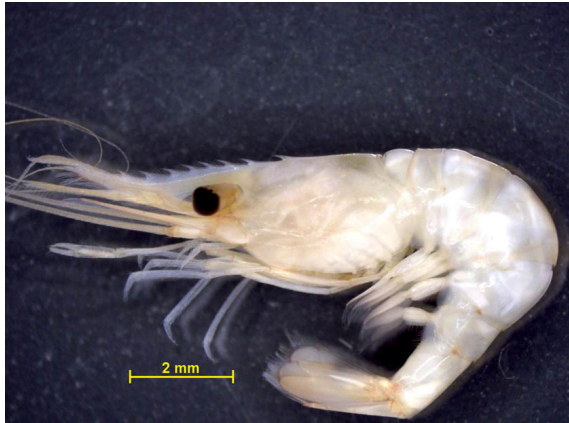
*Palaemon elegans* is mainly observed in shallow water substrates, including bare stones, rocks covered with green, brown and red macroalgae, bare sandy bottoms and sandy bottoms with beds of *Zostera marina* Linnaeus, 1753 or other higher plants (Berglund and Lagercrantz 1983; Lavikainen and Laine 2004; Janas et al. 2004; Kotta and Kuprijanov 2012).

In this paper we present new observations on the distribution of *Palaemon elegans* in the Gulf of Finland and the Archipelago Sea showing that it has spread and become established in the region. Our study compiled observations made during the coastal sampling of invasive species as well as photo documentations of the species made by non-professionals through a web portal in 2011. In addition, observations of *P. elegans* as a bycatch in *Rhitropanopeus harrisii* (Gould, 1841) traps (Fowler et al. 2013) were included in the results.

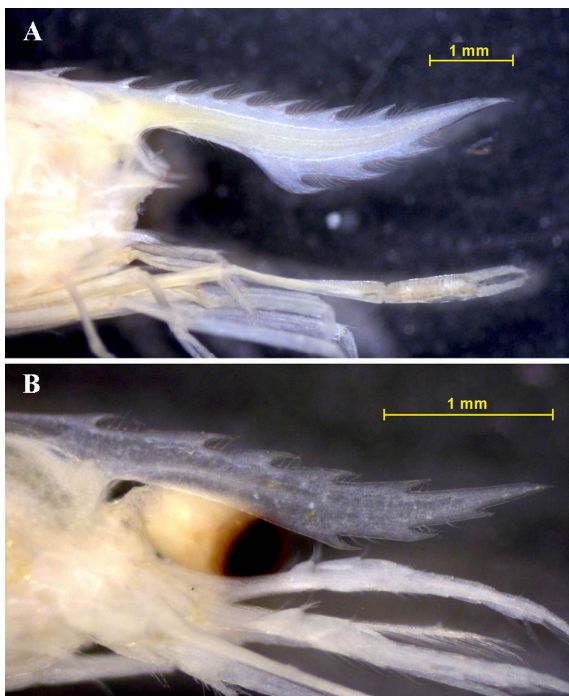
## Methods

Samples were collected from several locations along the Finnish part of the Gulf of Finland (Figure 1). In Virolahti, Hamina, Kotka, Loviisa, Porvoo, Espoo and Inkoo sampling was conducted in August 2011. Several sites were sampled in Helsinki and Tvärminne (Hanko) in June to August and one site in the Archipelago Sea in June 2011. Sampling sites covered different exposure regimes (exposed, semi-exposed and sheltered) and included different bottom types (stones, sandy, mud) and vegetation types (reeds, other higher plants, macroalgae). Within the reed beds, floating algae and other higher plants often occurred.

Sampling was performed using hand-nets, traps, and a quantitative tube sampler. Floating algae (*Fucus vesiculosus* Linnaeus, 1753, hereafter referred to as *Fucus*, and/or filamentous algae) and vascular plants (*Potamogeton perfoliatus* L., *Stuckenia pectinata* (L.) Börner, 1912, *Myriophyllum spicatum* L.) were collected with a handnet, or the surface of the bottom or

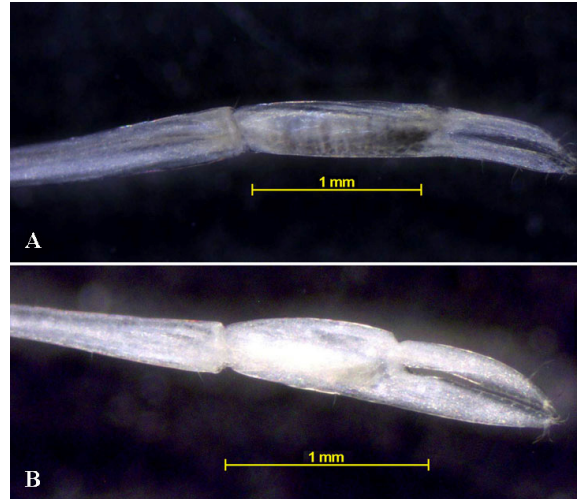


**Figure 2.** *Palaemon elegans* caught in reed beds in Loviisa area (Valkolampi, public beach); preserved specimen (Photograph by S.A. Malavin).



**Figure 3.** Rostrum of *Palaemon elegans* (A) and *P. adspersus* (B); preserved specimens (Photographs by S.A. Malavin).

the algal overgrowth was scraped with the net. In sites with attached *Fucus*, the whole thalli were collected in the net along with the stones. The attached plants were washed on shore to remove all *Palaemon* spp. and then put back in the water. The collected drift macrophytes were either washed on shore or in the laboratory. All *Palaemon* spp. were taken alive to the laboratory and identified to species.



**Figure 4.** Chela of *Palaemon elegans* (A) and *P. adspersus* (B); preserved specimens (Photographs by S.A. Malavin).

The trap sampling used commercial crayfish traps (similar to Evo type traps; Westman et al. 1979) that were lined with a fine mesh (2–4 mm) to better retain prawns. A clump of *Fucus* was placed inside the trap to provide shelter for the animals. The traps were anchored in < 1m depth inside or by the edge of a reed bed. The traps were kept in place overnight and the numbers recorded were from 2–3 successive nights (and 1–3 traps) in each site. When the traps were emptied, all *Palaemon* specimens were taken alive to the laboratory and identified to species.

In the inner Archipelago Sea, the distribution and population dynamics of the recent invader *Rhithropanopeus harrisii* were being studied by Fowler et al. (2013) in 2012. The sampling consisted of artificial habitats made of plastic or metal crates filled with cleaned oyster shells or pieces of flower pots that were placed in several sites. The crates remained in place for a week at which time they were removed, and the oyster shells and flower pot pieces carefully examined to find all hidden animals. Some of the organisms collected and recorded were *P. elegans* and this information was forwarded to one of the authors.

The tube sampling was carried out with a cylindrical 0.031 m<sup>2</sup> corer. At each location, two to five core samples were taken and the contents pooled. The contents were washed on a 0.25 mm screen and all *Palaemon* specimens were removed, preserved in 4% formalin solution, and identified to species in the laboratory.

In all sampling programs, specimens of *Palaemon elegans* were identified by their colouring (stripes and deep blue joints in legs), the number of teeth in the rostrum (Barnes 1994), and the number of segments in the mandibular palps (Hayward et al. 1995) (Figures 2–4).

A website for reporting observations of aquatic alien species in the coastal areas of Finland was established in 2011 by the Finnish Game and Fisheries Research Institute and the Finnish Environment Institute SYKE ([http://www.riistakala.info/alien\\_species/](http://www.riistakala.info/alien_species/)). The citizens and researchers were asked to describe the observation site and identify its coordinates by placing it on a Google map. They were also asked to attach photographs or give details of the identification. The observations were verified by experts.

## Results and discussion

Our results show that *Palaemon elegans* is widely established in the north-eastern Baltic Sea. Along the southern coast of Finland it was found in several sites between Loviisa and Naantali, sometimes at high densities (Figure 1, Appendix 1). Near the island Klobben in Tvärminne, 60 specimens in total were collected over three successive nights (three traps for 2 nights plus 1 trap for 1 night) in traps set beside a small reed stand on the sheltered side of a small island. An additional 19 specimens were collected by one trap set overnight for two successive nights at a slightly more exposed site. The same traps also retained larger numbers of the native prawn *Palaemon adspersus* Rathke, 1837. In addition, the internet observations identified many sites with numerous *P. elegans* present, especially in the Archipelago Sea.

Many ovigerous *Palaemon elegans* females were observed indicating that the species reproduces in the study area. Also, juveniles (< 1 cm) were observed in late summer samples. In addition, during a monitoring of soft bottom benthos, a *Palaemon* sp. megalopa larva was found in an Ekman dredge sample taken at a depth of 14 m in Velkuanmaa, Archipelago Sea (60°26.15'N, 21°36.12'E). Identification according to the key by Fincham and Figueras (1986) suggests the megalopa was *P. elegans*.

In 2011, *Palaemon elegans* was found for the first time and in high densities along the Estonian coasts from the Gulf of Riga and the Baltic Proper to the Gulf of Finland (Figure 1) (Kotta and Kuprijanov 2012). Also the Estonian

populations were reproducing, as ovigerous females were common in the samples. In the Estonian coastal sea, *P. elegans* inhabited nearly all types of coastal vegetated habitats, and in the Gulf of Finland and the Baltic Proper also occurred in sparsely vegetated areas down to 15–20 m depths. The species was very abundant within charophyte beds and within the dense foliage of the angiosperm Sago pondweed *Stuckenia pectinata* (L.) Börner, 1912.

In samplings by a hand-net or a corer, the number of caught individuals was low (1–7) while larger quantities were caught with the traps. High densities of the prawn were also reported in the web page, but this may in part be explained by the fact that large swarms catch peoples' attention while planned samplings are done randomly. Nocturnal swimming activity has been observed in *Palaemon elegans* (Berglund 1980) as well as in other palaemonid prawns (Guerao and Abello 1996) and also one of the web observers stated that during night prawns could be seen swimming in the water.

Our observations contrast the opinion that *Palaemon elegans* would not be able to reproduce successfully in the northern Baltic Sea (Lavikainen and Laine 2004) due to poor survival of the pelagic larvae at low salinities (Berglund 1985). However, as the Baltic population originates from the Mediterranean or Black Sea populations (Reuschel et al. 2010), it probably responds differently to low salinity compared to the Atlantic populations studied by Berglund (1985). In Poland, low salinity did not prevent reproduction of *P. elegans* but larval survival was not investigated (Janas and Mańkucka 2010). However, Grabowski (2006) reports that in the Bay of Puck in Poland, with salinity < 6 PSU, *P. elegans* individuals from small post-larval juveniles to mature ovigerous females were found. In our study area from the Archipelago Sea to Loviisa (the easternmost site of the observations in this study), salinity ranged between 5 and 6 PSU. Thus, this low salinity seems to be still high enough for *P. elegans* reproduction in the western and central parts of the Gulf of Finland. In the eastern Gulf of Finland *P. elegans* was not found despite extensive sampling in the Russian coastal waters of the gulf in August 2010 (V. Panov, unpubl. data). It remains to be seen whether this is due to low salinities (with the values below 2.5 PSU during the survey) preventing reproduction and thus establishment of *P. elegans* in the area or some other unknown environmental variables.



Alternatively, *P. elegans* may be still colonizing the gulf as Janas et al. (2013) showed that *P. elegans* from the Baltic Sea survives well at salinities down to 1 PSU while below 1 PSU the survival sharply declines.

Grabowski (2006) suggests that *Palaemon elegans* may have outcompeted *P. adspersus* in the open Baltic coast of Poland. Although there is no ongoing monitoring for *Palaemon* spp. in Finland, our data demonstrate that such competitive exclusion has not occurred in the Finnish coast. In contrary, *P. adspersus* was very abundant in most sampled sites in summer 2011, especially among the dying floating algae near the shoreline. However, laboratory experiments have shown that of these two species *P. elegans* survives in low salinities better, which indicates that it may extend its distribution in the Baltic Sea to areas where salinity is too low for *P. adspersus* (Janas et al. 2013).

*Palaemon elegans* is an omnivore feeding on macroalgae, detritus, and invertebrates (Janas and Barańska 2008). Plant detritus is a main component in the food (Burukovsky 2012), although the diet varies according to availability of different food items in the environment (Janas and Barańska 2008). However, in experiments, *P. elegans* preferred invertebrates over algal food (Persson et al. 2008). As *P. elegans* may consume large quantities of gammarid amphipods, an introduction of the alien palaemonid may exert a strong predatory pressure on another invasive species, *Gammarus tigrinus* Sexton, 1939, which was observed to be a dominant amphipod in many of the *P. elegans* sites in this study.

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## Supplementary material:

**Appendix 1.** Observations of *Palaemon elegans* in the Archipelago Sea and the Finnish and Estonian parts (Kotta and Kuprijanov 2012) of the Gulf of Finland in 2007–2012. The number of the observation refers to the map in Figure 1. Methods: H: handnet; T: adjusted crayfish trap; C: corer 0.03 m<sup>2</sup>; F: frame sampler 0.04 m<sup>2</sup>; K: kick-net; D: diver's observation; www: reported in the website, method not mentioned unless otherwise stated; R: bycatch from *Rhithropanopeus harrisi* traps. N P.e: number of *P. elegans* individuals. % P.e: percentage of *P. elegans* of all *Palaemon* spp.; NA data for all *Palaemon* spp. not available; *Fucus*: *F. vesiculosus*, *Potamogeton*: *Potamogeton perfoliatus*, *Cladophora*: *C. glomerata*, *Myriophyllum*: *M. spicatum*, *Pilayella*: *P. littoralis*, *Stuckenia*: *S. pectinata*, *Chara*: *C. baltica*.

No	Location name	Location coordinates		Sampling site description	Sampling date	Method	N P.e.	% P.e.	Remarks
		Latitude, N	Longitude, E						
1	Naantali, Velkuanmaa	60°26.2'	21°36.1'	soft bottom; depth 14 m	24.10.2011	Ekman	1?		1)
2	Naantali, Lempisaari	60°29.3'	21°46.2'	mud, <i>Fucus</i>	05.06.2012	R	5	NA	
3	Rymättylä, Kuulinen	60°23.9'	22°01.8'	exposed, rock, <i>Fucus</i>	13., 14.06.2011	H	0		
4	Rymättylä, Lapila	60°23.9'	22°02.5'	sand	15.05., 27.05.2012	R	6	NA	
5	Rymättylä, Airismaa	60°19.0'	21°57.8'	stony shore; depth 0.2–1.5 m	18.09.2010	www	>20	NA	
6	Kramppi	60°17.3'	21°58.4'	<i>Fucus</i>	26.05.2012	R	5	NA	
7	Grangrundet	60°18.7'	22°04.8'	sand	17.05., 27.05.2012	R	13	NA	
8	Lamassaari	60°14.0'	21°56.9'	sand	27.05.2012	R	2	NA	
9	Högholmen	60°14.5'	21°59.6'	sand	13.05.2012	R	2	NA	
10	Tuorla	60°24.5'	22°26.4'	mud	05.06.2012	R	9	NA	
11	Parainen, Kirjalansaari	60°19.3'	22°21.2'	reed	29.09.2007	www	10	NA	
12	Parainen, Munkvik	60°17.5'	22°18.6'	seaside of reed belt	29.10.2011	www	4	NA	
13	Parainen, Lemlahti	60°14.6'	22°22.7'	shallow shore, stones and mud; no macrophytes.	01.10.2011	www	50	NA	
14	Sauvo, Peimari	60°16.0'	22°27.8'	rock, reed; depth 0–1.5 m	21.08.2011–27.08.2011	www (H)	8–9	NA	

**Appendix 1 (continued).**

No	Location name	Location coordinates		Sampling site description	Sampling date	Method	N P.e.	% P.e.	Remarks
		Latitude, N	Longitude, E						
15	Kasnäs	59°56.5'	22°25.8'	underneath a large buoy attached to an aquaculture mesh bag	10.11.2011	www	>100	NA	
16	Tvärminne, Gräsgrundet	59°51.3'	23°14.2'	sheltered, sand, reed, floating <i>Fucus</i>	03.08.2011	H	0		no P. spp
17	Tvärminne, Långholmen	59°51.0'	23°14.8'	cobble littoral, <i>Potamogeton</i> ; sand, <i>Cladophora</i> , floating <i>Fucus</i>	03.08., 09.08. 2011	H, C	0		
18	Tvärminne, Krogarviken	59°50.8'	23°14.9'	reed, floating <i>Fucus</i> + filamentous algae	28.07., 03.08.; 03.–05.08.2011	H T	0		
19	Tvärminne, Vikaskär	59°50.8'	23°15.2'	reed, floating <i>Fucus</i>	09.08.2011	H	1	50	
20	Tvärminne, Jovskär A	59°50.8'	23°15.2'	reed	28.07.2011; 03.–05.08.2011	H T	0		
21	Tvärminne, Jovskär B	59°50.7'	23°15.1'	reed	03.–05.08.2011	T	19	51	
22	Tvärminne, Klobben N	59°50.5'	23°14.7'	sheltered strait, reed, floating <i>Fucus</i>	22.–25.07. 2011	T	60	38	
23	Tvärminne, Klobben S	59°50.5'	23°14.8'	exposed, rock, stones, <i>Fucus</i>	07.07.2011	H	0		
24	Tvärminne, Klobben E	59°50.5'	23°14.8'	reed, floating <i>Fucus</i>	07.07.2011	H	1	2	
25	Tvärminne, Halsholmen	59°50.5'	23°15.3'	exposed, rock, <i>Fucus</i>	06.07.2011	H	0		
26	Tvärminne, Halsholmen, bay	59°50.5'	23°15.5'	bay in an island; inner part ( <i>Myriophyllum</i> ) & mouth ( <i>Fucus</i> )	01.–03.08. 2011	T	0		
27	Tvärminne, Rovholmen	59°50.4'	23°15.0'	exposed, stones, <i>Fucus</i> , filamentous algae	21.07.2011 20.–22.07. 2011	H T	0		
28	Tvärminne, Vindskären	59°49.7'	23°12.6'	shallow bay in an island; rocks, <i>Fucus</i>	02.08.2011	H	1	5	
29	Tvärminne, Granbusken	59°48.9'	23°14.7'	semi-exposed bay in an outer archipelago island; depth ~2 m	28.08.2011	www (D)	15–20	NA	
30	Tvärminne, Långskär	59°49.0'	23°15.1'	exposed, open sea; rock, <i>Fucus</i>	05.07.2011	H	0		no P. spp
31	Inkoo, beach	60°02.0'	24°00.2'	near a beach; reed, small stones, filamentous algae	09.08.2011	H	5	71	
32	Porkkala, Söderskär	59°56.3'	24°26.8'	outer archipelago, small bay; rocks, shore vegetation, some <i>Fucus</i> , <i>Myriophyllum</i> .	11.09.2011	www (K)	20	NA	
33	Espoo, Hanasaari	60°09.8'	24°50.2'	cobble littoral	09.08.2011	C	1	20	11 ind m <sup>-2</sup>
34	Helsinki, Lauttasaari	60°08.8'	24°53.5'	breakwater opposite a harbour, stones, shallow; dying filamentous algae, litter	20.06.2011 11.08.2011	H H	0 1		no P. spp
35	Helsinki, Harakka	60°08.9'	24°57.5'	rocky shallow shore	28.09.2011	www (H)	3	NA	
36	Helsinki, Laajasalo	60°09.8'	25°01.7'	reed, sand, stones	20.06., 11.08.2011	H	0		

## Appendix 1 (continued).

No	Location name	Location coordinates		Sampling site description	Sampling date	Method	N P.e.	% P.e.	Remarks
		Latitude, N	Longitude, E						
37	Helsinki, Marjaniemi beach	60°11.9'	25°04.4'	reed, rock, stones, filamentous algae (dying)	29.06.2011	H	0		
38	Helsinki, Marjaniemi marina	60°12.1'	25°05.9'	sand, stones, mud, reed	08.08.2011	H, C	0		
39	Helsinki, Uutela	60°12.2'	25°10.9'	breakwave, floating <i>Fucus</i> , filamentous algae	20.06., 11.08.2011	H	0		
40	Porvoo, Rantakylä	60°19.5'	25°31.8'	reed, small stones; <i>Myriophyllum</i> , <i>Potamogeton</i> .	08.08.2011	H	7	100	
41	Loviisa, Valko, beach	60°23.8'	26°15.1'	sand, reeds, <i>Cladophora</i>	08.08.2011	C	1	100	17 ind m <sup>-2</sup>
42	Loviisa, Valko, beach	60°23.8'	26°15.2'	reeds, stony bottom, rock, floating <i>Fucus</i>	08.08.2011	H	1	10	
43	Kotka, Munsaaari, Kymi River delta	60°28.3'	26°53.7'	sand, cobbles, reeds	08.08.2011	C	0		
44	Hamina	60°31.6'	27°14.9'	sand, cobble	11.08.2011	C	0		
45	Virolahti	60°34.8'	27°46.0'	sand, reeds, <i>Potamogeton</i>	11.08.2011	C	0		
46	Küdema Bay	58°33'	22°01'	limestone with <i>Fucus</i> , <i>Pilayella</i> , <i>Cladophora</i> ; 1–8 m	27.10.2011	H	10	NA	1 ind m <sup>-2</sup>
47	Kõiguste Bay	58°20'	23°00'	boulders mixed with sand; <i>Cladophora</i> , <i>Fucus</i> , <i>Potamogeton</i> , <i>Stuckenia</i> ; 1–3 m	26.07.2011	H	>20	NA	1–5 ind m <sup>-2</sup>
48	Haapsalu Bay	58°56'	23°28'	boulders mixed with sand; <i>Cladophora</i> , <i>Chara</i> ; 0.5 m	27.07.2011	F	1	NA	25 ind m <sup>-2</sup>
49	Tallinn Bay	59°32'	24°45'	shipwreck covered with brown and red filamentous algae; 15 m	09.06.2011	D	1	NA	
50	Muuga Bay	59°32'	24°53'	boulders mixed with clay and sand	02.10.2011	D	>50	NA	1–33 ind m <sup>-2</sup>
51	Hara Bay	59°35'	25°37'	boulders covered with <i>Cladophora</i> ; 1 m	27.07.2011	H	>20	NA	
52	Kunda Bay	59°32'	26°39'	<i>Cladophora</i> , <i>Fucus</i> , <i>Pilayella</i> ; 1 m	27.07.2011	H	1	NA	

1) *Palaemon* sp. megalopa larva. Identification according to the key by Fincham and Figueras (1986) suggests the megalopa was *P. elegans*.