Elinkeino-, liikenne- ja ympäristökeskus

REPORTS 2 | 2020

Monitoring of alien species Cercopagis pengoi in the Hanko area in1998 – 2005

ALEXANDER ANTSULEVICH

Monitoring of alien species *Cercopagis pengoi* in the Hanko area in1998-2005

(Vieraslajin Cercopagis pengoi seuranta ja esiintyminen Hangon edustalla asemalla Längden UUS-23 vuosina 1995-2005)

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COMPILED 1.6.2006

REPORTS 2 | 2020
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Centre for Economic Development, Transport and the Environment for Uusimaa

Cover photo: Helsingin kaupunki, Ympäristöpalvelut

ISBN 978-952-314-837-6 (PDF)
ISSN 2242-2854 (online)
URN:ISBN:978-952-314-837-6

www.doria.fi/ely-keskus

Content

1. Introduction

Alien predatory planktonic crustacean *Cercopagis pengoi* appeared in the eastern Baltic (Gulf of Riga) in year 1992. In 1995 in the Gulf of Finland (GOF) almost simultaneously it was registered in areas of water of Estonia, Finland and Russia (St.-Petersburg Region) (Kivi, 1995; Ojaveer, Lumberg. 1995; Avinski, 1997). The route (vector) and the way of its self-introduction (invasion) to the GOF is more-or-less understandable. By origin *C. pengoi* is Ponto-Caspian species. From several species of genus *Cercopagis*, endemic to the Caspian sea *C. pengoi* is only one, which was known from 60th years of last century outside of this sea. As well it inhabited neighboring basins of the Black and Azov sea and sometimes the water-bodies with almost fresh water conditions (Atlas bespozvonochnikh Kaspijskogo Morja (Atlas of invertebrates of Caspian Sea), 1968). So, it is most ecologically high-tolerant representative of the whole genus *Cercopagis*. That is why the long fresh water way via Volga river system, numerous canals and reservoirs from the Black Sea basin (most probably than from Caspian Sea) wasn't harmful for this aliens. Evidently the invaders were transported in ballast water tanks of cargo vessels. If adult crustaceans are not very tolerant to unfavorable environmental conditions, but their resting eggs are very good protected and resistant to stressing environmental changes (Krylov, Panov, 1998; Antsulevich, Välipakka, 2006). The exact point of invasion is unknown. Earliest findings belongs to the Gulf of Riga. Possibly, the multiple invasion of several sites may have place.

Since the year 1997 Southeast Finland Regional Environmental Centre carries out regular monitoring of this alien species within the area of water from Pÿhtää to Vyborg Bay by total square over 1000 km^2. In the year 1997, soon after invasion the density of *C. pengoi* as 1800 $ind.m^{-3}$ once was observed in SE Finland – the biggest one wherever registered in the GOF area (Uitto et al., 1999; Antsulevich, Välipakka, 2000). However the knowledge about *C. pengoi* distribution, abundance and seasonal dynamics in other parts of the GOF are rather fragmentary or absent at all. The monitoring data of UUS from Hanko area, collected during long period of years 1998 – 2005, is rather helpful to fill these empties.

2. Material and methods

Plankton material was collected in period 1998-2005. All samples, but only from one site (st. UUS-23, Längden) were investigated in total amount 50 samples. UUS-23 is offshore and rather deep station with maximal depth 60 m. Every year on this station from 4 (year 2004) to 8 (years 1998, 1999, 2001) samples were collected, earliest per year in January (22.01.1998) and latest in November (14.11.2000). Usually each year the period of sampling covered the period of C. pengoi presence in plankton. But in years 2002 and 2004 because of technical reasons and storms the sampling was abrupt in September and August - on a peak of population development.

The samples were collected with vertical non-closing plankton nets. During the whole period three different nets were in use with diameters as 24 cm (mesh size 50 mkm), 33 cm and 35 cm (mesh size 150 mkm). All nets and mesh sizes are suitable for *C. pengoi* catch, however the bigger one (35 cm) is preferable.

Samples were collected from standard horizons 10 – 0 m (years 2000-2005), but earlier (year 1999) they were taken from whole water column as 55 - 0 m, what makes impossible the direct comparison of the data. This problem was resolved successfully and simple way. Relatively to Finland *C. pengoi* is the warm-water organism. In the GOF it inhabits above the thermocline, mostly concentrating in upper horizon 0 – 10 m. So, from the 55 - 0 m water column *C. pengoi* inhabits only in upper 0 -15 m, what was taken into account for the re-calculation of the data to the cubic meter.

The samples were preserved in solution of neutral formalin and occurred in good condition.

All samples were investigated under the microscope totally; no methods, using fragmentary inspection were in use. For investigation and counting of individuals was used special labyrinthal cup ("cup of Bogorov") of volume 20 ml, portion by portion.

Generally this material can be regarded as rather valuable and representative but for one site (station UUS-23) only. Judging from the results of similar monitoring carried out in SE Finland, the abundance of *C. pengoi* may vary more than one order of magnitude from station to station, even when collected in the same day. So, still remains the question if the station UUS-23 is representative for the Hanko area in the whole.

Biomass of *C. pengoi*, like many other planktonic organisms can be easy calculated by multiplication of the density to mean individual mass. Unfortunately, because of too complicated body shape the individual mass of *C. pengoi* may not theoretically calculated from geometrical plans, like it can be done, for example, for many copepods. Mean individual mass of *Cercopagis* approximately was accepted as 0,3 mg (wet weight), i.e. as equal to one of *Bythotrephes* – taxonomically most relative crustacean, quite similar to *Cercopagis* by size, body shape and general outlook. But exactly mean individual mass depends of the proportion between juvenile and mature individuals (the difference in their mass can be 10 times or more), percentage of sexual females with eggs, amount of forms of intermedial sizes and stages of maturation. These parameters depend of the season, structure of population and even of predator's pressure (plankton-feeding fish picks up bigger specimens). It means for exact determination of mean individual mass it should be done all the time newly for every local population (investigation site) and for every period of sampling, what is of course not reasonable for monitoring. Anna Uitto from Helsinki University (Uitto et al., 1999) calculated the coefficient 2,13 to be applied for the recalculation from live animals mass to their dry weight.

3. Results

Primary data in form of 8 annual tables (table 1998-2005) with data on seasonal changes of *C. pengoi* abundance presented as separate file of format .XLS. The tables are not included, but only refereed and discussed below. For comparison the rich data from SE Finland Regional Environmental Centre (KAS) was involved. That data from region of Pÿhtää – Kotka - Hamina mostly published in several papers and abstracts (Uitto et al., 1999; Antsulevich, Välipakka, 2000; 2006) or web-site of KAS, but partly unpublished.

Because of very high swing of variation of spatial and temporal distribution of *C. pengoi* density within the one season, we considered that maximum values of observed density can be most adequate characteristic of the each year. Maximal values from year to year may slide on time axis within the wide period of July – September. It depends of the velocity of summer water warming up in certain year and of the intensity of parthenogenetic reproduction.

Together with this the data on earliest and latest finding of *C. pengoi* in plankton were selected as "basic facts", which may serve to comparison among the several years.

Maximal density of *C. pengoi*, registered at all years of the observation (1998-2005) described on the diagram (fig. 1).

Fig. 1. Maximal density (N *ind.m*$^{-3}$) of alien species *Cercopagis pengoi*, registered at years
(Hanko area, station UUS-23)

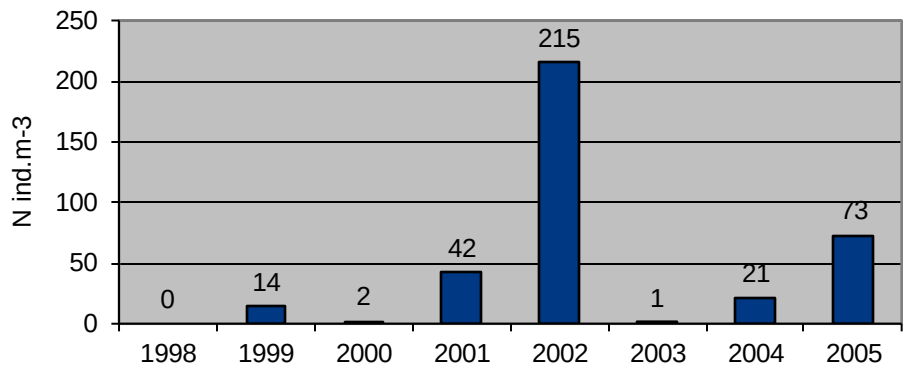


Fig 1. Maximal density of C. pengoi, registered at all years of the observation (1998-2005).

C. pengoi was found on the station UUS-23 all years with exception of 1998. But only at year 2002 its abundance can be estimated as high (Fig. 2). For comparison the same data was combined in one diagram with the data from SE Finland (KAS), where abundance of *C. pengoi* last decade was found as one of highest in the Baltic region and even world-wide (fig. 2).

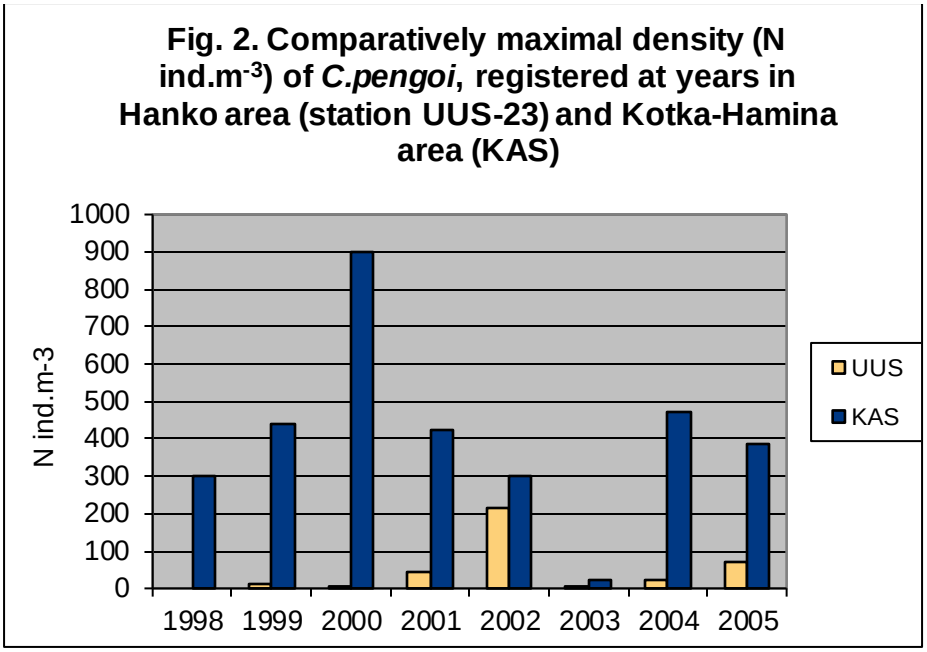


Fig 2. Maximal density of *C. pengoi* at station UUS-23 (UUS) and in Kotka-Hamina area (KAS).

The year 1997 soon after *C. pengoi* invasion of the GOF its maximal abundance in SE Finland as 1800 ind.m^{-3} was the highest wherever registered in the GOF. Such "density explosion" is not rare phenomena for new invaders just occupied new area. Additionally abnormally warm summer of 1997 promoted to "density explosion" of this warm-water alien species. Next year 1998, in contrary, was characterized by abnormally cold summer, what certainly inhibited the population development. Maximal density in SE Finland dropped down dramatically and at 1998 it was registered on the level 300 ind.m^{-3} (Uitto et al., 1999; Antsulevich, Välipakka, 2000). Curiously, that in 1998 on the station UUS-23 *C. pengoi* wasn't found at all (Fig. 2). All next years C. pengoi was found in plankton of station UUS-23, but always its abundance was less (usually much less), than in SE Finland. Only in the year 2002 the abundance of this species in Hanko area (215 ind.m^{-3}) was very similar to one from SE Finland (fig. 2).

The year 2003 for the GOF was characterized by powerful marine water inflow from the West, what resulted the poor oxygen conditions at the bottom, up to real anoxia in deeper (over 40 m) zones of bottom (KAS monitoring data). In spite of *C. pengoi* is plankton organism, its resting eggs spend bigger part of the year in the bottom sediment, where they can die off in anoxic condition (fig. 3).

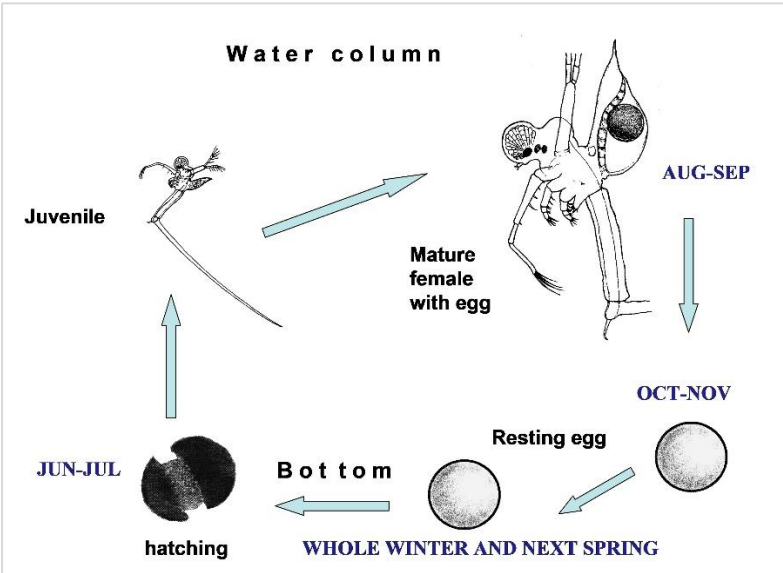


Fig. 3. The life-cycle of *C. pengoi* in the N-E Gulf of Finland (simplified) (after Antsulevich, Välipakka, 2006).

It was observed in deeper zones of SE Finland in the summer of 2003, what lead to incredible declining of *C. pengoi* in SE Finland (Antsulevich, Välipakka, 2006). Evidently similar process had place in Hanko area and the bottom anoxia might be a reason of enormous declining *of C. pengoi* abundance from 215 ind.m^{-3} in 2002 to only 1 ind.m^{-3} in 2003 (fig. 1).

In seasonal aspect the population of *C. pengoi* usually has two peaks of abundance with the short depression in between. The first peak caused by sexual reproduction (hatching from resting eggs), the second and bigger one is the result of parthenogenetic reproduction. Two graphs of seasonal changes on station UUS-23 are presented below (fig. 4-5).

Fig. 4. Seasonal dynamics of *C. pengoi* density (N ind.m^{-3}) on station UUS-23 in year 2002

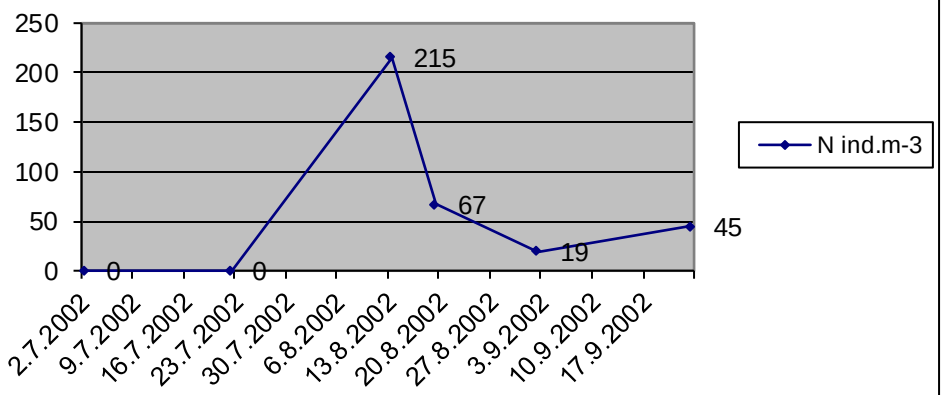
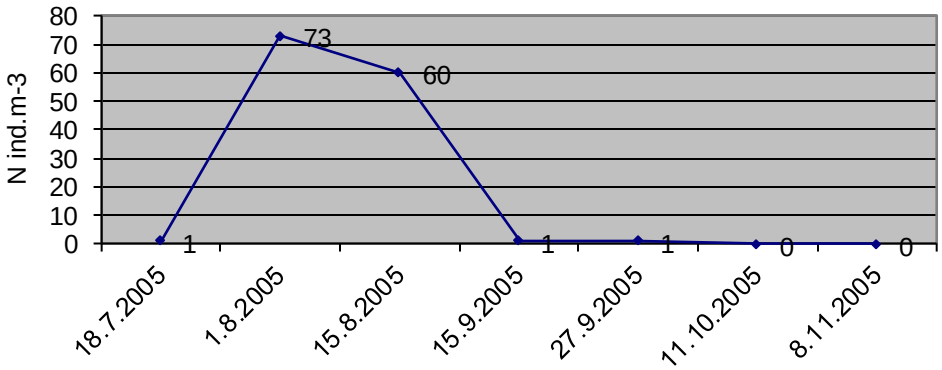


Fig. 5. Seasonal dynamics of *C. pengoi* density (N ind.m^{-3}) in the year 2005 (station UUS-23)



Figs 4-5. Seasonal changes in the abundance of *C. pengoi* at station UUS-23 in 2002 and 2005

In the GOF the main peak usually occurs in August, but sometimes may occur in July and in September as well. Earliest appearance of *C. pengoi* in plankton on station UUS-23 was registered 18.07.2005 (in SE Finland 04.07) ; the latest presence - 28.09.1999 (in SE Finland 05.11). Considerably this data may be specified, when more material will be involved (especially, when collecting from June).

Large crustaceans *C. pengoi* has individual mass one-two orders of magnitude bigger than other mass species of plankton community. In spite of non-impressive values of density, they have much more significant partial biomass. Maximal annual biomass changes of *C. pengoi* are described on the diagram (fig. 6). Remarkable values of biomass were created in years 2001, 2002 and 2005; the biggest 64,5 mg m^{-3} was registered in 2002. That three years *C. pengoi* was sub-dominant or dominant by biomass species of the plankton community in site UUS-23 and certainly played important role for plankton-feeding fish nutrition. Other years its biomass was rather little.

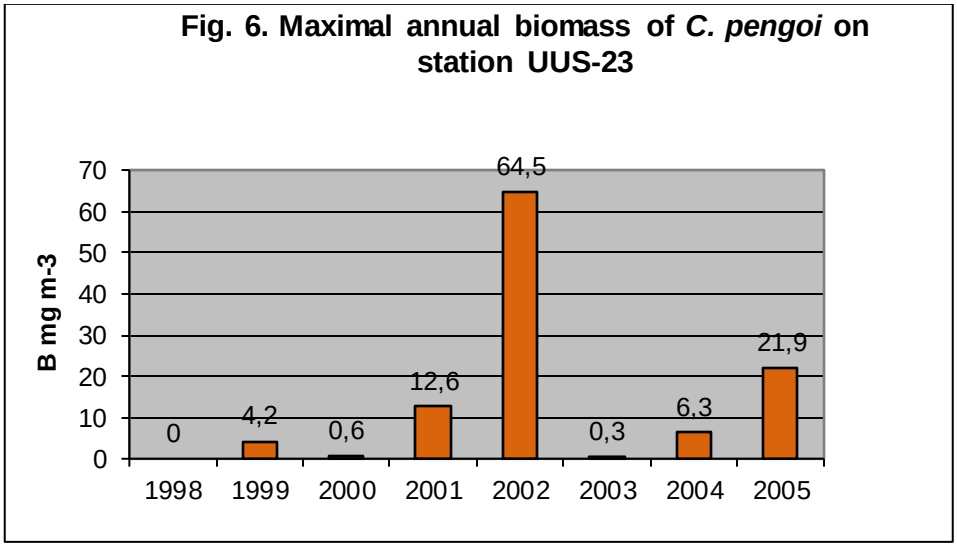


Fig 6. . Maximal annual biomass changes of *C. pengoi* at station UUS-23 in 1998-2005.

The part of gamogenetic (sexual) females with eggs in the local population was varied from 0 to 16%. This data considered as insufficient for any conclusions, but in general it corresponds to the data from SE Finland (Antsulevich, Välipakka, 2000).

4. Conclusions and considerations

The material, collected from long-term period was limited by only one site – station UUS-23. The first year of observation 1998 *C. pengoi* wasn't found there at all, and it firstly was registered in year 1999. Judging from this result the consideration can be pushed forward that "C. pengoi appeared in Hanko area few years later, than in SE Finland and in Russian part of the GOF". However it is unreasonable to do such conclusion before additional material from Hanko area from period of years 1998-1995 will be inspected. Especially any plankton samples from this area collected in year 1997 are interesting, because this year characterized by incredible abundance of *C. pengoi* in eastern part of the GOF.

Starting from the 1999 *C. pengoi* was registered every year, but only in year 2002 its abundance (N = 215 ind. m^{-3}; B = 64,5 mg m^{-3}) was comparable with one from E part of the GOF. All other years it was substantially less than in SE Finland. The reason for this is not very understandable, because the only evident environmental difference between these two areas is the salinity 1-2 pro mille higher in Hanko area. The Gulf of Finland is the marginal, the northernmost part of *C. pengoi* area of distribution and even quite little fluctuations of main environmental factors (temperature, salinity, etc.) may play limiting role.
The depression of abundance in the year 2003, probably has the same nature (bottom anoxia in summer period), as it was reported for SE Finland (see text above).

Still unknown how typical the station UUS-23 for the entire Hanko area. Expectantly some consideration will be more evident, if additional spatial and temporal material from the Hanko area will be involved.

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Appendix

Fig 1 Maximal density (N ind.m^{-3}) at station UUS-23 in 1998-2005

Year	Count
1998	0
1999	14
2000	2
2001	42
2002	215
2003	1
2004	21
2005	73

Fig 2 Comparatively maximal density (N ind.m^{-3}) of *C.pengoi* in Hanko area (UUS) and Kotka-Hamina area (KAS)

Year	Count UUS	Count KAS
1998	0	300
1999	14	442
2000	2	900
2001	42	425
2002	215	302
2003	1	22
2004	21	470
2005	73	384

Fig 4. Seasonal dynamics of *C. pengoi* density (N ind.m^{-3}) on station UUS-23 in year 2002

Date	Count
2.7.2002	0
22.7.2002	0
13.8.2002	215
19.8.2002	67
2.9.2002	19
23.9.2002	45

Fig 5. Seasonal dynamics of *C. pengoi* density (N ind.m^{-3}) on station UUS-23 in year 2005

Date	Count
18.7.2005	1
1.8.2005	73
15.8.2005	60
15.9.2005	1
27.9.2005	1
11.10.2005	0
8.11.2005	0

Fig 6. Maximal annual biomass (mg m^{-3}) changes of *C. pengoi* at station UUS-23 in 1998-2005.

Date	Count
1998	0
1999	4,2
2000	0,6
2001	12,6
2002	64,5
2003	0,3
2004	6,3
2005	21,9

K U V A I L U L E H T I

Julkaisusarjan nimi ja numero
Raportteja 2/2020

Vastuualue
Ympäristö ja luonnonvarat

Tekijät
Alexander Antsulevich

Julkaisuaika
Tammikuu 2020

Kustantaja | Julkaisija
Uudenmaan elinkeino-, liikenne- ja ympäristökeskus

Hankkeen rahoittaja | toimeksiantaja

Julkaisun nimi

Vieraslajin Cercopagis pengoi seuranta ja esiintyminen Suomenlahdella Hangon edustalla asemalla Längden UUS-23 vuosina 1995-2005

Tiivistelmä

Vieraslaji *Cercopagis pengoi* havaittiin Riianlahdella vuonna 1992 ja Suomenlahdella 1995. Koukkuvesikirppu on planktonäyriäinen ja kotoisin Kaspianmeren alueelta. Tämän petovesikirppulajin esiintymistä seurattiin vuosina 1998-2005 Hankoniemen edustalla asemalla Längden, UUS-23. Lajia ei havaittu vuoden 1998 näytteissä. Se esiintyi kaikkina muina seurantavuosina, mutta runsaana vain vuonna 2002.

Koukkuvesikirpun aikuisvaihe on planktinen, mutta munat vajoavat meren pohjalle ja voivat siellä kärsiä pohjanläheisestä happivajeesta. Yksilömäärän voimakas romahtaminen tasosta 215 ind.m^{-3} v. 2002 tasoon 1 ind.m^{-3} v. 2003 johtui ilmeisesti hapenpuutteesta.

Asiasanat (YSA:n mukaan)

ISBN (painettu)	ISBN (PDF)	ISSN-L	ISSN (painettu)	ISSN (verkkojulkaisu)
	978-952-314-837-6			2242-2854

www	URN	Kieli	Sivumäärä
www.doria.fi/ely-keskus	URN:ISBN:978-952-314-837-6	Englanti	Teksti

Kustannuspaikka ja aika
Helsinki 2020

P R E S E N T A T I O N S B L A D

Publikationens serie och nummer
Rapporter 2/2020

Ansvarsområde
Miljö och naturresurser

Författare
Alexander Antsulevich

Publiceringsdatum
January 2020

Utgivare | Förläggare
Närings-, trafik- och miljöcentralen i Nyland

Projektets finansiär | uppdragsgivare

Publikationens titel

Uppföljning av den invasiva arten Cercopagis pengoi i Finska viken utanför Hangöudd på station Längden UUS-23 åren 1998-2005

Sammandrag

Den invasive arten rowattenloppan *Cercopagis pengoi* är ett pelagiskt kräftdjur som påträffades för första gången i Rigabukten år 1992 och i Finska viken år 1995. Rowattenloppan härstammar från den Ponto-Kaspiska regionen. Under åren 1998-2005 togs planktonprover utanför Hangöudd på stationen Längden UUS-23. I proven från 1998 saknas rowattenloppan, men den förekom alla andra uppföljningsår. Endast år 2002 anses den ha förekommit i riklig mängd.

C. pengoi är en planktisk art, vars ägg ligger i bottensedimentet under en stor del av året och kan där dö till följd av syrebrist. Syrebrist var troligtvis orsak till den markanta nedgången i individantalet från 215 ind.m^{-3} år 2002 till endast 1 ind.m^{-3} år 2003.

Nyckelord (enligt Allärs)

ISBN (tryckt)	ISBN (PDF)	ISSN-L	ISSN (tryckt)	ISSN (webbpublikation)
	978-952-314-837-6			2242-2854

WWW	URN	Språk	Sidantal
www.doria.fi/ely-keskus	URN:ISBN:978-952-314-837-6	Engelska	Teksti

Förläggningsort och datum
Helsingfors 2020

D O C U M E N T A T I O N P A G E

Publication serie and number
Reports 2/2020

Publication serie and number
Environment and Natural Resources

Author(s)
Alexander Antsulevich

Date
January 2020

Publisher
Centre for Economic Development, Transport and the Environment for Uusimaa

Title of publication
Monitoring of the alien species Cecopagis pengoi in the Hanko area of the Gulf of Finland in 1998-2005

Abstract
The alien predatory planktonic crustacean *Cercopagis pengoi* appeared in the Gulf of Riga in 1992 and in the Gulf of Finland in 1995. By origin *C. pengoi* is Ponto-Caspian species. During 1998-2005 plankton samples were taken at the entrance to the Gulf of Finland, at station Längden, UUS-23. *C. pengoi* was not found in samples taken 1998, but occurred after that every sampling year. Only in 2002 its abundance can be estimated as high.

C. pengoi is a planktonic organism, but its resting eggs spend bigger part of the year in the bottom sediment, where they can die off anoxic condition. Evidently anoxia in Hanko area might be a reason of the enormous declining *of C. pengoi* abundance from 215 ind.m^{-3} in 2002 to only 1 ind.m^{-3} in 2003.

Key words

ISBN (print)	ISBN (PDF)	ISSN-L	ISSN (print)	ISSN (online)
	978-952-314-837-6			2242-2854

www	URN	Language	Number of pages
www.doria.fi/ely-keskus	URN:ISBN:978-952-314-837-6	English	Teksti

Distributor
Publication is only available in internet: www.doria.fi

Place of publication and date
Helsinki 2020

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ISBN 978-952-314-837-6 (PDF)
ISSN 2242-2854 (online)
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www.doria.fi/ely-keskus