NOBANIS –Invasive Alien Species Fact Sheet

Cercopagis pengoi

Author of this fact sheet: Christina Birnbaum, Estonian University of Life Sciences, Institute of Agricultural and Environmental Sciences, Kreutzwaldi 64 Tartu 51014, phone, e-mail: chbirnbaum@yahoo.com

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Species description

Scientific names: *Cercopagis pengoi*, (Ostroumov, 1891), Cercopagididae (Martin JW, Cash-Clark CE 1995)
Synonyms: *Cercopagis (Apagis) ossiani* (Simm and Ojaveer 1999, Makarewicz *et al.* 2001)
Common names: Wasserfloh (DE), Kaspischer Wasserfloh (DE), Vesikirp (EE), Petovesikirppu (FI), Fish-hook waterflea (GB), Angelhaken- Cerkopagis (LT), Cercopagis (LV), Церкопаг (RU), Wioślarka kaspijska (PL), Rovvattenloppa (SE).

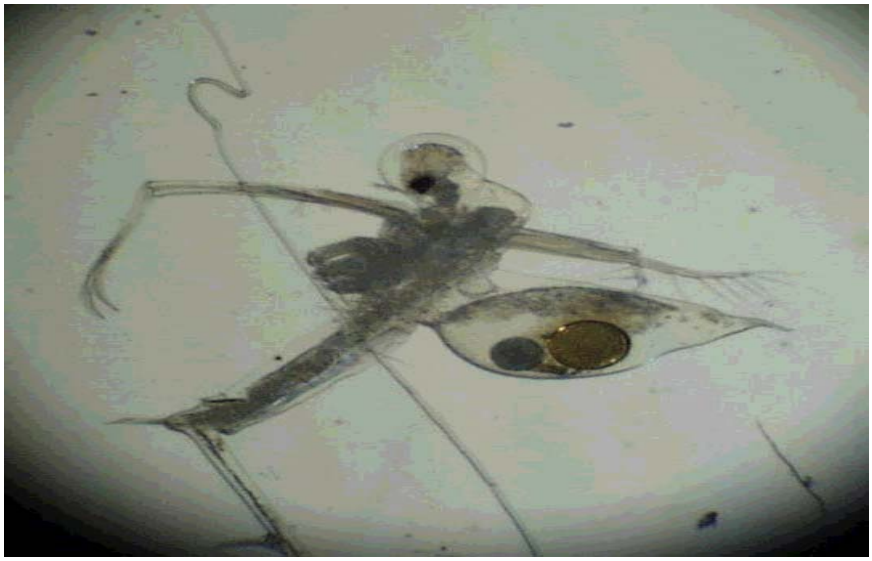

Fig 1. *Cercopagis pengoi*, close up, photo by Mart Simm.

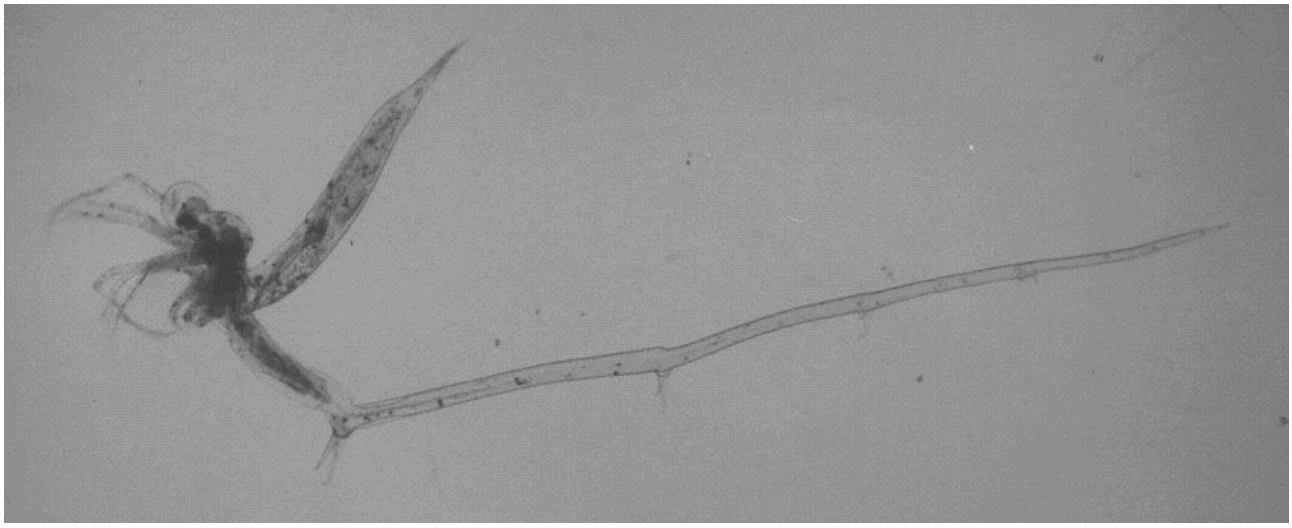

Fig 2. The 'spring form' of Cercopagis pengoi, photo by Henn Ojaveer.

Fig 3. *C. pengoi* “fishing net-plague” (with close-up), photo by Viktoras Didžiulis

Species identification

The following most pronounced parts of the body of the cladoceran *Cercopagis pengoi* can be identified: the head, the second pair of antenna, four pairs of thoracic legs (the first leg is 3-4 times longer than other legs), abdomen, caudal process and a brood pouch in females. Body length of females varies from 1.2 to 2.0 mm and that of males from 1.1-1.4 mm. The caudal process exceeds the main body 5-7 times by length (Mordukhai - Boltovskoi and Rivier 1987), however there is a high degree of regional variability in morphology (Grigorovich *et al.* 2000). The most distinctive feature is the long caudal process which has a loop-like curvature at the end. The head is essentially

composed of a large single eye, where the amount of black pigment makes less than one half of the diameter of the eye. Characteristically for *C. pengoi*, length of the abdomen is about equal to that of the remaining body (the caudal process excluded).

Native range
C. pengoi is a euryhaline species. They are more abundant at lower (3 - 8 psu) salinities in the North Caspian Sea (Mordukhai-Boltovskoi and Rivier 1971, 1987). Until the invasion into the Baltic Sea, the distribution area of *C. pengoi* was mainly restricted to the Ponto-Caspian region: the Caspian, Azov and Aral Seas together with lower reaches of the rivers entering to these waterbodies – the Danube, Dniester, Bug, Dnieper, Don and Volga. *Cercopagis* inhabits coastal lakes in Bulgaria and Turkey (Guher 2004) and man-made reservoirs at Dnieper, Volga and Don (Mordukhai-Boltovskoi and Rivier 1987, Rivier 1998).

Alien distribution

History of introduction and geographical spread
First findings in Estonia were in southern coast of the Gulf of Finland (Muuga Bay) and the northeastern Gulf of Riga (Pärnu Bay), in 1992. According to HELCOM 1996, *Cercopagis pengoi* was first recorded in 1991 in the coastal zone of the southern part of the Gulf of Riga.
In difference from Gulf of Riga where the species continued its presence in 1993-1994, *C. pengoi* was not encountered in zooplankton samples in the Gulf of Finland in these years. Since 1995, the species was continuously reported from several localities in the northern and eastern Gulf of Finland (*e.g.*, Kivi 1995, Avinski 1997, Uitto *et al.* 1999). At some stations, sampled in September 1995 in the Gulf of Riga, it comprised 25% of the total zooplankton biomass (Ojaveer and Lumberg 1995, Ojaveer *et al.* 1998). Since then the distribution area of *Cercopagis* has substantially expanded to include:

1) western Baltic and northern Baltic proper (the Gotland basin and Stockholm archipelago, west coast of the Baltic Proper, 1997, Gorokhova *et al.* 2000)
2) northern Baltic (Gulf of Bothnia, 1999, Andersen and Gorokhova 2004, ICES 2005.)
3) southern Baltic (Gulf of Gdansk, Vistula lagoon, 1999, Pomeranian Bay, 2004, Naumenko and Polunina 2000, Zmudzinski 1999, Bielecka *et al.* 2000, ICES 2005).
4) Lake Ontario (North America) in 1998, the species was observed in the following year in Lake Michigan and five New York Fingerling lakes (MacIsaac *et al.* 1999, Makarewicz *et al.* 2001) and it continues to spread (Therriault *et al.* 2002).

The colonization of North America by *Cercopagis pengoi* appears to be a secondary introduction from the Baltic Sea via ballast water (Cristescu *et al.* 2001).

Pathways of introduction
Presumably with the ballast water and by attachment to hulls or fishing gears (Leppäkoski and Olenin 2000).

Alien status in region
Cecopagis in the Baltic Sea has spread rapidly and the population size has grown (Kull 2005). At present *Cercopagis* is widely distributed in many parts of the Baltic Sea: Gulf of Finland, Gulf of Riga, Bothnian and Gdansk bays, Baltic Proper and Väinameri, Åland and Stockholm archipelagos, see also Table 1 (ICES 2005).
In Lithuania, *C. pengoi* is common since 1999. The highest abundance is usually observed in the northeastern part of the coastal zone. However it is found throughout the whole coastal zone, as well as in nearly fresh water of the Curonian lagoon.

As this euryhaline species originates from warmer climate conditions, global warming should favour the extension of its area in the Baltic Sea region and support further increase in abundance. *Cercopagis* was recently recorded from German waters in the Pomeranian Bay region in 2004 (the first record in Germany, ICES 2005).

Country	Not found	Not established	Rare	local	Common	Very common	Not known
Denmark	X						
Estonia				X			
European part of Russia				X			
Finland				X			
Faroe Islands	X						
Germany			X				
Greenland	X						
Iceland	X						
Latvia				X			
Lithuania				X			
Norway	X						
Poland			X				
Sweden				X			

Table 1. The frequency and establishment of *Cercopagis pengoi*, please refer also to the information provided for this species at www.nobanis.org/search.asp. Legend for this table: **Not found** –The species is not found in the country; **Not established** - The species has not formed self-reproducing populations (but is found as a casual or incidental species); **Rare** - Few sites where it is found in the country; **Local** - Locally abundant, many individuals in some areas of the country; **Common** - Many sites in the country; **Very common** - Many sites and many individuals; **Not known** – No information was available.

Ecology

Habitat description

Cercopagis pengoi is a euryhaline and eurythermic species, occurring in both brackish (up to 17 psu) and freshwaters, as well as in waters with highly variable temperatures (3 – 38 ºC; *cf.* Gorokhova *et al.* 2000). It prefers the brackish-water environment, but has also been found in freshwater conditions and warm water environment. Its distribution is mostly confined to upper layers during the day and night. Only a few individuals have been recorded in colder waters beneath the seasonal thermocline. The species does not perform strong diurnal vertical migrations (Avinski 1997, Krylov *et al.* 1999, Benoit *et al.* 2002).

Reproduction and life cycle

Similar to other cladocerans, *C. pengoi* is a cyclic parthenogen reproducing mostly asexually throughout the summer season. Sexual reproduction intensifies in late autumn as the water temperature declines (Mordukhai-Boltovskoi and Rivier 1987). The parthenogenically-produced young develop in a fluid-filled dorsal brood pouch that ruptures to release the young. In late summer and autumn, parthenogenic females produce eggs that develop into males and gametogenic females, which copulate. Gametogenic reproduction results in resting eggs that are released when the brood pouch ruptures and which overwinter in the sediment. After a refractory period

development proceeds and neonates hatch in spring-summer, depending on local temperatures, to re-found the population (Mordukhai-Boltovskoi and Rivier 1987, Rivier 1998). Parthenogenic females of the first generation of *C. pengoi* that hatch from resting eggs are anatomically distinct from parthenogenic females of following generations. They have a short straight caudal spine unlike the characteristically looped caudal spine of parthenogenically-produced individuals (Simm and Ojaveer 1999). Sexual females are reproductive only at instars II and III, producing 1-4 resting eggs, while parthenogenic females produce between 1 and 24 embryos; average clutch size decreases gradually from instar I to instar III and from early to late stage of embryonic development (Grigorovich *et al.* 2000).
No experimental data on respiration, growth and feeding of *C. pengoi* is available. According to the morphology of the mouth parts (raptatory leggs with no filtration devices) they are considered to be predators (Mordukhai-Boltovskoi and Rivier 1971, 1987). Cercopagids capture their prey with the first pair of thoracic legs, puncture its cuticle by mandibles, and suck the prey body contents (Mordukhai-Boltovskoi and Rivier 1987, Rivier 1998). Detailed information on feeding behavior of *C. pengoi* is not available. Diet includes mainly small crustaceans, both micro- and mesozooplankton (Mordukhai-Boltovskoi 1968, Rivier 1998, Laxson *et al.* 2003, Gorokhova *et al.* 2005).

Dispersal and spread
The distribution of all *Cercopagis* species except *C. pengoi* is restricted to the Caspian Sea. *C. pengoi* is the only species which extended its distribution to Black, Azov and Aral Seas and some brackish-water coastal lakes (Mordukhai-Boltovskoi and Rivier 1987). After construction of the cascades of reservoirs on the Don and Dnieper Rivers, *C. pengoi* penetrated Kakhovka, Zaporozhsk, Kremenchug, Tsimlyansk and Veselovsk Reservoirs, thus demonstrating its ability to establish permanent populations in fresh waters (Tseeb 1962, Mordukhai-Boltovskoi 1965, Glamazda 1971, Mordukhai-Boltovskoi and Galinskiy 1974, Gusynskaya and Zdanova 1978, Volovich 1978). However, until recently it was not known from the waterbodies north of Kiev (Ukraine).
The species usually appears in June when water temperature reaches 13.5-17^{o}C and disappears in September when the water temperature decreases to 12^{o}C. Highest abundance is usually observed within 16-18 ^{o}C range in July - August.
Within its natural range in the Caspian Sea the species performs vertical diurnal migrations between down to 50-60 m (daytime), and surface (at night). Juveniles do not migrate deeper than 30 m (Mordukhai-Boltovskoi, 1987). No migrations were observed in the Baltic (Krylov *et al.* 1999). However in the Gulf of Riga high abundance of Cercopagis pengoi was found above the thermocline at depths of 30-40 m (Strake 2002).

Impact

Affected habitats and indigenous organisms
Due to the massive spread of *Cercopagis* in, *e.g.* Pärnu Bay (Gulf of Riga), the population of another small waterflea *Bosmina coregoni maritima* has drastically decreased (Kull 2005).
In the spring and summer seasons, when the number of *Bosmina* in the water is too low, *Cercopagis* competes with fish for food, which enhances eutrophication effects because of heavy predation on grazing zooplankton. The result of this massive distribution of *Cercopagis* has caused disturbances in the food chain and increased food competition (Kull 2005).
However, *Cercopagis* is itself a very important food for small herring, stickleback, smelt and bleak (due to its numbers) (Kull 2005).
Presently, the *Cercopagis* invasion has additionally resulted in elevating relative importance of warm-water planktonic invertebrates in the energy flow to cold-water bentho-pelagic fish (through

direct predation). In some sheltered coastal shallow areas characterised by high *Cercopagis* but low predator abundance in the warm season, part of the *Cercopagis* production may die and sink to the bottom, and undergo there heterotrophic decomposition processes. This obviously complicates energy transfer to higher trophic levels in these areas. However, studies to date have shown that sinking of dead animals to bottom is probably not intense in deeper areas (Estonian Marine Institute, fact sheet).
C. pengoi is a potential competitor with young stages of planktivorous fish for herbivorous zooplankton (Vanderploeg *et al.* 2002). Several lines of evidence indicate that *C. pengoi* may affect resident zooplankton communities by selective predation: Lake Ontario (Benoit *et al.* 2002); Gulf of Riga (Ojaveer *et al.* 1999, 2004); Gulf of Finland (Uitto *et al.* 1999). Such changes may result in decreased grazing pressure on phytoplankton and enhanced algal blooms. On the other hand, zooplanktivorous fish both in the Baltic (Antsulevich and Välipakka 2000, Gorokhova *et al.* 2004, Ojaveer *et al.* 2004) and in the Great Lakes (Bushnoe *et al.* 2003) have been reported to prey on *C. pengoi* implying that it has become a new food source, particularly for larger fish. It is, however, difficult to study food competition between small fish and *C. pengoi* because of the lack of feeding studies on the latter.

Genetic effects
No genetic effects are reported.

Human health effects
In Russia, fishermen cleaning the nets from attached dry *Cercopagis* remains complain about allergic reactions ("Finish gulf attacked by bioaliens")

Economic and societal effects (positive/negative)
C. pengoi tends to attach to fishing gears, clog nets and trawls, causing problems and substantial economic losses for fishermen (Leppäkoski and Olenin 2000). In the Baltic Sea, the mass development of *Cercopagis* was accompanied by the formation of a "paste" fouling fishing nets and trawls (see fig. 3.) (Kivi 1995, Ojaveer and Lumberg 1995). Little is known about the biofouling ability of *C. pengoi* in its native area. However, one may suppose that "the fishing net's plague" "when suddenly all the fishing nets at a vast distance dye during one day being ill by a net's illness, a special algae" could be attributed to *C. pengoi* (Khlebnikov 1990).
Biofouling of fishing equipment by *Cercopagis* in the eastern Gulf of Finland is already a serious problem, resulting in substantial economic losses. Economic losses at a fish farm, located at the northern shore of the lower Neva Estuary (Primorsk), in 1996-1998 were at least $50 000. These losses were the result of a drastic decline in the fish catches in the Primorsk (Koivisto) area and cost of unsuccessful fishing efforts in areas with abundant *Cercopagis* due to biofouling of fishing equipment (Panov *et al.* 1999). The same problem was found at whitefish fisheries in the eastern Gulf of Finland (GAAS 2000), inner parts of the Archipelago Sea (K. Häkkilä, pers. comm.), northern Bothnian Sea (K.-E. Storberg, pers. comm.) and in Lithuania (I. Olenina, pers. comm.). Since 1999, the occurrence of *Cercopagis* within north-eastern range of the Lithuanian coastal zone has had severe impacts on commercial fishery by clogging gill-nets and thus drastically reducing commercial catches. Changes in food-web and energy transfer in lower trophic levels, due to the invasion of *Cercopagis* will likely impact the structure of fish stocks (Gorokhova pers. comm.).
If the density of *Cercopagis* does not decrease significantly in the nearest future, it may seriously affect commercial fisheries. High-risk areas are the Gulf of Finland. the Gulf of Riga, the coastal lagoons and the German Boddens, known as centres of xenodiversity, i.e., areas that host many well established non-indigenous species (Leppäkoski and Olenin 2000). Considering present intensive shipping activity, future development of new ports in the eastern Gulf and creation of new international transport and invasion corridors, the Gulf of Finland can be identified as a "hot spot"

area in the Baltic Sea in terms of vulnerability to alien species and high potential of established invaders to negatively affect the ecosystems (Panov *et al.* 1999).

Management approaches

Prevention methods
It is very difficult to control the distribution of invasive species and prevent their spread once they have become established in the area. Management of ballast waters and cleaning ship hulls can be considered as prevention measures against *C. pengoi*. (Kull 2005, Sea Grant 2004, Baltic Sea Alien Species Database). Cleaning and drying fishing gears and boat equipment prior to relocating it to another water body could be complemented with chemical disinfection agents to reduce the risk of spreading *C. pengoi* from one water body to another (Sea Grant 2004).

Eradication, control and monitoring efforts
No specific eradication and control efforts are known. In the Baltic Sea, the seasonal abundance of *C. pengoi*, as a part of zooplankton community, is addressed within HELCOM Monitoring Programme.
With no way to eradicate the well-established population of *Cercopagis* or control its further spread in the Baltic Sea, one can only try to prevent its spread to adjacent fresh-water bodies (Leppäkoski 2001).

Information and awareness
The Estonian Ministry of Environment has published two booklets introducing invasive alien species of local importance (in 2001 and 2005) and has also created an electronic invasive alien species database, available at also in English (Kull 2005). The purpose of those booklets is to make the wider range of people aware of the problems going hand-in-hand with the spread of invasive species and also to explain and show how the species look (through the pictures included in the booklets) and give some simple hints how the spread of species could be controlled. The species has also been included into the Baltic Sea Alien Species Database.
Today the occurrence of *Cercopagis pengoi* in German waters is not a subject of the scientific and public attention. However, a purposeful information platform is not installed in Germany yet. Education and awareness raising is needed (S. Nehring pers. comm.).

Knowledge and research
Feeding experiments have shown that *Cercopagis* consumes other zooplankters, for instance, small cladocerans (Laxson *et al.* 2003), the larvae of acorn barnacle (*Balanus*) and adult copepods like *Eurytemora affinis* and *Acartia* spp. Thus, the invasion of *Cercopagis* has significantly changed the former food web and aggravated the competition for food (Kull 2005).
The further spread of *Cercopagis* will be monitored carefully (Gorokhova *et al.* 2000), the species being one of the few recent introductions and obviously the most important one in both ecological and economic terms into the pelagic subsystem of the Baltic Sea. Ongoing (*e.g.*, Uitto *et al.* 1999, Ojaveer *et al.* 2000) and future research will help us to understand the ecological role of this invasive species (specially the potential impacts that *Cercopagis* will have on the Baltic food web) and assess its economic impact in the Baltic Sea.
Quite similar and taxonomically close species *Bythrotrepes longimanus* from the same native range invades fresh waters. It is already known from lakes Ladozhskoe and Onezhskoe (Mordukhai-Boltovskoi 1987).

Recommendations or comments from experts and local communities

Management of ballast waters and cleaning the hulls can be considered as some of the prevention methods against *C. pengoi* (Kull 2005, Baltic Sea Alien Species Database).
Strategies to implement the IMO Guidelines are needed. In the case of brackish water areas, such as the Baltic Sea, the ballast water exchange *en route* in open sea with fully oceanic conditions represents a practicable, even if not fully effective, method reducing the risk of further introductions of fresh and brackish water organisms (Gollasch and Leppäkoski 1999).
Cercopagis is native to warmer climatic conditions than those prevailing in the Baltic area. Global warming should favour its further spread in the Baltic, support further increase in abundance, and increase the risk of its invasion into the great lakes of Finland (Pienimäki and Leppäkoski 2004), Sweden, Estonia and north-western Russia (Ladoga), connected with the invaded parts of the Baltic by sea traffic. There is recent evidence of species introductions from the Baltic to the Finnish lake district where the mitten crab (*Eriocheir sinensis*) was first found in 1999 (Valovirta and Eronen 2000).
Given the linkages between the lakes and the Baltic Sea, it is likely that *Cercopagis* will spread throughout the lakes with time. Therefore, a risk assessment should be performed including both abiotic (temperature, pH) and biotic (food availability, predators) parameters that either facilitate or prevent *Cercopagis'* spread into lakes adjacent to the Baltic Sea. (Leppäkoski 2001).

References and other resources

Contact persons

Henn Ojaveer (EE), Estonian Marine Institute, University of Tartu, Mäealuse 10A 12618 Tallinn, Estonia, e-mail: henn@sea.ee

Mart Simm (EE), Estonian Marine Institute, University of Tartu, Mäealuse 10A 12618 Tallinn, Estonia, e-mail: mart.simm@ut.ee

Viktoras Didziulis (LT) (Cercopagis within the coastal zone and its impact on coastal fisheries), Klaipeda University, CORPI, H. Manto 84, Klaipeda, e-mail: viktoras@ekoinf.net

Zita Gasiunaite (LT) (Cercopagis within the Curronian lagoon), Klaipeda University, CORPI, H. Manto 84, Klaipeda.

Elena Gorokhova (SE), Department of Systems Ecology, Stockholm University, Sv. Arrhenius v. 21A, 10691 Stockholm, Sweden, e-mail: elenag@ecology.su.se

Solvita Strake (LV), Institute of Aquatic Ecology, University of Latvia, Daugavgrivas 8, Riga, LV 1048, tel.: +371 7610850, e-mail: solvita@hydro.edu.lv

Stefan Nehring (DE), AeT umweltplanung, Bismarckstrasse 19, D-56068 Koblenz, Germany Phone: +49 261 1330398; e-mail: nehring@aet-umweltplanung.de

Michal Grabowski (PL), University of Lodz, Faculty of Biology and Environmental Protection, Institute of Ecology and Environmental Protection, Department of Invertebrate Zoology and Hydrobiology, ul. S. Banacha 12/16; 90-237 Lodz, e-mail: michalg@biol.uni.lodz.pl

Piotr Gruszka (PL), University of Agriculture in Szczecin, Faculty of Food Technology and Fisheries, Department of Marine Ecology and Environmental Protection, ul. Kazimierza Krolewicza 4; 71-550 Szczecin, e-mail: pgruszka@fish.ar.szczecin.pl

Olafur S. Astthorsson (IS), Ph. D., Deputy Director, Marine Research Institute, Skulagata 4, P.O. Box 1390, Reykjavik, Telephone: +354 575 20 00, Telefax: +354 575 20 01, email: osa@hafro.is

Erkki Leppäkoski (FI), Dept. Environmental and Marine Biology, Åbo Akademi University, FIN-20500 Turku, email: eleppakoski@abo.fi

Jørgen Olesen (DK), Zoological Museum, Invertebrate Department
Universitetsparken 15, DK-2100 Copenhagen Ø, Denmark Tel: (+45) 35 32 10 45
Fax: (+45) 35 32 10 10, E-mail: jolesen@snm.ku.dk

Links

Regional Biological Invasions Center, *C. pengoi* fact-sheet
Estonian Marine Institute, *C. pengoi* fact-sheet.
Baltic Sea Alien Species Database, Fact sheet on *C. pengoi*

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