Cercopagis pengoi 简体中文 正體中文 **System:** Brackish

Kingdom	Phylum	Class	Order	Family
Animalia	Arthropoda	Branchiopoda	Diplostraca	Cercopagidae

Common name Kaspischer Wasserfloh (German), cercopag (Russian), fishhook waterflea (English), r��vtoiduline vesikirp (Estonian), petovesikirppu (Finnish), rovvattenloppa (Swedish), tserkopag (Russian)

Synonym *Cercopagis (Apagis) ossiani* , (Mordukhai-Boltovskoi 1968)

Similar species *Bythotrephes longimanus*

Summary Cercopagis pengoi is a water flea native to the Ponto-Aralo-Caspian basin in South Eastern Europe, at the meeting point of the Middle East, Europe and Asia. It has spread from its native range and become invasive in some waterways of Eastern Europe and in the Baltic Sea. It has been introduced to the Great Lakes of North America, quickly becoming established and is now increasing its range and abundance. Cercopagis pengoi is a voracious predator and may compete with other planktivores. Through this competition, C. pengoi has the potential to affect the abundance and condition of zooplanktivorous fish and fish larvae. It also interferes with fisheries by clogging nets and fishing gear.

[view this species on IUCN Red List](https://www.iucnredlist.org)

Species Description
The most pronounced parts of the body are the head, the second pair of antenna, four pairs of thoracic legs (thoracopodsI-IV), abdomen, caudal process, and a brood pouch in females. 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. The second antenna is a large appendage containing of two branches - the endopod and exopod. The first pair of thoracic legs (thoracopods I) are 3-4 times longer than the second ones. Abdomen length is equal to the length of the rest of the body, and spines are large, equal to 2-3 diameters of caudal process (Mordukhai-Boltovskoi & Rivier, 1987; Rivier 1998). Parthenogenic females of the first generation of *C. pengoi* that hatch from resting eggs are morphologically 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 & Ojaveer 1999). *C. pengoi* possesses a high degree of regional variability in morphology. Largest adult parthenogenic females are found in the Baltic Sea (mean body length 2.0 mm), while those in the Caspian Sea and in Lake Ontario are smaller (1.7 and 1.4 mm, respectively). Caudal process is largest in the instar III parthenogenic females from the Baltic Sea (mean length 9.6 mm), medium in Lake Ontario (8.6 mm), and shortest in females from the Caspian Sea (7.5 mm). However, relative to body length, the length of caudal process is largest in populations from Lake Ontario (mean 5.9 mm), medium in the Baltic (4.9 mm), and smallest in the Caspian populations (4.3 mm) (Grigorovich *et al*. 2000).

Notes
The paucity of ecological studies on *C. pengoi* is in part due to the difficulties in handling and culturing *Cercopagis* as this hampers experimental studies.

Lifecycle Stages
Female, both parthenogenic and gametogenic, and male *Cercopagis pengoi* possess 3 life-history stages or instars, which differ by number of spines, or barbs, on the caudal process. At each molt, the animal sheds its exoskeleton to the base of the caudal process. A new pair of proximal barbs and the growth of an intercalary segment are inserted between the existing tail spine and the body. The newborn parthenogenic females (instar I) have one pair of barbs on the caudal process, compact oval embryos in the brood pouch without a pointed apex. The second stage (instar II) has two pairs of barbs and the mature stage (instar III) of the parthenogenic female has a large brood pouch with a pointed apex housing embryos. In males at this stage paired penes behind the last thoracic legs and a toothed hook on the first pair of legs are developed (Mordukhai-Boltovskoi & Rivier, 1987; Rivier 1998). Parthenogenic females of the first generation of *C. pengoi* proceed through 3 moult yielding 4 pairs of proximal barbs on the caudal process unlike the females of following generations that undergo 2 molts to reach adulthood (Simm & Ojaveer 1999).

Uses
In the Baltic and in the Great Lakes, zooplanktivorous fish and mysids are reported to prey on *C. pengoi*, implying that it has become a new food source. Its importance increases in larger fish (Antsulevich and Välipakka 2000; Gorokhova *et al*. 2004; Ojaveer *et al*. 2004; Bushnoe *et al*. 2003) and in actively migrating mysids (Gorokhova and Lehtiniemi 2007).

Habitat Description
Cercopagis pengoi is a euryhaline and eurythermic, having a wide tolerance to salinity temperatures. It occurs in both brackish, up to 17%, and fresh waters, as well as temperatures of 3 – 38 ºC (c.f. Gorokhova *et al.* 2000). However, highest population densities are found at summer temperatures (16 – 26 ºC) and at salinities of up to 10% (Mordukhai-Boltovskoi & Rivier, 1987; Rivier, 1998). Although some specimens may be found at temperatures of 10 °C it generally requires temperatures of 15 °C or higher to establish a significant population. It also resides above the thermocline in stratified waters in warmer, more active waters (Pollumae & Valjataga, 2004). Both in the Caspian Sea (Rivier, 1998) and Lake Ontario (Ojaveer *et al.* 2001) *C. pengoi* abundance increases with distance from shore, suggesting that this is a typical pelagic species, which live in the open sea, away from the littoral zone.

Reproduction
As many other cladocerans, *Cercopagis pengoi* is a cyclic parthenogen. It reproduces parthenogenically during the summer and gametogenically later in the year. 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, which are released when the brood pouch ruptures, and 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). 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). The embryonic development time of parthenogenic *Cercopagis* in the Baltic Sea is 3.2 d and generation time is 14.7 d, which implies that during summer season there could be 5-7 generations, depending on temperature (Svensson and Gorokhova 2007).

Nutrition
Cercopagis pengoi is a generalist feeder which preys on various species of cladocerans, copepods, rotifers, i.e., both micro- and mesozooplankton (Mordukhai-Boltovskoi 1968; Laxson *et al*. 2003; Gorokhova *et al*. 2005; Lehtiniemi and Linden 2006; Pichlova-Ptacnikova and Vanderploeg 2009). It is able to capture and handle prey about its own body size to those seventeen times smaller. Cercopagids capture their prey with the thoracopods I, retain it by thoracopods II-IV, crush its cuticle by mandibles, and suck the prey body contents (Mordukhai-Boltovskoi 1968; Mordukhai-Boltovskoi and Rivier 1987).

General Impacts
Cercopagis pengoi preys on native zooplankton, may compete with native zooplanktivores, fouls fishing nets and other equipment, and may cause an array of other ecological impacts to aquatic systems. *C. pengoi* affects resident zooplankton communities by selective predation in Lake Ontario (Benoit *et al*. 2002); Gulf of Riga (Ojaveer *et al*. 1999, 2004); Gulf of Finland (Uitto *et al*. 1999; Lehtiniemi & Gorokhova 2008). Its invasion and populations in the Baltic Sea correlate to significant declines in small, cladoceran prey species *Bosmina coregoni maritime*, *Evadne nordmanni*, and *Pleopsis polyphemoides* (Kotta *et al*. 2006). A similar decrease in the abundance of copepods, including key species *Eurytemora affinis*, in the Gulf of Finland is believed to be caused by *C. pengoi* as well (Lehtiniemi & Gorokhova 2008). It is also a potential competitor with young stages of planktivorous fish for herbivorous zooplankton (Vanderploeg *et al*. 2002). Such changes in ecology may result in increased competition among zooplanktivores, decreased grazing pressure on phytoplankton, enhanced algal blooms, and major changes to higher trophic levels.\r\n
Additionally, this large cladoceran tends to attach to fishing gears, clogs nets and trawls, causing problems and ultimate economic losses for fishermen. Reports of their fouling and costly impacts have come from the Gulf of Finland, the Neva Estuary, the Archipelago Sea, the Northern Bothnian Sea, and on the coasts of Lithuania (Birnbaum 2006 and references therein). Its effects on the food-web and energy transfer in lower trophic levels are likely to cause problems with fish stocks (E. Gorokhova pers. comm., in Birnbaum 2006; Ojaveer *et al*. 2001). Anecdotal evidence suggests that it can cause allergic reactions in fisherman who clean remains from nets (Leppäkoski & Olenin 2000; ICES 2002).

Management Info
There is currently no known method of eradication or control for *Cercopagis pengoi*. Prevention of establishment and spread are the only means of management. Most probably, all trans-oceanic introductions of *C. pengoi* have resulted from the dumping of ship ballast water containing adults or eggs in new locations. Strengthening and improving existing ballast water regulations and promoting awareness of *C. pengoi* would therefore help in preventing the spread (Birnbaum, 2006). Prompted by the explosive increase of ship-borne exotic species in the Great Lakes, the USA implemented a regulation that requires inbound vessels to exchange freshwater/estuarine ballast with highly saline oceanic water in May 1993 (Ricciardi and MacIssac 2002). In theory, this procedure should have greatly reduce the risk of invasion as freshwater organisms would be purged or killed by seawater and would be replaced by marine organisms that would not survive if released into the freshwaters. However, the recent invasion of *C. pengoi* causes concern as it was apparently introduced after implementation of ballast water regulations, which raises concern that either these measures are not effective against gametogenic eggs of *Cercopagis* or control over the water exchange is not effective.\r\n
A few measures are recommended to prevent further local spread of *C. pengoi* and other species with similar ecology. Bait or bait water should not be released into water body or transport from one water body to another. Good containment measures should be followed to control both the spread of adults and resting eggs, which are capable of surviving desiccation and freezing for periods of several years. Rinsing boat and equipment with hot water (>40°C), high-pressure water spray, or drying boat and equipment for at least 5 days before re-entering water body will help to control the spread of adult *C. pengoi*. Thoroughly draining and cleaning motor; bilge, transom and live wells; bait buckets; and fishing apparatus and gear will help to control the spread of adult *C. pengoi* and resting eggs (Crosier and Molloy, Undated).

Pathway

Principal source: [Birnbaum, C. (2006): NOBANIS – Invasive Alien Species Fact Sheet – Cercopagis pengoi. – From: Online Database of the North European and Baltic Network on Invasive Alien Species – NOBANIS www.nobanis.org]
[Mordukhai-Boltovskoi & Rivier, 1987 *Cercopagis pengoi* - fishhook waterflea]

Compiler: IUCN/SSC Invasive Species Specialist Group (ISSG)

Review: Elena Gorokhova, Professor, Dept. of Applied Environmental Science, Stockholm University, Sweden

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ALIEN RANGE

[4] ATLANTIC - NORTHEAST
[1] ESTONIA
[1] FINLAND
[1] GERMANY
[1] GREAT LAKES
[1] LAKE ERIE
[1] LAKE HURON
[1] LAKE MICHIGAN
[1] LAKE ONTARIO
[1] LAKE SUPERIOR
[1] LATVIA
[1] LITHUANIA
[1] POLAND
[1] ROMANIA
[1] RUSSIAN FEDERATION
[1] SWEDEN
[1] TURKEY
[1] UKRAINE
[3] UNITED STATES

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Summary: The electronic tool kits made available on the Cefas page for free download are Crown Copyright (2007-2008). As such, these are freeware and may be freely distributed provided this notice is retained. No warranty, expressed or implied, is made and users should satisfy themselves as to the applicability of the results in any given circumstance. Toolkits available include 1) FISK- Freshwater Fish Invasiveness Scoring Kit (English and Spanish language version); 2) MFISK- Marine Fish Invasiveness Scoring Kit; 3) MI-ISK- Marine invertebrate Invasiveness Scoring Kit; 4) FI-ISK- Freshwater Invertebrate Invasiveness Scoring Kit and AmphISK- Amphibian Invasiveness Scoring Kit. These tool kits were developed by Cefas, with new VisualBasic and computational programming by Lorenzo Vilizzi, David Cooper, Andy South and Gordon H. Copp, based on VisualBasic code in the original Weed Risk Assessment (WRA) tool kit of P.C. Pheloung, P.A. Williams & S.R. Halloy (1999).
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Summary: Cercopagis pengoi is a new and abundant non-indigenous predator species in the Lake Ontario food web. We explored the impact of this predator on the levels of a chlorinated hydrocarbon in the pelagic food web through assessments of seasonal abundance and mirex concentrations of Cercopagis pengoi (Ostroumov) and the planktivorous alewife (Alosa pseudoharengus). Abundance, stable isotope, and alewife stomach data indicate that Cercopagis pengoi has become an established portion of the Lake Ontario food web. Cercopagis, a predaceous cladoceran, feeds on the lower portion of the trophic web and is clearly fed upon by the planktivorous alewife. Cercopagis is a link in the Lake Ontario food web, in which energy and materials are being passed from one level of the trophic web to another. However, mirex levels of the planktivorous alewife did not increase during the period of highest Cercopagis abundance. The annual load of mirex (mass of Cercopagis times concentration) transferred from one level of the trophic web to the next is low. In the summer, when Cercopagis is abundant, alewives were not feeding on them.
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Warner, David, Rudstam, Lars G., Benoit, Hugues, Mills, Edward L., Johannsson, Ora. 2006. Changes in seasonal nearshore zooplankton abundance patterns in Lake Ontario following establishment of the exotic predator *Cercopagis pengoi*. Journal of Great Lakes Research. 32(3). 2006. 531-542.
Summary: Cercopagis pengoi, a zooplanktivore first discovered in Lake Ontario in 1998, may reduce availability of prey for planktivorous fish. Cercoapgis pengoi is most abundant in late summer and fall. Therefore, we hypothesized that abundance of small zooplankton (bosminids and cyclopoids) species would decrease at that time. To determine if the establishment of C. pengoi was followed by changes in the zooplankton community, seasonal patterns in nearshore zooplankton collected from May to October 1995-2000 were examined. Early summer density of small zooplankton was similar in all years while late summer and fall densities were significantly lower in 1998-2000 than in 1995-1997. The declines of small zooplankton coincided seasonally with the peak in C. pengoi density. Other possible causes for the observed changes in small zooplankton are less likely. High levels of fish predation should have resulted in smaller zooplankton in 1998-2000 than in 1995-1997 and larger declines in Daphnia than other groups. This was not observed. There was no significant decline in chlorophyll-a concentrations or changes in temperature between 1995-1997 and 1998-2000. There re, the declines in density of small zooplankton were most likely the result of C. pengoi predation. The effect of C. pengoi establishment on alewives is increased competition for zooplankton prey but C. pengoi has replaced a portion of the zooplankton biomass and adult alewife diet formerly dominated by Diacyclops thomasi and Bosmina longirostris.
Witt, Allison M., Caceres, Carla E. 2004. Potential predator-prey relationships between *Bythotrephes longimanus* and *Cercopagis pengoi* in southwestern Lake Michigan. Journal of Great Lakes Research. 30(4). 2004. 519-527.
Witt, Allison M., Dettmer, John M., Caceres, Carla E. 2005. *Cercopagis pengoi* in southwestern Lake Michigan in four years following invasion. Journal of Great Lakes Research. 31(3). 2005. 245-252.
Summary: In 1999, a long-term monitoring program in southwestern Lake Michigan captured the invasion of Cercopagis pengoi (fish hook flea), a predatory zooplankton native to the Ponto-Caspian region. This invasion provided an opportunity to examine both the responses of a population following establishment in a new area and the immediate response of the native community. We compared seasonal dynamics and several morphological and life history traits of C. pengoi both among and within the 4 years following its invasion into Lake Michigan. Samples collected from five nearshore sites in southwestern Lake Michigan from 1999-2002 indicated that the average density doubled from 75 individuals/m(3) in 1999 to 150 individuals/m(3) in 2002. We found no evidence for rapid changes in body size or average clutch size as the population established. We did, however observe a shift in seasonal phenology, with the population occurring in the water column earlier each year. By 2002, Cercopagis pengoi appeared in the water column by July and persisted until early fall. We also compared the average monthly densities of several potential prey items in August in the years before (1998-1999) and after (2000-2003) establishment. Although we found a significant reduction in the average number of rotifers, the general trend was a decline in all zooplankton species. Given the number of previously established exotic species in this system, it may prove difficult to quantify the impact of this most recent addition on what is left of the native community.