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# ON THE ROLE OF *CERCOPAGIS (CERCOPAGIS) PENGOI* (OSTROUMOV) IN PÄRNU BAY AND THE NE PART OF THE GULF OF RIGA ECOSYSTEM

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**Abstract.** The invasion of a new Cladocera species, *Cercopagis (Cercopagis) pengoi* (Ostroumov), into Pärnu Bay and the NE part of the Gulf of Riga ecosystem is reported. A brief description of its geographic origin and distribution, morphology, and systematics is also presented. Our investigations show that the distribution of *C. pengoi* is patchy in the Gulf of Riga. The main predator of *C. pengoi* is Baltic herring in the Gulf of Riga. Despite of the abundant presence of copepods, the herring diet (0-group excluded) consists mainly of the cladoceran *C. pengoi*. In several stations up to 100% of herring stomachs contained this species.

*C. pengoi* plays a minor role in the diet of the three-spined stickleback, nine-spined stickleback, and smelt. The stomachs of the 0-group Baltic herring, sprat, white bream, and bleak did not contain this cladoceran species.

**Key words:** Gulf of Riga ecosystem, *Cercopagis pengoi*.

## INTRODUCTION

Investigations in the Gulf of Riga ecosystem were started by K. Frisch and H. Riikoja in the 1920s. During the past 40 years several changes in the Gulf of Riga ecosystem structure have been reported, including changes in the phytoplankton species composition and an increase in primary production; decrease and disappearance of a considerable number of zooplankton, zoobenthos, and fish species that require unpolluted water; rapid development of heterotrophic microbiological communities; decrease in the catches of several fish species, etc. (Ojaveer, in press). These changes are mainly caused by periodical local and global climate fluctuations and by human activities (high pollution load and resource exploitation). On the other hand, these changes indicate a labile character of the Gulf of Riga ecosystem. The lability is also evidenced by a sharp outbreak of a new cladoceran species, never before found in the Gulf of Riga. The presence of *Cercopagis (Cercopagis) pengoi* in the Gulf of Riga was for the first time stated in July and August 1992 (Lumberg, unpubl. data). However, the ecological role of that species remained unknown.

Another outburst of *C. pengoi* was observed in July and August 1994. In 1994 some ecological investigations were performed in order to assess the role of this cladoceran species in the local marine food web.

## MATERIAL AND METHODS

Bottom trawlings (mesh size 10 mm) were performed in Pärnu Bay and the NE part of the Gulf of Riga (Fig. 1) on 18 August (stations 1—3) and 23 August (stations 4—6 and a control trawling at station 1) 1994. The temperature of water layers and the oxygen concentration in the near-bottom water were measured with the thermo-oximeter MARVET JUNIOR, model MJ94. Zooplankton was sampled at each station (large Juday net with a mesh size of 100 μm). The fish stomach fullness and the fat content in its intestines were estimated on a scale from 0 (empty) to 3 (full).

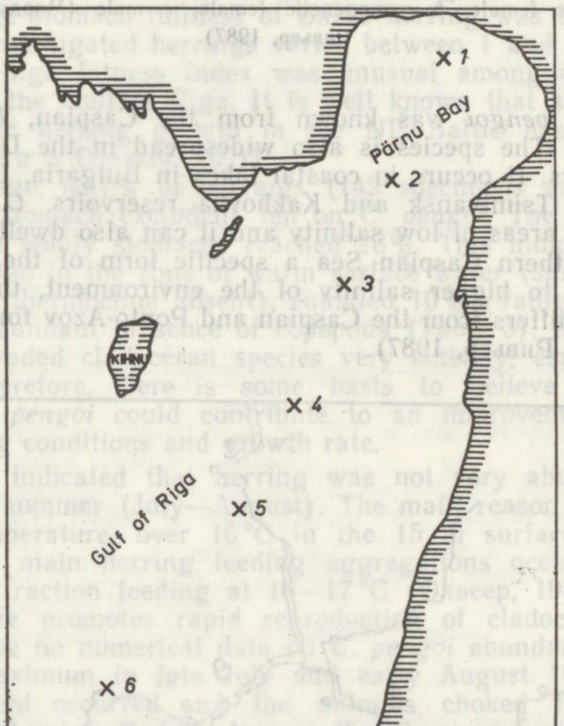


Fig. 1. Location of the sampling stations (*1—6*) in Pärnu Bay and the NE part of the Gulf of Riga.

## CHARACTERISTICS OF *CERCOPAGIS (CERCOPAGIS) PENGOI* (OSTROUMOV, 1981)

The species belongs to the order Cladocera, genus *Cercopagis* (Sars, 1897).

The body of the animal is clearly divided into head, pectoral limbs, and tail spine. The anterior part of the head consists of a round eye, in which the amount of dark pigment is considerably smaller than the eye diameter (Fig. 2). The length of the female is 1.2—2.0 mm, that of the male 1.1—1.4 mm.


Fig. 2. *Cercopagis (Cercopagis) pengoi* (Ostroumov, 1891).
*a* parthenogenetic female; *b* gamogenetic female; *c* male (Мордухай-Болтовской & Ривьер, 1987).

Earlier *C. pengoi* was known from the Caspian, Azov, and Aral seas (Fig. 3). The species is also widespread in the Danube, Dnieper, and Bug rivers. It occurs in coastal lakes in Bulgaria. It has also been found in the Tsimlyansk and Kakhovka reservoirs. *C. pengoi* occurs usually in the areas of low salinity and it can also dwell in fresh water.

In the northern Caspian Sea a specific form of the species occurs. Probably due to higher salinity of the environment, the *C. pengoi* of the Aral Sea differs from the Caspian and Ponto-Azov forms (Мордухай-Болтовской & Ривьер, 1987).


Fig. 3. Occurrence of *Cercopagis (Cercopagis) pengoi* (Мордухай-Болтовской & Ривьер, 1987).
*1* Black Sea, *2* Sea of Azov, *3* Caspian Sea, *4* Aral Sea, *5* Danube, *6* Bug, *7* Dnieper, *8* Don, *9* Volga, *10* Dniester.

## RESULTS AND DISCUSSION

*C. pengoi* was first discovered in Pärnu Bay and the NE part of the Gulf of Riga on 9 July 1992 (2 ind·m$^{-3}$). In late July and August massive occurrence of that species was observed. Some individuals (2 ind·m$^{-3}$) were found as late as on 5 October 1992. The surface water temperature was 12.7°C at that time.

In July—August 1994 massive occurrence of *C. pengoi* in the NE Gulf of Riga repeated.

Results of Baltic herring (*Clupea harengus membras* L.) stomach analysis in 1994 revealed that *C. pengoi* plays an important role in the diet of this fish species. The studied stomachs (0-group fish excluded) contained both half-digested and fresh *C. pengoi*, indicating that the cladoceran is a suitable, energetically profitable, and freely consumable prey of Baltic herring in the area investigated. During our investigations in 1994 the average stomach fullness of Baltic herring was two units. The fatness of the investigated herrings varied between 1 and 3 (mean 1.5). This relatively high fatness index was unusual among the commonly lean herring in the Gulf of Riga. It is well known that since the early 1980s the Baltic herring growth in the NE Baltic has considerably reduced (Lumberg & Ojaveer, 1991).

On an average, 83.1% of herrings (142 specimens analysed, those with an empty stomach excluded) fed on *C. pengoi*. The percentage of individuals with empty stomachs reached 18%. This indicator for stations 1—5, situated in the zone of warm surface water (surface temperature over 16°C, thermocline absent), equalled 10% (Tables 1, 2). Thus, despite of an abundant presence of copepods (Table 3), herring fed on the recently invaded cladoceran species very actively, especially above thermocline. Therefore, there is some basis to believe that further presence of *C. pengoi* could contribute to an improvement of Baltic herring's feeding conditions and growth rate.

Our catches indicated that herring was not very abundant in the studied area in summer (July—August). The main reason was probably high water temperature, over 16°C in the 15 m surface layer. It is known that the main herring feeding aggregations occur at 2—14°C with a smaller fraction feeding at 16—17°C (Оявеер, 1988). However, high temperature promotes rapid reproduction of cladocerans. Unfortunately, we have no numerical data on *C. pengoi* abundance during its reproduction maximum in late July and early August 1994, when its mass development occurred and the animals choked fishing gears. During our field work in late August the *C. pengoi* community was already declining (surface water temperature varied from 17.8°C at station 1 to 16.3°C at station 5). No adhesion of *C. pengoi* to trawl was observed. Herring abundance in the warm surface layer during the *C. pengoi* abundance maximum is rather low. Therefore, despite of its high stomach fullness, herring can utilize only a minor part of the *C. pengoi* biomass production. Probably the bulk of the *C. pengoi* biomass is mineralized and transferred into the biogeochemical matter and energy cycle via sedimentation and subsequent heterotrophic destruction. At station 5, only 18% of the feeding herring consumed *C. pengoi*, whereas at station 4 this percentage reached 100% and at station 6 was 67%. These facts could point to an unequal and mosaic distribution of the *C. pengoi* community over the studied area.

We did not find any *C. pengoi* specimens in the stomachs of the 0-group herring. The juvenile herring feeds only on copepod nauplii occurring abundantly in plankton (Table 3). Consequently, the presence of *C. pengoi* has no direct impact upon the survival and abundance of

*Table 1*

**Some results of the Baltic herring stomach analyses**

| Station | Number of individuals analysed | Percentage of individuals (with empty stomachs excluded) feeding on *Cercopagis pengoi* | Percentage of individuals with empty stomachs |
|---|---|---|---|
| 1 | 8 | 100 | 0 |
| 1* | 20 | 100 | 0 |
| 2 | 15 | 93 | 7 |
| 3 | 20 | 100 | 0 |
| 4 | 20 | 100 | 10 |
| 5 | 20 | 18 | 45 |
| 6 | 39 | 67 | 62 |
| TOTAL | 142 | MEAN 83 | 18 |

* control trawling.

*Table 2*

**Characteristics of the sampling stations**

| Station | Depth, m | Thermocline | Near-bottom water layer temperature, °C | Near-bottom water layer oxygen concentr., ppm |
|---|---|---|---|---|
| 1 | 6 | absent | 17.8 | 9.3 |
| 2 | 8 | absent | 17.7 | 9.6 |
| 3 | 12 | absent | 15.2 | 3.9 |
| 4 | 15 | absent | 16.4 | 3.8 |
| 5 | 20 | absent | 13.9 | 4.3 |
| 6 | 29 | at 18—20 m | 4.5 | 4.7 |

*Table 3*

**Zooplankton abundance (individuals per m³) in stations 1, 2, and 3 on 18 August and at control sampling in station 1 (1*) on 23 August**

| Zooplankton groups | Station | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 1* |
| Rotatoria | 18 200 | 47 100 | 38 640 | 22 920 |
| *Cercopagis pengoi* | 280 | 100 | 40 | 300 |
| Cladocera | 360 | 200 | 40 | 300 |
| Copepoda nauplii | 5 760 | 16 400 | 7 800 | 29 940 |
| Copepoda | 10 120 | 29 550 | 13 120 | 39 360 |
| Mollusca larvae | 40 | 150 | 200 | 180 |
| Cirripedia larvae | 400 | 700 | 120 | 3 420 |
| TOTAL | 29 120 | 77 700 | 52 120 | 66 180 |

* control trawling.

the 0-group herring and the strength of the forming herring year-class depends mainly on the abundance of copepod nauplii. Obviously, *C. pengoi* is too big for the 0-group herring.

Other important commercial fish species — sprat (that is not abundant in the Gulf of Riga), white bream, and bleak — did not feed on that cladoceran species. Three-spined stickleback, nine-spined stickleback, and smelt stomach contained among other food half-digested *C. pengoi* specimens. Consequently, the cladoceran *C. pengoi,* which has recently invaded into the Gulf of Riga, has become an important constituent of the local food web and is directly grazed by fishes.

However, in connection with the *C. pengoi* invasion into the Gulf of Riga, a number of questions should be clarified with further studies, e.g. what the diet of *C. pengoi* in the Gulf of Riga is, which advantages this species has in competition with other zooplankton species traditionally occurring in the Gulf of Riga, and how its abundant presence will influence the functioning of the ecosystem of the Gulf of Riga.


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