International Council for
the Exploration of the Sea

CM 2000/U:14
Marine Habitats
Theme Session on Marine Biological Invasions: Retrospectives for the 20th Century - Prospective for the 21st Century

NEW CLADOCERA SPECIES – *CERCOPAGIS PENGOI* (OSTROUMOV, 1891) (CRUSTACEA) IN THE VISTULA LAGOON ON THE BALTIC SEA

by

Naumenko E.N. and Yu.Yu.Polunina

Atlantic Scientific Research Institute of Marine Fisheries and Oceanography (AtlantNIRO), 5 Dm.Donskoy Str., Kaliningrad, 236000 Russia [*Fax: (0112)219997, Tel.: (0112)22-55-06, e-mail: liman@atlant.baltnet.ru*]

P.P.Shirshov Institute of Oceanology, Atlantic Branch, 1 Prospekt Mira, Kaliningrad, 236000 Russia [*Fax: (0112)272945, Tel.: (0112)45-27-11, e-mail:igelin@mail.ru*]

NEW CLADOCERA SPECIES – *CERCOPAGIS PENGOI* (OSTROUMOV, 1891) (CRUSTACEA) IN THE VISTULA LAGOON ON THE BALTIC SEA

by
Naumenko E.N. and Yu.Yu.Polunina

Atlantic Scientific Research Institute of Marine Fisheries and Oceanography (AtlantNIRO), 5 Dm.Donskoy Str., Kaliningrad, 236000 Russia [*Fax: (0112)219997, Tel.: (0112)22-55-06, e-mail: liman@atlant.baltnet.ru*]

P.P.Shirshov Institute of Oceanology, Atlantic Branch, 1 Prospekt Mira, Kaliningrad, 236000 Russia [*Fax: (0112)272945, Tel.: (0112)45-27-11, e-mail: igelin@mail.ru*]

SUMMARY

Cercopagis pengoi (Ostroumov, 1891) is a predatory Cladocera from the Ponto-Caspian basin. Its expansion into the Baltic Sea had started from 1980s. The species penetrated with ballast waters through the Volgo-Balt channel system. In 1992 it was recorded in the Gulf of Riga, and later on in 1995 – in the Gulf of Finland as well. In 1999 *C.pengoi* was found in the Gdansk Lagoon and in the early August it was recorded in the Vistula Lagoon. *Cercopagis pengoi* was recorded in the Vistula Lagoon for the first time on 9 August 1999. The maximum abundance (310 ind./m^3) of the species was found in the channel between the Lagoon and the Baltic Sea. Gamogenesic females with latent eggs were observed in the population. In the late August (26, 29 August) the peak density of the species (530 ind./m^3) was found along the Baltic Spit. Distribution pattern of the species corresponds to the main marine currents direction, which allows to assume that this species has invaded into the Vistula Lagoon from the Baltic Sea with wind-driven currents. Availability of gamogenetic females with latent eggs shows that *C.pengoi* may naturalize. The biocenotic consequences of such large predator invasion into the lagoon may be very serious, especially taking into account the high vulnerability of this community.

INTRODUCTION

Cercopagis pengoi (Ostroumov, 1891) belongs to the aborigine species of the Ponto-Caspian basin. It inhabits mainly the brackish water areas of the Azov, Caspian and Aral Seas. The data are available evidencing its existence in the lagoons of Danube, Dnepr-Bug, near-coast lakes of Bulgaria. It had naturalized in the Kakhovka and Cimliansk reservoirs (Mordukhay-Boltovskoy, Rivier, 1987). The species has a broad ecological valency, including euryhalinity. It may inhabit even fresh-water basins. *C.pengoi* reached the Baltic Sea basin through the channel system and with ballast waters. It is observed in the lakes of the North America. In the Baltic Sea *C.pengoi* was recorded for the first time in the Gulf of Riga in 1992 (Ojaveer, Lumberg, 1995). In 1995 this species was found in the eastern Gulf of Finland (Krylov, Panov, 1998). Later on *C.pengoi* extended its distribution area to the north and south of the Baltic Sea. In July 1999 it was recorded in the Gdansk Lagoon during the joint Russian-German expedition at R/V "*Alkor*" by Karasiova (2000). In the Vistula Lagoon *C.pengoi* was found by Naumenko during the AtlantNIRO expedition and then by Yu.Polunina in the AO IO RAN expedition.

MATERIAL AND METHODS

During the AtlantNIRO expedition zooplankton was sampled at 9 standard stations in the open part of the Lagoon by means of 10 litters Vovk's plankton samplers from 3 depth levels (surface, middle and lower). In the AO IO RAN expedition sampling was carried out at 36 stations totally, including the coastal zone with Nansen net 14 cm in opening. The mesh size of both samplers was similar (0.094 mm) (mill screen No. 59). In the coastal zone sampling was made with a measure bottle and samples were filtered through the same netting. All samples were fixed in 4% formaldehyde. Both cameral and statistic processing of samples were performed according to the commonly used methods (Methodical recommendations...,1984). The software developed at AtlantNIRO was applied. Zooplankton biomass was estimated using weight/length relation (Balushkina, Winberg, 1979).

In the AO IO RAN expedition the data on water temperature and salinity were obtained with the sensor "Idronaut". The data on water salinity in the Vistula Lagoon for the early August 1999 were kindly provided by Doctor of Geography Yu.M.Senin.

THE RESULTS

C.pengoi was found in the Vistula Lagoon for the first time in zooplankton samples collected during the AtlantNIRO expedition on 9 August 1999. Crustacea abundance in the lagoon varied from 30 to 310 ind./m^3 and on average amounted to 2% of zooplankton abundance and 10% of zooplankton biomass. The population was represented by individuals of 1.00-2.75 mm in length. Juveniles constituted the bulk of the population (above 50%) (Fig. 1). Sexual maturation was observed at the length of 1. 75 mm. All partenogenctic females carried eggs in marsupii. Fecundity varied from 6 to 10 eggs. The number of gamogenetic females was small (about 1%). They carried 1 winter egg. The males abundance was almost the same.

Distribution of *C.pengoi* over the area was determined by the water salinity. The highest abundance was observed at the stations near the sea straight, where the water salinity

exceeded 6‰ (Fig. 2) as reported Yu.M.Senin. The abundance amounted to about 300 ind./m^3. In the stations remoted from the strait, the number of *C.pengoi* reduced sharply. Besides, the survivals were sexual mature individuals, as a rule.

The AO IO RAN expedition was carried out on 27, 29 August 1999. According to their data *C.pengoi* abundance varied from 17 to 533 ind./m^3 . The population length composition varied from 1.00 to 2.50 mm. Age composition of the population slightly changed (Fig. 1). Juveniles, partenogenetic females and males were available. More than 50% of the population were represented by sexual mature females with eggs in marsupii. No females with latent eggs were observed in samples.

Distribution of *C.pengoi* over the area had also changed. This species was recorded in the southwestern part of the Lagoon. At the same time, the peak abundance was found at the stations located against the Baltic strait and along the Baltic Spit towards the Russian-Polish frontier (Fig. 3).

DISCUSSION

The Ponto-Caspian species *C.pengoi* belongs to Cercopagidae family (Polyphenoidea subfamily), included into Cladocera. All Polyphemoidea are predators, therefore they considerable differed from other Cladocera both ecologically and morphologically. As all other Polyphemoidea, *C.pengoi* is a typical representative of plankton with well-developed adaptive means for gliding in the water column. Owing to its long tail appendix they are able to glide and make complex movements. In the native basin– the Caspian Sea – *C.pengoi* inhabits only in the open sea. Its highest density is observed over the depths below 400 m (Mordukhay-Boltovskoy, Rivier, 1987).

In respect of water salinity *C.pengoi* may be referred to highly euryhaline species. In the Caspian Sea this species inhabits at water salinity from 0 to 13 ‰ while the range of 2-10‰ is the optimal one (Rivier, 1968). However, there are other optimal salinity estimates for various basins generally being within the range of the Caspian Sea (Mordukhay-Boltovskoy, Rivier, 1987). At the same time the (1400 ind./m^3) was observed in the absolutely freshwater Kakhovka reservoir (Tseeb, 1962). The water ionic composition significantly affects the population development in various basins. Besides, it was noted that all Caspian fauna species successfully reproduced outside the native basin at lower salinity (Mordukhay-Boltovskoy, 1960).

As all other Cladocera, *C.pengoi* is a summer warm-loving species. As other Caspian Polyphemoidea it is a highly eurythermal species. It appears within the plankton in spring, approaches mass development in summer, and lays latent eggs in autumn at temperature decrease, which provides their survival during unfavourable winter season. In the Caspian Sea *C.pengoi* appears in plankton at 17° C and disappears at the temperature below 13-16° C (Rivier, Mordukhay-Boltovskoy, 1966). In the Gulf of Finland *C.pengoi* actively reproduces in August, while its highest density is observed in the upper 10-m layer of the warm water (Telesh *et al.*, 2000). Its abundance in the Gulf of Finland during naturalization period approached 2 thous. ind./m^3. Besides, this species density was significantly higher than in the Caspian Sea. *C.pengoi* formed a dense mucous mass, which clotted fishing nets and trawls. Fishing nets should be removed, dried and released from this species, which hampered the normal fishery process. It should be noted that in the Gulf of Finland this species starts reproduction much earlier than in the Caspian Sea and produces the higher number of latent

eggs (Telesh *et al.*, 2000). These pools of eggs promote fast expansion of the species with the vessels ballast waters into the Baltic Sea basins.

C.pengoi abundance dynamics during the naturalization period in the Gulf of Finland evidenced that this species is able to acclimatize itself in the Vistula Lagoon. In general the hydrological regime of the Vistula Lagoon is favourable to *C.pengoi*. The average depth is 2.7 m (maximum 5.2 m), and the water is sufficiently warmed and mixed (Soloviev, 1971). The water salinity varies by years and seasons within 2-6‰ (Zhuravleva, Tshosinska, 1971) and exceeds no the salinity range of *C.pengoi* original distribution area. Sexual mature population of *C.pengoi* in the Vistula Lagoon just as in the native basin and in the Gulf of Finland is comprised of partenogenetic and gamogenetic females and males. However, the number of gamogenetic females with latent eggs is considerably lower in the Vistula Lagoon. In the Gulf of Finland *C.pengoi* gamogenetic females appeared in the population much earlier they in the original distribution area. In the Caspian Sea females lay one (rarely two) latent egg, in the Gulf of Finland two (rarely three) winter eggs (Rivier, 1969; Krylov, Panov, 1998). In the Vistula Lagoon the gamogenetic females fecundity (one latent egg) is similar to that in the native basin.

The more fact of availability of females with latent eggs in the Vistula Lagoon evidenced that this species will be able to survive in unfavourable conditions and start to develop as soon as the favourable conditions occurred.

In the Vistula Lagoon the temperature and salinity regimes are to significant extent determine by the sea wind-driven flows bringing cool saline waters into the Lagoon (Chubarenco *et al.*, 1999). In the seasonal aspect the sea waters intrusion under the impact of predominating winds is observed from July and continues as a rule till winter. The second peak of winter-driving winds is observed in March (Hydrometeorology..., 1992). *C.pengoi* distribution over the Vistula Lagoon during both expeditions corresponded to predominating flows direction. This allows to conclude that *C.pengoi* appearance is related to the intrusion from the Baltic Sea, where it was recorded by E.M.Karasiova in July 1999 in high amount (Karasiova, 2000).

Biocenosis consequences of such large predator invasion into the Vistula Lagoon are hardly predictable at present. Zooplankton community of the Lagoon is affected by the variable salinity gradient and becomes very vulnerable (Naumenko, 1999a, b). Besides, in summer zooplankton is under severe trophic pressure of juvenile Baltic herring (*Clupea harengus membras*), actively feeding upon zooplankton in June-July. In this period zooplankton abundance and biomass decrease by 10-100 times (Naumenko, 1990a). Naturalization of the additional predator in the Vistula Lagoon may negatively affect zooplankton structure.

At present no data on *C.pengoi* place in the trophic chain of the Vistula Lagoon ecosystem are available. In the Azov Sea *C.pengoi* is the basis of sardelle and khamsa food ration, as well as of many other Caspian plankton feeding fishes and juveniles (Mordukhoy-Boltovskoy, Rivier, 1987). The data are available to evidence other planktivorous fishes feeding upon this Cladocera in the Baltic Sea (Ojaveer, Lumberg, 1995) and in the Gulf of Finland where it is an important food item of the Baltic herring of various age groups (Antsulevich, Valipakka, 1999). It may be assumed that *C.pengoi* will be used as a food item by planktivorous of the Vislula Lagoon. However, juvenile Baltic herring predominates among the planktivorous fishes since it develops here from eggs to post-larvae stage. It is hard

to say whether (*C.pengoi*) will be available to herring, because of its large size. Whitebait (*Osmerus eperlanus eperlanus morpha spirinchus L.)* is another planktivorous fish of the Lagoon, however, its abundance is extremely low.

CONCLUSIONS

1. *C.pengoi* was transported into the Vistula Lagoon with sea flow in the early August 1999, and its distribution over the area corresponded to the dominating current.
2. *C.pengoi* maximum abundance amounted to about 300-500 ind./m^3 which agreed with the observations of this species intrusion during the initial naturalization in other basins.
3. *C.pengoi* population was represented by individuals of 1.00-2.75 mm in length and consisted mostly of juveniles, partenogenetic and gamogenetic females and males.
4. Partenogenetic females laied 6-10 eggs while gamogenetic females had 1 latent egg.
5. Availability of gamogenetic females in the population allows to assume the *C.pengoi* extends its distribution area and will naturalized in the Vistula Lagoon, having favourable conditions to this species.

ACKNOWLEDGMENTS

The authors are sincerely grateful to Doctor of Biology M.M.Khlopnikov, the Head of Lagoons Laboratory of AtlantNIRO, for his valuable and useful comments and kind assistance. The authors are very grateful to Doctor of Geography Yu.M.Senin for kindly provided data on salinity.

REFERENCES

Antsulevich A. , Valipakka P. 1999. *Cercopagis pengoi* - an important food item of the Baltic herring in the eastern Gulf of Finland . Functional diversity and ecosystem dynamics of the Baltic Sea. Alien species in the brackish water ecosystems: Abstracts 16th Baltic Biologists Symposium, Klaipeda, Lithuania, June 21-26, 1999. Klaipeda, P. 13.

Balushkina E.V., Winberg G.G. 1979. Weight-length relation of plankton species. General principles of water ecosystems researches.Edited by G.G.Winberg. L., 169-172 pp. (in Russian).

Chubarenko B.V., Chubarenko I.P., Kuleshov A.F. 1999. The results of 1994-1997 field investigations of hydrological structure and transparency of water in Russian part of Vistula Lagoon. Freshwater fish and the herring populations in the coastal lagoons: Environment and Fisheries (Proceedings of Symposium), Gdynia, 6-7 May 1998 (Poland). Gdynia, 1999. P.45-59.

Hydrometeorology and hydrochemistry of seas in the USSR. Vol. III, issue 1, St.-Petersburg, Hydrometeoizdat, 1992. P. 450 (in Russian).

Karasiova E.M. 2000. First recording of *Cercopagis pengoi* (Ostrounov, 1891) in the open south-eastern Baltic Sea. Species-invaders in the European seas of Russia : Thesis of the report of the scientific seminar. Murmansk, 27-28 January, 2000. Murmansk, 2000. 48-49 pp. (in Russian).

Krylov P. I. , Panov V. E. 1998. Resting eggs in the life cycle of *Cercopagis pengoi*, a recent invader of the Baltic Sea . Arch. Hydrobiol.Spec. Issues Advanc.Limnol. V.52, 383-392 pp.

Methodical recommendations on sampling and material processing in hydrobiological researches in freshwater basins. Zooplankton and its production. A.A.Salazkin, M.B.Ivanova, V.A.Ogorodnikov. Leningrad:State Research Institute of lake and river fisheries. 1984. P. 33 (in Russian).

Mordukhay-Boltovskoy F.D. 1960. Caspian fauna in the Azov-Alask Sea basin. M. L. Nauka, P. 288 (in Russian).

Mordukhay-Boltovskoy F.D., Rivier I.K. 1987. Predatory Polonidae, Polyphemidae. Corcopagidae and Leptodoridae of the world fauna. L. Nauka, 1987, P. 182 (in Russian).

Naumenko E.N. 1999. Species composition, seasonal and long-term dynamics of zooplankton abundance and biomass in the Vistula Lagoon of the Baltic Sea . Freshwater fish and the herring populations in the coastal lagoons: Environment and Fisheries (Proceedings of Symposium), Gdynia, 6-7 May 1998 (Poland). Gdynia, 1999a. 161- 173 pp..

Naumenko E.N. 1999. Trophic chain length of zooplankton community in Vistula Lagoon and environment factors impact. ICES, Doc., C.M. 1999b/Z:09. P. 29

Ojaveer H., Lumberg A. 1995. On the role of *Cercopagis pengoi* (Ostroumov) in Parnu Bay and the NE part of the Gulf of Riga ecosystem.. Proc.Estonian Acad.Sci.Ecol .V.5 (1/2), P. 20-25.

Rivier I.K. 1967. Ecology and biology of polyphemidae in the Caspian Sea. Abstract of thesis for a Doctor of Biology degree. M., P. 11 (in Russian).

Rivier I.K. 1969. Reproduction of Cladocera, Polyphemidae in the Caspian Sea. Physiology of water organisms and their role in organic matter turnover. Collected papers. Institute of Inland basins biology SA USSR. L. Nauka, Issue 19(22), 119-128 pp. (in Russian).

Rivier I.K., Mordukhay-Boltovskoy F.D. 1966. Data on Caspian Polyphemidae biology. Plankton and benthos of inland basins: Collected papers. Institute of Inland Basins biology SA USSR, M.-L.:Nauka, Issue 12(15), 159-169 pp. (in Russian).

Solovyov I.I. 1971. Morphological characteristics of the Lagoon and its coast line. Hydrometeorological regime of the Vistula Lagoon/Edited by N.N.Lazarenko, A.Mayenskiy. L.Hydrometizdat. 6-10 pp. (in Russian).

Telesh I.V., Krylov P.I., Bolschagin P.V., Litvinchuk L.F., Panov V.E. 2000. Results of biological researches of Ponto-Caspian Cladocera *Cercopagis pengoi* in the Gull of Finland of the Baltic Sea. Species-invaders in the European Seas of Russian: Thesis of the Workshop Report, Murmansk, 27-28 January 2000, Murmansk, 2000. 87-89 pp. (in Russian).

Tseeb Ya.Ya. 1962. Kakhovka hydroelectric station impact upon fish forage resources in the lower Dnepr. Problems of Ecology. Vol. 5. 236-238 pp. (in Russian).

Zhuravleva L.A., Tshosinska A. 1971. Hydrochemical regime. Hydrochemical regime of the Vistula Lagoon. Edites by N.N. Lazarenko, A.Mayevskiy. L., Hydrometizdat, 1971. 219-262 pp. (in Russian).

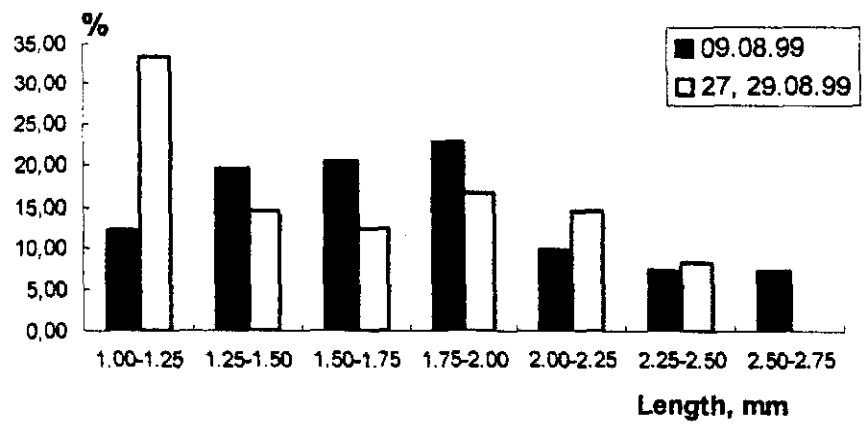

Fig.1. Length composition of *C.pengoi* population in the Vistula Lagoon

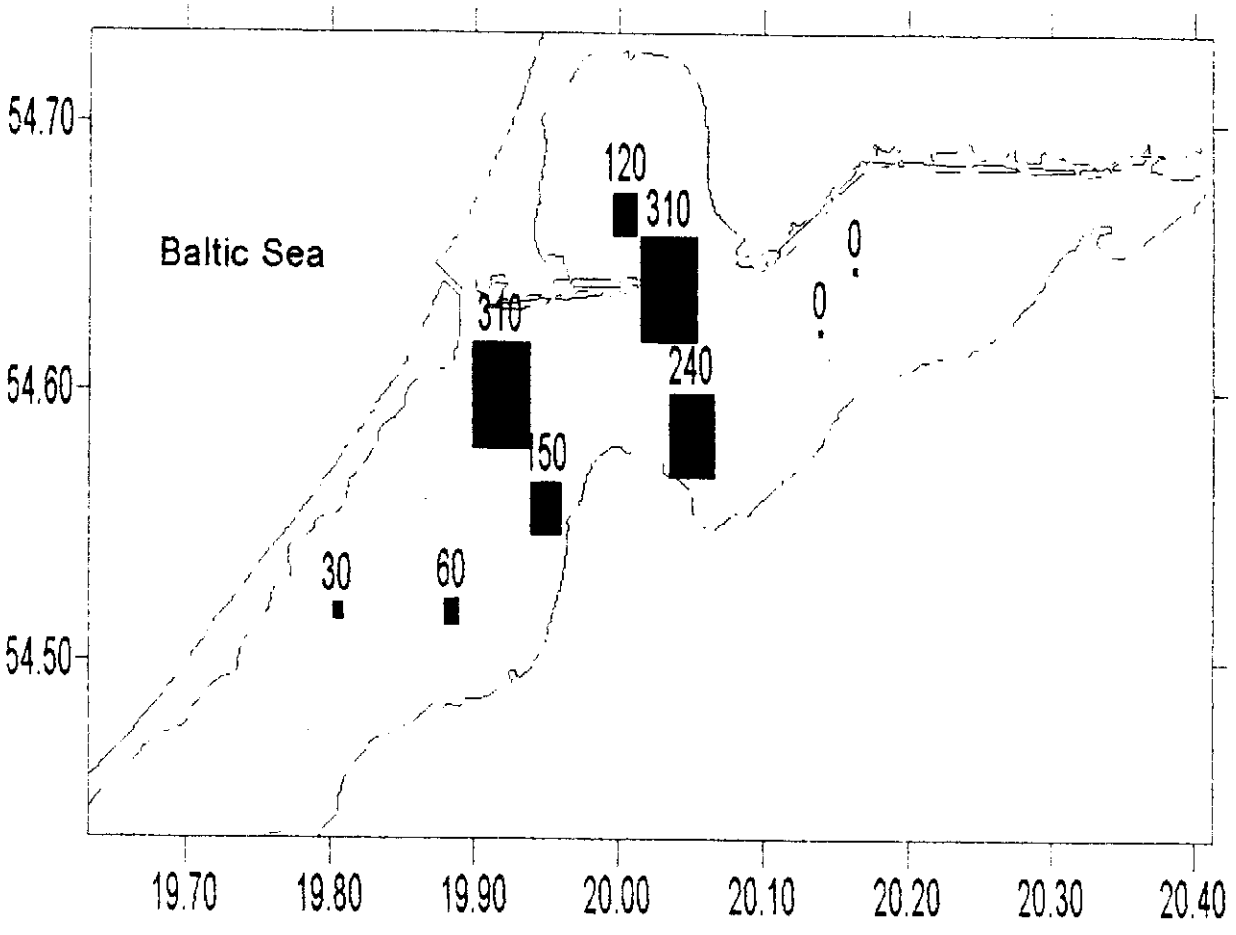

Fig.2. C.pengoi distribution in the Vistula Lagoon on 9 August 1999.

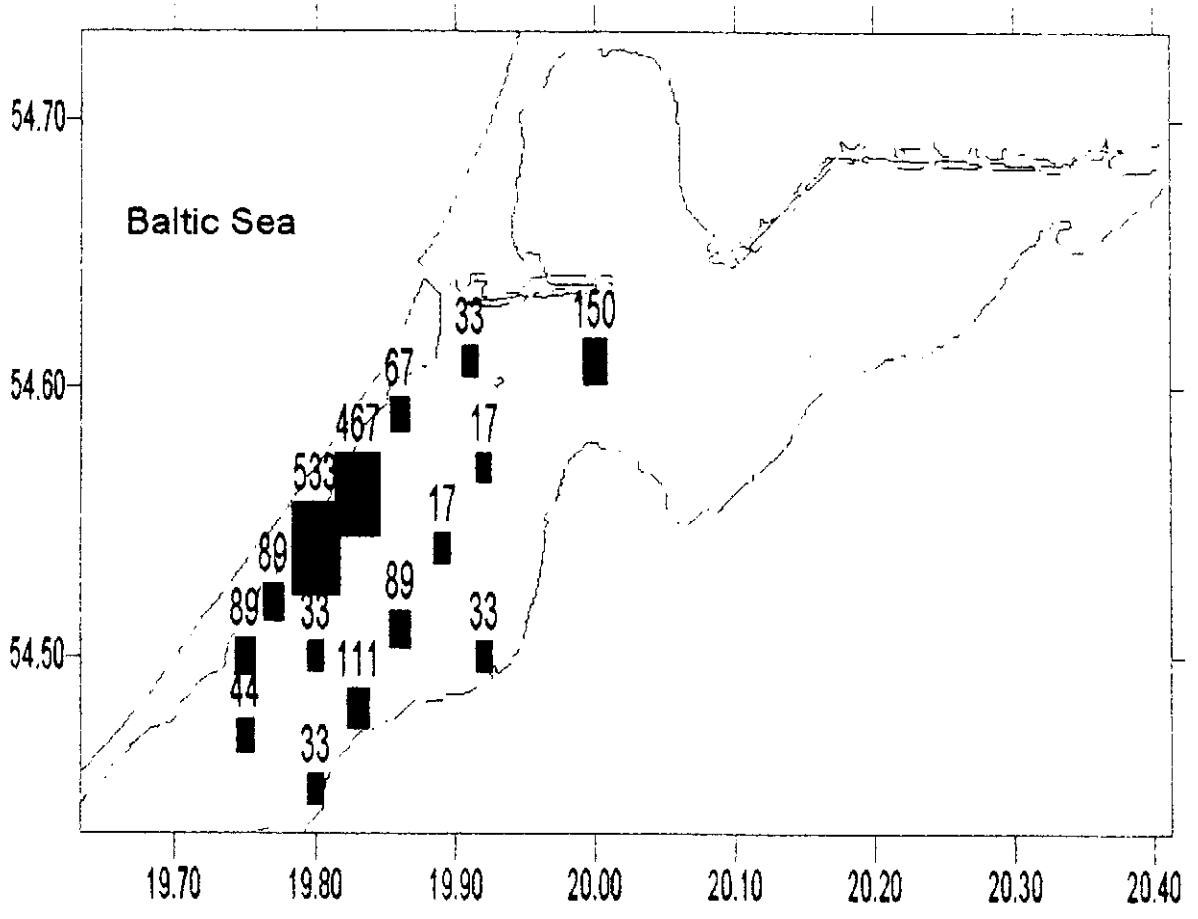

Fig.3. C.pengoi distriburion in the Vistula Lagoon on 27, 29 August 1999.