Attachment No 2

AUTOREFERAT

1. Name and surname:

Luiza Bielecka

2. Diplomas and academic degrees

1996 PhD in the field of oceanography (08.11.1996), University of Gdańsk, Faculty of Biology, Geography and Oceanology, Institute of Oceanography, PhD thesis *Cyclopoida wybranych rejonów wód antarktycznych* – the supervision of Prof. Dr. Hab. Maria Iwona Żmijewska.

1988 Master of oceanography (28.09.1988), biological oceanography, University of Gdańsk, Faculty of Biology, Geography and Oceanology, Institute of Oceanography, Master Thesis: *Rozmieszczenie Chaetognatha w wybranych rejonach strefy przybrzeżnej oraz wodach otwartych Antarktyki* – the supervision of Prof. Dr. Hab. Maria Iwona Żmijewska.

3. Information on previous employment in scientific / artistic

2010-2014 University of Gdańsk, Faculty of Biology, Geography and Oceanology, Institute of Oceanography (from 2011 Faculty of Oceanography and Geography), Institute of Oceanography, Department of Marine Plankton Research: senior Lecturer.

1997-2009 University of Gdańsk, Faculty of Biology, Geography and Oceanology, Institute of Oceanography, Institute of Oceanography, Department of Marine Plankton Research/Department of Functioning of Marine Ecosystems/ Department of Marine Biology and Ecology: Assistant Professor.

1993-1996 University of Gdańsk, Institute of Oceanography, Department of Marine Biology and Ecology: Assistant.

4. Scientific achievement resulting from the Act on Academic Degrees (Dz. U. no 65, 595):

a) Title of the scientific achievement

The natural and anthropogenic variability of the zooplankton in the Polish zone of the Southern Baltic

b) List of scientific paper:

[4b I] **Bielecka L.**, Gaj M., Mudrak S., Żmijewska M. I., 2000, *The seasonal and short-term variability of zooplankton taxonomic composition in the shallow coastal area of the Gulf of Gdańsk*, Oceanological Studies, vol. XXIX (1), 57-76.

[4b II] **Bielecka L.**, Żmijewska M. I., Szymborska A., 2000, *A new predatory cladoceran Cercopagis (Cercopagis) pengoi (Ostroumov 1891) in the Gulf of Gdańsk*, Oceanologia, 42 (3): 371-374.

[4b III] Józefczuk A., Guzera E., **Bielecka L.**, 2003, *Short-termand seasonal variability of mesozooplankton at two coastal stations (Gdynia, Sopot) in the shallow water zone of the Gulf of Gdańsk*, Oceanologia, 45 (2): 317-336.

[4b IV] **Bielecka L.**, Krajewska-Sołtys A., Szymanek L., Szymelfenig M., 2005, *Mesozooplankton in the Hel upwelling region (The Balic Sea)*, Oceanological and Hydrobiological Studies, vol. XXXIV, Supplement 2, 137-161.

[4b V] **Bielecka L.**, Krajewska-Sołtys A., Mudrak-Cegiołka S., 2014, *Spatial distribution and population characteristics of the invasive cladoceran Cercopagis pengoi in the Polish coastal zone seven years after the first record*, Oceanological and Hydrobiological Studies 43 (3): 201-210. DOI: 10.2478/s13545-014-0134-y.

[4b VI] **Bielecka L.** Mudrak-Cegiołka S., Kalarus M., 2014, *Evadne anonyx G. O. Sars, 1897- the first record of this Ponto-Caspian cladoceran in the Gulf of Gdańsk (Baltic Sea)*, Oceanologia 56 (1): 141-150. DOI: 10.5697/oc.56-1.141.

[4b VII] **Bielecka L.**, Boehnke R., 2014, *Epibionts and parasites on crustaceans (Copepoda, Cladocera, Cirripedia larvae) inhabiting the Gulf of Gdańsk (Baltic Sea) in very large number*, Oceanologia 56 (3): 629-638. DOI: 10.5697/oc.56-3.629.

c) Scientific objective:

The title of the work: *The natural and anthropogenic variability of the zooplankton in the Polish zone of the Southern Baltic*

Introduction

Growing threats to the natural environment, which stem from the antropopressure increasing especially in recent decades, represent a key problem of the contemporary world as well as a central challenge to science, including natural sciences. Deliberate as well as coincidental activities of man lead to transformations of natural biosystems, the results of which are difficult to predict and can often be impossible to stop. In the face of these threats, what is extremely important is not only their monitoring, but also a deep understanding of the fundamental principles of the functioning of ecosystems and the awareness of their complexities. Each ecosystem has its own specificity; it is atypical in its own way. Each has its own potential for changeability and self-regulation. Each ecosystem provides us with precious information leading to a better understanding of the changes which we currently confront on a global scale.

Aside from the climate changes and the loss of habitats, the all-pervasive phenomenon of the introduction of non-indigenous species, including invasive alien species, presents one of the greatest contemporary challenges. Biological invasions are natural processes occurring in aquatic environments and, as such, they have taken place ever since species became capable of expanding and colonizing new territories. However, at the time when humans intensively intrude in the natural environment and obliterate its inherent barriers, the natural ways of the expansion of species play a much lesser role in comparison to those resulting from the antropopressure. Despite the fact that the invasive alien species represent only a small percentage of all non-indigenous species, they have, nevertheless, become a source of serious ecological, economic, and social problems. They pose one of the greatest threats to the natural richness of marine ecosystems, and their expansion leads to significant homogenization of environments.

The Baltic Sea is a very interesting, hydrologically and ecologically diverse water body. It is an estuary-like inland reservoir with significantly limited access to fully salty oceanic waters. It has many bays, which are protected from the wind, and whose shallow surface waters warm up quickly in summers. The Baltic Sea receives very large amounts of fresh water from rivers, which significantly desalts its estuaries and provides much pollution. On the one hand, the functioning of the Baltic ecosystems is a derivative of the changing regime of the exchange of water with the Northern Sea; on the other, it is heavily impacted by a level of intensity of the intake of the fresh inland waters. Both processes play a key role in

sustaining a relative balance of life in the global as well as local context. The Baltic Sea is one of the most polluted sea and is particularly vulnerable to the environmental degradation.

Because of its unique character, the Baltic Sea seems especially susceptible to the current environmental changes. Their results have been observed for many years, mostly in coastal areas, bays, and estuaries. They are, among others: the eutrophication; the expansion of the allochthonous species of the pelagic and benthic fauna; the radical decline of some native populations; the transformation of the trophic web; the general degradation and fragmentation of habitats. This list of phenomena can be further expanded to incorporate the more distinct presence of the filtrating organisms belonging to the Protoza, including the free living as well as epibionts and the parasites growing on the bodies of crustaceans and significantly affecting their condition.

The Baltic Sea is an ecosystem that undergoes dynamic changes. Monitoring and recording these changes creates a history that should become an important point of reference for prognosticating and modelling the overall evolution of this process. The understanding of the phenomena that determine and condition the functioning of the Baltic ecosystem is especially important at the time when our awareness of global changes is growing. The direction of my research is closely integrated in this larger approach. My research explores the natural and very diverse – in both seasonal and spatial terms – changeability of the Baltic zooplankton. At the same time, it analyzes phenomena closely connected to antropopressure, such as bioinvasions and the declining condition of the plankton crustaceans.

The object of my studies is not coincidental. The animal plankton is a particularly significant element of the sea life. The plankton crustaceans – including Cladocera and Copepodia which are the most important direct object of most of my works presented for evaluation – are the most essential component of the zooplankton. They play a vital role as a basic food item on the menu of many species of invertebrates, larvae, and juvenile fish, including plankton-eating fish of economic significance. The zooplankton also constitutes an extraordinarily sensitive bio-indicator of changes in natural environment.

Below is the description of the scientific purpose and of the main accomplishments of each work included in the *Scientific Accomplishment*. These works are divided thematically into three parts.

The contributions of the co-authors of the works listed as scientific accomplishments are described in the attached statements.

I. Natural variability of zooplankton - specific nature of zooplankton functioning in the coastal zone of the Southern Baltic

[4b I]

Bielecka L., Gaj M., Mudrak S., Żmijewska M. I., 2000, *The seasonal and short-term variability of zooplankton taxonomic composition in the shallow coastal area of Gulf of Gdańsk*, Oceanological Studies, vol. XXIX (1), 57-76.

The zooplankton of the Gulf of Gdańsk has been monitored by the Institute of Oceanography of the University of Gdańsk since many years. The material was taken from a stable net of stations situated far away from the shore. The samples have been usually collected at month or quarter intervals. As the dynamic of the changes in the composition and abundance of individual zooplankton components increases towards shallower regions, where hydrological conditions are much less stable, I have prepared assumptions to carry out new and more detailed research. I focused my attention on the zooplankton inhabiting the shallowest zone in the Gulf of Gdańsk, on water-land contact, because this zone has been hitherto neglected by scientists. The aim of the investigation was to recognize: (i) qualitative and quantitative composition of zooplankton in the region close to the shoreline, (ii) dynamics of short-time (month and seasonal) changes, and (iii) comparison of pelagic fauna living close to the cost with that observed and described in distant regions, also in the open water in the Gulf of Gdańsk.

To be equal to the scientific assumptions, zooplankton samples were taken at the station situated in Gdynia (close to Marine Boulevard), at week intervals, for 13 successive months. Assuming that small organisms could be abundant in the study region, the hauls were made with Copenhagen net, 50 μm mesh size. Double way of sampling, i.e. vertical to 1 m depth, and horizontal at a distance not less than 60 m, enabled the precise determination of zooplankton taxonomic composition and abundance.

Due to the adopted sampling method and permanent water temperature monitoring, it was possible to monitor exactly the seasonal and frequency changes in the region. The main part of the study was the analysis of zooplankton, which was described with the separation of all elements belonging to holo-, mero- and tychoplankton. The detailed investigations

revealed that zooplankton taxonomic composition and density changed not only seasonally, but in most cases also weekly. High dynamics in zooplankton diversity and high degree of zooplankton instability were observed. On the other hand, it was found that some members of holoplankton, e.g. copepods of *Acartia* genus, seem to be independent of the changes in thermal conditions. They were observed permanently as a dominant element of local fauna. It is worthy to note, that taxonomic diversity of zooplankton reflects the significance of individual taxa in the plankton not only when they show highest concentration, but also when their abundance is low and at the same time they make a dominant fraction. High sampling frequency made it also possible to determine the periods of the fastest changes in zooplankton and the precise time of the presence of individual animal groups in water and duration of their dominance. It was found that depending of taxon the time of the dominance in plankton was between some and dozen or so weeks. It should be emphasized that the differences in taxa density even reached the values of more than ten thousands. It was found that such rapid and clear changes were not applied only to the animals representing individual species, what could result from a typical species succession, but were observed even in whole holo- and meroplankton. The results obtained also showed an exceptionally high abundance of meroplakton larvae on the border between water and land, and significant larvae contribution to the whole zooplankton. It was especially related to the youngest developmental forms of Cirripedia (nauplii *Balanus improvisus*) and Bivalvia (veliger). Therefore, it could be assumed that this part of the Gulf of Gdańsk is an important reservoir for planktonic developmental stages occurring in the developmental cycles of bottom and overgrowing fauna.

[4b III]

Józefczuk A., Guzera E., Bielecka L., 2003, Short-*term and seasonal variability of mesozooplankton at two coastal stations (Gdynia, Sopot) in the shallow water zone of the Gulf of Gdańsk*, Oceanologia, 45 (2): 317-336.

The work presents detailed results of the investigations that have been started in 1998. However, they have been modified and extended by new elements. This time, two stations were chosen. They were located near Gdynia and Sopot, within the distance of ca. 12 km. Furthermore; the measurements of salinity and wind speed were also included. The plankton material was collected at previously fixed high frequency, for 12 successive months in 2001.

The main assumptions of the study were similar to those presented earlier, i.e. monitoring and recognition of short-term and seasonal fluctuations of zooplankton in the

coastal zone. However, this time the investigations were also focused on: (i) the comparison of the changes at nearby sites - the degree of their similarity and specificity, is the littoral zone of the Gulf of Gdańsk homogeneous, and (ii) the examination on the effect of temperature and water salinity on the course of these changes.

The study gave interesting results. They showed a relatively great diversity between two stations. First of all, it could be stated that despite the similar taxonomic composition at both stations, the abundance and contribution of some taxa were quite different. For example, at the Gdynia station, the contribution of meroplanktonic larvae was two times higher on the average, and, what is interesting; significantly higher abundance of Ciriipedia larvae was observed. On the other hand, at the Sopot station the dominance was shown by the larvae of veliger type (Bivalvia and Gastropoda). In the case of Mollusca larvae abundance, the distinct difference was confirmed by statistical analysis. It was also found that the littoral zone near Gdynia was poorer in Rotatoria. It is worth to note that the values of temperature and salinity were similar at both stations, and the direction of their changes at week intervals was also similar. The dynamics of zooplankton abundance changes was very high, and the week amplitude reached even almost 100- and 1000-fold values. The presented results confirmed the permanent, irrespective of the season, presence of copepods with *Acartia* spp. as a dominant taxon. Although no significant changes in water temperature and taxonomic composition of copepods were observed, there was a clear decrease in copepod concentration in the summer period.

The statistical analysis of all main animal groups pointed at different dependency level between the animal concentration and environmental parameters. In many cases the correlations were insignificant, and the dependencies difficult to observe. However, the strong positive correlation between Cladocera abundance and water temperature was noted. Furthermore, it was shown that the occurrence and concentrations of Polychaeta larvae were negatively correlated with water temperature and somewhat weaker with wind speed. However, it should be underlined that the relationships for Polychaeta were observed at only one station. Similar situation was found for Copepoda (positive and negative correlation for temperature and salinity, respectively) and *Balanus improvisus* larvae (positive correlation with salinity). The results of the study could be the evidence of incomparably higher dynamics of environmental changes in shallow-water areas as compared to open water, and of a certain unpredictability and local character of the changes. Nevertheless, high

concentrations of plankton animals seem to confirm the importance of this region for the development of organisms and enrichment of the Gulf of Gdańsk with pelagic fauna.

To investigate the biological diversity of zooplankton in the littoral zone, Simpson index (D) was determined. The values, calculated at week intervals, were form close to zero in the coldest period to 0.05 in the middle of summer. The mean value for individual months reached its maximum of 0.76. The results indicate a relatively high diversity of zooplankton in shallow water of the Gulf of Gdańsk as compared to those described earlier in the literature.

[4b IV]

Bielecka L., Krajewska-Sołtys A., Szymanek L., Szymelfenig M., 2006, *Mesozooplankton in the Hel upwelling region (the Baltic Sea)*, Oceanological and Hydrobiological Studies, vol. XXXIV, Supplement 2, 137-161.

The work presents the results of zooplankton analysis in the zones of Baltic upwelling. It is known that hydrological conditions of the Baltic Sea are determined mainly by its isolation from oceanic water and high influx of river water what results in strong thermal and salinity stratification. Interesting hydrological features of the Baltic Sea are raising currents, so-called upwellings, identified at several dozen sites located along the coast. The currents carry on cold bottom water to the surface and cause, among others, a change in plankton concentration and species composition. Their duration depends on frequency and lifespan of this phenomenon. Taking into account very scarce data on Baltic plankton in upwelling zones, such investigations have been started in the Institute of Oceanography by dr M. Szymelfenig.

As a person of great experience in work on zooplankton biology and ecology, I was invited to take part in this project. The main aim of the study was to describe the effect of the upwelling phenomenon observed near the Hel Peninsula on qualitative and quantitative structure, and biomass of so-called net zooplankton.

Field study was conducted in 2000-2002, and the upwelling phenomenon was observed 7 times. In every case, zooplankton samples were collected at 3 stations, chosen on the base of earlier hydrological measurements and situated within and outside the upwelling region. The analysis included taxonomic composition, abundance and biomass of zooplankton. Statistical methods were applied to illustrate animal grouping. Simpson diversity index (D) was determined for individual stations in the course of frontal phenomena.

The research near the Hel Peninsula showed that, during the occurrence of raising currents, the region was under simultaneous influence of the water from the Gulf of Gdańsk. Such hydrological situation was reflected in qualitative and quantitative composition of zooplankton that appeared to be rather typical of the open water of the Baltic Sea and the Gulf of Gdańsk. However, in spite of natural seasonal variability of zooplankton, it was succeeded to find regularity in zooplankton grouping under the upwelling influence. Such regularity was clearly observed in the second half of the summer season. At that time, the animals typical of deep and cold water (e.g. a copepod of *Pseudocalanus* genus) and benthic species (Harpacticoida) were sampled. Mesozooplankton diversity was relatively high, frequently in the upwelling centre. The most significant differences in mesozooplankton assemblages were noted when the distance and the differences in water temperature between the upwelling centre and reference area were the biggest. The results obtained suggest that frontal phenomena near the Hel Peninsula were too short in time and their intensity was relatively low. Therefore, the clear formation of permanent groups typical of upwelling phenomenon was difficult to observe.

II. Expansion of allochthonous species into the Southern Baltic

[4b II]

Bielecka L., Żmijewska M. I., Szymborska A., 2000, *A new predatory cladoceran Cercopagis (Cercopagis) pengoi (Ostroumov 1891) in the Gulf of Gdańsk*, Oceanologia, 42 (3): 371-374.

In 1999-2000, in the course of the study on zooplankton diversity in the coastal zone of the Gulf of Gdańsk, biological analyses brought some new and interesting data. They concerned the appearance of the first specimens of *C. pengoi* in this region. *C. pengoi* belongs to predatory big Cladocera from Cercopagidae family, and most of the species representatives inhabit the Caspian Sea. However, the species is also observed in the other Ponto-Caspian regions, among others, in the Black and Azov Seas, and also in bordering rivers (e.g. Dniester or Don). *C. pengoi* belongs to euryhaline animals preferring brachic water and, as most Cladocera, is thermophile.

First reports on the introduction of *C. pengoi* into the Baltic Sea come from the Finn and Riga Bays where the cladoceran has appeared in 1992. According to the presented work, after 7 years it reached the Gulf of Gdańsk. First specimens were observed near Gdynia, straight away at high concentration (more than 1000 ind./m^3), at the end of July 1999. It is the earliest observation of *C. pengoi* in the gulf. The species was found for the second time at the

beginning of August but its concentration was 3-fold lower. Despite of comprehensive works, other cases of *C. pengoi* occurrence near Gdynia were not observed. However, in the same year in August, some other researchers reported the cladoceran at some other sites of the gulf and in the Vistula Lagoon. Introduction of *C. pengoi* into the Polish zone of the Baltic Sea has initiated the series of my investigations on alien species that last till present. This study is financially supported by the University of Gdańsk and Ministry of Science and Higher Education.

[4b V]

Bielecka L., Krajewska-Sołtys A., Mudrak-Cegiołka S., 2014, *Spatial distribution and population characteristics of the invasive cladoceran Cercopagis pengoi in the Polish coastal zone seven years after the first record*, Oceanological and Hydrobiological Studies 43 (3): 201-210. DOI: 10.2478/s13545-014-0134-y.

For successive years, despite frequent investigations of zooplankton within a broad net of stations in the Gulf of Gdańsk, the occurrence of *C. pengoi* was not observed. However, the species was sporadically and irregularly noted in the open water of the Southern Baltic, also near the Hel Peninsula in August 2002, during the earlier-mentioned study on upwelling. Seven years after introduction, I have observed *C. pengoi* for the second time, and the detailed results of the investigations have been described in the present work.

The investigations were carried out in the Gulf of Gdańsk in 2006 (13 stations monitored by the Institute of Oceanography), and in the open water along the Polish coast (11 stations monitored by the National Marine Fisheries Research Institute). Hauls were made usually once a week with a Copenhagen net WP-2 type, 100 μm mesh diameter. To perform the spatial analysis of zooplankton distribution, the samples were taken in layers, the maximum depth was 105 m. To determine environmental background, temperature and salinity were measured at every layer. It is worth to note that all planktonic material was segregated, and all *C. pengoi* specimens were chosen. It is important in the case of alien species as initially not numerous specimens could be unnoticed when the standard for zooplankton sub-sample methods of analysis are applied. The animals were subjected to a detailed population and biometric analysis.

If the occurrence of *C. pengoi* and its role in the zooplankton of north-east Baltic have been well-documented, the data on the cladoceran in waters surrounding the Polish coast were

general and limited mainly to short communications. Therefore, the chief goal of the study carried out over my guidance with the cooperation with the National Marine Fisheries Research Institute was to recognize in detail: (i) occurrence, abundance and spatial distribution, and (ii) population structure of *C. pengoi* (including developmental stages, sex and body size) in the Gulf of Gdańsk and in the open water of Polish Baltic coast.

The presented results are an important supplement of the hitherto published data on *C. pengoi*. It is the first complex description of the population in the Gulf of Gdańsk. Furthermore, the paper documents new facts on its expansion in the Polish Baltic zone. It was found that in 2006 *C. pengoi* inhabited the water from the Puck Bay through the stations of Sopot and Świbno profiles to the Krynica profile, and in the open part of the Baltic Sea its range expended into the west direction, to the station located at the latitude of Ustka city (17° 00' 00" E). Biological and hydrological analyses showed that *C. pengoi* occurred from June to August in a broad range of temperature and water salinity values, 2.33 - 23.6ºC and 2.7 - 13.97 PSU, respectively. The data obtained confirm the plasticity of this eurybiontic species. However, it should be noted that if C. pengoi occurs in the Baltic Sea at a broad and stable range of water temperature, it was observed at highest salinity values (14 PSU). Such high salinity as for the species was measured at the station located at most westerly point of *C. pengoi* occurrence in the Polish Baltic water.

Quantitative analyses enabled to state that in 2006 the population of *C. pengoi* was significantly less abundant than in the other parts of the Baltic Sea. Maximum abundance was also 3-fold lower than that observed 7 years earlier in the Gulf of Gdańsk. It could be presumed that in 1999 the abundance of more than 1000 ind./ m^3 was rather a matter of case because for many successive years *C. pengoi* was not observed in this region. Perhaps, it was only an immigrant population. However, this time it was found that in 2006 the population of *C. pengoi* was of stable nature. For the first time, the animals were permanently noted for 9 successive weeks, although this period was shorter as compared to the Riga Bay or the Vistula Lagoon. In the eastern Baltic the individuals of *C. pengoi* appeared in plankton as early as in May, when the water temperature is between 12 and 13ºC. It is interesting that similar and even higher values of water temperature were observed in the Gulf of Gdańsk in June; however, first individuals of *C. pengoi* were noted at the beginning of July. The reasons of such situation are not known so far. However, it is worth to notice that in many papers the authors provide the results of water temperature only for surface water since they consider it

as an adequate parameter for thermophile cladocerans. Taking into account the fact that a new generation hatches from resting eggs after winter hibernation, it is important, however, to monitor thermal conditions also at the bottom. Therefore, in the presented investigations hydrological conditions were monitored precisely at the border of every haul.

The analysis of samples collected in layers showed that in the Gulf of Gdańsk and open water of the Southern Baltic the population of *C. pengoi* inhabited the entire water column, from surface water to 80 m depth. However, the vertical distribution was heterogeneous - the individuals were more often found at a depth above 20 m what could be the evidence of their preferences for shallower water; but also some sites were noted where the highest concentration was observed in the deepest layer. If it was determined that the abundance of *C. pengoi* was positively correlated with temperature, the tendency of this species occurrence above thermocline was not observed, despite of clear stratification in the Gulf of Gdańsk. However, the differentiation of horizontal distribution was noted. In July and August, the highest densities of *C. pengoi* were observed at the stations away from the coast and in the shallowest water, respectively.

Detailed population and biometric investigations demonstrated that in 2006 *C. pengoi* was represented by all developmental (age) stages, so-called barb stage (BS) with different number of spine pairs on caudal process (BS I-III) including partheno- and gamogenetic females, and males. It was found that the composition of *C. pengoi* population changed not only in time. Significant differences were also observed between the stations located in the western and eastern parts of the bay. However, it was evidenced that the majority of the populations was invariably formed by juvenile individuals, and the whole population was dominated by parthenogenetic females what points at high reproductive potential, which maintained the population in water for over 2.5 months. The results of the content of female hatching chambers showed that parthenogenetic females carried up to 11 embryos, and the gamogenetic ones usually 2 resting eggs. Biometric analysis of *C. pengoi* was performed for all spectrum of the population, i.e. every developmental group and the individuals of every sex. Unfortunately, most researches provide only the dimensions of mature individuals and only those could be compared with the results obtained in the presented paper. It was found that the length of mature individuals in the Gulf of Gdańsk, mainly parthenogenetic females, was somewhat higher or similar to those inhabiting the Neva Estuary or the Bay of Riga

Basing on the performed analyses, it could be presumed that the distribution and abundance of *C. pengoi* in the Southern Baltic indicate, for the time being, a relatively early stage of colonisation of this area, in spite of favourable enough environmental conditions. However, it seems that the observed reproductive potential is sufficient to inhabit successfully this part of the Baltic Sea. This presumption could be confirmed by high abundance of gametogenetic females with two resting eggs. It was also observed that the population of C. pengoi is characterized by peculiar specificity evidencing local conditions that will undoubtedly influence the developmental trend of the species in the Southern Baltic in future.

[4b VI]

Bielecka L. Mudrak-Cegiołka S., Kalarus M., 2014, *Evadne anonyx G. O. Sars, 1897 – the first record of Ponto-Caspian cladoceran in the Gulf of Gdańsk (Baltic Sea)*, Oceanologia 56 (1): 141-150. DOI: 10.5697/oc.56-1.141.

The paper describes another introduction of alien planktonic species into the Gulf of Gdańsk. It is the second representative of predatory cladocerans, *Evadne anonyx*, and belonging, similarly as that described earlier, to the Ponto-Caspian fauna. It is a thermophile species occurring in the plankton of its native area at temperature of 11.4ºC - 26.4ºC and broad salinity range from 4 to even 30 PSU.

In the Baltic Sea *E. anonyx* appeared for the first time in the central part of the Finn Bay in 1999. The presented results show that it was observed in the Gulf of Gdańsk not until 2006, when its population started to become more stable. Seven years passed from the first observation of *E. anonyx* in the Baltic Sea to its appearance in the Gulf of Gdańsk. It is worth to notice that it was the same time period as in the case of the expansion of *C. pengoi* range, which has appeared in the Finn Bay in 1992, and in the Gulf of Gdańsk in 1999. Due to the appearance of new species in the Southern Baltic, detailed investigations were carried out aimed at the recognition of: (i) the range of *E. anonyx* in the Gulf of Gdańsk, and (ii) basic characteristics of the populations. Similarly as in the previous paper, this publication is the first one that describes the phenomenon of a new introduction.

On the base of the study, it was found that *E. anonyx* occurred in the Gulf of Gdańsk in July and August. The individuals were sampled at 10 - 13 stations, in 18 of 50 hauls. No specimens were collected at three stations. In the eastern part of the Baltic Sea *E. anonyx* is most abundant in summer (June and July), and first individuals usually appear at the end of

June, or even in May, and are regularly observed to September. Our study show that the cladoceran occurred in the Gulf of Gdańsk for a significantly shorter time period, ca. 1.5 month. Quantitative analysis indicated that the abundance of the population of *E. anonyx* was 0.33-2.0 and 0.11-6.0 ind./m^3 in July and August, respectively. The highest abundance was observed in the eastern part of the Gulf of Gdańsk, in the surface water of shallow water station. Low concentrations of *E. anonyx* are similar to those reported from the Finn Bay at the onset of invasion. Basing on the analysis of the samples collected in layers from the whole water column, it could be stated that the representatives of *E. anonyx* occurred in the Gulf of Gdańsk up to 20 m depth. Hydrological data indicate that in the period of *E. anonyx* occurrence water temperature and salinity values were 10.5 - 23.6ºC and 2.7-7.5 PSU, respectively. Maximum abundance of the animals was noted at 19ºC and 7.2 PSU. The ranges of environmental parameters given for the Gulf of Gdańsk are rather broad as compared to those from other regions of the Baltic Sea. However, it should be remembered that 2006 is the first year of this species presence, and therefore, the results obtained should be treated with caution for the time being.

It was recognized that the population of *E. anonyx* was represented by all developmental stages: juvenile individuals, parthenogenetic females, gamogenetic females and males. The presence of juvenile individuals was observed mainly in July when, at some stations, they were only one element of the population; in August they were observed only once. The analyses showed that, irrespective of abundance, juveniles always occurred in the shallowest water layer, 0-10 m. Population investigations demonstrated that in both summer months parthenogenetic females were present at most stations up to 20 m depth, and they carried 2-9 embryos in their hatching chambers. It was found that gametogenetic females appeared only in August, in the surface water layer. The analysis of their hatching chambers showed that all females carried 2 resting eggs. The observed time differentiation of the population of E. *anonyx* was similar to that described for other regions of the Baltic Sea. However, it should be emphasised that in some Baltic regions, where *E. anonyx* appeared much earlier, most of gametogenetic females carry single resting eggs, and parthenogenetic females possess less embryos. Morphometric analysis of the individuals from the Gulf of Gdańsk demonstrated that their body size is comparable to that of specimens in other parts of the Baltic Sea. However, it should be bear in mind that the biometric data for the Gulf of Gdańsk are so far scarce and include relatively small number of individuals. Therefore, we

should treat them with caution. The presented results clearly indicate that the presence of *E. anonyx* in the Gulf of Gdańsk in 2006 undoubtedly bear signs of initial introduction.

III. Epibiosis and parasitism on planktonic crustaceans

[4b VII]

Bielecka L., Boehnke R., 2014, *Epibionts and parasites on crustaceans (Copepoda, Cladocera, Cirripedia larvae) inhabiting the Gulf of Gdańsk (Baltic Sea) in very large number*, Oceanologia 56 (3): 629-638. DOI: 10.5697/oc.56-3.629.

The paper presents the results of research conducted under my direction, regarding the phenomenon of epibiosis and parasitism on crustaceans in the Baltic Sea.

Crustacea, and among them Copepoda, are one of the most significant components of the zooplankton of all the seas and oceans. In the Baltic Sea the first occurrence of epizoic Protozoa on copepods living in waters of low salinity was reported long time ago. In 1980s a strong "attack" of Protozoa on Calanoida from the Gulf of Gdańsk was noted, which included both overgrowth (*Vorticella* and *Zoothamnium*) and parasitic infestation (*Ellobiopsis*). Since then, there have not been any reports concerning the observation of such phenomena in the Gulf of Gdańsk.

The plankton material was collected in 1998, 1999 and 2006, during all seasons. In the laboratory, the representatives of taxa belonging to Copepoda, Cladocera and Cirripedia, and the development stages (nauplius, copepodite I-V, mature males and females) were determined. The epizoic and parasitic protozoans on crustaceans were identified, the degree of infestations and the localization of protozoans on various body parts were analyzed.

Ciliated epibionts were distinguished into two categories: Peritricha type I - individual organisms or tufts of organisms (like genus *Vorticella*); Peritricha type II - clearly branched colonies (like genus *Zoothamnium*). Such separation was introduced due to the deformation of the body of organisms observed in the preserved material. The epizoic and parasitic protozoans on crustaceans were identified, the degree of infestations and the location of protozoans on various body parts were investigated.

The analyses of the planktonic material revealed the presence of seven taxa of Calanoida and representatives of benthic Harpacticoida, Cladocera and Cirripedia larvae. Among copepods the dominant taxa were *Acartia spp*. and *Temora longicornis*. Epibionts and parasites were noted on various taxa of crustaceans. Overgrown with the ciliated Protozoa

(Peritricha type I and type II) Calanoida (Copepoda) were observed, as were body deformations related to the presence of the parasite *Ellobiopsis*. These organisms were found at all research stations and in all research periods, and constituted more than 10% of all Copepoda.

The current study confirms a relatively large scale of this phenomenon and shows that not only Calanoida are infested by epibionts and parasites. The range of changes observed on the crustacean bodies is very close to the taxonomic structure and abundance of Copepoda in the studied area. In the Gulf of Gdańsk the most common is the genus *Acartia* spp., *Temora longicornis* and *Centropages hamatus*. This may indicate that the most abundant taxa were the most commonly attacked.

Epibiosis and parasitism, in variable range, were observed on adult organisms (females, males), juvenile (copepodit) and larval (nauplii) stages. All of the infestations detected on Copepoda occurred mainly on the prosome including the cephalosome, and rarely on the urosome. Usually up to ⅓ of the animal body surface was overgrown with organisms, and only in several cases they covered more than ½ of the body area.

For the first time representatives of other groups of crustaceans, Cladocera (*Bosmina* sp.), Harpacticoida and Cirripedia larvae (nauplii), have been observed with epizoic and parasitic protozoans. To the authors' knowledge there is no data available on epibiosis on Harpacticoida as well as parasitism on Cladocera or Cirripedia larvae in the Gulf of Gdańsk, although these crustaceans (especially Cladocera and nauplii of Cirripedia) are present there in very high densities and can be dominant components of zooplankton. However, the prevalence of the infection seems to be relatively low for now.

It is worth to mention that he phenomenon of epibiosis and parasitism is widespread in zooplankton community from both aquatic environments, marine and brackish. Both, parasitism and epibiosis are considered harmful for planktonic animals. Overgrowth of epizoic Protozoa can reduce swimming speed in Copepoda, especially when the antennae are heavily infested. Heavy-infested specimens are also more visible to predators, becoming easy prey for planktivorous animals. Parasitism by *Ellobiopsis* sp. has also the potential to reduce the fecundity of copepods .

IV. The principal results of the research evidenced in the cycle of publications presented above:

1. I explored and documented short-term, seasonal, and multiannual variability of zooplankton in the coastal waters of the southern Baltic. My research demonstrates the unusual dynamics of the zooplankton of this region and a local character of this variability. It also provides valuable data regarding the functioning of this group of organisms. I proved that the zooplankton is a sensitive bio-indicator of seasonal and short-term environmental changes. High frequency of field research enabled me to precisely determine the longevity of the occurrence and the time of the domination in the water of particular taxa of the holo- and meroplankton.

2. I demonstrated that very high concentrations of meroplankton occur in the shallow waters close to the shoreline. In these waters, the majority of the larval and juvenile forms of many representatives of the benthic organisms, especially crustaceans and molluscs, live and develop. Therefore, this zone should be treated as a kind of reservoir feeding the entire ecosystem of the Baltic Sea. This area is important for sustaining the continuity of the development of the fauna of the sea bottom and the stability of the functioning of the entire ecosystem. This process is especially essential in a context of the intensification of human impact on the ecosystem of the coastal parts of the Baltic Sea, which can lead to degradation of this ecosystem's sources of life.

3. I initiated research on the introduction of non-indigenous species in the Polish zone of the Baltic Sea. I demonstrated that the southern Baltic became a new habitat for representatives of the Ponto-Caspian plankton: *Cercopagis pengoi* and *Evadne anonyx*. I caught the starting point of their introduction; described the range of their occurrence; defined the new liminal values of temperature and salinity in their new territory; and observed the invasion process. Regarding both of these species, I explored in detail the character and makeup of their populations; determined the fertility of the gamogenetic and parthenogenetic females; and described the biometric features of the local populations. It is worth noting that this exploration reflects the most recent priorities of the European Union, which emphasize the significance of research elucidating the expansion patterns of non-indigenous, and especially the invasive alien, species.

4. I identified the phenomenon of epibiosis and parasitism occurring on copepods belonging to calanoids. I determined the scale of this phenomenon regarding the

character of the changes and the taxa composition of the crustaceans. I also made the first observations of the presence of epibionts and parasites on representatives of other groups of crustaceans, such as benthic Harpacticoida, cladoceran of the genus of *Bosmina*, and meroplanktonic larvae of *Balanus improvises*. This research is especially significant regarding the condition of the infected crustaceans which, as hosts of epiphytes and parasites, can lose their characteristic mobility or the reproductive potential appropriate for the survival and development of their species. It should be emphasized that plankton crustaceans play a key role as a medial link of the trophic web and a basic food source of many invertebrates and fish.

Conclusion

The Baltic Sea has a relatively short geological history, which results in, among others, the open character of this reservoir, characterized by a high number of undeveloped ecological niches. Such niches provide ideal settling grounds for non-indigenous species that find there very limited local competition, which, in turn, boosts their potential for further expansion. The Baltic Sea also belongs to the areas, in which the effects of climate changes are especially evident. This is particularly characteristic of the northern parts of the sea, and is evidenced by the shifts in the range of the occurrence of some species. At the same time, the Baltic is one of the most eutrophicated and degraded environments, in which the condition of the flora and fauna is worsening. Because of the intensification of these negative tendencies, it seems that the exploration of both the naturally-occurring as well as the man-made processes should become a key reference point for forecasting and modeling the future of this sea.

5. Description of other scientific and research achievements

Scientific Achievements (Attachment No 3)

I was a full-time student of the master degree program at the Faculty of Biology, Geography, and Oceanography of the University of Gdańsk in 1983–1988 . I graduated with a Master of Science degree in biological oceanography on September 28, 1988 when I defended my thesis entitled *Distribution of Chaetognatha in selected regions of the coastal and open waters of Antarctica,* which was written under the supervision of Prof. Dr. Hab. Maria Iwona Żmijewska. After graduation, I returned to my hometown of Warsaw for a year, where I worked as a teacher of biology and chemistry at the No. 210 Elementary School. It was then

that I received an offer from Prof. Żmijewska and Prof. Wiktor to return to the university to write a doctoral thesis. Since I enjoyed the nature of scientific research while writing my master's thesis, I decided to return to Gdańsk to study at the Environmental Doctoral Studies of Biology and Oceanography at the University of Gdańsk. I conducted my scientific research in the Department of Marine Biology and Ecology, initially under supervision of Prof. Wiktor, and later under Prof. Żmijewska. I was offered to continue the topic of Antarctic zooplankton, however, this time I was to study crustaceans of the families *Oncaeidae* and *Oithonidae*, which are smaller than Chaetognatha. Since zooplankton had become an object of interest for me during my studies, I gladly accepted the challenge. I was hired by the Institute of Oceanography in 1993 as an assistant in the department where I began working on my doctoral thesis. On November 18, 1996 I was awarded a doctorate in Natural Sciences in the field of oceanography for my doctoral thesis entitled *Cyclopoida in selected regions of the Antarctic*, which was completed under the supervision of Prof. Żmijewska. The examining committee comprised Prof. Wiktor and Prof. Dr. Hab. Stanisław Rakusa Suszczewski. At the request of the committee, my doctoral thesis was awarded an honorable mention by the Council of the Faculty of Biology, Geography and Oceanology.

Since my master's work, my scientific interests have focused on the biology and ecology of zooplankton of Antarctic waters, with particular emphasis on population dynamics, life cycles, and methods of environmental adaptation. Initially, I focused on predatory specimens of the phylum Chaetognatha, later I started working on the then poorly identified and relatively scantily described copepods Cyclopoida (*Oncaeidae*, *Oithonidae*). This new task proved to be very demanding. Cyclopoida are much smaller organisms than the frequently described copepods of the genus Calanoida. As they are crustaceans, their identification is not simple; it requires knowledge of many specific characteristics and extraordinary precision. In addition, these animals have a complex development cycle in which different types of larvae and juvenile forms occur. Because to this, analyzing Cyclopoida is a tedious, time-consuming and labor-intensive process. I conducted identifications in this field under the supervision of Prof. Żmijewska, but I also consulted them with Dr. Cornelia Metz of the Alfred Wegener Institute (AWI) in Bremerhaven, Germany. The main objective of my doctoral thesis was identifying the species composition of Cyclopoida in different regions of the Southern Ocean (Bransfield Strait, Croker Passage, and the Scotia Sea) and in different seasons; tracing the variation of the quantitative distribution of individual taxa, identifying their environmental preferences, and determining

the age structure of the dominant species. The results of these studies show that Cyclopoida are a vital component of the testaceous plankton in neritic zones of the Antarctic, forming much larger concentrations than other organisms. I concluded that both cosmopolitan and endemic species are found among them, and I also verified the species composition in relation to the most recent taxonomic research. There are two groups of species that are characteristic of particular basins, as well as seasons. I also demonstrate that at both the species and family levels, what typifies Cyclopoida is its desynchronized development and distinct spatial separation. Years of work on these crustaceans resulted in my doctoral thesis, three publications (two pre-doctoral and one post-doctoral) that appeared in peer-reviewed journals, as well as a paper presented at the 20th Polar Symposium. During this time, I also prepared and published two peer-reviewed studies on the Antarctic Chaetognatha.

Having earned my doctorate in February 1997, I was appointed the position of assistant professor in the Department of Marine Biology and Ecology. I have worked on the team led by Prof. Dr. Hab. M. I. Żmijewska since then. The department's structure had changed over time; it is currently called the Department of Marine Plankton Research. I worked as an assistant professor until September 2010, following that I was appointed the position of senior lecturer, which I continue to hold until now. I spent six months in 2012 and 2013 on sick leave.

My post-doctoral scientific activities have involved several thematically diverse areas, but they were focused entirely on research in the field of planktology. On one hand, thanks to gaining access to the extremely valuable and unique samples collected in Antarctica, which were in the possession of Prof. Żmijewska, I was able to conduct extensive research on the zooplankton of the polar regions. On the other hand, the activity of the entire team at the department, as well as my own, allowed me to gradually begin to assemble resources and set in motion a mainly independent research path, focused generally on the metazooplankton of the Baltic Sea.

The exploration of pelagic fauna of the Antarctic had initially become the dominant subject of my scientific activities. Despite the extensive Polish and foreign research in this field, the literature of the corresponding research literature could not provide sufficient information on the nature of qualitative-quantitative, population, trophic and behavioral dependencies. Due to the fact that the ecosystem of the Southern Ocean is distinguished by enhanced dynamics and severity of environmental conditions and the pelagic zone undergoes

especially high dynamics in seasonal events, work in these regions provided a wide range of research opportunities. Thanks to the cooperation coordinated by Prof. Żmijewska, along with Stanisław Rakusa-Suszczewski from the Department of Antarctic Biology, Polish Academy of Sciences, and Prof. Dr. Hab. Wojciech Kittel from the Department of Polar Biology and Oceanology, University of Lodz, I was able to study samples collected at a station located in the Admiralty Bay near the Henryk Arctowski Polish Antarctic Station. Thanks to the diversity of the zooplankton species composition and the nature of the processes which occur there, the coastal region of the Antarctic is particularly well-suited for taxonomic and ecological studies. Specifically, Admiralty Bay is the perfect place to study the functioning of the local pelagic fauna, because of its distinct shelf nature, including high variability caused by local factors (e.g., intensive water mass circulation, snowmelt runoff during the summer which alters the environment of the bay). By complying with these opportunities and challenges, along with Prof. Żmijewska as part of the CS-EASIZ program, I carried out research on Copepoda (Cyclopoida and Calanoida) and Chaetognatha. I analyzed the time-spatial differentiation of the leading species. I tracked population and age structures, as well as individual variation in the context of short-term and seasonal changes. It should be noted that the planktonic material for research was collected with great frequency, considering the conditions of the Antarctic, and included not only material from the most common summer season, but also the remaining months of the year. At this time, along with Prof. Żmijewska, I cooperated with the Atlantic Research Institute of Marine Fisheries and Oceanography AtlantNIRO in Kaliningrad (Russia) in the exchange of identification experiences and plankton materials. Subsequently we began to work with Dr. Sławomir Kwaśniewski and Wojciech Walkusz, MSc., from the Institute of Oceanology PAS in Sopot to develop together resources for comparing the neritic Arctic and Antarctic ecosystems. In recent years, I was invited by the P. P. Shirshov Institute of Oceanology of the Russian Academy of Sciences to commence collaboration; this was instigated by Dr. Hab. Prof. UG Natalia Gorska. In late 2010 and early 2011, I participated in a scientific expedition, the Polish part of which was co-organized by me. I was also responsible for the preparation of the detailed plan and scope of the research. The goal of the expedition was to study large-scale phenomena occurring in the region of the Atlantic Ocean, along transects South Africa-Antarctica and Antarctica-South America (Drake Passage). During the research cruises, in cooperation with Prof. Dr. Hab. Maciej Wołowicz and Dr. Anna Panasiuk-Chodnicka, we collected very rich, valuable planktonic material. It was used for further studies, which due to the research capacity

continue to this day. This time I focused on a much broader taxonomic spectrum: I analyzed Protozoa, a large group of Entomostraca (Calanoida, Cyclopoida, Ostracoda), Chaetognatha, and meroplankton. In the field of Antarctic meroplankton (from the Admiralty Bay), I also work with Dr. Hab. Prof. IO PAS Piotr Kukliński. In 2012, I was also invited to work with Dr. Hab., Prof. IO PAS Katarzyna Błachowiak-Samołyk on the effectiveness of catching Arctic zooplankton with the use of a variety of plankton nets (research being finalized for publication). In conclusion, the years of my work in the field of planktology of polar waters resulted in the publication of eight papers in peer-reviewed, international journals; the preparation of 15 presentations at Polish and international conferences; obtaining funds for individual research at UG for eight projects managed by myself. In addition, I served as the principle investigator on one UG project and one project funded by the Ministry of Science and Higher Education, and cooperated with two international projects.

Shortly after receiving my doctorate, my research activity expanded to include new topics related to the functioning of coastal ecosystems of the Baltic Sea. I initiated my research with a meticulous qualitative analysis of metazooplankton. This time, I was interested in the entire taxonomic and population spectrum of organisms belonging to holo- and meroplankton. Therefore, in order to obtain the necessary skills in the identification of species and their associated developmental stages, I spent a considerable amount of time on gathering the necessary literature, and on work in the laboratory at the microscope. At the time, the department where I worked had gathered years of planktonic material, which was used for observation and research. The subsequent decision that I made was to plan, organize, and coordinate the research of short-term zooplankton variability in the water-land contact zone. Such research seemed to me interesting and innovative, since monitoring in Gdańsk Bay at the time was conducted far from the shore, with a frequency of, at the most, once a month. We found that the aforementioned research provided a lot of interesting information on the subject of the character and dynamics of the organisms inhabiting this zone not only in the short term, but also among seasons and annually.

Many opportunities for co-operation and participation in research led by others appeared, because I had become very well-oriented in the field of planktology, with extensive experience in identification. Among other opportunities, I was invited to conduct the final development and summary of interdisciplinary research conducted by Dr. Hab. Maria Szymelfenig on bio-physico-chemical changes in the upwelling zones occurring along the Hel

Peninsula. I also participated, as principle investigator, in a ministerial research project by Dr. Hab. Prof. IO PAS Lidia Dzierzbicka-Głowacka, on the subject of creating a mathematical model tasked with determining the seasonal dynamics of phytoplankton and mesozooplankton in the Gdańsk Bay. At this time I also applied for funding for my own research, the subject of which had evolved. The next task that I put myself to, was to study the phenomena of fouling and parasitic infestation of Baltic copepods, which I had been noticing for years with varying intensity. I could see the rationale for such research in the fact that in an era of intense socio-economic changes, which directly interfere with the natural environment, new threats, such as, eutrophication were revealed. With the use of my own resources, as well as, archival resources located at the department, I initiated and coordinated research on the changes affecting copepods. This research provided much interesting, new information on the scale of the phenomenon (not only copepods were affected), the degree of fouling of different species and developmental forms, as well as the type of epizoites and parasites. Because such changes are considered as unfavorable for plankton, debilitating the condition, and even leading to the death of the organisms, the knowledge gained during the research is not only of scientific, but also of practical value. Similar importance can be attributed to the subsequent studies, which I undertook and conducted to a large extent independently concerning the introduction of alien species and their expansion in the southern part of the Baltic Sea. With successive, annual collection of planktonic material from waters of the Gdańsk Bay, we were able to observe the appearance of two allochthonous species in the basin, whose native habitat is the Ponto-Caspian region. These include representatives of the predatory cladocerans, *Cercopagis pengoi*, which first appeared in 1999, and *Evadne anonyx* recorded seven years later in 2006. The highly detailed analyses I conducted, allowed the preparation of new information about the life of these species, in the subsequent basins of the Baltic Sea they inhabited. I identified the fundamental environmental parameters determining their occurrence in the Polish zone of the Baltic and the boundaries changing during their expansion. I also described the local nature of their populations, the specificity of distribution, and the range of horizontal and vertical occurrence. The knowledge acquired from this research provides further information on the adaptability of introduced species, and the extent of the phenomenon of bioinvasion in the Baltic Sea. Most of these studies, and the results obtained, resulted in scientific publications that comprise the *habilitacja* dissertation submitted for assessment. The summarized results of many years of my studies for the better understanding of the functioning of zooplankton in the Baltic, within the scope of natural and anthropogenic

environmental changes, is published in 11 original research papers in internationally recognized journals. The research was made possible, in part, thanks to funding I acquired through four University of Gdańsk grants which I directed as part of individual research, and one three-year research project funded by the Ministry of Science and Higher Education. The results of my research were also presented at 26 Polish and international symposiums and conferences. I also participated in additional training courses on the identification of zooplankton and statistical analysis of results of biological development. Many years of gradual acquisition of knowledge and skills required to work on such a diverse group of organisms that are marine zooplankton, enabled me to develop my own research techniques and, through acquired financial resources, the creation of a well-equipped laboratory. I always tried to share my experience with other scientists, often being their teacher at the initial stage of their work. I also gladly invited young students to scientific cooperation, often realizing with them parts of my individual research topics.

My research activity is constantly evolving, but I remain faithful to the specialization I chose many years ago. Today, I continue to work on the expansion of alien species, tracing and analyzing the subsequent years of their occurrence or temporary absence. I am also involved in working with the P. P. Shirshov Institute of Oceanology of the Russian Academy of Sciences in the field of comprehensive studies of the Baltic Sea, and in the international research project BALSAM (Baltic Sea Pilot Project: Testing new concepts for integrated environmental monitoring of the Baltic Sea), the Polish contribution of which is coordinated by Dr. Hab., Prof. UG Monika Normant. I also continue research on Antarctic zooplankton, summarizing the analysis taken from the trials collected during the aforementioned expedition with my participation. Recently, I compiled the results of the research on Chaetognatha of the Admiralty Bay (manuscript in the review in the Polish Polar Research; PPRes 83 07A). The combined experience, gained from scientific and didactic work, has recently given me the opportunity to prepare a handbook for students on the biology, reproduction, and development of marine fauna (work in press).

In total, my accomplishments comprise 26 original research papers published in English, 20 of which are currently indexed by the Institute for Scientific Information. I presented the results of my research at numerous conferences and symposiums, being the author or co-author of 36 papers and posters. My work has been recognized and appreciated

by the university; I was twice awarded the Team Award of the Rector of UG and received the Polish state distinction of The Silver Cross of Merit.

The total impact factor (IF) for the years 2006-2014, in which most of the journals had already been indexed, is 6.867, the number of MNiSW points, according to the date of publication is 142.

Summarizing my accomplishments in accordance with the current state of journal indexation, IF=16.629, the number of MNiSW points is 372.

According to the SCOPUS database: H=5, the number of citations is 83.

Teaching And Popularization Achievements

Since the start of my work in the Institute of Oceanography, my teaching activity has been done in different ways. At the beginning, working at the position of the assistant in 1993-1996, I taught the students of Oceanography field only laboratory and field courses, gaining the experience under the guidance of prof. Krystyna Wiktor and prof. Iwona Żmijewska. Since 1997, after getting my Ph.D. and taking up the position of the adjunct, the spectrum of my courses has been significantly expanded. I have started to prepare original lectures within the courses "Biology of marine fauna", and then "Basics of marine fauna biology". In 1997-2014, my teaching duties included the courses within Oceanography, Environment Protection and Nature fields, in full- and part-time Master's degree studies (5- and 2-years), Bachelor's degree studies (3-years), and Post-graduate studies. The number of my yearly teaching hours frequently exceeded the standard. My teaching achievement included, among others, the preparation of contents and materials, and conducting of a dozen or so courses. I am the author of original programmes for three Oceanography courses (lectures and classes for Bachelor's and Master's degree students), and co-author of the programmes for eight other courses within Oceanography and Environment Protection fields (Attachment No 4.1).

I also conducted the courses for foreign students in English. In 2004, within the Erasmus programme, I organized the course "*Biological oceanography*" for students from Portugal. In 2007, I was asked by Umeå Marine Sciences Centre (Sweden) to prepare an original course on the identification methods of Baltic zooplankton. I conducted the course at marine station in Umeå (Attachment No 4.1).

I was also very active in taking care of diploma works, i.e. preparing students to diploma works, planning their experiments, organizing their place for work. In 1997-2012 I was the supervisor of 24 Masters of Science in Oceanography and Environment Protection fields. I have also prepared over 20 reviews of Bachelor's and Master's diploma works in the above fields (Attachment No 4.1). For many years (1998-2005) I was a tutor for 1st year students of Oceanography and students' protector in Oceanography and Environment Protection fields (Attachment No 4.2).

Thanks to the teaching skills I have gained, I was engaged in a variety of educational and popular science activities. I organized classes on marine biology for secondary schools in Gdynia. I have prepared "*Oceanographic workshop for the youth*" - the educational project for secondary schools in Pomerania region that has been realized by the Institute of Oceanography, University of Gdańsk since 2010. Within the above project, I have conducted my own subject "*Zooplankton - fascinating and unknown world of seas and oceans*". I was also asked to be an essential advisor for the translation of the book „*Oceans the Macmillan Visual guide*" by Hutchinson and L. E. Hawkins, and two parts of documentary natural films for Planete TV. Preparing educational materials and serving at the faculty stand, I was taking an active part in many editions of Baltic Science Festival (Attachment No 4.2).

My various teaching activities contributed to close cooperation with Oceanography students. In 2007, on students' application, for my outstanding teaching achievements I was honoured by the Rector of the University of Gdańsk with the prestigious 2nd degree prize named after Krzysztof Celestyn Mrongowiusz. A year earlier, I was distinguished with the Commission of National Education Medal (Attachment No 4.4).

Organizational Achievements

Having obtained Ph.D. degree, I have tried to take a very active part in the works to the benefit of the Institute of Oceanography, Faculty of Oceanography and Geography (formerly the Faculty of Biology, Geography and Oceanography), and University of Gdańsk (Attachment No 4.3 A&B). My organizational activity was twin-track. On one hand, it was directly connected with the organization and quality of teaching in the Institute of Oceanography, and on the other one; it was related to the functioning of institute, faculty and university as a whole. Within this activity, in 1996-2014, I took various positions and fulfilled different duties. For two terms of office (in 2005-2008 and 2008-2012) I held very responsible and challenging position of Vice Director for Teaching Affairs in the Institute of

Oceanography. It was the period of fundamental changes in teaching systems - firstly, the entry into the Bologna Process and the implementation of Teaching Standards, and secondly, the adaptation of teaching programmes to the National Qualifications Framework (NQF).

This was connected with general reorganization of study schedules and programmes. At the same time period, there was also a need for the modifications of teaching programmes resulting from the current orders of University authorities. High dynamics of changes in teaching process forced me to develop from the bases new procedures, mechanisms and principles in teaching management and functioning, and practices to make these activities more efficient. In such situation, I was obliged for a permanent increase in my professional qualifications. Therefore, I took part in many trainings and courses on the development of academic education (REA) that were organized by the University of Gdańsk.

As the Director for Teaching Affairs, I took active part in the preparation of materials for two important events in the University of Gdańsk, i.e. University Accreditation Committee (2007) and Polish Accreditation Committee (2012). I have made a substantial contribution to the preparation of so-called reports of self-esteem, faculty strategy or teaching concept. The both Committees appreciated the high quality of education and organization of teaching process, and awarded the highest grades to the Institute of Oceanography and the Faculty of Oceanography and Geography. I was also responsible for the admission of student candidates. I exercised permanent supervision over the principles and process of admission, among others functioning of admission committees. On two occasions, I was the chair of Faculty Admission Committee. The admission process was connected with the preparation of information leaflets and annual organization of Akademia fairs where I presented the educational offer of the Institute of Oceanography. Many times I took part in Baltic Science Festival and prepared educational projects promoting the Institute and study fields - as I gained external financing, it was possible to organize classes for schoolchildren and to buy necessary equipment. I also supported the board of the institute directors in other activities, e.g. the project of the new training-research vessel construction (Attachment No 4.3 B).

Moreover, for many years I worked in many different institute, faculty and university committees. I was a chair of the Committee for National Qualifications Framework in Oceanography field, member of the University Admission Committee, secretary and member of the Faculty Admission Committees, member of the Faculty Committee for Teaching Quality Assurance, member of the Faculty Council, member of the Institute of Oceanography

Council, member of examination committees for diploma exams, syllabus coordinator etc (Attachment No 4.3 A&B).

I always tried to be at students' disposal - all the time I have closely cooperated with students and encouraged them to be engaged in the institute and faculty affairs. The students actively cooperated with me in developing new study programmes adapted to National Qualifications Framework - they co-created the programmes and gave their opinions on them. My work at the position of the Vice Director for Teaching Affairs was highly appreciated by the authorities of the University of Gdańsk. In 2012, in recognition of my organizational achievements and very positive contribution to the improvement of teaching quality in the Faculty of Oceanography and Geography, I received the individual 1st grade prize awarded by the Rector of the University of Gdańsk (Attachment No 4.4).

Apart from the duties resulting from my activity as the Vice Director for Teaching Affairs, in 2000-2001 I coorganized the National Scientific Conference "*Oceanography - from the knowledge to practice*" and the 3rd International Symposium on Functioning of Coastal Ecosystems in Various Geographical Regions in Gdynia, and in 1998 and 2003 - Akademia fairs (Attachment No 4.3 C).

In 2009-2010, within the cooperation with the P.P. Shirshov Institute of Oceanology, Russian Academy of Sciences, I took an active part in the organization of two international scientific expeditions. The first of them was focused on the research on subtropical and Antarctic regions, and the second one was conducted in the Gulf of Gdańsk and the central Baltic Sea (Attachment No 4.3 D).

In recent years I was invited to review scientific manuscripts for such foreign journals as Hydrobiology and Aquatic Invasions (Attachment No 4.3 E). Since 2003 I have been a member of several polish and foreign scientific societies, among others the Committee of Sea Exploration (2003-2006), Polish Hydrobiological Society, World Association of Copepodologists (WAC) and Estuarine Research Federation (ERF). I am also engaged in the works on expert databases for the spread and functioning of alien species in Poland and in the world. I am a member of some scientific nets, e.g. MarBef. (Attachment No 4.3 F).

For the entirety of my work, I was awarded by the President of the Republic of Poland with Silver Cross of Honour (2001) and Silver Medal for Long Service (2012) (Attachment No 4.4).

Inna Bielecka